

Pedestrian Safety Program Strategic Plan

FINAL Background Report

Submitted By:

UNC Highway Safety Research Center
Westat
VHB

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TABLE OF CONTENTS

List of Figures	iv
List of Tables	v
Executive Summary	1
Project Purpose	1
Project Methodology	1
Results and Discussion	2
Pedestrian Safety Issues: Past, Present, and Future	2
Key Research Gaps	3
Collaborative Research Opportunities	5
Disseminating Information and Technology Transfer	6
Conclusion and Next Steps	7
Introduction	8
Project Background	8
Project Goal and Objectives	8
Project Study Design	9
Methodology for Evaluating Existing FHWA Products	9
Methodology for Stakeholder Participation	11
Pedestrian Safety Concerns in the U.S.	13
Factors Related to Pedestrian Crashes and Fatalities	13
Age	14
Gender	14
Vulnerable or Overrepresented Groups	15
Alcohol	15
Vehicle Speed	15
Other Factors	16
Common Crash Types	17
High Crash States and Cities in the U.S.	17
Crashes in Rural Versus Urban Areas	19
Crashes by Road Type	20
Future Demographic, Social, and Policy Changes	21
Aging Population	21
Immigrant Population and Population Growth	22
Other Demographic Trends	23
Development Trends	23
Travel Trends	24

Policy and Funding Changes	25
Literature Review.....	28
Previous FHWA Initiatives.....	29
Existing FHWA Safety Mission and Goals	30
Existing Research Agendas from Federal Agencies	31
AASHTO’s Strategic Approach to Safety Tactical Roadmap	32
NHTSA Pedestrian Safety Research Agenda	33
TRB Pedestrian Committee Research Needs Statements	35
APA Projects Related to Pedestrian Research	36
Results and Discussion	36
Key Findings from Data Analysis.....	36
Key Pedestrian Safety Issues	37
Key Findings from Literature Review	40
Gaps in the Data Available for Pedestrian Safety Research	40
Gaps in the Research Literature	43
Collaborative Research Opportunities	50
Product Delivery and Technology Transfer.....	51
Key Findings from Stakeholder Input.....	53
Respondent Characteristics	54
Familiarity and Recent Usage	55
Ease of Use, Usefulness, and Strength of Impact	57
Knowledge Gained, Important Future Role, and Sharing.....	60
Sharing and Product Delivery Methods	62
Miscellaneous Product Comments.....	63
Overall Conclusions from Product Evaluation	63
Technology Transfer	64
Limitations of the Study.....	65
Recommendations for Future Activities	65
References	66
Appendix I: FHWA Product Evaluation Survey	88
Appendix II: FHWA Product Evaluation Survey Results	121
Respondent Characteristics.....	121
Familiarity, Recent Usage, and Types of Use.....	121
Miscellaneous Product Comments.....	123
Appendix III: Stakeholder Participants in Workshop I.....	134
Appendix IV: Workshop I Discussion Questions	135
Discussion I: Vision, Goals, and Measurable Objectives of the Strategic Plan	135

Discussion II: Prioritizing Recommended Research Initiatives and Activities	135
Discussion III: Other Elements of the Plan.....	136
Appendix V: Literature Review of Publications and Guides.....	137
Problem Identification and Data Collection	137
Analysis and Decision-Making Tools.....	145
Development and Evaluation of Countermeasures	150
Research Compendiums.....	150
Intersections	153
Midblock Crossing.....	156
Transit and Multimodal.....	158
Lighting and Nighttime Issues	158
Speed Management, Traffic Calming, and Roadway Design.....	159
Pedestrians with Disabilities	160
Enforcement.....	161
Education	161
Other	162
Product Delivery and Technology Transfer.....	164
National Guides	164
State/Local Guides	167
Training Courses and Workshops.....	167
Webinars	169
Conferences.....	169
Newsletters.....	170
Software	171
Selected International Research and Reports.....	173

LIST OF FIGURES

Figure 1. Model for the Development of the Strategic Plan.	9
Figure 2. Long-term Pedestrian Fatality Trend.....	13
Figure 3. Long-term Pedestrian Injury Trend.	14
Figure 4: Pedestrian Injury Severity Based on Vehicle Speed.	16
Figure 5. Federal Pedestrian and Bicycle Funding Trends.	27
Figure 6. Percent of Respondents Familiar with Product/Deployment.	55
Figure 7. Percentage of Respondents Who Used Product/Deployment in Last Three Years.....	56
Figure 8. Average Reported Score for Ease of Use of Product/Deployment.	57
Figure 9. Average Usefulness Score for Recently Used Products/Deployments.	58
Figure 10. Average Safety Impact Ranking as Perceived by Recent Users of Products/Deployments.	59
Figure 11. Percent of Recent Users Who Felt the Product/Deployment Gave them Helpful Knowledge.	60
Figure 12. Percent of Recent Users Who Felt Product/Deployment Will Play Important Future Role.	61
Figure 13. Percent of Respondents Who Shared Product/Deployment.	62

LIST OF TABLES

Table 1. FHWA Products Evaluated.....	10
Table 2: Participating Stakeholders	12
Table 3. Alcohol Involvement by Road User.	15
Table 4. Common Pedestrian Crash Types.....	17
Table 5. States with Highest Pedestrian Fatalities in 2008.....	17
Table 6. States with Lowest Pedestrian Fatalities in 2008.....	18
Table 7. Cities with Highest Pedestrian Fatalities, 1997-2006.....	18
Table 8. States with Highest Pedestrian Fatality Rates in 2008.	18
Table 9. States with Lowest Pedestrian Fatality Rate in 2008.....	19
Table 10. States with Highest Average Pedestrian Fatality Rate, 1997-2008.	19
Table 11. States with Lowest Average Pedestrian Fatality Rate, 1997-2008.....	19
Table 12. Pedestrian Fatalities and Injuries by Road Type, 2008.	21
Table 13. Cities with Fastest Growing Immigrant Populations, 2000-2007.	23
Table 14. Ten Fastest Growing U.S. Metro Areas, 2007-2008.	24
Table 15. Ten Fastest Losing U.S. Metro Areas, 2007-2008.	24
Table 16. Top Ranked Research Need in Each Plan Category.....	54
Table 17. Product/Deployment Usage in the Last Three Years (Percentages).....	122

EXECUTIVE SUMMARY

Project Purpose

Pedestrian injuries, fatalities, and accessibility continue to be a serious concern in the United States. A data-driven Strategic Plan is needed to identify gaps in existing research, resources, and deployment and prioritize short- and long-term activities that the Federal Highway Administration (FHWA) can undertake to improve pedestrian safety over the next 15 years. This Background Report provides the knowledge base behind the Strategic Plan and documents the activities and findings of the project that support the development of the Plan.

Project Methodology

To develop the Background Report underlying the Strategic Plan, the project team utilized four main sources of information: 1) a data analysis of pedestrian crash and walking trends and expected demographic changes, 2) a literature review of recently published pedestrian safety research and resources, 3) an evaluation of existing FHWA products and dissemination strategies, and 4) stakeholder feedback and expert opinion on research and information needs to advance pedestrian safety efforts. The methods/process for each of these is as follows:

1. **Data analysis:** This was based on a secondary review of several information sources, including the National Highway Traffic Safety Administration (NHTSA) data, published reports that examined Fatality Analysis Reporting System (FARS) and National Household Travel Survey (NHTS) data, Census data, and others. The analysis synthesizes pedestrian safety and demographic trends such as: pedestrian crash and fatality trends (including age, gender, alcohol-involvement, vehicle speed, etc.); crash types and crash locations; future demographic, social, and policy changes (including aging, population growth, development and travel trends, and policy and funding changes at the national level, etc.).
2. **Literature review:** An extensive literature review was conducted to identify key findings and gaps in pedestrian safety research. The literature review included an examination of nearly 200 journal articles, comprehensive studies, broad-based syntheses, pedestrian design technical references, and meta-analyses of the pedestrian safety research literature for the years 2000-2008. The research was organized into four major topic areas: 1) problem identification and assessment, 2) analysis and decision making tools, 3) development and evaluation of countermeasures, and 4) product delivery and technology transfer. The review also included a synthesis of existing national research agendas from relevant organizations, as well as a review and critique of existing national data sources that supports research on pedestrian safety issues.
3. **Evaluation of existing products:** Westat performed an independent evaluation of 17 existing FHWA products by conducting a targeted web-based survey of 478 people, followed by more focused telephone interviews with 85 respondents. The questions covered issues such as: user demographics, product usage, ease-of-use, impact and importance of the product in addressing pedestrian safety issues, and how professionals

prefer to receive information. This information was useful in guiding the recommendations for future technology transfer and product deployment.

4. **Stakeholder feedback and expert opinion:** A one-day stakeholder workshop was conducted in December 2008 to solicit input on needed research and research priorities from a diverse group of stakeholders and pedestrian safety experts. Stakeholders received background information on pedestrian safety trends and research findings before the meeting. During the meeting, a series of break-out sessions were held to discuss the vision and goals for the plan; identify and prioritize research needs; and brainstorm plan implementation challenges and solutions. After the breakout sessions, a list of research topics discussed was compiled, ranked by each stakeholder, and used to identify critical research needs to be included in the Strategic Plan. A complete list of stakeholder participants can be found in Appendix III.

Results and Discussion

Pedestrian Safety Issues: Past, Present, and Future

A big picture review of pedestrian crash trends, walking patterns, and future demographic changes revealed four key areas of need for pedestrian safety research and technology transfer, as well as opportunities with the highest potential to reduce pedestrian crashes. The findings include the following, which are described in detail in the full report:

1. Funding research on understanding the needs of older pedestrians and developing planning and design best practices for accommodating older pedestrians will be critical as older pedestrians are a quickly growing demographic group already overrepresented in pedestrian crashes and fatalities.
2. More knowledge is necessary regarding the epidemiology of crashes involving immigrant pedestrians, who are often overrepresented in pedestrian crashes, and which educational, enforcement, encouragement, or environmental/engineering solutions are effective in reducing these crashes. With the large expected growth of this population in coming years, research and development related to this demographic group will likely have a high payoff for improving pedestrian safety nationwide.
3. Currently, 73 percent of pedestrian fatalities occur in urban areas, and America's rapid urbanization will likely lead to more pedestrian crashes occurring in urban areas in the next 15 years. With rapid metropolitan growth and historically high pedestrian crash frequencies and rates, states in the South and Southwest should be targeted for technology deployment.
4. Within urban areas, the majority of pedestrian fatalities occur on arterial roads. High-speed, high-volume multilane arterial roads have long been known to be a problem for pedestrians; this concern is only expected to rise as communities continue to place bus stops and other pedestrian attractors along these facilities. A focus on research to examine

and improve pedestrian safety when crossing and when walking along multilane arterial roads will likely have a wide application to addressing pedestrian crashes in the future.

Key Research Gaps

Research gaps were identified by reviewing a wide selection of published literature on pedestrian safety and by gathering input from pedestrian safety experts and key stakeholders. Overwhelmingly, the issues identified by the experts and the literature review were supported by the pedestrian trends identified in the above section, suggesting that all of research needs identified have a high payoff potential for reducing pedestrian crashes in the long run. The key research gaps identified (in no particular order) include:

A. Problem Identification and Data Collection

1. Evaluation on MUTCD Devices for Vulnerable Pedestrians (Topic: Research on older pedestrian crash trends and issues related to aging (including sight/hearing/mobility loss) that can be addressed through changes to the built environment)
2. Understanding Diverse Vision Needs of Pedestrians (Topic: Research on pedestrians with diverse vision needs including safety studies, sight-impaired pedestrian behavior, and best practices in facility design)
3. Race/Ethnicity Evaluation for Pedestrian Morbidity and Mortality (Topic: Research on the socio-economic factors related to pedestrian crashes, including low-income pedestrians and recent immigrants, and what countermeasures are most appropriate)
4. Evaluating Methods for Collecting Pedestrian Exposure Data (Topic: Research to collect and evaluate sources of pedestrian exposure data and develop recommendations for a national source for exposure database, as well as recommendations for collecting data)
5. Automated Pedestrian/Vehicle Conflict Video Data Collection (Topic: Research on the use of video data collection to detect, measure, and evaluate pedestrian/vehicle conflicts and the accuracy compared to human observations)
6. Evaluating of Automated Pedestrian Detection Technologies (Topic: Research testing the accuracy and effectiveness of automatic pedestrian detectors to 1) detect pedestrians to activate pedestrian signals (and minimize false calls and missed calls) and 2) to count pedestrians and measure walking levels along a street or crossing a street)
7. Effect of Hand-Held Communication Device Use on Pedestrian Safety (Topic: Research on pedestrian and driver distractions including the use of mobile telephones and mp3 players to explore 1) the relationship between pedestrian and driver distraction and pedestrian safety and 2) how to collect this data most effectively)
8. Methods to Improve Physical Conditions for Pedestrians along Existing Roads (Topic: Research examining non-vehicle related pedestrian safety issues (including facility maintenance) and recommendations for collecting data)

B. Managing Safety Through Analysis and Decision-Making

9. Identification and Prioritization of High Pedestrian Crash Locations/Areas (Topic: Research to generate best practices in pedestrian problem area identification (including the use of GIS, crash data, and land use data) and prioritization to assist practitioners in accurately and systematically identifying pedestrian risk areas that

- could be pro-actively treated)
10. Using National Exposure Data to Examine the Relationship Between Pedestrian Exposure and Safety (Topic: Research using national exposure data to better explore the relationship between pedestrian exposure and safety)
 11. Identification and Use of Pedestrian Facility/Safety Funds (Topic: Research that explores how communities can obtain, allocate, and use transportation funds in an efficient and effective manner, and how funding levels relate directly or indirectly to pedestrian safety outcomes)
 12. Relationships Between Land Use, the Built Environment, and Pedestrian Safety (Topic: Research on the relationship between land use/the built environment and pedestrian safety)

C. Innovative Research and Evaluation

13. Cost-effective Retrofits for High-Speed Multilane Arterial Roads for Pedestrians (Topic: Research on how to cost-effectively retrofit high-speed multilane arterial roads, and how to balance safety improvements with other tradeoffs, such as operational effects of lowering speeds or traffic volume)
14. Effects of Traffic Signals on Pedestrian Behavior and Safety (Topic: Research on the effects of cycle length and signal phasing on pedestrian behavior (including yielding) and other transportation issues (such as congestion and red-light-running, etc) and guidance for helping to address pedestrian safety issues at signalized intersections)
15. The Effect of Roadway Features on Pedestrian Crashes on Urban and Suburban Corridors (Topic: Research on roadway design and other factors of the built environment that influence a motorist's decision to yield to pedestrians (especially in urban areas), as well as countermeasures (such as traffic calming policies) to improve driver yielding behavior)
16. Develop Guidelines for Pedestrian Midblock Crossings (Topic: Research on the locations of crossings based on site-specific characteristics (including block length, location of pedestrian generators, pedestrian and vehicle volumes, other pedestrian facilities, etc) to improve pedestrian safety at mid-block crossings)
17. Pedestrian Crash Reduction Factors (Topic: Research identifying additional Crash Reduction Factors (CRFs) and contextual factors related to treatment effectiveness, including innovative technologies such as the HAWK signal and Rectangular Rapid Flash Beacon)
18. Accessible Pedestrian Signals (Topic: Research on APS devices, specifically the impacts and benefits for non-disability users, guidance on maintenance audits and protocol, as well as guidance on where APS devices are most beneficial and should be prioritized, or where fixed-time operation should be used)
19. Best Practices and Pedestrian Safety Concerns Related to Transit Access in Urban Areas (Topic: Research on 1) pedestrian safety concerns around transit (including bus stops, light and heavy rail, and streetcars), around at-grade rail crossings, and along railways and on 2) best practices related to transit access and increasing transit ridership through pedestrian facility improvement)
20. Research on the Effects of White Lighting in Reducing Pedestrian Nighttime Crashes and to Evaluate Emerging Lighting Technologies in Real World Conditions (Topic: Research to better understand the promise of LED lighting in reducing pedestrian crashes and to evaluate emerging lighting technologies in real world conditions)

21. Effects of New Pedestrian Facilities on Pedestrian Exposure (Topic: Research to evaluate how new pedestrian facilities affect pedestrian exposure data and to determine the increase facility use using before and after case studies of pedestrian facility projects)
22. Increasing the Safety of Interactions Between Pedestrians and Large Commercial Vehicles (Trucks and Buses) in Urban Areas (Topic: Research identifying pedestrian safety improvements with regard to large commercial vehicles, especially in urban areas)

D. Technology Transfer

23. Case Studies of Model City/County Ordinances that Support a Vibrant Pedestrian Network (Topic: Research on pedestrian safety outcomes in the form of case studies as related to pedestrian-supportive policies such as Complete Streets and others)
24. Automobile Parking and Pedestrian Safety: A Search for a Unifying Frame of Reference (Topic: Determine best practices in parking lot design for increased pedestrian safety, gains in urban livability, and sustainability)
25. Best Practices for Pedestrian Facility Maintenance (Topic: Research on best practices for pedestrian facility maintenance)

Collaborative Research Opportunities

In many cases, there are research needs that go beyond the mission and scope of FHWA, but are of vital concern for pedestrian safety. For all research that is more appropriately funded by other organizations, it is recommended that FHWA coordinate with those organizations to discuss pedestrian safety topics and how they can be addressed through collaborative, cross-cutting research and how funded research can incorporate issues that are of interest to FHWA. The Federal Transit Administration (FTA) and National Highway Traffic Safety Administration (NHTSA) have also been involved in pedestrian safety research for some time, making coordination on the development of the Strategic Plan a unique opportunity for inter-agency cooperation. Some key research areas where collaboration opportunities exist include:

1. Research or other efforts aimed at improving the collection process for pedestrian crash data to capture all crashes, more accurately record information, and to include additional data of interest (such as pedestrian or driver distraction); this work should also include a component to better train law officers to investigate pedestrian crashes (and assess fault) as well as understand and enforce pedestrian laws.
2. Research on the level and impact of pedestrian alcohol and drug use on pedestrian crashes, especially serious injury and fatal crashes, and evaluation and guidance for potential countermeasures.
3. Research on pedestrian distractions (such as cell phones or MP3 players) and how they contribute to pedestrian crashes, as well as the impact of driver distractions on pedestrian collisions.
4. Research on school site locations and design issues and how it impacts pedestrian safety, as well as research on education of people of all ages in pedestrian safety.

5. Research on quiet cars/roads and how less sound-based information to make decisions may affect older pedestrians or others with hearing loss or disability (Some research is already being completed on this topic by a research group headed by NHTSA).

Disseminating Information and Technology Transfer

From the evaluation of 17 existing FHWA products and their usage in recent years, there were several findings that provide significant insights into how research products are received/used and what is needed in the future in terms of technology deployment:

1. Familiarity and Usage: Overall, in most cases only about half of respondents who claimed familiarity with a product actually used it in the last three years. Even among transportation professionals who had previously ordered FHWA materials, there appeared to be a widespread lack of familiarity with the many FHWA products available for use. Additional marketing and distribution of these materials is needed with the caveat that some materials are tailored to a specific audience and may not need to be marketed to all transportation professionals.
2. Ease of Use: All products/deployments were rated above the scale midpoint (5) for ease-of-use. The three products/deployments that recent users rated as the easiest to use were those geared for widespread use by a more general audience: Pedestrian and Bicycle Safety Materials for Hispanic Audiences, Walkability Checklist, and Bicycle Safer Journey. In contrast, the most difficult to use products tended to be more technical in nature and require significant data inputs, such as the Bicycle Compatibility Index and the Pedestrian and Bicycle Intersection Safety Indices. There appears to be a need for more products aimed at a general audience that can be easily used by all, or more training and support for practitioners wanting to use the more technical tools.
3. Product Usefulness: Overall, all products/deployments were rated above the midpoint for usefulness. The products/deployments that recent users rated as the most useful overall were the Pedestrian and Bicyclist University Course and Walkability Checklist. The products that gave them the most knowledge for reducing crashes and injuries were the Pedestrian Road Safety Audit Guidelines and Prompt Lists, How to Develop a Pedestrian Safety Action Plan, and the Ped/Bike Crash Analysis Tool. However, some of the products that were ranked as the most useful were also ranked as the least used (not necessarily by the same respondents). This indicates a critical need to ensure that more professionals are aware of these products.
4. Product Impact on Pedestrian Safety: The products/deployments rated as having the most impact included the report Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations, Pedestrian and Bicyclist University Course, and How to Develop a Pedestrian Safety Action Plan. Similarly, users felt that the Pedestrian Safety Guide and Countermeasure Selection System and the Resident's Guide for Creating Safe and Walkable Communities will be likely to play an important future role in reducing crashes/injuries/fatalities. It is interesting to note that most of these products have been

heavily marketed and supported by programmatic efforts (such as webinars, monthly conference calls, listservs, workshops, and even funding to use and apply the information) to engage and train transportation professionals on the use of these products. More effort to systematically support the use of key products and research tools appears necessary in order for the projects to have an impact on pedestrian safety.

5. Product Delivery: In general, respondents preferred to receive their information through web-based formats, including e-mail (77 percent), Web site (68 percent), and Webconference/webinar (31 percent). Only 19 percent of respondents preferred receiving information through conferences, as travel budgets to attend such events are increasingly shrinking. It is recommended that product delivery strategies continue to take advantage of Web-based technologies, and to look more into opportunities for using social media, which is growing at a rapid pace and offers a low-cost option for reaching millions of individuals in an interconnected online network.

Conclusion and Next Steps

The next step in the process is to reconvene with pedestrian stakeholders to host a workshop to discuss the final recommendations documented in this Background Report and to prioritize the needed research, considering project scope, needed funding, and timeline. In addition, the development of potential products or the revision of existing products should also be discussed in the workshop. This will ensure that the survey feedback can be meaningfully incorporated into the Strategic Plan final document. The results of the workshop will drive the development of the final Strategic Plan. The FHWA should continue to coordinate with the FTA and the NHTSA in facilitating an open and cooperative revision process for the Strategic Plan.

INTRODUCTION

Project Background

Pedestrian injuries, fatalities, and accessibility continue to be a serious concern in the U.S. Federal Highway Administration's (FHWA) Office of Safety and the Turner Fairbank Pedestrian and Bicyclist Research and Development Program are charged with developing pedestrian safety-related products, research documents, and technology for a wide range of users to aid in improving conditions for pedestrians. A Pedestrian Safety Program Strategic Plan is needed to guide the agency's direction in effectively developing and disseminating relevant products in the future. These tools will ultimately aid in the reduction of pedestrian fatalities and injuries and increase pedestrian accessibility.

Specifically, a Strategic Plan is needed to identify gaps in existing research, resources, and deployment and prioritize short- and long-term activities that FHWA can undertake to improve pedestrian safety. This Plan will provide a 15 year framework for FHWA activities, including conducting original safety research, developing safety programs and products, ensuring technology deployment, and updating, enhancing, or supplementing existing products or programs. The Strategic Plan is data-driven, informed and supported by original research and analysis of pedestrian crash/injury and other data, literature reviews, an evaluation of existing products and distribution methods, and input from a diverse group of informed stakeholders, including representatives of State and local agencies, all documented in this report. Finally, the Strategic Plan is intended to fit within the framework of FHWA's mission, strategic objectives, and scope. The Federal Transit Administration (FTA) and the National Highway Traffic Safety Administration (NHTSA) are also important contributors in this process and their input will be considered in shaping the final Strategic Plan.

Project Goal and Objectives

The principal goal of this project was to develop a Pedestrian Safety Program Strategic Plan as described above. Key objectives of the project include:

- Developing a fact base by reviewing existing pedestrian safety literature and analyzing selected pedestrian crash databases and demographic data to identify high-risk populations, crash types, and issues where more in-depth research is needed.
- Reviewing and synthesizing available pedestrian research problem statements, agendas, and safety plans developed by states, agencies, and research professionals.
- Obtaining input from identified stakeholders on research needs and dissemination methods.
- Conducting an evaluation of existing FHWA products to determine how they have been used, whether they have helped improve safety, and what could be improved or marketed better in the future.

The Strategic Plan is intended to be based on findings from the data analysis, literature review, and stakeholder input and establish short and long term goals and objectives that can be measured and tracked. It recommends research likely to have the greatest impact in improving

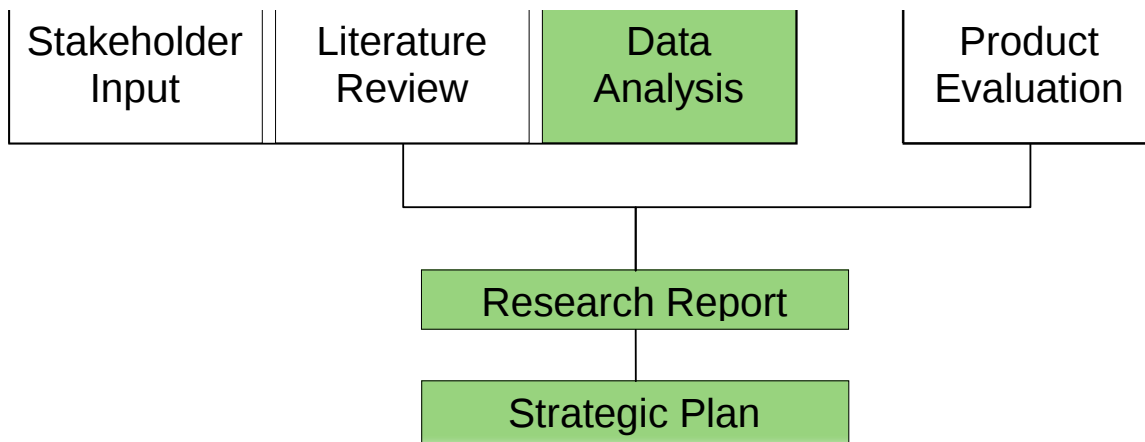
pedestrian safety for a variety of groups and situations, and based on an evaluation of existing products and technology deployment methods it recommends effective methods to market and disseminate research results, new technologies, and related guides and tools.

This Background Report provides the knowledge base behind the Strategic Plan and documents the activities and findings of the project that supported the development of the Plan.

PROJECT STUDY DESIGN

To develop the foundation and information underlying the Strategic Plan, the project team utilized four main sources of information: 1) a data analysis of pedestrian crash and walking trends and expected demographic changes, 2) a literature review of recently published pedestrian safety research and resources, 3) an evaluation of existing FHWA products and dissemination strategies, and 4) stakeholder feedback and expert opinion on research and information needs to advance pedestrian safety efforts (see Figure 1).

Figure 1. Model for the Development of the Strategic Plan.



The methodology for performing the data analysis was based on a secondary review of several information sources, including the National Highway Traffic Safety Administration (NHTSA) Safety Fact Sheets, published reports that examined Fatality Analysis Reporting System (FARS) and National Household Travel Survey (NHTS) data, and others. No new data was collected; in some cases, FARS or other data was reviewed directly to confirm trends or examine previously unexplored issues.

The methodology for the literature review is defined more in the literature review section below. The method for conducting the product evaluation and the process for receiving stakeholder input is described below.

Methodology for Evaluating Existing FHWA Products

To conduct an independent evaluation and unbiased assessment of existing FHWA products, Westat was brought in to work directly with FHWA. Westat's overall approach to the product

evaluations was to conduct a targeted Web-based survey followed by a smaller set of telephone interviews with a selected group of respondents. Seventeen products were evaluated (see Table 1); based on these products and deployments, questionnaire items were carefully developed based on cognitive interviewing and piloting. An example of the survey is provided in Appendix I.

Table 1. FHWA Products Evaluated.

Title	Link
Bicycle Safer Journey	http://safety.fhwa.dot.gov/ped_bike/ped_bike_order.htm
Bicycle Compatibility Index	http://www.bicyclinginfo.org/library/details.cfm?id=28
Bikesafe: Bicycle Safety Guide and Countermeasure Selection System	http://www.bicyclinginfo.org/bikesafe/
How to Develop a Pedestrian Safety Action Plan	http://www.walkinginfo.org/library/details.cfm?id=229
Ped/Bike Crash Analysis Tool	http://www.walkinginfo.org/facts/pbcat/index.cfm
Pedestrian and Bicycle Safety Materials for Hispanic Audiences	http://safety.fhwa.dot.gov/ped_bike/hispanic/materials/index.cfm
Pedestrian and Bicyclist Intersection Safety Indices	http://www.tfhr.gov/safety/pedbike/pubs/06125/index.htm
Pedestrian and Bicyclist University Course	http://www.tfhr.gov/safety/pedbike/pubs/05085/index.htm
Pedestrian Forum Newsletter	http://safety.fhwa.dot.gov/ped_bike/pedforum/index.cfm
Pedestrian Road Safety Audit Guidelines and Prompt Lists	http://drusilla.hsrrc.unc.edu/cms/downloads/PedRSA.reduced.pdf
Pedestrian Safety Campaign	http://safety.fhwa.dot.gov/local_rural/pedcampaign/
Pedestrian Safer Journey	http://safety.fhwa.dot.gov/saferjourney/
Pedestrian Safety Guide for Transit Agencies	http://safety.fhwa.dot.gov/ped_bike/ped_transit/ped_transguide/index.cfm#toc
Pedsafe: Pedestrian Safety Guide and Countermeasure Selection System	http://www.walkinginfo.org/pedsafe/index.cfm
Resident's Guide for Creating Safe and Walkable Communities	http://safety.fhwa.dot.gov/ped_bike/ped_community/ped_walkguide/index.cfm
Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations	http://www.walkinginfo.org/library/details.cfm?id=54
Walkability Checklist	http://www.nhtsa.dot.gov/PEOPLE/injury/pedbimot/ped/walk1.html

Westat surveyed 2,452 individuals who have ordered and are or have been users of FHWA products. Participants were limited to the United States. The survey took approximately 15-25 minutes per person. 478 respondents completed the entire survey, yielding a response rate of 19.5 percent, which is common among Web-based surveys. Participants were emailed individual links in three waves, with follow-up reminders if they did not respond within one week to increase the response rate. Beyond the general survey, follow-up phone interviews (lasting approximately 5 - 15 minutes) were conducted with 85 professionals (5 for each of the 17 products evaluated) to obtain more detailed information regarding their views on improvements and materials that are needed. Interviews were scheduled based on information submitted by respondents at the end of the Web survey where they were asked to volunteer for a follow-up discussion about specific products. Each person was interviewed about one product, with approximately three to five individuals interviewed for each product. The details of survey

implementation are discussed below.

Prior to surveying the target population, Westat submitted questions to cognitive testing using available Westat staff and select FHWA personnel through the project Contracting Officer's Technical Representative (COTR) to verify understandability of questions included in the instrument, instructions, and response options. Westat used a Web-based survey design, with multiple choice and rating questions based on a branching tree structure, with space for additional open-ended comments for certain questions. This design was chosen for a number of reasons: it is efficient and affordable compared to other survey methods; it made use of FHWA email data available for people who ordered products, which represented a realistic range of product users; and it allowed for better control over having all survey questions completed in the desired order.

The set of surveys gathered a range of information:

- General demographic and business information (e.g., age, location, profession, organization characteristics).
- Product usage, ease-of-use, and impact questions to determine which FHWA products were ordered/used and how recently they were utilized. Note—each product was presented with a blurb description and images to facilitate participant's ratings.
- Product specific follow-up questions based on the materials ordered/used.
- Interest/desire for FHWA products not currently available or overall limitations of materials.

Data analyses and summaries were composed of basic frequencies and response distributions of multiple-choice and rating questions, as well as qualitative information from open-ended questions and interview questions. For the results of the survey, see the results section.

Methodology for Stakeholder Participation

A one-day stakeholder workshop was conducted in December 2008 to solicit input on needed research and research priorities from a diverse group of stakeholders and pedestrian safety experts. The stakeholders in attendance at this workshop are listed in Figure 2 below as well as in Appendix 3. In advance of the meeting, a “stakeholder packet” was sent to participants to provide background on the project, an agenda for the meeting, a summary of pedestrian crash trends, and a brief literature review of recently completed pedestrian research. To facilitate the discussion, the stakeholders were divided into three groups, each of which broke out to discuss key aspects of the pedestrian safety plan: 1) Vision, Goals, and Measurable Objectives of the Strategic Plan; 2) Prioritizing Recommended Research Initiatives and Activities; and 3) Plan Implementation. Appendix IV lists some of the discussion questions covered during the workshop during each of the three workshops. For this report, the discussion related to prioritizing recommended research initiatives and activities is the focus and is covered in more depth in the Results and Discussion section. The discussion of plan vision and goals, as well as plan implementation, was used to directly shape the development of the Strategic Plan.

After the breakout sessions, a list of research topics discussed was compiled, and each stakeholder (including FHWA representatives present at the meeting) ranked each research topic on a scale of 1 to 5, as well as provided a “top choice” for a research topic within each major topic area: 1) Problem Identification and Data Collection, 2) Analysis and Decision-Making, 3) Development and Evaluation of Countermeasures, and 4) Product Delivery and Technology Transfer. The list of top 10 research topics from this voting process is discussed in the Findings and Discussion section. The list of topics voted on in this meeting included topics identified in the workshop as well as all topics previously identified by TRB Pedestrian Committee and listed in the research needs statement database.

Table 2: Participating Stakeholders

Name	Organization
Andrew Dannenberg	Centers for Disease Control
Anne Marie Doherty	NYC Pedestrian Coordinator
Dan Burden	Walkable Communities, Inc
David Levinger	America Walks
Dennis Cannon	U.S. Access Board
Dennis Scott	FL DOT
Jana Lynott	American Association of Retired Persons (AARP)
Janet Barlow	Accessible Design for the Blind
John LaPlante	AASHTO Non-Motorized Committee
Laura Fraade-Blanar	Insurance Institute for Highway Safety
Lauren Marchetti	National Center for Safe Routes to School
Lois Thibault	U.S. Access Board
Kit Keller	Association of Pedestrian and Bicycle Professionals
Kristen Grove	Chicago Ped/Bike Coordinator
Marsha Mason	CALTRANS
Matthew Ridgway	ITE Non-Motorized Committee
Michael Cynecki	City of Phoenix Traffic Engineer
Richard F. Pain	Transportation Research Board
Richard Nassi	City of Tucson Traffic Engineer (retired)
Ron Van Houten	Western Michigan University
Sharon Roerty	National Center for Bicycling and Walking
Shawn Turner	Texas Transportation Institute/TRB Pedestrian Committee Chair
Stephen Krest	Farmington, NM Ped/Bike Coordinator
Thomas Huber	WI State Ped/Bike Coordinator

After the stakeholder workshop, the list of research topics was further refined by the project team, taking into account the mission and scope of FHWA’s Office of Safety, knowledge of current or past studies documented in the literature, the expertise of pedestrian safety professionals at the FTA and NHTSA, and national pedestrian safety trend data. The following criteria were used to select the highest priority research topics:

- Was the project ranked as a high priority, relative to other topics, by pedestrian safety experts from a range of backgrounds?
- Was the project previously identified as an issue of concern by other organizations (including TRB Pedestrian Committee and Federal agencies)?
- Does the project fill a gap in existing literature or build onto areas where current information is lacking?

- Does the project fit within the jurisdiction and scope of FHWA Turner Fairbank and Office of Safety (i.e., is it primarily oriented to safety and issues related to the built environment, as opposed to education/enforcement/environment/health)?
- Does the project have the potential to address pedestrian safety issues for a wide range of communities, crash types, and citizens?

Based on these criteria, a short list of research topics was developed, which is further discussed in the Results and Discussion section below.

PEDESTRIAN SAFETY CONCERNS IN THE U.S.

Factors Related to Pedestrian Crashes and Fatalities

According to the 2001 National Household Travel Survey (the most recent travel survey data available), walking trips accounted for 2.8 percent of commutes to work, and 8.6 percent of all trips. As pedestrians are the most vulnerable of all road users, they are overrepresented in crashes, especially fatal crashes, in comparison to their mode share of trips. In 2007, there were 4,654 pedestrians killed in traffic accidents, representing a 3 percent decrease from the 4,795 deaths in 2006. Pedestrian fatalities have fallen by 12.5 percent since 1997, and 17 percent since 1993 (see Figure 2). However, it is not clear if this decrease is due to changes in pedestrian activity (i.e., fewer people walking) or improvements in walking conditions, or a combination of both. In fact, data regarding the number of pedestrians using a facility, or pedestrian exposure data, is not included in Figures 2 and 3.



Figure 2. Long-term Pedestrian Fatality Trend.
(Source: NHTSA, 2007).

In terms of injuries, 2007 saw the highest number since 2003. The 70,000 reported injuries in 2007 represent a 15 percent increase from the previous year. However, reported injuries have fallen almost 17 percent since 1995 (see Figure 3). It is important to note that these figures represent only estimates of reported pedestrian injuries, and studies have shown that actual injury rates could be much higher due to unreported cases. In addition, the lack of pedestrian exposure data also affects the validity of the following conclusions. Following this figure are some pedestrian safety trends surrounding various issues.

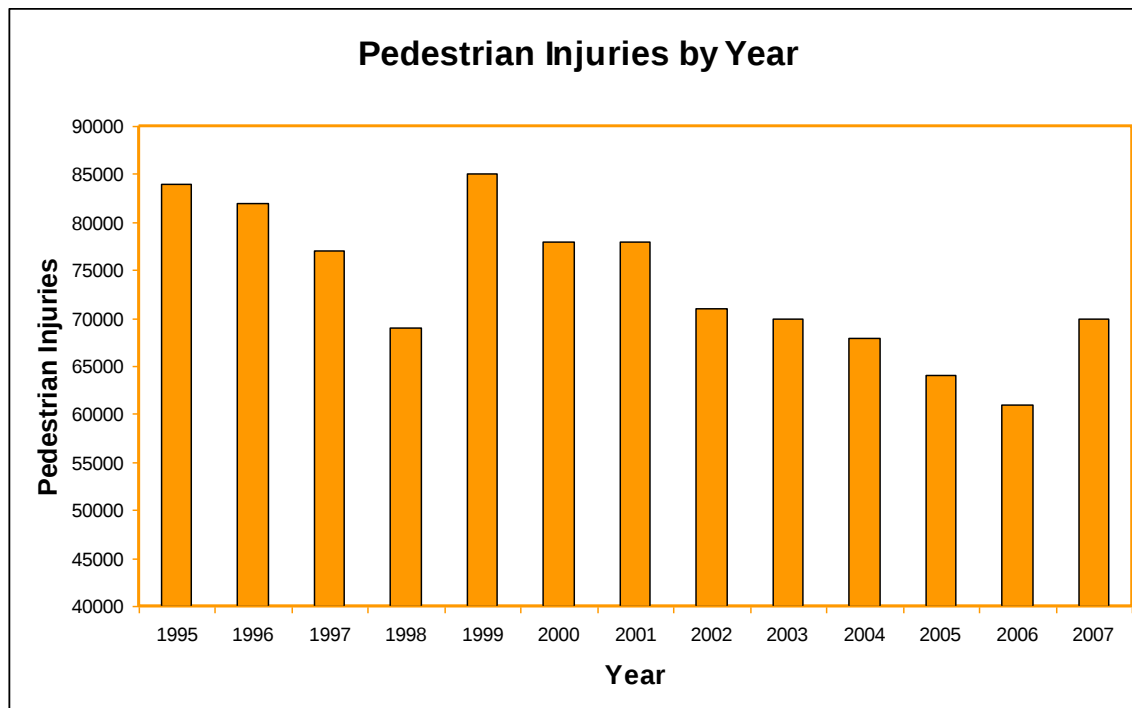


Figure 3. Long-term Pedestrian Injury Trend.
(Source: NHTSA, 2007).

Age

Making up only 9 percent of the total U.S. population, individuals over the age of 70 accounted for 16 percent of all pedestrian fatalities in 2007. Children under the age of 15, roughly 23 percent of the population, represented 8 percent of the total pedestrian fatalities, and 25 percent of pedestrian injuries. These crash estimates may correlate with the exposure (i.e., amount of walking activity) of each age group.

Gender

Males represented 70 percent of pedestrians killed in traffic accidents in 2007. The male fatality rate of 2.19 per 100,000 population was substantially higher than the female fatality rate of 0.91 per 100,000 population. According to the 2001 NHTS data, the number of walking trips taken by males and females was roughly equal, so there is little evidence to support the notion that males are more “exposed” than females in terms of pedestrian trip-making. However, there is some evidence that males in general may walk longer distances than females, which may increase their

exposure in terms of time and distance as a pedestrian (Clifton & Levi, 2005). Speculation has also been made that males may be more likely to take risks than females or to walk in more dangerous locations than females. Little information exists on this issue and more research is needed to understand the relationship between gender and pedestrian safety.

Vulnerable or Overrepresented Groups

As described in the section on age, older pedestrians are overrepresented in fatal pedestrian crashes as compared to their representation in the general population. Also, both Hispanic and African American pedestrians tend to be overrepresented in fatal crashes. In 2006, Hispanic pedestrians accounted for 17 percent of pedestrian fatalities, but were only 15 percent of the U.S. population (Chang, 2008). Similarly, African American pedestrians accounted for 14 percent of pedestrian fatalities but only 12 percent of the U.S. population (NHTSA, 2008b; U.S Census Bureau, 2006).

As described on the section on gender, males are twice as likely to be involved in fatal pedestrian crashes as females. Children are also slightly overrepresented in pedestrian crashes, but not pedestrian fatalities. From 1997 to 2006, children under the age of 15 (a group that made up 21 percent of the population) represented 8 percent of pedestrian fatalities and 23 percent of pedestrian crashes (Chang, 2008).

Alcohol

Alcohol was involved in 49 percent of pedestrian fatalities in 2007. Table 3 represents alcohol use by the driver, the pedestrian, or both parties involved in a fatal crash.

Table 3. Alcohol Involvement by Road User.

	No Driver Alcohol (percent) n=3694	Driver Alcohol, BAC = .01-.07 (percent) n=240	Driver Alcohol, BAC= .08+ (percent) n=644	Total Number	Total Percent
No Pedestrian Alcohol	51	3	7	2775	61
Pedestrian Alcohol, BAC = .01-.07	3	0	1	198	4
Pedestrian Alcohol, BAC= .08+	27	2	6	1605	35
Total Percent	81	5	14	4578	100

(Source: NHTSA, 2007).

Vehicle Speed

The speed of a vehicle is a major determinant in the severity of a crash. According to one study (and several other studies have found similar results), a pedestrian hit at 40 miles per hour has an 85 percent chance of fatality, while a pedestrian hit at 20 miles per hour has only a 5 percent chance of fatality (U.K.DOT, 1987). Additionally, even though the proportion of fatalities resulting from crashes goes down as the vehicle speed decreases, there are still a large number of injuries that result from moderate and lower-speed crashes (see Figure 4).

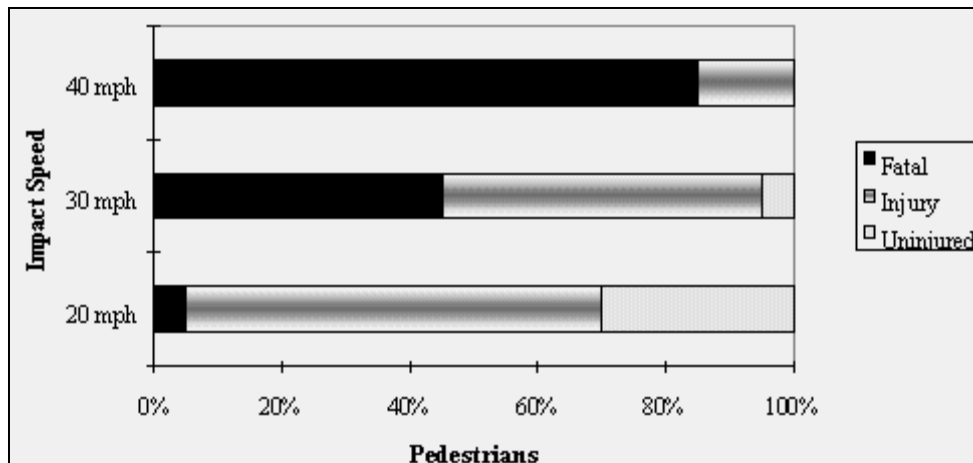


Figure 4: Pedestrian Injury Severity Based on Vehicle Speed.

(Source: Traffic Advisory Unit, 1993).

High vehicle speeds may be related to the road type (local/collector/arterial), road context (rural/urban), and road design (i.e., the presence of pedestrian infrastructure). More detail with regards to these typologies can be found in the following sections. Some tactics that have been implemented to discourage speeding have included traffic calming and citywide speed limit reductions. While these may incite resistance from politicians and residents because of concerns regarding longer travel times, studies show a relatively minor impact on travel times. Pedestrians are likely to gain the most from speed limit reductions, but benefits have been seen for drivers as well through reductions in road crashes, generally improved attitudes and awareness towards safety, a more livable environment, and increased automobile energy efficiency (Archer, 2008).

Several other studies, completed independent of each other, also support the relationship between higher speeds and more severe traffic-related injuries or death (Leaf & Preusser, 1999; TRB, 1998). This relationship may be because at higher speeds, drivers are less likely to see a pedestrian and are even less likely to be able to stop in time to avoid a collision (Harkey & Zegeer, 2004).

While the relationship between vehicle speed and injury severity is fairly well understood, it is not clear how speed contributes to the cause of a crash or how many pedestrian crashes have resulted in part because of driver speeding (or how speeding is defined or measured). Currently, most data collected by crash investigators is not reliable in assessing the role of driver speed in crashes. More work is needed to improve data collection and support research on understanding driver speed and speeding behaviors as they relate to pedestrian safety.

Other Factors

Several other factors also characterized pedestrian fatalities in 2007:

- Most fatalities occurred at non-intersection locations (77 percent).
- The vast majority of fatalities (90 percent) occurred during normal weather conditions.
- About two-thirds (67 percent) of pedestrian fatalities occurred at night.

Common Crash Types

The following crash types were most often reported for pedestrian fatalities in 2008:

Table 4. Common Pedestrian Crash Types.

Crash Type	Number	Percent*†
Improper crossing of roadway or intersection	831	19.0
Walking, playing, working, etc. in roadway	842	19.2
Failure to yield right of way	741	16.9
Not visible	479	10.9
Physical impairment	617	14.1
Darting or running into road	480	11.0
None reported	1506	34.4
Other factors	448	10.3

(Source: FARS, 2008). *Note: Multiple crash factors were reported for many fatalities, so the sum of percentages may not equal 100 percent. †Note: These percentages do not account for pedestrian exposure data.

Crash types for pedestrian injuries at the national level are not known at this time.

Locational Factors Related to Pedestrian Safety

High Crash States and Cities in the U.S.

There are different ways to quantify pedestrian crashes. Two common ways are: 1) raw crash numbers, or frequency, of pedestrians involved in crashes, and 2) by rates, which can normalize crash numbers by population or some other measure, such as time spent walking or distance traveled. Since we do not have consistent and accurate national data regarding time spent walking, distance traveled, or pedestrian exposure, we will present pedestrian crash statistics by frequency and as a rate per 100,000 population.

By Frequency

In 2008, the following states had the highest number of pedestrian fatalities:

Table 5. States with Highest Pedestrian Fatalities in 2008.

State	2008 Pedestrian fatalities
California	623
Florida	487
Texas	408
New York	294
North Carolina	157

(Source: FARS, 2008).

These states had the lowest number of pedestrian fatalities in 2008:

Table 6. States with Lowest Pedestrian Fatalities in 2008.

State	2008 Pedestrian fatalities
North Dakota	7
Wyoming	7
Nebraska	5
Alaska	2
Vermont	1

(Source: FARS, 2008).

Table 7. Cities with Highest Pedestrian Fatalities, 1997-2006.

City	Percent of national pedestrian fatalities that occurred in city*	Number of pedestrian fatalities in city
New York, NY	3.5	1,743
Los Angeles, CA	2.0	986
Chicago, IL	1.4	687
Phoenix, AZ	1.1	540
Houston, TX	1.0	514

(Source: Chang, 2008). *Note: This does not include consideration of pedestrian exposure data.

By Rate

Fatality rates (fatalities per 100,000 population) are one way to compare different localities in terms of pedestrian crashes. However, rates may be a biased measure to use without also considering other measures, such as exposure, since the rate alone cannot show whether more/fewer people are killed or more/fewer people are walking in general in these locations. Rates should not be used to compare two locations where it is expected that pedestrian exposure (i.e., the number of people walking) differs dramatically. This is because pedestrian crashes are not thought to have a straight-line relationship with pedestrian exposure, so comparing rates between two very different exposure situations may not give an accurate comparison. The NCHRP Report 08-78 will seek to address this issue, but may fall short of creating a universally applicable guide for all situations (TRB, 2010). The FHWA should continue to lead research in the area of pedestrian exposure, just as they have done for motor vehicle volume data collection with the Traffic Monitoring Guide and Highway Pavement Management System. Pedestrian exposure data is critical for understanding and evaluating pedestrian risk.

In 2008, the following states had the highest rates of pedestrian fatalities per 100,000 population:

Table 8. States with Highest Pedestrian Fatality Rates in 2008.

State	2008 Fatality rate (per 100,000 population)
Florida	2.67
Delaware	2.41
Louisiana	2.40
South Carolina	2.23
Nevada	2.15

(Source: NHTSA, 2007).

By contrast, the following states had the lowest rates of pedestrian fatalities in 2008:

Table 9. States with Lowest Pedestrian Fatality Rate in 2008.

State	2008 Fatality rate (per 100,000 population)
Vermont	0.16
Nebraska	0.28
Alaska	0.44
Minnesota	0.50
New Hampshire	0.53

(Source: NHTSA, 2007).

Between 1997 and 2008, the following states have had the highest average rate of pedestrian fatalities per 100,000 population:

Table 10. States with Highest Average Pedestrian Fatality Rate, 1997-2008.

State	Average fatality rate, 1997-2008 (per 100,000 population)
Florida	2.90
New Mexico	2.62
District of Columbia	2.48
Louisiana	2.45
South Carolina	2.38

(Source: FARS, 2008).

The following states have had the lowest average rate of pedestrian fatalities between 1997 and 2008:

Table 11. States with Lowest Average Pedestrian Fatality Rate, 1997-2008.

State	Average fatality rate, 1997-2008 (per 100,000 population)
Nebraska	0.50
Virginia	0.68
Minnesota	0.69
Iowa	0.70
New Hampshire	0.76

(Source: FARS, 2008).

Crashes in Rural Versus Urban Areas

In 2007, about 73 percent of fatalities occurred in urban areas (NHTSA, 2008a). A study using police reports from 2001 to 2002 and 2001 NHTS data in New York State looked at the urban and rural variation in walking patterns and pedestrian crashes. The study estimated the rates of pedestrian/motor vehicle crashes according to miles walked and resident age. The study found that in urban New York City, “the rate of pedestrian crashes per resident year was about four times that in rural areas; in small and mid-size urban areas it was double that of rural areas. However, pedestrian–vehicle collision rates based on miles walked were similar in all urban areas and about twice those in rural areas” (Zhu, 2008). Thus, for New York (and probably other states), it is likely that the higher numbers (and rates per capita) of pedestrian crashes in urban areas are correlated to the higher rates of walking in those areas, as compared to rural areas lacking facilities or a high enough density of destinations within walking distance.

While rural areas may experience fewer crashes or lower pedestrian crash rates, the crashes that do occur tend to be more severe. Regardless of age or sex, pedestrians are 2.3 times more likely to die from a crash with a motor vehicle in a rural setting than in an urban setting (Mueller, 1988). Approximately 57 percent of *all* automobile fatalities in 2007 occurred in rural roads, even though travel on rural areas comprises only 40 percent of total vehicle miles traveled (Federal Highway Administration, 2007). According to PEDSAFE, this trend could be attributed to the presence of higher vehicle speeds on rural roads in combination with the absence of sidewalks, paths, or shoulders to separate pedestrians from traffic (Harkey & Zegeer, 2004). Exacerbating these existing conditions, crashes in rural areas are often located farther away from quality emergency care, requiring more time for Emergency Medical Services to arrive (Mueller, 1988).

Crashes by Road Type

In urban areas in 2007, the majority of pedestrian fatalities (more than 50 percent of all fatalities) occurred on arterial roads, with a smaller percentage (14 percent of all fatalities) on local roads or streets. For injuries that occurred in urban areas, the trend was similar: close to 50 percent of all pedestrian injuries occurred on arterial roads, with an additional 17 percent of all pedestrian injury crashes occurring on local roads.

In rural areas in 2007, almost 16 percent of all pedestrian fatalities occurred on arterial roads, with another 6 percent on local roads or streets. The trend is similar for injury crashes.

Overall, for both fatality and injury crashes involving pedestrians, the majority of crashes occur on various types of arterial roads. Thus, future research focusing on these road conditions and potential solutions is needed.

Table 12. Pedestrian Fatalities and Injuries by Road Type, 2008.

Road Type	Percent of total pedestrian fatalities	Percent of total pedestrian injuries
Total		
Principal Arterial-Interstate	11.68	15.51
Principal Arterial-Other Expressways or Freeways	11.37	10.25
Principal Arterial	30.34	26.04
Minor Arterial	18.76	16.07
Collector	5.66	4.99
Local Road or Street	20.82	23.27
Unknown or Blank	1.37	1.66
Rural*		
Rural Principal Arterial-Interstate	3.62	3.88
Rural Principal Arterial-Other	6.63	4.43
Rural Minor Arterial	4.19	5.54
Rural Major Collector	5.05	4.99
Rural Minor Collector	1.41	1.66
Rural Local Road or Street	6.42	5.82
Unknown Rural	0.19	0.55
Urban*		
Urban Principal Arterial-Interstate	8.06	11.63
Urban Principal Arterial-Other Freeways or Expressways	4.74	5.82
Urban Other Principal Arterial	26.15	20.50
Urban Minor Arterial	13.71	11.08
Urban Collector	4.25	3.32
Urban Local Road or Street	14.40	17.45
Unknown Urban	0.21	1.11

(Source: FARS, 2008). *Note: May not add up to 100 percent as blank responses were not available for the urban and rural strata.

Future Demographic, Social, and Policy Changes

Significant population and other trends have been observed in growth, development, and transportation patterns in the United States and are expected to continue. Most apparent among these changes is the growth of the population on the whole and, more specifically, the growth of immigrant and older adult populations. In addition, the increasing urbanization of the country, the recent decrease in vehicle miles traveled, economic crisis, climate change, gas price fluctuations, and changes in transportation and housing policy may result in potential shifts in travel behavior that should be considered in pedestrian safety research.

Aging Population

One of the most notable demographic trends in the United States is the growing senior population. The growth of the older adult age group will likely be one of the most significant factors affecting changes in travel behavior in the near future (Litman, 2009). In 2000, approximately 35 million adults aged 65 and over lived in the United States. By 2025, the number of people aged 65 and older in the U.S. is projected to top 63 million (Shrestha, 2006). The growth of this age group represents an overall aging of the country as a whole: the 65 and up age group will make up 18.2 percent of the population in 2025 (up from 12.4 percent in 2000) while children and adolescents will decrease from 28.5 percent to 26.3 percent and the proportion of 20-64 year olds will decrease from 59 percent to 55.5 percent. The aging of the U.S. is already noticeable—from 2000 to 2008, the median age in the United States increased from 35.3 years to 36.8 years (U.S. Census Bureau, 2000 and 2008). It is expected that the population as a whole will continue to age for several decades due to increased life expectancies, low birth rates, and the aging of the baby boomer generation, which will begin turning 65 in 2010 (Shrestha, 2006).

Several characteristics of the older adult population are worth noting. Unlike previous generations, this generation of older adults is residing primarily in Sunbelt, suburban, and exurban settings—a new trend sometimes called “aging in place” (Frey, 2007). At the same time, older adults are often dependent on alternative forms of transportation, such as walking and public transit, as they tend to live up to 10 years beyond the age when they are able to operate a motor vehicle (Foley, 2002). Consequently, the mobility of older adults in automobile oriented suburban settings may be compromised and their safety and ability to walk in these settings will be increasingly important. In addition, pedestrian infrastructure should consider the needs of older walkers, who are more likely to have a physical disability or walk at a slower pace than younger pedestrians (Lynott, Haase, Nelson, Taylor, Twadell, Ulmer, et al., 2009).

The safety of older pedestrians currently presents a significant concern. Older adults are more likely to be involved in pedestrian vehicle crashes that result in a fatality. In 2007, 70,000 pedestrian injuries and 4,654 pedestrian fatalities were recorded in the United States. Older adults made up 13 percent of the population in 2007, but accounted for 9 percent of pedestrian injuries and 21 percent of pedestrian fatalities (NHTSA, 2008a; U.S. Census Bureau, 2007).

Immigrant Population and Population Growth

Like older adults, the immigrant population in the United States is growing, residing increasingly in the suburbs, and is often dependent on walking and public transit for travel (FHWA, 2006b; Singer, 2009; Wilson, 2009). Immigration accounted for 42 percent of population growth between 2000 and 2005 (Wilson, 2009). In 2007, Latin American immigrants accounted for over half of all immigrants living in the U.S. (Wilson, 2009). On the whole, immigrants tend to have lower unemployment rates, higher poverty rates, and lower levels of education than U.S. born citizens (Wilson, 2009). In 2007, over half of the immigrants in the United States settled in the suburbs and just over a third lived in primary cities (Wilson, 2009). The Southeast is home to most of the top 10 cities with the fastest growing immigrant populations, which are listed in Table 13.

Table 13. Cities with Fastest Growing Immigrant Populations, 2000-2007.

City	Percent growth in immigrant population, 2000-2007
Cape Coral, FL	122
Greenville, SC	77
Lakeland, FL	75
Nashville, TN	74
Little Rock, AR	74
Knoxville, TN	72
Indianapolis, IN	71
Las Vegas, NV	65
Birmingham, AL	65
Orlando, FL	64

(Source: Wilson, 2009).

The U.S. population on the whole is expected to grow 19 percent by 2020 and 29 percent by 2030 and the Hispanic population will likely account for much of that growth. While the white, non-Hispanic population is anticipated to increase by 5 percent in 2020 and 7 percent by 2030, the Hispanic population is expected to grow at a much faster rate—68 percent by 2020 and 105 percent by 2030 (U.S. Census Bureau, 2004). In general, Hispanic people living in the U.S. are younger than the U.S. population on the whole. In fact, 25 percent of children under five are Hispanic (U.S. Census Bureau, 2009). Recent immigrant households are less likely to own a car and are more dependent on transit and walking as forms of transportation than native born residents (FHWA, 2006b). While the Hispanic population makes up 15 percent of the population, Hispanic people are involved with 17 percent of pedestrian-vehicle crashes (Chang, 2008). Because of their travel behavior, immigrant populations as well as native born Hispanic populations may merit particular attention in pedestrian safety planning and research.

Other Demographic Trends

As a result of this rapidly growing immigrant population and other demographic changes, the United States is expected to see minority groups become the majority versus the Caucasian demographic by 2042 (Frey, 2008). Based on historic travel patterns of minority populations, it is possible that the growth in these groups may result in noticeable changes in travel behavior, including higher rates of walking nationally. Despite rising per capita income, the U.S. has also seen recent increases in poverty. Rising rates of poverty pre-dated the current recession and poverty has become increasingly prevalent in the suburbs (Frey, Berube, Singer, & Wilson, 2009). Low-income households are less likely to own a car and more likely to use alternative forms of transportation, such as walking and public transit (Litman, 2009). In addition, the current economic climate and high rate of unemployment across the nation may have implications for travel behavior in the near future (e.g., such as an increase in the number of people walking or using transit and crossing busy roads where the transit stops are located, etc.).

Development Trends

As of 2000, 80 percent of U.S. residents lived in a metropolitan region; more than half of these metropolitan residents live in suburban settings (Litman, 2009; U.S. Census Bureau, 2000). Of the 100 fastest growing metropolitan areas, 71 were located in the South and 26 were located in the West (U.S. Census Bureau, 2009). Over half of the fastest growing counties were located in

Texas, Georgia, North Carolina, or Utah (U.S. Census Bureau, 2009). The top 10 fastest growing metropolitan statistical areas (MSA) are shown in Table 14.

Table 14. Ten Fastest Growing U.S. Metro Areas, 2007-2008.

Metropolitan statistical area	Percent growth, 2007-2008
Raleigh-Cary, NC	4.3
Austin-Round Rock, TX	3.8
Kennewick-Pasco-Richland, WA	3.5
Palm Coast, FL	3.5
Gainesville, GA	3.5
Provo-Orem, UT	3.4
Charlotte-Gastonia-Concord, NC-SC	3.4
Idaho Falls, ID	3.2
Logan, UT-ID	3.2
St. George, UT	3.1

(Source: U.S. Census Bureau, 2009).

The top 10 fastest losing MSAs are:

Table 15. Ten Fastest Losing U.S. Metro Areas, 2007-2008.

Metropolitan statistical area	Percent loss, 2007-2008
Hinesville-Fort Stewart, GA	-2.5
Lawton, OK	-1.9
Punta Gorda, FL	-1.6
Jackson, MI	-1.6
Flint, MI	-1.2
Pine Bluff, AR	-0.9
Youngstown-Warren-Boardman, OH-PA	-0.8
Fort Walton Beach-Crestview-Destin, FL	-0.8
Saginaw-Saginaw Township North, MI	-0.8
Detroit-Warren-Livonia, MI	-0.7

(Source: U.S. Census Bureau, 2009).

The concentration of growth in the Southern and Western portions of the country may indicate geographic areas for further study focusing on traffic and pedestrian safety. Additionally, the increase of Hispanic and elderly populations living in the suburbs, as well as the rising prevalence of suburban poverty, may have implications for mode choice, mobility, and traffic safety in a setting that is typically considered auto-centric.

Travel Trends

Nationally, the journey to work trip in 2000 was usually made by private car for 75.7 percent of people, by carpooling for 12.2 percent of people, by transit for 4.6 percent of people, by foot for 3.3 percent of people, and by other means for the remaining 4.2 percent. In 2001, the travel mode for all trip purposes shows travel behavior that is quite different than the journey to work trip. Driving alone accounts for 41.5 percent of trips; driving with others accounts for 43.7 percent of trips; transit accounts for 1.8 percent of trips; walking accounts for 9 percent of trips; and other means make up the remaining 3.9 percent of trips (FHWA, nd).

The national mode share of journey to work trips taken by public transit has shown steady and significant increases of 0.1 percent each year since 2006. However, the distribution of walking trips has not shown significant increases, holding at a steady 2.8-2.9 percent of the total commuting trips over the same time period (U.S. Census Bureau, 2008). Federal Transit Administration (FTA) investment in transit has been increasing steadily from 2000-2007, with the number of grants being awarded for major programs more than doubling and the amount of funds being offered increasing by approximately 36 percent (FTA, 2007). The steady increase in transit investment in conjunction with the plateau in walking trips may suggest a need for better pedestrian accessibility to transit.

Low-income populations travel less frequently, have the lowest income groups (household incomes of less than \$20,000 a year), and are much less likely to own an automobile (Pucher & Renne, 2003). Car ownership is highly associated with travel mode choice. Households without a vehicle make 41 percent of their trips by foot, compared with 12.5 percent for households that own one car (Pucher & Renne, 2003). For African Americans, Asians, and Hispanics, walking accounts for 12-13 percent of trips; whites walk for 8.6 percent of trips. Measured together, low-income nonminority households, African Americans, and Hispanics account for 63 percent of transit users in general and 73 percent of bus riders (Pucher & Renne, 2003). Recent immigrants are also five times as likely to use transit as settled immigrants and U.S. born residents and less than half of recent adult immigrants are licensed to drive (FHWA, 2006b). Fatality rates per mile for pedestrians are much higher than other travel modes (on a per mile basis, pedestrians are 36 times more likely to be involved in a fatal crash than car drivers and passengers) (Pucher & Renne, 2003).

While the private car is the dominate form of travel for the vast majority of trips, vehicle miles traveled (VMT) per capita plateaued in 2000 and, since 2005, has even begun to decline (Puentes & Tomer, 2008). Many of the factors thought to have contributed to past increases in VMT have ceased to have an impact on travel; specifically, the entry of women into the workforce and vehicle ownership rates have likely reached a saturation point (Puentes & Tomer, 2008). There are indications that travel behavior is sensitive to gas price fluctuations in the long run; however, the recent drops in VMT cannot be entirely attributed to recent record high gas prices as the VMT decreases preceded the gas price volatility (Puentes & Tomer, 2008; Litman, 2008). VMT is also affected by income, development patterns, the presence of transportation alternatives, and cultural norms (Litman, 2008; Pucher & Renne, 2003).

It is likely that expected increases in gas prices will change travel patterns, but it is unclear exactly what shape those changes will take. Historically, travelers react to sustained rising gas prices by purchasing more fuel efficient cars and reducing the number of trips they take. There are indications that, when possible, travelers who typically drive in a private car will switch to public transit in the face of high gas prices (Austin, 2008; Litman, 2009).

Policy and Funding Changes

In spring 2009, the U.S. Department of Transportation (DOT) and U.S. Department of Housing and Urban Development announced a partnership and inter-agency task force that would focus on creating sustainable communities. Key priorities of this partnership include bringing affordable housing and employment opportunities closer together, enhancing transportation options and reducing travel times, coordinating transportation and land use planning, and supporting the livability and health of neighborhoods and communities (U.S. DOT, 2009). These priorities indicate a national level focus on creating places that are dense, mixed-use, and walkable. This major shift in policy focus may eventually impact travel patterns around the country, including potential modal shifts. This livability agenda may provide new opportunities for pedestrian safety research.

Policy priorities and funding for pedestrians are inherently intertwined. The FHWA, FTA, and NHTSA all play an important role in pedestrian safety research and should establish a cooperative partnership to facilitate further research. At the national level, there are several sources of federal funding currently available for pedestrian issues. They include, but are not limited to the following:

- Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU): <http://www.walkinginfo.org/funding/history.cfm>
- Transportation Investment Generating Economic Recovery (TIGER) Discretionary Grants (TDR): <http://www.dot.gov/recovery/ost/>
- Congestion Mitigation and Air Quality (CMAQ): <http://www.fhwa.dot.gov/environment/cmaq/cmaqbroc.pdf>
- Transportation Enhancements (TE): www.enhancements.org
- Federal Transit Administration New Starts and New Freedom grants: http://www.fta.dot.gov/planning/planning_environment_5221.html and http://www.fta.dot.gov/laws/circulars/leg_reg_6624.html
- Community Development Block Grants (CDBG): <http://www.hud.gov/offices/cpd/communitydevelopment/programs/>
- Communities Putting Prevention to Work: <http://www.hhs.gov/recovery/programs/cdc/chronicdisease.html>
- Safe Routes to School Program (SRTS): <http://www.saferoutesinfo.org/>

Through these and other sources, the total amount of pedestrian (and bicycle) funding from federal sources has increased by over \$300 million over the past 10 years. However, this proportion has only accounted for about 1-1.5 percent of total annual Federal Aid Highway Program funds reserved for transportation projects (FHWA, 2006a) (see Figure 4). While federal funding available for pedestrian improvements has been increasing steadily over time, it still remains a small portion of the overall transportation budget.

Federal Pedestrian and Bicycle Funding and Total Federal Aid Highway Program Funding Fiscal Years 1995–2008

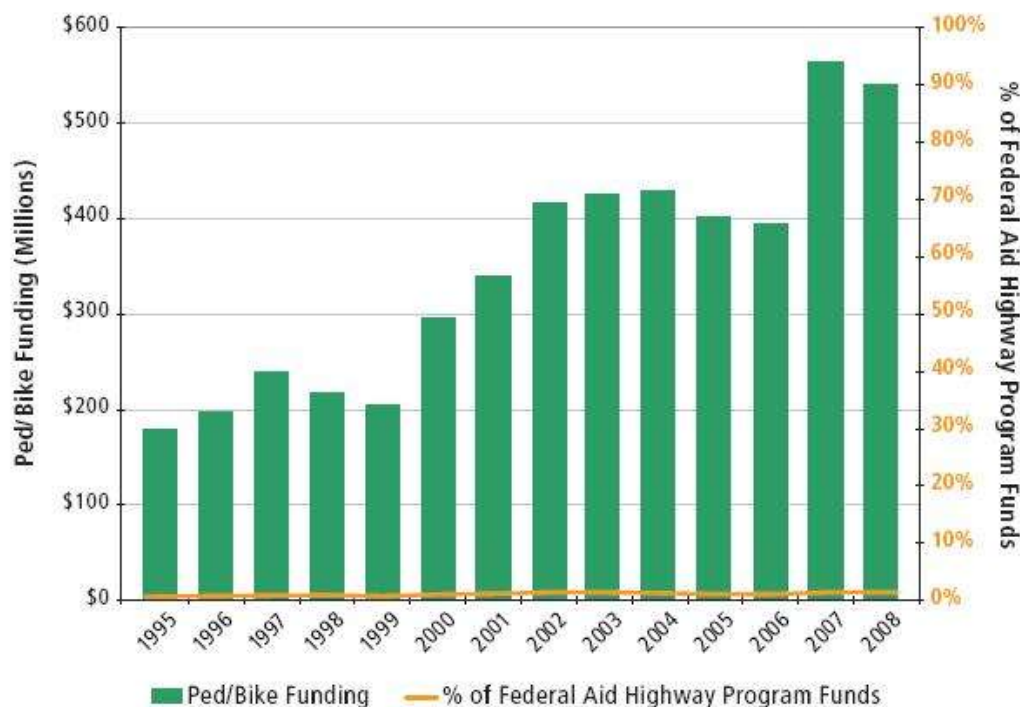


Figure 5. Federal Pedestrian and Bicycle Funding Trends.
(Source: FHWA, 2006a).

Though state and local sources of funding for transportation projects exist, federal support is perhaps the most critical to creating, improving, and maintaining pedestrian infrastructure and facilities (Cradock, 2009). The use of funds for pedestrian projects and research has not been studied extensively, yet several trends in practice have been revealed through what has been researched. Counties with lower educational attainment, low populations, higher poverty levels or a greater proportion of households owning two or more cars were less likely to implement a pedestrian-related project. Additionally, among counties that implemented a project, low educational attainment was associated with lower levels of per capita funding. This gap presents an issue of equity and safety, as individuals in areas with low socioeconomic levels are more likely to need to walk to destinations safely and could benefit most from pedestrian-related projects (Cradock, 2009).

Additional funding for pedestrian projects has increased in recent years with SAFETEA-LU, the stimulus bill, SRTS, and TIGER. However, though this has increased nonmotorized investments, studies show states have not taken full advantage of available funding. Nationally, only 80.4 percent of the \$9.4 billion available through the TE program since 1992 has been utilized, and only 35 percent of the SRTS program funding available has been obligated since 2005 (Ernst & Shoup, 2009). While this is important to note because it leaves possible projects and improvements unrealized, it also makes the programs liable for federal rescission requirements,

where states return any unspent funds. In FY 2008, states returned over \$98.5 million through rescissions, equal to a 12 percent reduction in 2008 TE apportionments (Ernst & Shoup, 2009).

The forthcoming CLEAN-TEA bill targets and promotes clean and alternative forms of transportation, such as walking and bicycling, by providing additional funding from future cap-and-trade programs. It is still unclear to what extent communities will take advantage of this new opportunity, or how they will modify their budgets to make better use of already available funding sources. Studies and the upcoming funding options suggest there should be a greater focus on providing adequate education and opportunity for communities so they are aware of what funding options are available, especially areas that are less likely to implement a project. This would minimize funding concerns, a major barrier to implementing projects. Also, more efforts should be taken to document the patterns of federal funding for pedestrian improvements so that trends and gaps in practice may be recognized and addressed.

LITERATURE REVIEW

To develop the knowledge base for the Strategic Plan, the project team conducted an extensive literature review to identify key findings and gaps in pedestrian safety research. The literature review included comprehensive studies, broad-based syntheses, pedestrian design technical references, and meta-analyses of the pedestrian safety research literature for the years 2000-2008. It also included national and international articles published within the last five years from sources such as Transportation Research Records, Accident Analysis and Prevention, and other transportation research journals. Sources for citations include Transportation Research Information Services (TRIS), ScienceDirect, and the ISI Web of Science, as well as a series of targeted Internet searches. The review included an examination of nearly 200 articles organized into four major topic areas: 1) problem identification and assessment, 2) analysis and decision making tools, 3) development and evaluation of countermeasures, and 4) product delivery and technology transfer. Section 3 is further divided into the following subsections to properly categorize the countermeasures: Research Compendiums, Intersections, Midblock Crossings, Transit and Multimodal, Speed Management, Traffic Calming, Roadway Design, Visibility and Nighttime Issues, Education, Enforcement, Pedestrians With Disabilities, and Other.

This review does not attempt to cite all of the pedestrian research literature published during the period, but it does emphasize the major safety-related studies published in recent years. Only limited citations are given to the extensive literature of conference papers, especially those presented at the Transportation Research Board (TRB) and Institute of Transportation Engineers (ITE) conferences held during the period of coverage. Foreign pedestrian research literature was selectively considered. These international sources have been mostly incorporated into the aforementioned sections depending on the topic.

See Appendix VI for the complete literature review of publications and guides from the U.S. and abroad. See the “Key Findings from Literature Review” in the Discussion section below for major trends that came from the literature review.

The literature review also synthesized existing research agendas from various federal organizations with an interest in pedestrian safety. The project team examined the mission

statement, goals, and specific objectives of each organization (FHWA Turner Fairbank and Office of Safety, NHTSA, Centers for Disease Control and Prevention (CDC), Environmental Protection Agency (EPA), TRB Pedestrian Committee) to better understand agency priorities, jurisdiction, scope, and previous efforts at identifying pedestrian safety needs.

Finally, the literature review included a summary and brief evaluation of the existing data sources available for conducting pedestrian safety research and the limitations and needs for future research. The review of existing data sources is summarized in the Findings and Discussion section.

Previous FHWA Initiatives

The Federal Highway Administration's previous Pedestrian Safety Tactical Roadmap (dated April, 2006) consisted of a chart of project areas and a year-by-year schedule that ranges from 2004-2010. The chart organizes project topics first by four "thrusts" and then further by "topics":

- A. Problem identification and assessment
 - A.1. Risk assessment and exposure data
- B. Analysis and decision making tools
 - B.1. Enhancement of Pedestrian and Bicycle Crash Analysis Tool (PBCAT) V.2
 - B.2. Pedestrian safety at midblock and intersection crossing
 - B.3. Expert systems
 - B.4. Develop pedestrian and bicycle road safety audit module
- C. Development and evaluation of countermeasures
 - C.1. Intelligent Transportation Systems (ITS) solutions
 - C.2. Traffic calming
 - C.3. Shared use paths
 - C.4. Partnerships
- D. Product delivery
 - D.1. Conference support
 - D.2. Classes and workshops
 - D.3. Marketing and outreach
 - D.4. Project and product evaluation

Many of the topics in thrust areas A-C have been addressed through projects and products developed since 2004. PBCAT version 2.0 was released in July 2006 with upgrades and edits from version 1.0 (including customizable data entry forms, crash analysis information more compatible with other data processing programs, and detailed descriptions of countermeasures for specific crash types). FHWA has also supported the development of a guide and workshop module related to pedestrian road safety audits, a pedestrian safety expert system (i.e., PEDSAFE), a *Safety Index for Assessing Pedestrian Safety at Intersections*, resources on traffic calming and shared use paths, and a study of *ITS Technologies to Reduce Pedestrian Injuries and Fatalities*. For thrust area D, a considerable amount of activities have also been conducted, including conference support at a number of conferences across the nation, pedestrian safety action plan and pedestrian safety design courses taught through the National Highway Institute (NHI) and through other contractors, marketing and outreach through the quarterly Pedestrian

Forum e-newsletter, as well as partnerships, project, and program evaluation. Additional information can be found in the Product Delivery and Technology Transfer section of the Literature Review in Appendix VI.

Only one or two topics have yet to be addressed, including A.1 (risk assessment and exposure data) and B.2 (pedestrian safety at midblock locations). As of 2009, it is expected that a National Cooperative Highway Research Program (NCHRP) project will include the development of pedestrian exposure prediction models related in part to the issue in A.1, and proposed FHWA projects for the 2010 fiscal year will include a project to examine pedestrian safety issues and solutions related to midblock locations. The development of a bicycle road safety audit was initiated in FY 2009 as well.

This roadmap provides a framework which is to be utilized in the Strategic Plan, and these recent goals and activities were taken into consideration in the development of recommended research.

Existing FHWA Safety Mission and Goals

The Federal Highway Administration's Pedestrian Safety Tactical Roadmap notes that the objective of the roadmap is to "reduce the highway fatality rate to 1.0 per hundred million vehicle miles traveled by 2008." The overall 2008 fatality rate, 1.27 per 100 million vehicle miles traveled, fell short of this previously stated goal (FARS, 2008). However, the fatality rate varies based on crash location. In 2001, the urban-rural fatality rates per 100 million vehicle miles were 1.0 and 2.3, respectively. In 2004, they were 1.0 and 2.1, respectively, and by 2007, the urban-rural fatality rates were 0.88 and 2.21, respectively (Federal Highway Administration, 2001; 2004; 2007). Though the overall rate has been decreasing, the goal of 1.0 per 100 million vehicle miles traveled has been met in urban areas, but not yet in rural areas.

FHWA set the following two goals for bicycling and walking in their 1994 National Bicycling and Walking Study:

- Double the percentage of trips made by bicycling and walking in the United States from 7.9 percent to 15.8 percent of all travel trips; and
- Simultaneously reduce the number of bicyclists and pedestrians killed or injured in traffic crashes by 10 percent.

Since then, there has been slow but steady progress in building safer facilities and supporting more bicycling and walking trips:

- Between 1995 and 2001, the number of bicycling and walking trips increased from 23.6 billion to 38.6 billion. As a percentage of total trips, bicycling and walking accounted for 6.2 percent in 1995 and 9.5 percent in 2001, falling short of the national goal of 15.8 percent. Updated bicycling and walking trip statistics will be released in early 2010.
- From 1995 to 2007, there was a 16.6 percent reduction in pedestrian fatalities and a 15.9 percent reduction in bicyclist fatalities. Estimated pedestrian injuries have fallen 16.7 percent and bicyclist injuries have decreased 29.5 percent since 1995.

As the goal of increasing bicycle and pedestrian trips has yet to be reached, there is a need for adequate funding for projects, programs, and research that will support efforts to meet and exceed this national goal. Concurrently, as pedestrian and bicycle trips continue to rise, agencies must ensure that pedestrian and bicycle fatalities and injuries continue to fall. New safety goals are needed to promote future progress, and there is a national need for more comprehensive data to better measure and understand bicyclist and pedestrian safety trends. The onus of establishing new pedestrian and bicycle goals following the end of the reporting period should be completed by the United States Department of Transportation (USDOT). This is imperative for continuing the positive trends in pedestrian and bicycle crash mitigation and ensuring bicycling and walking levels continue to increase.

Existing Research Agendas from Federal Agencies

A number of existing research agendas related to pedestrian safety research were reviewed as part of this project, including:

- American Association of State Highway and Transportation Officials (AASHTO)
- National Highway Traffic Safety Administration (NHTSA)
- Centers for Disease Control and Prevention (CDC)
- Transportation Research Board Pedestrian Committee (TRB)
- American Planning Association (APA)

Additionally, an attempt was made to identify state-level pedestrian safety research agendas. The project team surveyed the Pedestrian and Bicycle State Coordinators via the State Coordinator listserv, but not a single respondent provided a state-level research agenda. Therefore, the team focused on examining research agendas at the national level that could be relevant to the development and implementation of the FHWA Office of Safety Strategic Pedestrian Safety Plan.

While all organizations approach pedestrian safety issues from varying perspectives, the organizations reviewed (see list above) appear to hold two common goals: 1) to reduce pedestrian crashes while increasing pedestrian activity, and 2) to raise awareness and understanding about how to best plan for and develop safe pedestrian environments. These organizations believe the above goals can be achieved by focusing on the factors that directly influence pedestrian safety—most commonly safety through education of both pedestrians and those responsible for providing pedestrian-related amenities and services.

Ideas for intervention vary, but there are commonalities. First off, each organization expressed the need to take a multidisciplinary and multifaceted approach, as one strategy focused on pedestrian infrastructure alone would not be as effective as it could be in conjunction with others. Along the same lines, many recommend approaching the problem from a behavioral, educational, environmental, and planning level simultaneously. Some groups note this could be achieved by collaborating with experts and organizations of other fields. Additionally, CDC, NHTSA, and the 2001 Child Pedestrian Safety Strategies encourage targeting both the driver and the pedestrian in educational outreach, as they are the two actors involved in crashes. The importance of evaluating and monitoring strategies to determine their effectiveness and to

monitor how they might be improved in the future is also stressed.

The following section relates the major pedestrian safety topic areas identified in the existing research agendas of the aforementioned organizations.

AASHTO's Strategic Approach to Safety Tactical Roadmap

Much like the Federal Highway Administration's Pedestrian Safety Tactical Roadmap, AASHTO's Tactical Roadmap organizes project topics first by five thrusts and then further by topics:

- A. Managing safety
 - A.1. Safety planning
 - A.2. Safety management processes and tools
 - A.3. Safety decision-making tools
 - A.4. General program management
 - A.5. Focused approach to safety
- B. Information, data, and improved understanding
 - B.1. Data systems and analysis
 - B.2. Improved data
- C. Evaluation
 - C.1. Program evaluation
 - C.2. Countermeasure evaluation
 - C.3. Product evaluation
- D. Technology and innovation transfer
 - D.1. Communication and outreach
 - D.2. Training and capacity building
 - D.3. Technical assistance
- E. Awareness
 - E.1. Decision makers and leaders
 - E.2. Practitioners
 - E.3. General public

Also, similar to the FHWA Roadmap, the AASHTO Roadmap includes safety projects, data systems, evaluation, and product delivery/technology transfer. Within the roadmap, there are three projects that specifically cover pedestrian-related research. They include:

- Project: Highway design handbook for older drivers and pedestrians
 - Thrust: Managing safety
 - Topic: Safety decision-making tools
 - Subtopic: System level tools
 - Principle Stakeholder group: FHWA, State DOTs, local highway agencies
 - Product or service: Updates to handbook
 - Anticipated delivery: 2004-2010
- Project: Pedestrian and Bicycle Crash Analysis Tool (PBCAT)

- Thrust: Managing safety
- Topic: Safety decision-making tools
- Subtopic: Project level tools
- Principle Stakeholder group: State and local pedestrian/bicycle coordinators and engineers
- Product or service: CD-ROM to help state and local pedestrian/bicyclist coordinators, planners, and engineers analyze their crash data
- Anticipated delivery: Beta version will be available 2/05, Final CD version will be released in 7/05, will have software support until 12/05
- Project: Pedestrians-Human factors
 - Thrust: Evaluation
 - Topic: Countermeasure evaluation
 - Subtopic: Basic research
 - Principle Stakeholder group: FHWA, State DOTs, local highway agencies
 - Product or service: Pedestrian countdown vs. flashing don't walk research report
 - Anticipated delivery: 2005

All of the above projects have been completed and the final reports delivered.

NHTSA Pedestrian Safety Research Agenda

The National Highway Traffic Safety Administration conducts critical behavioral and vehicle programs, and provides grants to the States for the administration of highway traffic safety programs. Its strategic goals and focus areas include: passenger vehicle occupants, non-occupants (pedestrians, cyclists, etc.), motorcycle riders, and large trucks and buses.

Currently, NHTSA's Office of Behavioral Safety Research (OBSR) is preparing a Five-Year Strategic Behavioral Research Plan. Though research initiatives outlined in the plan are targeted for the years 2010 to 2014, resultant research is relevant in both current and future applications. Focus issues are as follows:

- Alcohol-/drug-impaired driving
- Distracted driving
- Young/novice and older drivers
- Speed and unsafe driving practices
- Pedestrian safety
- Occupant safety
- Motorcycle safety
- School bus safety

The research agenda will be formulated based on input from researchers and practitioners from both transportation and non-transportation disciplines. Through a series of white papers, one on each subject, a solid background on the issue will be established and discussion can then be sparked about which key issues require further research. Additionally, a few researchers and practitioners will partake in a panel discussion on each target topic's research needs, while others

will be invited to comment via a Web site. The resulting plan will address a diversity of research needs within the area of pedestrian safety. On the subject of pedestrian safety, NHTSA cites education programs for pedestrians, drivers, and pedestrians of different age groups, as well as creating official pedestrian safety zones as some measures to take to reduce pedestrian-vehicle conflicts. These actions should be coordinated with FHWA's strategic research plan.

CDC Preventing Injuries - Transportation Injuries Research Agenda

The CDC Research Agenda on Preventing Transportation Injuries includes "Priority C: Evaluate the effectiveness of behavioral and environmental strategies to prevent pedestrian injury." The basis of Research Agenda Priority C is that as pedestrian-vehicle crashes involve a variety of factors, including but not limited to pedestrian-driver behavior, road type, vehicle speed, age and gender, a multifaceted approach is necessary to be effective in reducing overall pedestrian injuries. For example, researching and implementing intervention strategies which target drivers and their driving environment as well as pedestrians and their walking environment, such as through traffic calming measures or theory-based education and training programs, may prove to be more effective at reducing pedestrian-vehicle collisions than a focus on only one or the other. Providing stronger law enforcement while implementing these programs may also aid in influencing and educating pedestrian-driver behavior. The CDC proposes that strategies that are implemented concurrently may provide the strongest prevention plan for pedestrian injuries.

National Strategies for Advancing Child Pedestrian Safety (2001)

Understanding "pediatric pedestrian injuries" as a complex societal issue requiring collaboration of experts from diverse fields, the Center for Disease Control, the National Highway Traffic Safety Administration and the National SAFE KIDS Campaign joined forces to host The Panel to Prevent Pedestrian Injuries. It was an interdisciplinary conference held in September 2008, where almost 100 individuals from over 25 different disciplines discussed key topics, barriers, and next steps to reduce pedestrian injuries among children. These discussions are documented in the National Strategies for Advancing Child Pedestrian Safety. Though not intended as a federal plan of action, the document was written for anyone who is interested in reducing child-vehicle collisions while still "encouraging [children] to explore their environment by walking."

The strategies identified in this document include:

- Enhance public awareness about the need to improve safety for child pedestrians while promoting the health and environmental benefits of walking.
- Modify the behavior and attitudes of both pedestrians and drivers to improve sharing the road.
- Modify the physical environment to better support pedestrian traffic.
- Develop and conduct effective safe-walking programs.
- Conduct research to address gaps in knowledge and to translate research findings into effective programs and public policy.
- Conduct surveillance to measure children's pedestrian injury rates, quantify the amount of walking children normally do, and identify risk factors for injury.

TRB Pedestrian Committee Research Needs Statements

The TRB Pedestrian Committee's Research Needs Statements (RNS) contains more than 100 research needs statements specific to pedestrian research. They were developed over several years with the input of a number of pedestrian safety experts on the committee or research subcommittee. The research topic areas are separated into four major categories:

- Planning and policy
- Design, operations, and safety
- Human capacity and sensitivity to environment
- Society, culture, and behavior

The research needs are described further by subtopics within the four main categories:

- Facility evaluation
- Enforcement
- Crash risk analysis
- Demand management, generators, and forecasting
- Land use and urban design
- Education
- Health and physical activity
- ADA (Americans with Disabilities Act)

To further prioritize pedestrian safety research needs, the TRB Pedestrian Committee hosted two workshops to discuss research gaps and make recommendations for future priorities. The first of these workshops was held in conjunction with the 2008 Pro Walk/Pro Bike Conference in Seattle, WA. Using informal brainstorming sessions, attendees were divided into groups to discuss research priorities in the four main research categories (listed above).

A second workshop was held at the 2009 TRB Annual Meeting. Using a more formal structure, teams of attendees came up with research gaps in seven main categories. After listing the research needs and presenting the results to the group, each attendee voted on the topics to prioritize them among other research needs. The outcome of the workshop was the following list of research topics, beginning with the highest priority as determined by the group:

1. Data issues and their impact on analyzing pedestrian topics
2. Non-existent sidewalks along existing roads
3. Operational issues for existing facilities
4. Walk to transit
5. Walk to school
6. Transportation disadvantaged
7. Land development

While this prioritized list of topics is highly reflective of the makeup of the workshop panel (i.e., transportation researchers as opposed to transit providers, transit agencies, and practicing

planners and land developers), the main topics considered are consistent with other critical pedestrian safety issues identified. The specific topics discussed at the first TRB workshop and included in the research need database maintained by the committee were incorporated into the discussion at the Stakeholder Workshop for this project, and the findings are presented later in this report.

APA Projects Related to Pedestrian Research

While the APA did not have a specific pedestrian safety research agenda, their Web sites list several ongoing, long-term projects related to pedestrian safety research. These include:

- **Complete Streets:** Complete Streets is a research project launched by The American Planning Association and the National Complete Streets Coalition. The effort is intended to transform community planning, urban design, and engineering street design practices to better meet the needs of all forms of vehicular and non-vehicular transportation, including pedestrians and pedestrians with disabilities. The APA is seeking funding to prepare a Best Practices Manual on Complete Streets. It will be in the form of a Planning Advisory Service (PAS) Report.
- **Smart Growth Codes:** The APA research department received funding from the U.S. Environmental Protection Agency to continue and expand upon its research work on smart land development regulations. In the first phase of the project, APA drafted 11 model ordinances with commentary, including encouraging mixed uses, preserving open space and environmentally sensitive areas, providing a choice of housing types and transportation modes, including affordable housing, and making the development review process more predictable. In addition, smart growth ordinances encourage walking and bicycling, and increase human interaction, and support more active, socially engaged lifestyles that results in better public physical and mental health.

RESULTS AND DISCUSSION

Key Findings from Data Analysis

A big picture review of pedestrian crash trends, walking patterns, and future demographic changes described earlier revealed four key areas of need for pedestrian safety research and technology transfer, as well as opportunities with the highest potential to reduce pedestrian crashes. These include the following, which are described below in more detail:

- Understanding older pedestrian crash issues and solutions
- Understanding the causes of immigrant pedestrian crashes and potential solutions
- Understanding urban crash issues and best practices in planning and design, and focusing technology transfer in the rapidly-growing South and Southwest
- Understanding pedestrian needs on higher speed multilane arterial roads and best practices to accommodate pedestrians crossing these roads

As individuals over the age of 70 are over represented in pedestrian fatalities (16 percent of all pedestrian fatalities in 2007), and are expected to be a quickly growing demographic group in the coming years (projected to top 63 million by 2025), funding research on understanding the needs of older pedestrians and developing planning and design best practices for accommodating older pedestrians will be critical. Also, improvements made to better accommodate older pedestrians are likely to benefit all pedestrians, so there is a very high potential for crash reduction among all pedestrians.

Another important demographic group to consider is the rising immigrant population. As previously discussed, immigration accounted for 42 percent of population growth between 2000 and 2005 and the U.S. is expected to have a minority majority by 2042. Also, many immigrant groups and ethnic sub-populations, such as Hispanics, are overrepresented in pedestrian fatalities and injuries and often reside in lower-income areas with poor pedestrian facilities but no other means of travel. Little is known about the epidemiology of crashes involving immigrant pedestrians or what educational, enforcement, encouragement, or environmental/engineering solutions are effective in reducing these crashes. With the large expected growth of this population in coming years, research and development related to this demographic group will likely have a high payoff for improving pedestrian safety nationwide.

As noted previously, America's rapid urbanization will likely lead to more pedestrian crashes occurring in urban areas in the next 15 years. In 2007, 73 percent of fatalities occurred in urban areas. Additionally, many of the states with the most rapid metropolitan growth are also the states with historically high pedestrian crash frequencies and rates (primarily states in the South and Southwest such as Florida, New Mexico, Texas, and North Carolina). Some of this may be related to the immigrant population issues described above, but it is evident that a research and outreach focus on urban areas, especially in the South and Southwest, has the potential to reach a high percentage of the population and the most high-risk areas in the U.S.

Within urban areas, the majority of pedestrian fatalities in 2007 occurred on arterial roads. High-speed, high-volume multilane arterial roads have long been known to be a problem for pedestrians, especially for those trying to cross the road. The most common crash type found was related to the improper crossing of a roadway or intersection (almost 20 percent of all crashes typed). Thus, a focus on research to examine and improve pedestrian safety when crossing and when walking along multilane arterial roads will likely have a wide application to addressing pedestrian crashes in the future.

Key Pedestrian Safety Issues

As identified in existing FHWA research agendas, mission statements, and through discussion with FHWA staff, there are four key areas in which research is needed in order to comprehensively and systematically address pedestrian safety at the national level. These key areas, which form the framework of the Strategic Plan, are:

1. **Problem identification and data collection**—these projects support efforts to collect and make available comprehensive, timely, uniform, and accurate data related to

pedestrian activity, facilities, and use that can be used to inform safety decisions and prioritize efforts.

2. **Managing safety through analysis and decision-making**—these projects are intended to identify and foster comprehensive, strategic approaches to pedestrian safety and integration of pedestrian issues into planning and engineering processes.
3. **Innovative research and evaluation**—these projects involve conducting new research studies to fill knowledge gaps and analyze the effectiveness of pedestrian safety efforts and technologies.
4. **Technology transfer**—these projects involve disseminating products and knowledge to stakeholders through various outlets, including communication/outreach/marketing, training support, and technical assistance.

The recommended research topics identified in this project are listed under three of the four key research areas (areas 1, 2, and 3 above). Topics for technology transfer efforts (area 4) will be based on, and integrated with, some of the selected basic research topics from the following list. This list represents some of the top research ideas that have been identified as being the most needed (i.e., related to critical gaps in knowledge with little to no previous research in this area), as having the greatest potential short and long-term impact in improving pedestrian safety, and as fitting within the jurisdiction and scope of the Turner Fairbank Pedestrian and Bicyclist Research and Development Program and the Pedestrian and Bicycle Program in the Office of Safety.

A. Problem Identification and Data Collection

1. Evaluation on MUTCD Devices for Vulnerable Pedestrians (Topic: Research on older pedestrian crash trends and issues related to aging (including sight/hearing/mobility loss) that can be addressed through changes to the built environment)
2. Understanding Diverse Vision Needs of Pedestrians (Topic: Research on pedestrians with diverse vision needs including safety studies, sight-impaired pedestrian behavior, and best practices in facility design)
3. Race/Ethnicity Evaluation for Pedestrian Morbidity and Mortality (Topic: Research on the socio-economic factors related to pedestrian crashes, including low-income pedestrians and recent immigrants, and what countermeasures are most appropriate)
4. Evaluating Methods for Collecting Pedestrian Exposure Data (Topic: Research to collect and evaluate sources of pedestrian exposure data and develop recommendations for a national source for exposure database, as well as recommendations for collecting data)
5. Automated Pedestrian/Vehicle Conflict Video Data Collection (Topic: Research on the use of video data collection to detect, measure, and evaluate pedestrian/vehicle conflicts and the accuracy compared to human observations)
6. Evaluating of Automated Pedestrian Detection Technologies (Topic: Research testing the accuracy and effectiveness of automatic pedestrian detectors to 1) detect pedestrians to activate pedestrian signals (and minimize false calls and missed calls) and 2) to count pedestrians and measure walking levels along a street or crossing a street)
7. Effect of Hand-Held Communication Device Use on Pedestrian Safety (Topic: Research on pedestrian and driver distractions including the use of mobile telephones and mp3 players to explore 1) the relationship between pedestrian and driver

- distraction and pedestrian safety and 2) how to collect this data most effectively)
8. Methods to Improve Physical Conditions for Pedestrians along Existing Roads (Topic: Research examining non-vehicle related pedestrian safety issues (including facility maintenance) and recommendations for collecting data)

B. Managing Safety Through Analysis and Decision-Making

9. Identification and Prioritization of High Pedestrian Crash Locations/Areas (Topic: Research to generate best practices in pedestrian problem area identification (including the use of GIS, crash data, and land use data) and prioritization to assist practitioners in accurately and systematically identifying pedestrian risk areas that could be proactively treated)
10. Using National Exposure Data to Examine the Relationship between Pedestrian Exposure and Safety (Topic: Research using national exposure data to better explore the relationship between pedestrian exposure and safety)
11. Identification and Use of Pedestrian Facility/Safety Funds (Topic: Research that explores how communities can obtain, allocate, and use transportation funds in an efficient and effective manner, and how funding levels relate directly or indirectly to pedestrian safety outcomes)
12. Relationships between Land Use, the Built Environment, and Pedestrian Safety (Topic: Research on the relationship between land use/the built environment and pedestrian safety)

C. Innovative Research and Evaluation

13. Cost-effective Retro-fits for High-Speed Multilane Arterial Roads for Pedestrians (Topic: Research on how to cost-effectively retro-fit high-speed multilane arterial roads, and how to balance safety improvements with other tradeoffs, such as operational effects of lowering speeds or traffic volume)
14. Effects of Traffic Signals on Pedestrian Behavior and Safety (Topic: Research on the effects of cycle length and signal phasing on pedestrian behavior (including yielding) and other transportation issues (such as congestion and red-light-running, etc) and guidance for helping to address pedestrian safety issues at signalized intersections)
15. The Effect of Roadway Features on Pedestrian Crashes on Urban and Suburban Corridors (Topic: Research on roadway design and other factors of the built environment that influence a motorist's decision to yield to pedestrians (especially in urban areas), as well as countermeasures (such as traffic calming policies) to improve driver yielding behavior)
16. Develop Guidelines for Pedestrian Midblock Crossings (Topic: Research on the locations of crossings based on site-specific characteristics (including block length, location of pedestrian generators, pedestrian and vehicle volumes, other pedestrian facilities, etc) to improve pedestrian safety at mid-block crossings)
17. Pedestrian Crash Reduction Factors (Topic: Research identifying additional Crash Reduction Factors (CRFs) and contextual factors related to treatment effectiveness, including innovative technologies such as the HAWK signal and Rectangular Rapid Flash Beacon)
18. Accessible Pedestrian Signals (Topic: Research on APS devices, specifically the impacts and benefits for non-disability users, guidance on maintenance audits and protocol, as well as guidance on where APS devices are most beneficial and should be prioritized, or where fixed-time operation should be used)

19. Best Practices and Pedestrian Safety Concerns Related to Transit Access in Urban Areas (Topic: Research on 1) pedestrian safety concerns around transit (including bus stops, light and heavy rail, and streetcars), around at-grade rail crossings, and along railways and on 2) best practices related to transit access and increasing transit ridership through pedestrian facility improvement)
20. Research on the Effects of White Lighting in Reducing Pedestrian Nighttime Crashes and to Evaluate Emerging Lighting Technologies in Real-World Conditions (Topic: Research to better understand the promise of LED lighting in reducing pedestrian crashes and to evaluate emerging lighting technologies in real-world conditions)
21. (Topic: Research to evaluate how new pedestrian facilities affect pedestrian exposure data and to determine the increase facility use using before and after case studies of pedestrian facility projects)
22. Increasing the Safety of Interactions Between Pedestrians and Large Commercial Vehicles (Trucks and Buses) in Urban Areas (Topic: Research identifying pedestrian safety improvements with regard to large commercial vehicles, especially in urban areas)

D. Technology Transfer

23. Case Studies of Model City/County Ordinances that Support a Vibrant Pedestrian Network (Topic: Research on pedestrian safety outcomes in the form of case studies as related to pedestrian-supportive policies such as Complete Streets and others)
24. Automobile Parking and Pedestrian Safety: A Search for a Unifying Frame of Reference (Topic: Determine best practices in parking lot design for increased pedestrian safety, gains in urban livability, and sustainability)
25. Best Practices for Pedestrian Facility Maintenance (Topic: Research on best practices for pedestrian facility maintenance)

Key Findings from Literature Review

Based on the literature review described below, there were a number of pedestrian data sources and recent studies identified on pedestrian safety topics. The following presents some general findings based on the literature review of pedestrian data and safety papers published in recent years. It is organized by a discussion of critical gaps in the existing national data that can support research, gaps in the research literature that are of interest to the FHWA Office of Safety, opportunities for collaboration in addressing pedestrian safety issues with other organizations, and, finally, a summary of existing activities related to technology transfer and recommendations for future work.

Gaps in the Data Available for Pedestrian Safety Research

There are several national data sources available which are useful for pedestrian safety research and trend documentation. However, there is still critical lack of high-quality, nationally representative data that documents pedestrian trips and can be used to estimate pedestrian exposure and crash risk, key measures for evaluating pedestrian safety performance. There is also need for data sources that can be consistently compared over time and can connect pedestrian safety trends to area characteristics. The following section describes some of the

available data sources for understanding pedestrian safety issues and some limitations of these data in supporting high-quality research.

National Household Travel Survey (NHTS)

The National Household Travel Survey currently serves as the most comprehensive data source for transportation and travel statistics in the U.S. The NHTS collects data related to mode share, trip purpose, length, distance, as well as demographic information. States are also given the option of collecting more robust data sets as add-ons to the national NHTS data set, allowing those agencies to better understand trends in their state. The most recent NHTS survey was administered between April 2008 and May 2009, and the data is scheduled to be released in February of 2010.

Efforts have been made recently to increase the sample size of the survey and gather more specific information. The 2001 survey included 70,000 households, while the forthcoming 2008 data includes 155,000. The 2001 NHTS placed a greater focus on recording non-motorized trips than surveys in previous years, by explicitly asking respondents how many walking or biking trips they had taken during their survey day and over the week prior. Additionally, it provided more “trip purpose” answer options that are likely to be made by walking or bicycling, such as “exercise.” These trips, and ones similar to them, may have been missed in previous survey results. Due to improvements in the data collection process, the 2001 NHTS data results show an artificial increase in relation to previous years, simply by recording more trips that may have been uncounted before.

In addition to the evolution of the NHTS survey that makes it difficult to compare trends between surveys taken in different years, there are other limitations to the data. Recording self-reported information on non-motorized trips over the past weeks can be subject to question because it asks the individual to recall data. As the NHTS is a national survey documenting general travel trends, it lacks detail specific to smaller geographic areas and does not include information about infrastructure, surrounding land uses or characteristics of the survey population. These elements might further explain pedestrian crash and safety trends (Clifton and Krizek, 2004). Finally, the NHTS is only collected every five to seven years, meaning that there is a wide span of time during which no data is available. Because of this, it is very difficult to use the data to evaluate the effectiveness of specific countermeasures that are intended to influence pedestrian safety or activity.

Fatality Analysis Reporting System (FARS)

FARS is a national database of all motor vehicle crashes that result in a fatality to either a vehicle occupant or nonmotorist, from injuries resulting from the crash within 30 days of the crash. The crashes must occur on a path of travel that is typically open to the public in order to be included. This pre-requisite causes the database to underestimate pedestrian fatalities, since it does not include those that occur on private property. Composed of data formatted and reported by trained FARS analysts within each state, FARS data is compiled from police, medical examiner, and emergency medical service reports, as well as state highway and vehicle information files, among others. As data is sourced from a compendium of reports, the information may contain

missing or inaccurate data. Data about each crash are contained within four forms: accident, vehicle, driver, and person. Influence of alcohol in crashes is also recorded, but on different forms, and is not considered highly accurate due to the data collection and reporting practices of various states. After information is reported, quality control checks are run to try to ensure that available data is consistent, timely, complete, and accurate. Data is available for each year from 1975 to present.

U.S. Census and the American Community Survey (ACS)

The ACS is a survey, conducted by the U.S. Census Bureau since 1996 that provides communities a snapshot of how they can better plan for community change. It presents national economic, social, demographic, housing, and travel trends. A smaller sample of the U.S. population is surveyed than in the U.S. Census, approximately 3 million addresses, but it is conducted each year. An address may only be selected for the sample once every 5 years, and each participating address is chosen because it is representative of the surrounding community. Although more detailed information can be collected as a result of the smaller sample size, there is some margin of error in extrapolating the results of a sample to apply to national trends. Data is collected via a single day travel diary and a follow up phone interview.

One of the benefits of ACS and Census data is that it has regularly been collected for many years. However, like the NHTS survey described above, the ACS survey design and definitions have been modified over various years, and there are some elements that cannot be compared to other data years. While the definitions in regards to journey to work have not changed, care should still be taken in comparing this information across time. Some elements which have shifted may be geographic boundaries, definitions used to determine respondent residence, and the proportion of group quarters residents who are counted between the state and sub-state levels. One major limitation to the data is that it primarily reports commuting (to work) trips. While this information can be useful, it is possible that a large number of trips are not being reported, such as trips for exercise and recreation. Furthermore, mode splits, such as walking to the bus or train or walking on some days per week are not counted as “walking to work” trips, but as bus or train trips, so pedestrian trips are systematically undercounted.

National Survey of Bicyclist and Pedestrian Attitudes and Behavior (2002)

Spearheaded by NHTSA and the Bureau of Transportation Statistics (BTS), this survey is the first of its kind to document bicycling and pedestrian trips, behaviors, and attitudes across the nation. From that information, manners in which the environment and infrastructure for pedestrians and bicyclists may be improved are highlighted. The random-digit-dialing phone survey was administered to 9,616 respondents aged 16 years or older from June 11 to August 20, 2002. Participants provided information regarding the past 30 days of walking and bicycling, with the most detail in regards to the most recent travel day. Results were weighted to reflect the national population. A wealth of information is presented from the survey results, including an outline of reasons why people do not walk (ranging from disabilities and health reasons to bad weather) and the impact of broad features of community design on whether individuals choose to walk.

While this dataset is useful for gaining detailed insight into pedestrian travel trends in the summer of 2002, there are no additional years of data to which it can be compared, and the dataset does not purport to project year-round travel trends. Like the NHTS survey, this data source suffers from the bias and inaccuracies inherent to self-reported data, and it does not take into account other specific environmental features that can be explored in relation to the documented attitudes and behaviors. Additionally, the survey only includes individuals aged 16 and up; as children make up a large proportion of the walking and bicycling population, survey results may under represent pedestrian activity from these age groups.

National Automotive Sampling System: General Estimates System (GES)

Information for the GES has been collected since 1988, compiling data solely from Police Accident Reports (PARs). Recorded incidents all involve a motor vehicle traveling on a traffic way and must result in fatality, or some sort of injury or property damage. Each year, about 400 police jurisdictions in 60 areas are chosen that are representative of the geography, roadway mileage, population, and traffic density across the U.S. A weighted sampling procedure is used in this process to ensure that infrequent kinds of incidents are adequately represented. Of these 60 areas, GES data collectors take random samples of PARs from each week, for a total of about 50,000 PARs annually. Approximately 90 data elements from the PARs are then coded and formatted to protect individual privacy and checked for validity and consistency. Mathematical weights are assigned to each record so that national estimates can be made (NTSB, 2002).

GES data informs NHTSA and other DOT agency traffic safety analysts, as well as researchers and decision-makers. It is a useful resource because it monitors the entire range of incidents from minor to fatal, while the FARS database includes only fatalities. Also, since it documents only crashes that were serious enough to warrant a PAR, the data set focuses on incidents which are of greatest concern to the safety and well being of the general public. However, because of this criterion, it fails to include a potentially large amount of minor pedestrian-related incidents that could be useful to account for and understand. Also, the fact that the dataset is a national sample limits the amount of detailed information one might extract for smaller geographies. Along the same lines, even though records are mathematically weighted, there is still some margin of error to be expected when extrapolating trends for the nation from sample data.

Gaps in the Research Literature

All of the identified gaps discussed below are related to and consistent with the findings from the crash trend analysis that showed that focusing research on pedestrian crossings (at intersections and midblock locations, both signalized and unsignalized) and in urban areas (where there are likely to be more pedestrians and transit systems to include in studies) is important and has a high potential for affecting a large number of pedestrian crashes. The following paragraphs reflect the section on key pedestrian safety issues outlined above.

Problem Identification and Data Collection

Only a few studies have taken into account socio-economic issues when looking at pedestrian crash issues and potential countermeasures (McMahon, 2001; Xuemi, 2008; Christie, 2007;

Barton, 2007; Ryb, 2007). As previously discussed in the analysis of pedestrian crash trends, there is a strong need and a high payoff potential for better understanding pedestrian safety issues and effective solutions related to immigrant populations.

As identified in the analysis of pedestrian crash data above, there is also a great need and a high payoff potential for focusing research and outreach on older pedestrian related issues. Some work has been conducted to date on older pedestrians. Most of the work has been in reference to walking speeds and design issues at intersections (Stollof, 2007; Staplin, 2001). There remains a need to comprehensively understand older pedestrian safety issues, especially issues related to hearing, vision, and mobility loss, and appropriate infrastructure accommodations.

The concept of “Safety in Numbers” and the relationship of exposure and safety is one emerging topic that has not been adequately covered, in part because of the lack of quality national exposure data discussed earlier. Two studies (Jacobsen, 2003; and Geyer, 2006) have looked at the relationship between pedestrian volume and overall safety. However, neither study utilized a large sample size nor adjusted for potential confounders in their models, such as traffic characteristics. If there is a relationship between pedestrian volumes and overall safety (as measured by individual crash risk), then there are significant implications for interventions and decision-making that prioritizes increasing pedestrian activity. In addition, an analysis of best practices in the collection of pedestrian exposure data, especially in relation to National Exposure data, and an evaluation of Automated Pedestrian Detection Technologies and other video data collection techniques would provide greater insight into this relationship. The development of accurate pedestrian exposure measures will aid in elucidating how pedestrian volumes affect pedestrian safety as well as how new or rehabilitated pedestrian facilities affect levels of walking.

Hand-held communication devices such as mobile telephones are widely used by a large percentage of the population in the United States. Little research has been conducted regarding the effects of hand-held devices on pedestrian and driver concentration levels and safety, though various states have enacted laws prohibiting cellular phone use while driving. By conducting further research to determine the effects on pedestrian and driver safety, countermeasures and prohibitive legislation can be developed to address this issue.

Managing Safety through Analysis and Decision-Making

Pedestrian problem area identification (either intersection or high risk “zone”) and prioritization methods have been the subject of a few recent studies (Pulugartha, 2007; Schneider, 2004; Natarajan, 2008; Carter, 2006; Schneider, 2001). However, more research and tools are needed to help practitioners accurately and systematically identify pedestrian risk areas that could be pro-actively treated.

Also, while little research has explored sources of funding and how communities make funding decisions, funding is often cited as the primary challenge to addressing pedestrian safety concerns. There is a strong need for research that explores how communities can obtain, allocate, and use transportation funds in an efficient and effective manner, and how funding levels relate directly or indirectly to pedestrian safety outcomes.

Related to the concept of safety in numbers described in the section above is the concept that land use and development decisions, which affect the density of origins and destinations that pedestrians can access and subsequently mode choice, have a potential for a strong but indirect effect on overall pedestrian safety. While a number of studies from the planning and public health fields have begun exploring factors related to land use and the built environment that are related to walking, few studies have directly examined the relationship between land use and pedestrian safety. This area of research is thus ripe with opportunities for further exploration.

Innovative Research and Evaluation

Agencies frequently struggle with determining the appropriate measures for improving safety. One of the most sought after tools for implementing pedestrian safety measures are guidelines or criteria that describe conditions when a countermeasure may be effective in improving pedestrian safety. A good example of research that provides such guidelines is for crosswalk markings at unsignalized crossings (Zegeer, 2005). Not only is there a need for similar guidance for other measures, but there is a need for a more comprehensive approach for solving pedestrian safety issues. In essence, agencies need tools that enable them to make a comprehensive look at pedestrian treatments, are based on sound research, and provide estimates of their potential benefits (i.e., Crash Reduction Factors, CRFs). This section briefly describes studies that can be used to help agencies develop the guidance they need and describes some of the critical gaps. However, it should be noted that where research exists it may be limited in the depth or breadth in which it investigates a topic and more definitive studies may be needed to develop a truly comprehensive toolkit.

A few studies have found that high-speed roads are significantly associated with higher pedestrian crash risks and frequencies (Dewey, 2003; McMahon, 2001; Davis, 2006; Ray, 2007). Pedestrian safety studies have recently been published on speed as related to traffic signal operation (Lenne, 2007); traffic calming measures (Huang, 2001); and design issues related to speeding (Potts, 2007). However, little information has been published on the ways to cost-effectively retro-fit such types of roads, and how to balance safety improvements with other tradeoffs, such as operational effects of lowering speeds or traffic volume.

As described previously, pedestrian safety at intersections is a major area of concern for pedestrians and has received attention from several studies, primarily with respect to signs and pavement markings (Zegeer, 2005; Huang, 2000; Fitzpatrick, 2006; Nambisan, 2008; Mitman, 2008; Banerjee, 2007); signals and signal timing (Lu, 2009; Fayish, 2009; Acharjee, 2009; Schrock, 2008; Eccles, 2004; Qingfeng, 2005); and geometric design features (Jagannathan, 2005; Johnson, 2005) such as curb radii, lane width, and medians. More information is needed on the effects of cycle length and signal phasing (Leading Pedestrian Intervals [LPIs], split-phasing, lead/lag turn phasing, etc.) on pedestrian behavior and potential guidance for helping to address pedestrian safety issues at signalized intersections. Furthermore, while walking speed studies have demonstrated the benefits of going to a 3.5 ft/s walking speed for setting pedestrian clearance intervals, the potential problems associated with this change are not understood as clearly (e.g., increase traffic congestion, red-light-running, conflicting pedestrian-vehicle

movements, increased cycle length, etc.). A national study may help engineers understand these potential issues.

Pedestrian safety at midblock locations is another major area of concern that has begun to receive more attention, primarily with respect to problem identification (Sandt, 2006); signs (Ellis, 2007); signals and beacons (Turner, 2006; Fitzpatrick, 2009; Van Houten, 2007; Shurbutt, 2008); in-pavement flashing lights (Boyce, 2002; Hakkert, 2002; Huang, 2000; Rousseau, 2004; Nambisan, 2006); and geometric design features such as medians (Bowman, 1994). However, more research is needed to help agencies develop a more comprehensive approach to addressing this problem. Research on the ideal spacing of crossings and the locations of crossings based on site-specific characteristics (including block length, location of pedestrian generators, pedestrian and vehicle volumes, other pedestrian facilities, etc) would be of vital interest to roadway agencies.

Pedestrian safety outcomes as related to pedestrian-supportive policies is a topic not well covered in the U.S. While the effectiveness of individual treatments and statewide laws has received some coverage, policies related to pedestrian safety such as Complete Streets policies, context sensitive solutions, growth management and TDM policies, crosswalk marking policies, sidewalk improvement and maintenance policies, and others have received almost no attention. One study (Lord, 2003) looked at the effectiveness of Right-Turn-On-Red policies, but there have been several European studies examining different policies in relation to pedestrian safety (Muhlrad, 2007; Macbeth, 2005). Policies are one low-cost approach to prioritizing pedestrian safety and encouraging system-wide pedestrian safety improvements, so more information is needed on what policies are most effective in achieving pedestrian safety outcomes. By conducting case studies of effective policies, researchers can provide examples for implementation across the United States.

Some groundwork has been laid in identifying crash reduction factors—the percentage of reduction in a certain crash type (e.g., pedestrian crashes) that is expected due to implementing a given countermeasure — for various infrastructure improvements (FHWA, 2008; Murphy, 2007; TRB, 2005; Harwood, 2007; Harkey, 2008). A summary of the best known CRFs related to pedestrians is given in a publication “Toolbox of Countermeasures and their Potential Effectiveness for Pedestrian Crashes” (FHWA, 2008) that can be found online at <http://www.walkinginfo.org/training/pbic/references.cfm>. The study is based on a detailed review of safety research related on various engineering treatments for pedestrians from the U.S. and abroad. Tables of CRFs are given for several categories of countermeasures, including those related to signalization, geometric design, as well as a category of signs, markings, and operational measures. For example, signal-related countermeasures for which CRFs are given in that document include:

- Add exclusive pedestrian phasing
- Improve signal timing intervals
- Replacing existing WALK/DON'T WALK signals with countdown pedestrian signals
- Modify signal phasing (e.g., to leading pedestrian interval)
- Remove unwarranted signals
- Convert permissive or permissive/protected signals to protected left turn only phasing

- Convert permissive to permissive/protected left-turn phasing

Geometric improvements for which CRFs are given include:

- Convert unsignalized intersections to roundabouts
- Install pedestrian overpass/underpass (unsignalized intersections)
- Install raised medians
- Install raised pedestrian crossing
- Install refuge islands
- Install sidewalk
- Provide paved shoulder
- Narrow roadway cross-section from four lanes to three lanes

The table of CRFs for the signs, markings and operational improvements include the following countermeasures:

- Add intersection lighting
- Add segment lighting (i.e., add overhead lighting along a roadway section)
- Improve pavement friction (with skid resistant overlay)
- Increase enforcement
- Prohibit right-turn-on-red
- Prohibit left turns
- Restrict parking near intersections (to off street)

It is important to note that even though there appear to be some known effectiveness information for all of the countermeasures listed above (with some degree of confidence), additional information is needed. Clearly, for most of the countermeasures listed above, the CRFs provided are the result of one or two studies in which a single estimate of the CRF is given based on the study analysis, sometimes the result of data analysis from a limited number of sites and/or from a single jurisdiction. Furthermore, it is probably not safe to assume that a given treatment is equally effective in all areas of the U.S., and also for all types of site characteristics. For example, a treatment like countdown signals may not result in the exact same crash effects when installed at highly urbanized intersections in San Francisco (with high pedestrian volumes) as they would at a high-speed suburban intersection (with low pedestrian activity) in Kansas or Texas. Also, the impact of driver speed (or posted speed limits reflecting actual speeds) on pedestrian safety countermeasure effectiveness is not well documented. Some countermeasures that work well under relatively low-speed conditions (25 mi/h, 30 mi/h or 35 mi/h), may work less well under higher speed conditions (40 mi/h and 45 mi/h). These levels of effectiveness could be calibrated for different driver speed levels. Further research would certainly be beneficial for many of these treatments to better understand conditions under which they are more or less effective, so such information can then be compiled and transmitted to practitioners through training, guides, Web sites, and/or case studies.

Based on a review of the CRFs for countermeasures listed above, one may also identify several countermeasures for which reliable CRF data are not currently known. Notable examples of missing CRFs includes treatments such as pork-chop islands at right-turn slip lanes, intersection

turning radii, various types of signs and markings at unsignalized pedestrian crossings (e.g., “Yield to Pedestrian” signs in the street, rectangular rapid flash beacons at unsignalized crossings, HAWK signals, etc.), different types of lighting on various roadway types and speeds, certain traffic calming measures, and many others. As previously mentioned, one critical question for practitioners relates to the safety effectiveness of countermeasures that can be installed at midblock locations and at higher-speed, high-volume multi-lane roads, particularly near bus stop locations.

Accessibility issues of pedestrians with visual and mobility impairments has received some coverage in recent years (Schroeder, 2006; Axelson, 1999; Kirschbaum, 2001; Harkey, 2007; Bentzen, 2006; Wall, 2005b; Wall, 2005), many focusing on Accessible Pedestrian Signals (APS) and best practices for accommodating pedestrians with visual disabilities at various intersections. More research is needed on APS devices, specifically the impacts and benefits for non-disability users, guidance on maintenance audits and protocol, as well as guidance on where APS devices are most beneficial and should be prioritized, or where fixed-time operation should be used. Additionally, there is a need to synthesize best practices, based on existing research, for accommodating pedestrians with disabilities, especially at intersections, grade-separated crossings, in areas with hilly terrain, and in roadway environments where quiet vehicles are a concern.

Understanding of pedestrian safety concerns and best practices related to transit access is limited. While there are toolkits that can be used to access conditions at bus stops (ProjectACTION), only a few studies and guides (Pechoux, 2008; Nabors, 2008) have provided guidance on locating bus stops and improving access to transit for pedestrians. Some states have developed their own guidelines (Accessing Transit), but more comprehensive research-based information is needed, particularly with respect to streetcars and light-rail service, as these transit options become more available in communities across the U.S. and more heavily used.

Lighting and pedestrian visibility/conspicuity is one topic of pedestrian safety that has had considerable coverage in recent years (Siddiqui, 2006; Spainhour, 2006; Langham, 2003; Kwan, 2004; Gibbons, 2008; Gibbons, 2006; Sullivan, 2008; Wilken, 2001; Tyrrell, 2004; and Kwan, 2006). Thus, lighting may be one area where there is a need to translate the existing research into more user-friendly guides and work to disseminate the existing information. While there has been a considerable amount of research on some aspects of lighting, there could be value in conducting some future research on the effectiveness of various lighting types under different real-world roadway conditions. Additionally, there is a growing interest in the use of Light Emitting Diode (LED) lighting in communities, both as a way to reduce electricity costs and because of the improved color rendering compared to traditional lighting fixtures. Improved color rendering allows motorists to better detect pedestrians using more sensitive central cone vision, and this sensitivity allows for quicker processing of visual information, which can translate to faster reaction times (Plainis, 2005; Plainis, 2006). More research is needed to better understand the promise of LED lighting in reducing pedestrian crashes. Since lighting is a key factor in nighttime crashes (many of which also involve alcohol), and is also an important consideration for older drivers and pedestrians, it will be important to continue to disseminate best practices on countermeasures related to lighting and to research emerging technologies in lighting, such as LEDs, as they become more widely applied.

Level of Service (LOS) (and Quality and Safety) concepts have been extensively researched in recent years (Hummer, 2006; Highway Safety Manual, 2000; Guttenplan, 2008; Landis, 2001; Chu, 2001; Petritsch, 2006; Petritsch, 2005; Sisiopiku, 2006; Corbin, 2008) and models are available for sidewalks, intersections, and shared-use paths. Similarly, there are a number of different approaches to measuring the broader concept of “walkability” for neighborhoods and transit-oriented developments (Leslie, 2007; Schlossberg, 2004; Clifton, 2007). However, most of the LOS tools and models developed have not taken full consideration of pedestrians with disabilities or people with limited mobility. Given the existing body of work, a comprehensive resource/guide on LOS tools and methods is needed, as well as more research related to LOS and people with disabilities.

Pedestrian walking speed is another topic that has been well-covered by recent research efforts (Gates, 2006; Knoblauch, 1996; Montufar, 2007; Stollof, 2007), and the Manual on Uniform Traffic Control Devices (MUTCD) was recently modified with new guidance on pedestrian walking speed. However, many communities are now struggling with implementing new signal timing plans based on the changes in walking speed and are in need of guidance. Also, there is concern that going to a slower walking speed may increase pedestrian violations by increasing pedestrian wait times (Van Houten, 2007) or lead to other transportation consequences. There is a need to better understand the implications of changes in pedestrian signal timing. Case studies or other examples of how communities are successfully implementing the new MUTCD pedestrian walking speed criteria in their signal cycles, and the challenges that they faced or addressed through the process, are needed.

Large Commercial Vehicles (Trucks and Buses) are of particular concern in terms of pedestrian safety. While some research has been completed regarding pedestrians and transit, more research is needed to determine better strategies for increasing safety around trucks and buses, especially in urban areas.

Only a few studies were found related to pedestrian simulation (Lassarree, 2007), pedestrian detection and ITS treatments (Huang, 2008; Lovette, 2007); and trails and shared-use paths (Mellifant, 2006). However, these topics may not be among the highest priority issues in terms of safety, or the benefit of such studies may be limited to a smaller group of pedestrians.

Technology Transfer

The overprovision of parking facilities often creates unhealthy and unsafe public environments for pedestrians, while also reducing the livability of an urban space and undermining the desirability of pedestrian movement in the space. In addition, parking lots can also become dangerous environments for pedestrians. Research is needed to quantify some of the adverse effects of providing too much parking in relation to pedestrian safety and the implications on policy and practice in the design of towns and cities.

A great deal of research has been conducted relating to the safety effects of pedestrian and automobile interactions, while only some research has been conducted on the relationship between pedestrian safety and facility maintenance. More research is needed to establish best

practices for facility maintenance and to determine cost effective measures for maintaining safe pedestrian facilities.

Collaborative Research Opportunities

In many cases, there are research needs that go beyond the mission and scope of FHWA, but are of vital concern for pedestrian safety. For all research that is more appropriately funded by other organizations, it is recommended that FHWA coordinate with those organizations to discuss pedestrian safety topics and how they can be addressed through collaborative, cross-cutting research and how funded research can incorporate issues that are of interest to FHWA. The following is a discussion of pedestrian safety research topics that overlap with FHWA's mission but would need to be addressed through partnerships with other agencies.

A number of studies in the past five years have examined issues related to child pedestrian crashes, walking behaviors, and safety-related interventions (Nance, 2004; Leden, 2006; Shinar, 2007; Clifton, 2007; Barton, 2007; McDonald, 2007; McMillan, 2006; Zeedyk, 2003; Christie, 2007; Boarnet, 2005; Rosenbloom, 2008). Though not an official plan of action or funding, the National Strategies for Advancing Child Pedestrian Safety (2001) provided a cross-disciplinary examination of current issues and needs in improving child pedestrian safety. Also, the 2006 Safe Routes to School legislation provided ample funding to support research surrounding child pedestrians and school-related travel, so it is anticipated that much new information will be produced in the coming years. While child-related crashes continue to be a concern nationwide, there appears to be a number of research-related initiatives already focused on this topic, so heavy investment in child-specific research is not necessary from the FHWA Office of Safety. However, school siting and design and its impact on transportation safety is within the realm of FHWA's mission and is a subject not exhaustively researched to date; this and other school-related pedestrian safety issues should be discussed with other stakeholders.

Several studies have examined issues surrounding knowledge and compliance of pedestrian laws (Chu, 2003; Spainhour, 2006; Herbert, 2004; Kim, 2008; Kim, 2008a; Hatfield, 2007; Van Houten, 2004; Mitman, 2007). Currently, NHTSA's Office of Behavioral Safety Research is preparing a Five-Year Strategic Behavioral Research Plan for 2010-2014 with various focus topics. Laws and compliance are discussed within the pedestrian safety section. While this topic is considered to be more under the purview of NHTSA, law-related safety research is of interest to pedestrian safety. Specifically, work is needed to improve crash data collection by law officers and to train officers to better collect data, and to understand and enforce pedestrian laws. While not specific to pedestrians and pedestrian safety, the Institute of Transportation Engineers (ITE) prepared a survey of transportation engineers to better understand the deficiencies in collision reporting and to establish the data needs of transportation professionals (ITE, 2008). The results indicate a need for greater data accuracy and reporting, which is most easily remedied by providing better data entry training for police officers.

Only a few studies examined alcohol as a factor in pedestrian crashes (Spainhour, 2006; Herbert, 2004; Ryb, 2007). However, this topic is considered to be more under the purview of NHTSA and the National Institute on Alcohol Abuse and Alcoholism. NHTSA's Behavioral Research Plan also covers alcohol/drug impaired driving and pedestrian safety as two of the primary focus

issues. While alcohol-related safety research is not a key focus area for FHWA, effort should be made to support and be involved in alcohol research funded by other agencies that may relate to pedestrian safety.

A number of pedestrian education evaluations have been conducted (Glang, 2005; Berry, 2006; Batu, 2004; Mitman, 2007; Harre, 2004; Zegeer, 2008a; Harre, 2004). This topic is considered to be more under the purview of NHTSA, and touched upon in NHSTA's Behavioral Study Plan, but collaboration in education research and product dissemination is encouraged.

As pedestrian safety problems have been recently identified in relation to driver (and/or pedestrian) distractions due to cell phones, text messaging, and other sources there may be value in conducting research to better quantify the increased dangers to pedestrians and to explore potential roadway and traffic control implications. Although the primary intervention to address this concern is likely related to education and enforcement of laws banning cell phone use or texting (which have been passed in several states), this topic could be of growing interest to FHWA as cell phone and other technology use continues to grow.

Another emerging topic is the issue of quiet cars (such as hybrids), which recent studies have found to pose more safety risks to pedestrians than conventional cars due to the fact that they are harder for pedestrians to hear and detect (<http://content.usatoday.com/communities/driveon/post/2009/11/620001194/1>). As the percentage of quiet vehicles in the car fleet grows, and as the U.S. population continues to age and experience more cases of hearing and vision loss, this issue will likely become more pressing over time as well as be compounded by technological advances being made in developing "quiet" roads and pavements. FHWA should continue to explore this issue along with NHTSA and other stakeholders.

Product Delivery and Technology Transfer

A review of the current technology transfer activities reveals that while printed guides and other more traditional transfer activities remain prevalent, agencies are relying more and more upon interactive Web-based training, software, and Web guides as those technologies have grown. The literature review covers product delivery and technology transfer activities in the following categories:

- Guides (both national and state/local)
- Training courses and workshops
- Webinars
- Conferences
- Newsletters
- Software
- Web sites

Guides are available for the application of pedestrian safety treatments, countermeasures, and best practices. The AASHTO guide for the development of pedestrian facilities and the PEDSAFE countermeasure selection system are two of the technical guides represented in the

current literature, and two of the more comprehensive. Other national level guides allow agencies to conduct evaluations of roadways and pedestrian facilities, such as the Road Safety Audit Guidelines and Prompt Lists developed by the Federal Highway Administration. The guidebook *How to Develop a Pedestrian Safety Action Plan* explores the development of comprehensive safety programs to address pedestrian safety. Guides are also available for citizens and advocacy groups, as well as health and transit professionals. Local guides primarily address the design requirements of certain municipalities.

A variety of in-person training courses are available, from those focusing on technical knowledge and engineering concepts, to those addressing the needs of citizens and advocates. Recently developed curriculums for university level students allow pedestrian safety training to be made available to young professionals before they enter engineering, planning, and health professions. An emerging strategy to disseminate material and offer training is through Webinars and Web conferences. A number of groups recognize the travel and budget constraints of local agencies, and have begun offering trainings through easily accessible online platforms. Groups such as the Pedestrian and Bicycle Information Center (PBIC), the Institute of Transportation Engineers (ITE), the Association of Pedestrian and Bicycle Professionals (APBP), the Federal Highway Administration (FHWA), and others offer Webinars on a variety of topics.

Many conferences are held annually to discuss transportation safety and transportation issues, many of which focus on pedestrians. Specifically, the Pro Walk/ProBike conference allows advocates, researchers, and other professionals to share knowledge and best practices related to pedestrian and bicycle safety. The Transportation Research Board (TRB) annual meeting also draws a large number of pedestrian researchers and engineers. International conferences, such as the Walk 21 conference, allow professionals from all over the world to discuss pedestrian safety issues. These conferences are routinely attended by FHWA and NHTSA staff, as well as other professional organizations with an interest in sharing and disseminating research and information.

Newsletters allow organizations to stay in touch with their members and disseminate recent and upcoming research, tools, and training opportunities. Groups, such as the PBIC, APBP, the National Center for Bicycling and Walking (NCBW), and the FHWA, offer newsletters.

Web sites represent another emerging technology that has been utilized to share knowledge, tools, and resources. Some of the more comprehensive Web sites include two national clearinghouses: the PBIC and the National Center for Safe Routes to School. These organizations are intended to serve as comprehensive libraries that cover all resources related to pedestrian safety. The FHWA also offers a variety of tools and resources through its Web sites – the FHWA Bicycle and Pedestrian Program, Office of Safety, and Safety Research: Pedestrians and Bicyclists.

It is recommended that product delivery strategies continue to take advantage of Web-based technologies, specifically through social media. The area of social media has grown at a rapid pace, and certain services (such as Twitter and Facebook) offer the opportunity to reach millions of individuals in an interconnected online network, at an extremely low cost. Pedestrian safety professionals and researchers can utilize these services to assist with technology transfer and

product delivery. In addition, listserv emails are a good method for the dissemination of information to interested individuals.

Key Findings from Stakeholder Input

As mentioned in the Methodology section, during the Stakeholder Workshop a discussion was held on “Prioritizing Recommended Research Initiatives and Activities.” This provided a unique opportunity for cooperation between the FTA, FHWA, and NHTSA, which all have an interest in pedestrian safety. During this time, three breakout groups were asked to define their research needs more specifically. Results were compiled for each group, combined with previous recommended research topics from the TRB pedestrian committee, and then presented to the entire group to be ranked (141 research topics in total) based on importance of the issue and feasibility of the research to be conducted and to reduce pedestrian crashes. From this, the 10 most significant research topics or product delivery methods identified during the 2008 workshop, in descending order, were:

1. Roadway design and other factors affecting vehicle speeds and motorists’ decision to yield to pedestrians (especially in urban areas), as well as countermeasures to slow speeds and improve driver yielding behavior
2. Comprehensive and interdisciplinary pedestrian coursework for engineering and planning students in universities
3. Research evaluating how speed limits are set, especially in urban areas, and best practices for setting speed limits
4. Impact of land use and development patterns on walking and factors affecting mode choice and pedestrian safety
5. Research on the safety effects of multimodal design to create “complete streets,” as well as best practices and training materials related to complete streets
6. Research on how communities allocate funds for pedestrians, how funding levels relate to pedestrian safety, and best practices for prioritizing and increasing funding available for pedestrian projects
7. A further review of crash reduction factors related to pedestrians, and the development of additional Crash Reduction Factors
8. Guidance on providing pedestrian safety resources and expertise to small communities who do not have trained/experienced traffic engineers with a pedestrian safety background
9. Guidance for improving transit and transportation agency coordination to increase the safety of midblock pedestrian crossings near transit
10. Research demonstrating the effects of narrowing vehicle lanes (i.e., using bike lanes and/or other measures) on pedestrian safety

Of the topics identified, several of these overlap with gaps identified in the literature, including a need for research to cover issues related to vehicle speed and effective countermeasures (1, 3); best practices in roadway design (5, 10); comprehensive and high-quality CRFs (7); an understanding of safety as related to land use and pedestrian activity (4); more knowledge on pedestrian issues related to transit (9). Topic #2 is currently being addressed by a number of universities, working in collaboration with the Pedestrian and Bicycle Information Center, to

share course materials and further develop and disseminate comprehensive and interdisciplinary university materials. In addition, a workshop is planned for the January 2010 TRB Annual Meeting to discuss issues surrounding transportation education in universities as related to pedestrian and bicycle planning and design. Related to the issue of education, Topic #8 seems highly relevant, as a large number of communities clearly lack professionals with training on pedestrian safety issues; thus, education and product delivery efforts should include small communities as a focus for technology transfer. Topic #6, while not identified in the literature review, is of extreme interest to practitioners, as funding is often the primary barrier cited for why more pedestrian safety improvements are not made.

After the stakeholder group ranked all 141 research needs statements, they ranked their first choice in each of the four main categories of the plan framework. The primary choices, generally consistent with the list above, for each section are listed in Table 16.

Table 16. Top Ranked Research Need in Each Plan Category.

Category	Top Research Need
Problem Identification and Data Collection	Developing recommended methodology for exposure methods/counts
Managing Safety through Analysis and Decision Making	Impact of land use and development patterns on walking and factors affecting mode choice, as well as safety
Development and Evaluation of Countermeasures	Research on the safety effects of multimodal design to create “complete streets,” as well as best practices and training materials related to complete streets
Product Delivery and Technology Transfer	Comprehensive and interdisciplinary pedestrian coursework for engineering and planning students in universities

The only topic in this list that wasn’t in the top 10 list above was the one on “developing recommended methodology for exposure methods/counts.” This topic is actually soon to be funded by an NCHRP study (08-78), entitled “Estimating Bicycle and Walking for Planning and Project Development,” but additional work in this area is needed (TRB, 2010).

Key Findings from Existing FHWA Product Evaluation

The results of Westat’s product evaluation survey are presented in several sections below. The first section describes characteristics about the respondent sample. The second section reports the findings of familiarity with each product/deployment, recent usage, and types of use for each product/deployment. The third section focuses on respondents’ rated ease of use of the product, its usefulness, and an assessment of the potential impact or positive outcome as a result of using the product/deployment. The fourth section reports summary responses to questions of knowledge gained, important future roles, and sharing for products/deployments based on prior use.

Respondent Characteristics

The survey was sent to 2,452 individuals who have ordered products/deployments from FHWA’s Web site and are based in the United States. Of those emailed, 478 completed the survey. Those respondents were asked several questions about race, employment, and education. A majority of the respondents were white (88 percent). Relative to other options, 62 percent worked in cities

100K or larger and 43 percent represented state or local government organizations. Respondent occupations included planners, engineers, consultants, and government employees, among others, but 25 percent of respondents identified themselves most with a category not listed as an option. Additionally, 36 percent had received a Master's degree.

Familiarity and Recent Usage

For each product, participants were asked two questions about familiarity and recent usage that determined whether they would move to the more detailed rating questions that are in the following sections. The first question was “Have you heard of or are you familiar with _____, which is a product/deployment from the Federal Highway Administration?” The response format was Yes/No (Figure 6). Only two products were familiar to a majority of the respondents: Walkability Checklist (60 percent) and Pedestrian Safer Journey (51 percent). In contrast, the products with the lowest level of familiarity were the Pedestrian and Bicyclist University Course (18 percent), the Pedestrian Safety Guide for Transit Agencies (19 percent), and the Pedestrian Road Safety Audit Guidelines and Prompt Lists (20 percent). This lack of familiarity could be a function of the specific target audience of these products, which may not have adequately matched the respondents to the questionnaire. In fact, despite the lack of familiarity, the Pedestrian and Bicyclist University Course was ranked highest in terms of usefulness and second highest in terms of impact, and the Pedestrian Road Safety Audit Guidelines and Prompt Lists was ranked highest in terms of giving recent users knowledge to help reduce crashes/injuries/fatalities. Additionally, the University Course also ranked high in playing an important role in reducing crashes/injuries/fatalities. Overall, there was a clear lack of familiarity with many products by a majority of respondents.

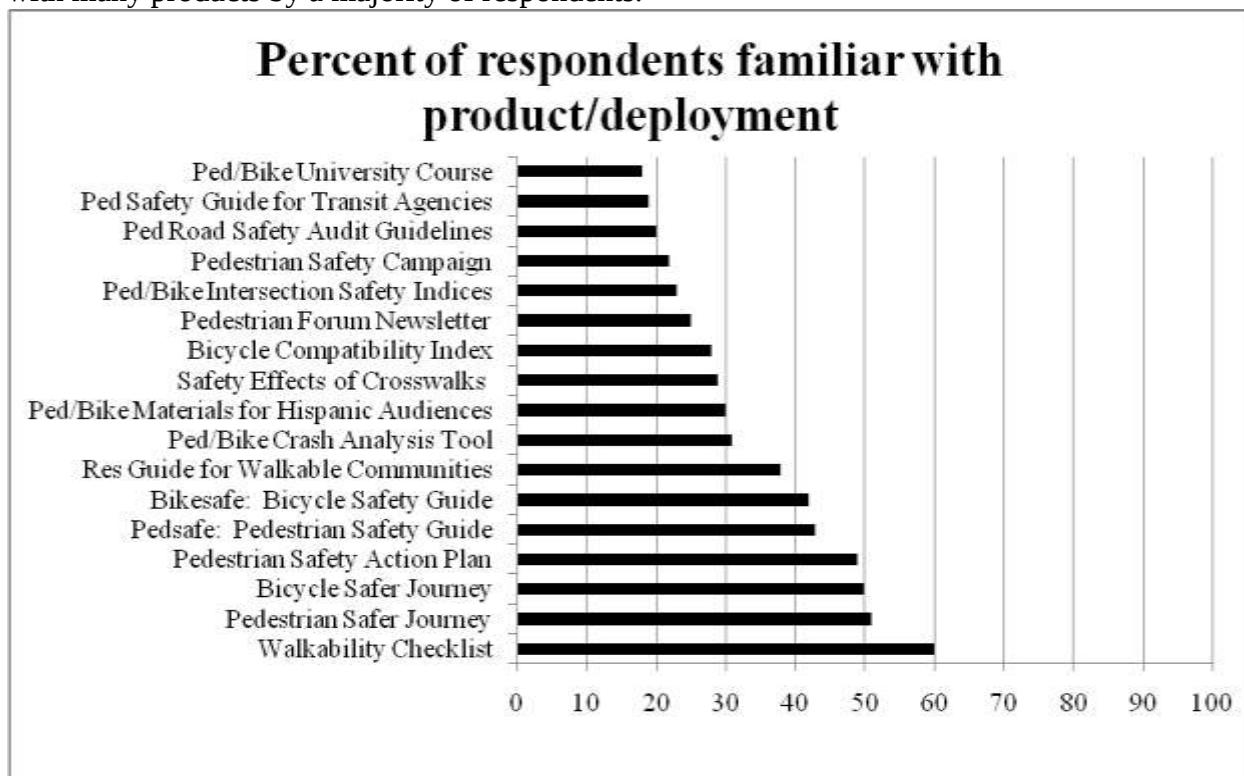


Figure 6. Percent of Respondents Familiar with Product/Deployment.

The second product/deployment question focused on recent usage: “Have you used _____ in the last three years?” The response format was Yes/No (Figure 7). The Walkability Checklist was the most commonly used product in the last three years, with almost a third of respondents having used it (31 percent). Several products were used by a small proportion of respondents: Pedestrian and Bicyclist University Course (6 percent), Pedestrian Safety Campaign (6 percent), Pedestrian Safety Guide for Transit Agencies (6 percent), and Pedestrian and Bicyclist Intersection Safety Indices (7 percent). Again, the lack of recent use could be attributed to the specific target audience of these products. Overall, in most cases only approximately half of respondents who claimed familiarity with a product actually used it in the last three years. *Types of Use* can be found in Appendix II.

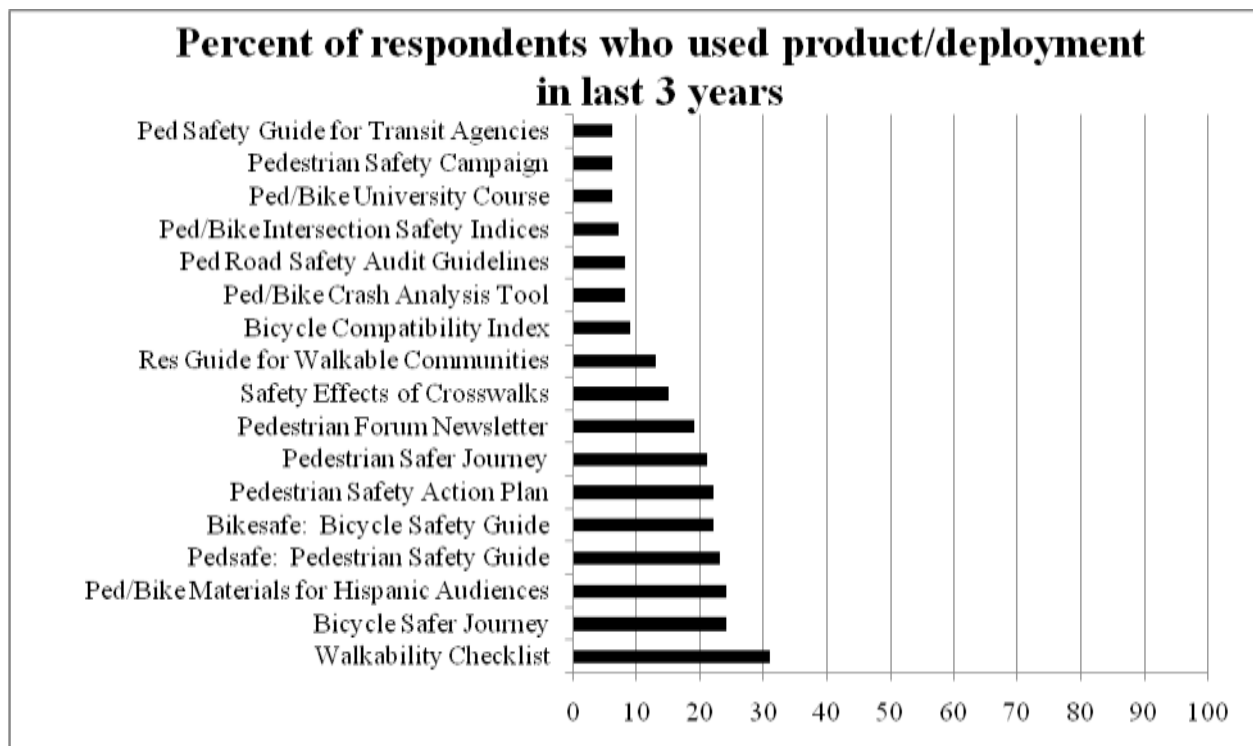
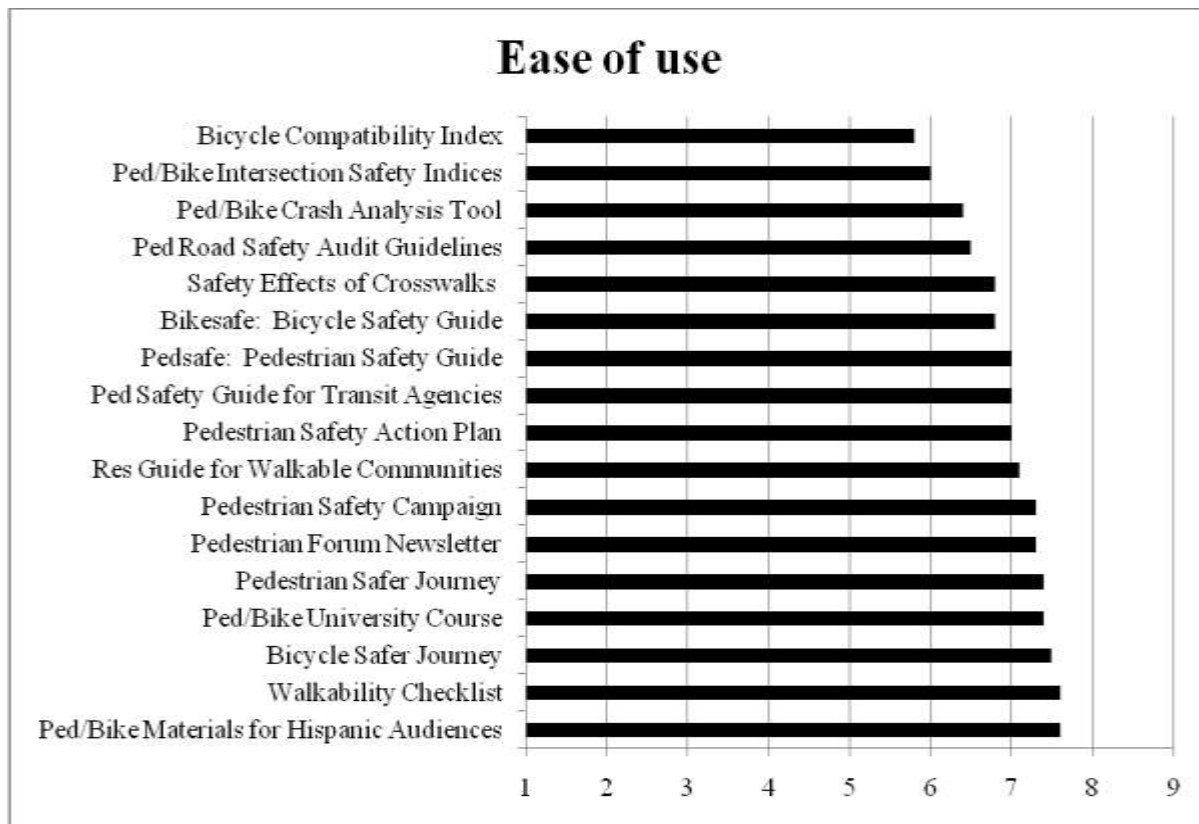


Figure 7. Percentage of Respondents Who Used Product/Deployment in Last Three Years.

Ease of Use, Usefulness, and Strength of Impact

Ease of Use

For each product, respondents were asked “How easy was _____ to use?” The response format was a rating scale that ranged from 1-9, with one being “extremely difficult to use” and nine being “extremely easy to use.” The mean ratings (Figure 8) are based only on the respondents who used the product/deployment in the last three years (“recent users”). The three products/deployments that *recent users* rated as the easiest to use were (mean rating in parenthesis): Pedestrian and Bicycle Safety Materials for Hispanic Audiences (7.6), Walkability Checklist (7.6), and Bicycle Safer Journey (7.5). In contrast, two products/deployments were rated the lowest in ease-of-use: Bicycle Compatibility Index (5.8) and Pedestrian and Bicycle Intersection Safety Indices (6.0). Overall, all products/deployments were rated above the scale midpoint (5) for ease-of-use.



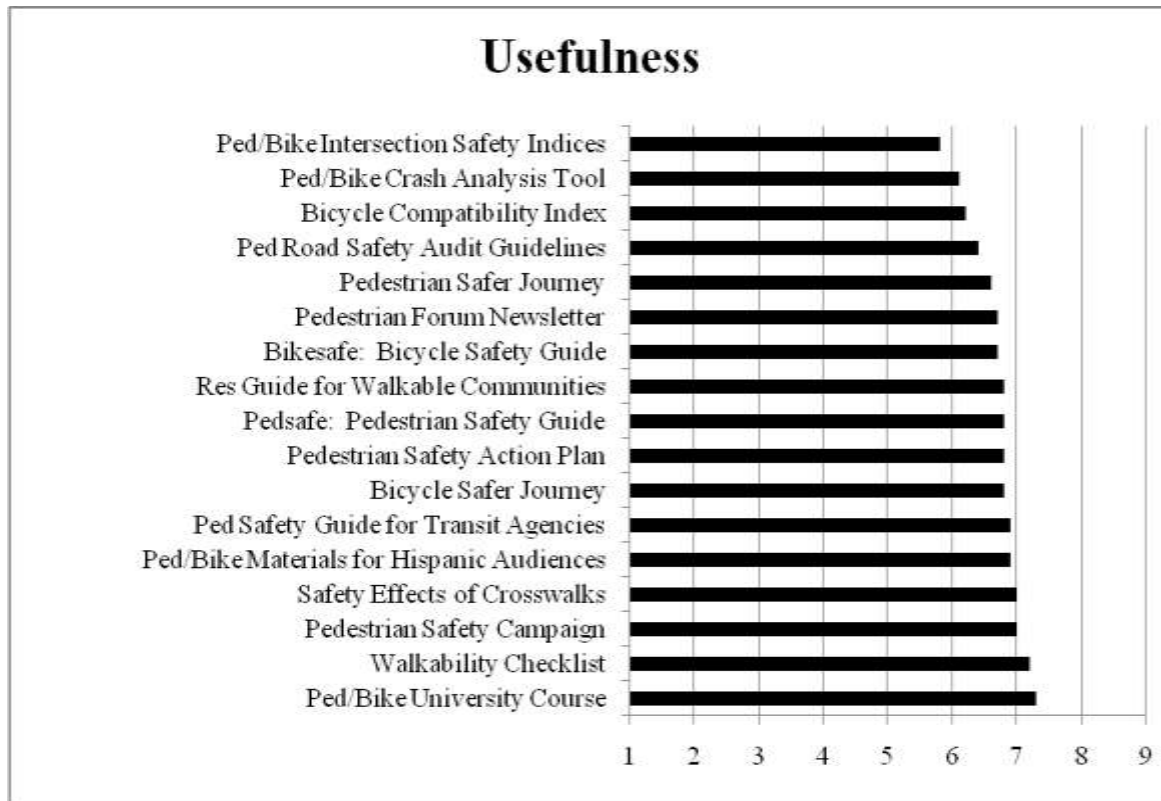
Note: 1 = Extremely difficult to use, 9 = Extremely easy to use

Figure 8. Average Reported Score for Ease of Use of Product/Deployment.

Usefulness

For each product, respondents were asked “How useful was _____ in helping you to carry out your work?” The response format was a rating scale that ranged from 1-9, with one being “extremely unuseful” and nine being “extremely useful.” The mean ratings (Figure 9) are based

only on the respondents who used the product/deployment in the last 3 years (“recent users”). The two products/deployments that *recent users* rated as the most useful (mean rating in parenthesis): Pedestrian and Bicyclist University Course (7.3) and Walkability Checklist (7.2). In contrast, three products/deployments were rated lowest in usefulness: Pedestrian and Bicycle Intersection Safety Indices (5.8), Ped/Bike Crash Analysis Tool (6.1), and Bicycle Compatibility Index (6.2). Overall, all products/deployments were rated above the midpoint (5) for ease-of-use.

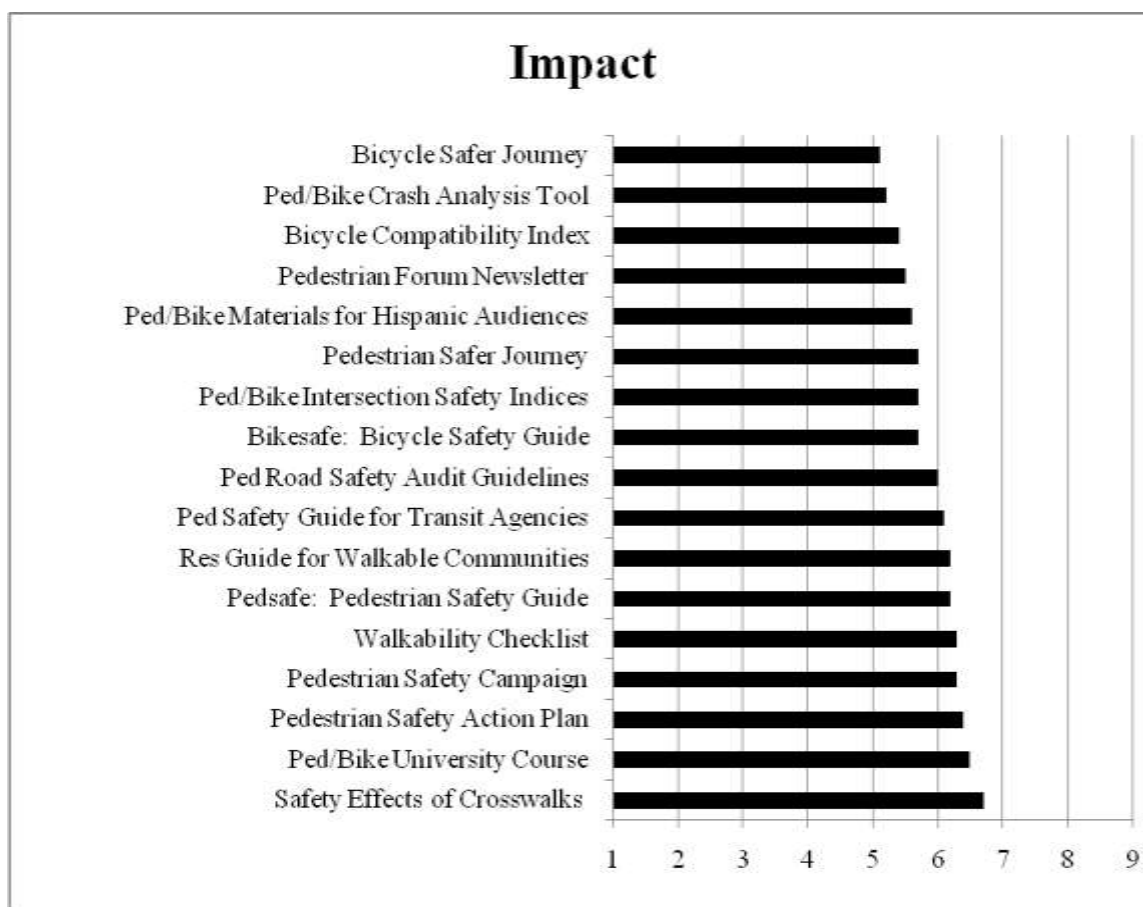


Note: 1 = Extremely unuseful, 9 = Extremely useful

Figure 9. Average Usefulness Score for Recently Used Products/Deployments.

Strength of Impact

For each product, respondents were asked “How much of an impact did _____ have on the way you carried out your work?” The response format was a rating scale that ranged from 1-9, with one being “extremely weak impact” and nine being “extremely strong impact.” The mean ratings (Figure 10) are based only on the respondents who used the product/deployment in the last three years (“recent users”). The three products/deployments rated as having the most impact (mean rating in parenthesis): Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations (6.7), Pedestrian and Bicyclist University Course (6.5), and How to Develop a Pedestrian Safety Action Plan (6.4). In contrast, three products/deployments were rated lowest in impact: Bicycle Safer Journey (5.1), Ped/Bike Crash Analysis Tool, and Bicycle Compatibility Index (5.4).



Note: 1 = Extremely weak impact, 9 = Extremely strong impact

Figure 10. Average Safety Impact Ranking as Perceived by Recent Users of Products/Deployments.

Knowledge Gained, Important Future Role, and Sharing

Knowledge that Contributed to Reduction of Crashes/Injuries/Fatalities

For each product, respondents were asked “Did the _____ give you knowledge that contributed to a reduction of crashes, injuries, and/or fatalities in your state/locality?” The response format was Yes/No. The percentages are not based on all respondents, but only on the respondents who used the product/deployment in the last three years (“recent users”), which was relatively small subset for many products (Figure 11). The three products/deployments that the most *recent users* felt gave them knowledge to help reduce crashes/injuries/fatalities were: Pedestrian Road Safety Audit Guidelines and Prompt Lists (65 percent), How to Develop a Pedestrian Safety Action Plan (64 percent), and Ped/Bike Crash Analysis Tool (64 percent). In contrast, the three products/deployments with the fewest percentages of recent users affirming useful knowledge in reducing crashes/fatalities/injuries were: Pedestrian and Bicycle Safety Materials for Hispanic Audiences (37 percent), Pedestrian Safety Guide for Transit Agencies (40 percent), and Pedestrian Forum Newsletter (43 percent).

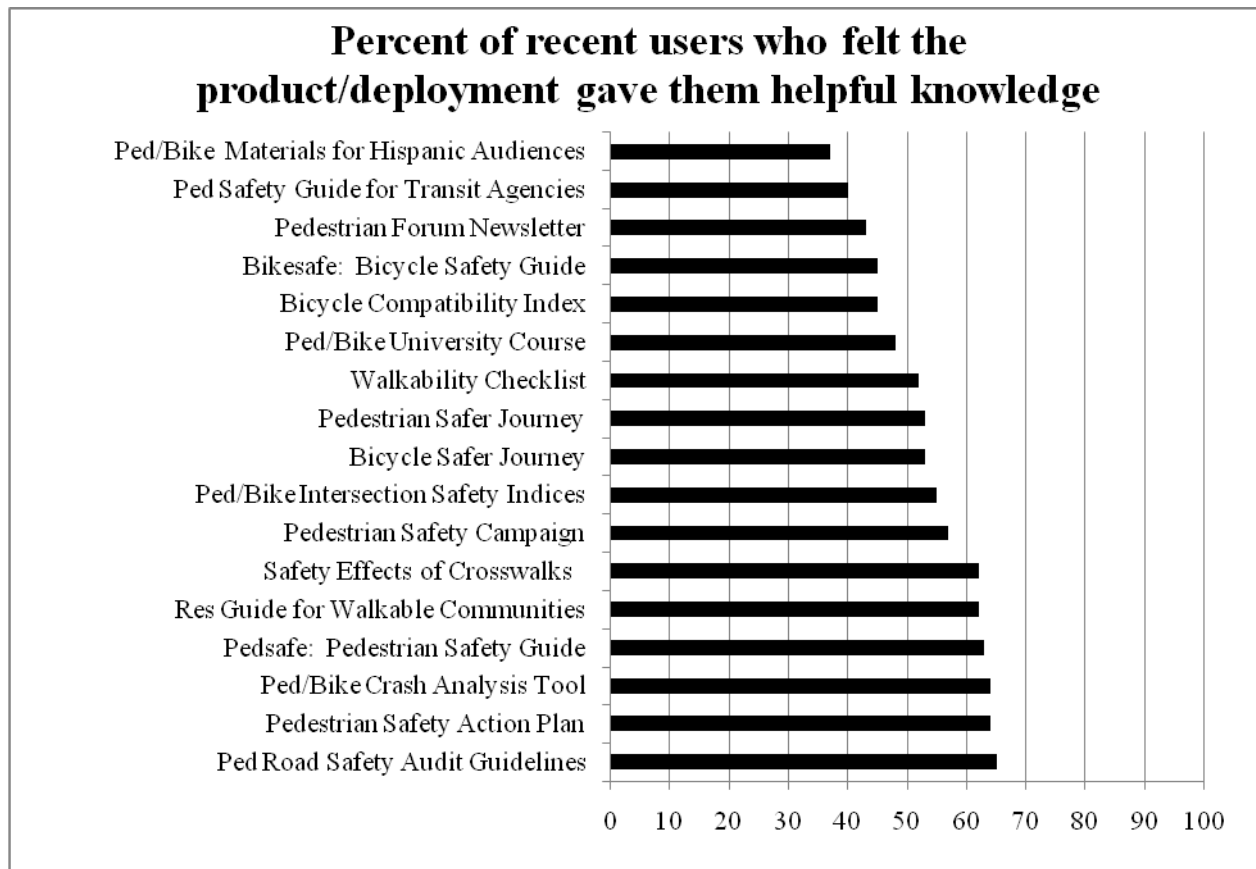


Figure 11. Percent of Recent Users Who Felt the Product/Deployment Gave them Helpful Knowledge.

Important Future Role in Reducing Crashes/Injuries/Fatalities

For each product, respondents were asked “Will the _____ play an important role in reducing crashes, injuries, and/or fatalities in the FUTURE?” The response format was Yes/No (Figure 12). The percentages displayed are not based on all respondents, but only on the respondents who used the product/deployment in the last three years (“recent users”), which was relatively small subset for many products. The three products/deployments that the most *recent users* felt would play an important future role in reducing crashes/injuries/fatalities were: Pedsafe: Pedestrian Safety Guide and Countermeasure Selection System (88 percent), How to Develop a Pedestrian Safety Action Plan (84 percent), Resident's Guide for Creating Safe and Walkable Communities (84 percent). In contrast, the three products/deployments with the fewest percentages of recent users affirming an important future role in reducing crashes/fatalities/injuries were: Pedestrian Forum Newsletter (66 percent), Pedestrian Safety Guide for Transit Agencies (67 percent), and Pedestrian and Bicycle Safety Materials for Hispanic Audiences (68 percent). Overall, Pedestrian and Bicycle Safety Materials for Hispanic Audiences, Pedestrian Safety Guide for Transit Agencies, and the Pedestrian Forum Newsletter had the lowest percentages of recent users that felt those products/deployments had useful information and would play an important role in reducing crashes/injuries/fatalities.

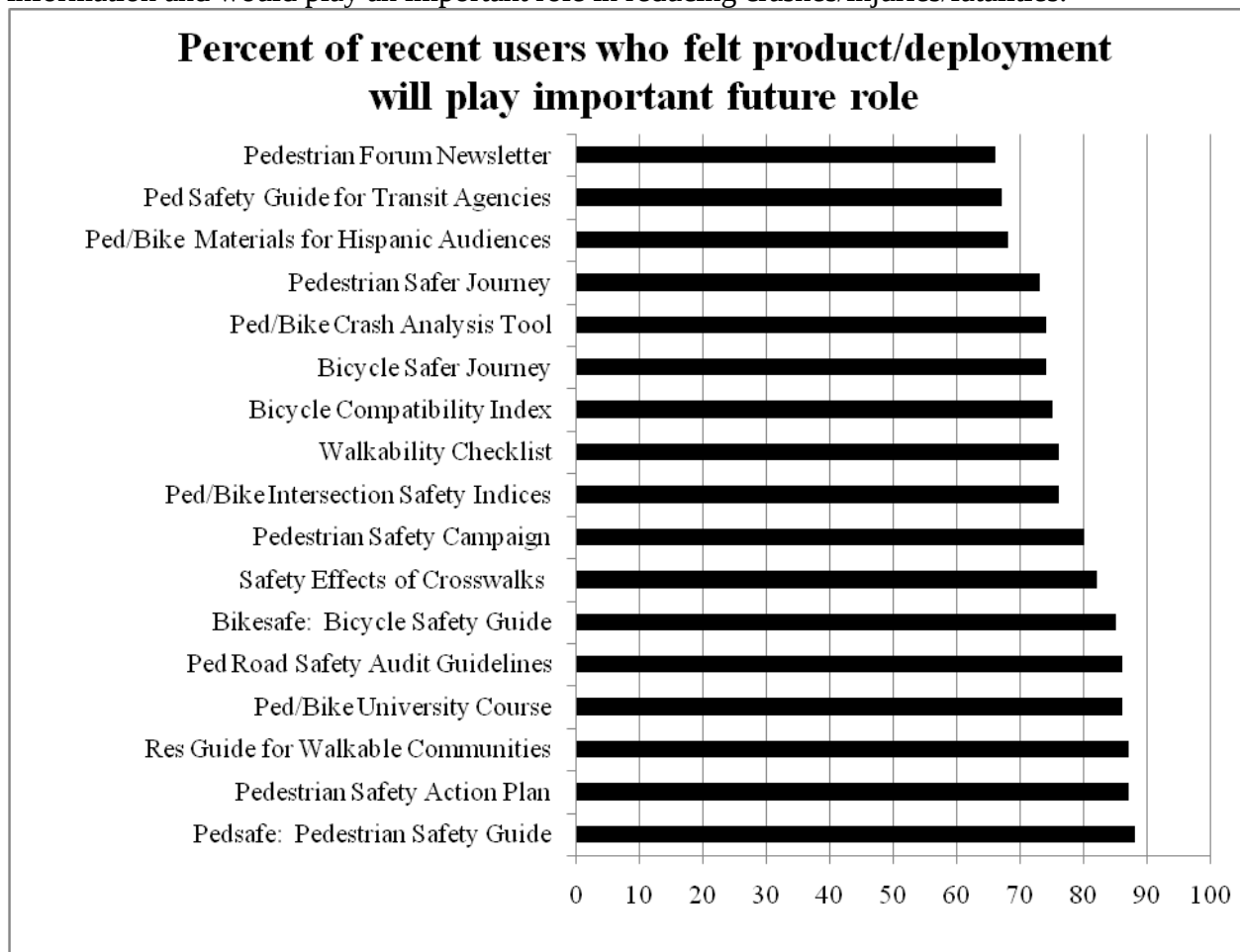


Figure 12. Percent of Recent Users Who Felt Product/Deployment Will Play Important Future Role.

Sharing and Product Delivery Methods

A large proportion of respondents shared products/deployments with others (69 percent, or 328 respondents). The percentages below are from the participants who reported sharing products/deployments (Figure 13). Note that participants were able to select more than one response, so totals will not add to 100. Respondents who reported sharing products/deployments chose to share them with: co-workers at their place of employment (66 percent), other professionals in their field (64 percent), and 30 percent shared with a variety of other people (with large portions going to students, parents, education professionals, activists, customers, and clients).

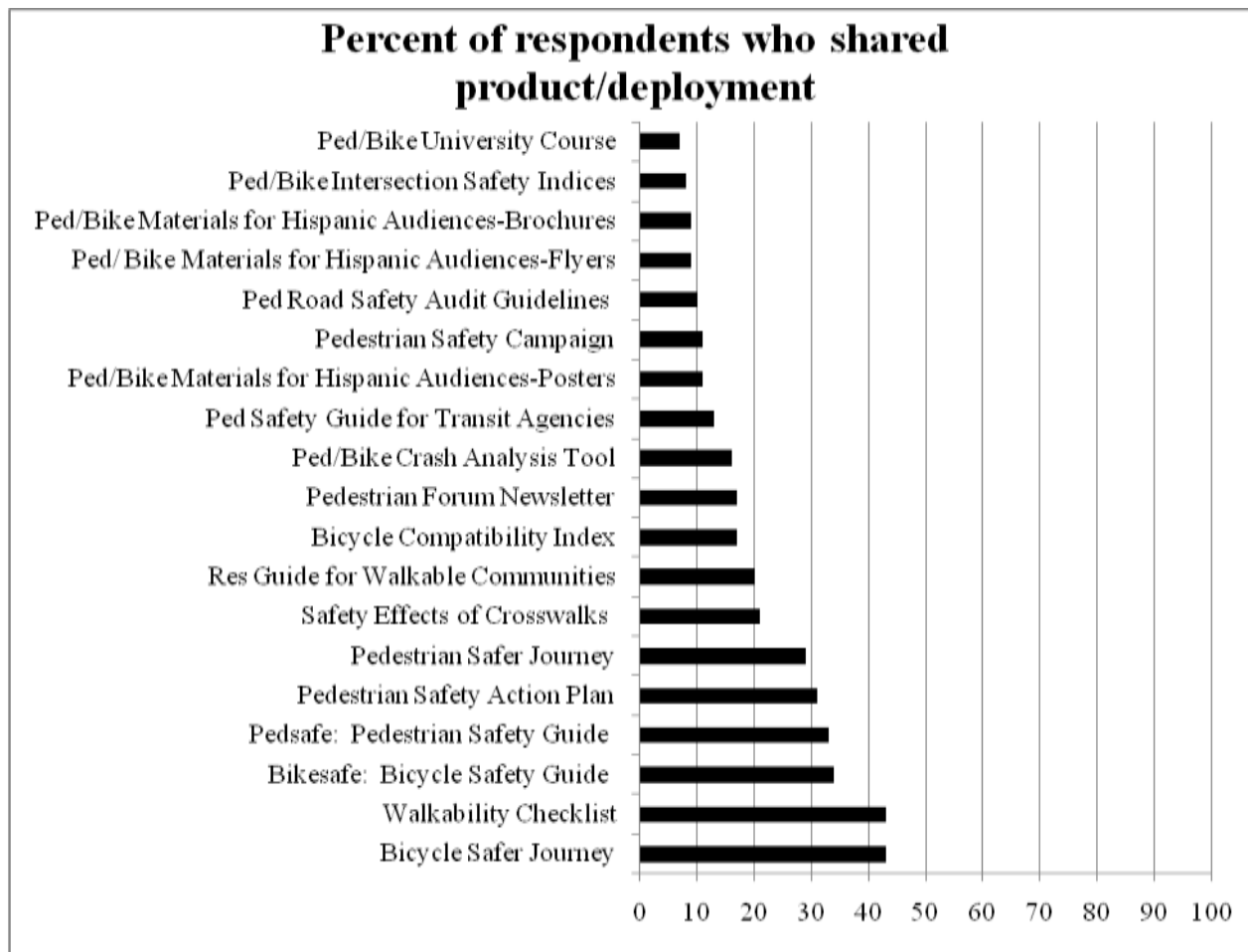


Figure 13. Percent of Respondents Who Shared Product/Deployment.

Respondents preferred to receive their information via e-mail (77 percent), followed by the Web site (68 percent), postal mail (43 percent), Webconference/Webinar (31 percent), conference (19 percent), RSS (6 percent), and other (4 percent). Please note that participants were able to select more than one option, so these percentages do not total 100.

Miscellaneous Product Comments

A subset of participants who volunteered for a short follow-up telephone interview was contacted following completion of the Web survey. Up to five participants were interviewed about each product/deployment (and each person was interviewed about one product). In addition to these telephone interviews, Web survey participants were able to leave additional comments about each product during the Web survey. A summary of representative comments derived from these two sources can be found in Appendix II.

Overall Conclusions from Product Evaluation

Overall, in most cases only about half of respondents who claimed familiarity with a product actually used it in the last three years. Even among transportation professionals who had previously ordered FHWA materials, there appeared to be a widespread lack of familiarity with the many FHWA products available for use. Additional marketing and distribution of these materials is needed. The Pedestrian and Bicyclist University Course and Pedestrian Safety Guides for Transit Agencies, however, are targeted at smaller audiences, which may account for the lack of knowledge about or use of these products among survey respondents.

In terms of ease of use, the products/deployments that recent users rated as the easiest to use were those geared for widespread use by a more general audience, while the most difficult to use products tended to be more technical in nature and require significant data inputs. There appears to be a need for more products aimed at a general audience that can be easily used by all, or more training and support for practitioners wanting to use the more technical tools.

In general, all products/deployments were rated fairly high in terms of usefulness. However, some of the products that were ranked as the most useful (such as the University Course) were also ranked as the least used (not necessarily by the same respondents). This indicates a critical need to ensure that more professionals are aware of these products and also that any marketing efforts are targeted at those professionals most likely to use the products.

The products/deployments rated as having the most impact on improving pedestrian safety tended to be the products that have been the most heavily marketed and supported by programmatic efforts (such as Webinars, monthly conference calls, listservs, workshops, and even funding to use and apply the information) to engage and train transportation professionals on the use of these products. For example, the How To Guide has been extensively marketed, additional content has been added, and courses were developed to supplement the guide and teach the materials to focus states throughout the U.S. over the past several years. For the Resident's Guide and the Road Safety Audit products, NHTSA and/or FHWA has provided funding for communities to pilot test the guides and also developed presentations and courses to help professionals and communities use the materials. More effort to systematically support the use of key products and research tools appears necessary in order for the projects to have an impact on pedestrian safety.

In relation to product delivery, respondents preferred to receive their information through web-based formats, including e-mail (77 percent), Web site (68 percent), and Webconference/Webinar (31 percent). Only 19 percent of respondents preferred receiving information through conferences, as travel budgets to attend such events are increasingly shrinking. It is recommended that product delivery strategies continue to take advantage of Web-based technologies, and to look more into opportunities for using social media, which is growing at a rapid pace and offers a low-cost option for reaching millions of individuals in an interconnected online network. This recommendation is consistent with the discussion in the Technology Transfer section of the literature review.

Technology Transfer

Several key audiences were identified as the potential users and benefactors of the above research projects and technology transfer activities:

- Transportation engineers/planners (both with and without pedestrian safety training)
- University students
- Ethnic populations
- Police officers
- Political leaders

Several methods and tactics were identified for conducting technology transfer:

- Web-based training
- Interactive use of social media
- Web site development and communication
- In-person training/workshops
- Direct mailing and e-mailing (can be through social media also)
- Event marketing at meetings/conferences
- Media relations with trade publications
- Certification for Professional Traffic Operations Engineer (PTOE) in pedestrian safety
- Traffic engineering internship program
- Public/private partnerships
- Supporting the use of the products through pilot programs and grants/projects to encourage use of the materials

The appropriateness of the information dissemination method or program will depend on the subject matter as well as the intended audience.

Nationwide, several “focus areas” may be good opportunities to distribute information and focus technology deployment. These include the geographic locations identified in the analysis of current and predicted pedestrian safety issues, including:

- Growing urban/suburban areas where pedestrian safety concerns may be compounded by poor facility design practices and rapid urbanization
- Areas in the Southwest U.S. and South U.S., which have had a history of pedestrian

- safety concerns and are experiencing a rise in vulnerable populations
- Cities with an overrepresentation of older or immigrant populations
- Smaller communities that do not have a trained or dedicated pedestrian coordinator or planner on staff

Limitations of the Study

A few elements may have affected the results of this project. First, lack of thorough pedestrian exposure data limited the level of exploration possible of high risk locations and populations across the U.S. Thus, the potential of the recommended research and projects to improve pedestrian safety cannot be accurately predicted or evaluated. Additionally, much of the recommended research was based on the expert opinion of the project team, as influenced by the available research, results of the pedestrian crash analysis, and input from the stakeholder groups. While all effort was made to establish a balanced and representative cross-section of pedestrian safety experts from across the U.S., the opinions obtained are nevertheless subjective and limited to the personal experiences and knowledge of those experts and may not be informed by or consistent with the full body of scientific evidence available.

Recommendations for Future Activities

It is recommended that the FHWA Office of Safety and the Turner Fairbank Pedestrian and Bicyclist Research and Development Program develop and implement a Strategic Plan that is informed by the findings in this report. This plan should be developed in collaboration with the stakeholders who have contributed to the findings in this report, as well as other agencies with an interest in pedestrian safety including the FTA and NHTSA. In implementing the Plan, it is recommended that the Offices continue collaboration and communication with other FHWA offices, programs, and other DOT agencies to coordinate and fund research topics with the highest potential to improve pedestrian safety nationwide.

Further, it is recommended that the Offices continue outreach to stakeholders, to obtain feedback on both the implementation and the evaluation of the Strategic Plan over time, and to respond to changes over time. The project team recommends yearly meetings of the technical advisory group and the stakeholder panel, among others, to assess the progress of the Strategic Plan implementation. In addition, a larger outreach effort could be conducted to survey the attitudes, perceptions, and statements of need from a broader group of pedestrian safety stakeholders, researchers, and other interest groups.

REFERENCES

1. AASHTO. (2004). *AASHTO guide for the planning, design, and operation of pedestrian facilities, 1st edition*. Washington, D.C.: American Association of State Highway Transportation Officials. Retrieved from <http://www.walkinginfo.org/library/details.cfm?id=2067>
2. Acharjee, S., Kattan, L., & Tay, R. (2009). *A Pilot Study on Pedestrian Scramble Operations in Calgary*. Presented at the 2009 Annual Meeting of the Transportation Research Board. Washington, D.C.: Transportation Research Board.
3. Alta Planning & Design. (2005). *Pedestrian and bicycle facilities in California: A technical reference and technology transfer synthesis for Caltrans planners and engineers*. Oakland, CA: Metropolitan Transportation Commission. Retrieved from http://www.dot.ca.gov/hq/traffops/survey/pedestrian/TR_MAY0405.pdf
4. Antonucci, N.D., Hardy, K.K., Slack, K.L., Pfefer, R., & Neuman, T.R. (2004). *A guide for addressing crashes at signalized intersections*. NCHRP Report 500, 12. Washington, D.C.: Transportation Research Board.
5. Archer, J., Fotheringham, N., Symmons, M., & Corben, B. (2008). Report #276 - The impact of lowered speed limits in urban and metropolitan areas. Monash University Accident Research Center. Retrieved from <http://www.monash.edu.au/muarc/reports/muarc276.html>
6. Austin, D. (2008). *Effects of gasoline prices on driving behavior and vehicle markets*. Washington, DC: Congressional Budget Office. Retrieved from <http://www.cbo.gov/ftpdocs/88xx/doc8893/01-14-GasolinePrices.pdf>
7. Axelson, P.W., Chesney, D.A., Galvan, D.V., Kirschbaum, J.B., Longmuir, P.E., Lyons, C., et al. (1999). *Designing sidewalks and trails for access, part I: Review of existing guidelines and practices*. Washington, D.C.: Federal Highway Administration. Retrieved from <http://www.fhwa.dot.gov/environment/sidewalks/>
8. Banerjee, I. and Ragland, D.R. (2007). Evaluation of countermeasures: A study on the effect of impactable yield signs installed at four intersections in San Francisco.” Presented at the 2007 Annual Meeting of the Transportation Research Board. Washington, D.C.: Transportation Research Board.
9. Barton, B.K., & Schwebel, D.C. (2007). The influences of demographics and individual differences on children’s selection of risky pedestrian routes. *Journal of Pediatric Psychology*, 32(3), 343-353.
10. Batu, S., Ergenekon, Y., Erbas, D., Akmanoglu, N. (2004). Teaching pedestrian skills to individuals with developmental disabilities. *Journal of Behavioral Education*, 13(3), 147-164. Retrieved from

<http://www.springerlink.com/content/wqm316474r635322/>

11. Bentzen, B.L., Scott, A.C., & Barlow, J.M. (2006). Accessible pedestrian signals: Effect of device features,” *Journal of the Transportation Research Board*, Number 1982, 30-37.
12. Berry, D. S. & Romo, C.V. (2006). Should ‘Cyrus the Centipede’ take a hike? Effects of Exposure to a pedestrian safety program on children’s safety knowledge and self-reported behaviors. *Journal of Safety Research*, 37(4), 333-341. Retrieved from <http://dx.doi.org/10.1016/j.jsr.2006.05.003>
13. Boarnet, M. G., Day, K., Anderson, C., McMillan, T., & Alfonzo, M. (2005). California's safe routes to school program. *Journal of the American Planning Association*, 71 (3), 301-317. Retrieved from <http://www.uctc.net/papers/773.pdf>
14. Bowman, B.L., & Vecellio, R.L. (1994). *Investigation of the impact of medians on road users*. (FHWA-RD-93-130). McLean, VA: Federal Highway Administration. Retrieved from <http://www.walkinginfo.org/library/details.cfm?id=2675>
15. Boyce, P., & Van Derlofske, J. (2002). *Pedestrian crosswalk safety: Evaluating in-pavement, flashing warning lights*. (FHWA-NJ-2002-015). Washington, D.C.: Federal Highway Administration. Retrieved from http://ntl.bts.gov/lib/19000/19700/19724/Crosswalk_Safety_Report.pdf
16. Bureau of Transportation Statistics. (2004). Sidewalks promote walking. *BTS Issue Brief*, Number 12. Washington, D.C.: U.S. Department of Transportation. Retrieved from http://www.bts.gov/publications/issue_briefs/number_12/pdf/entire.pdf
17. Bureau of Transportation Statistics. (2009 – Forthcoming). *2008 National Household Travel Survey*. Washington, D.C.: U.S. Department of Transportation. Retrieved from <http://nhts.ornl.gov/>
18. Campbell, B. J., Zegeer, C. V., Huang, H. H., & Cynecki, M. J. (2004). *A review of pedestrian safety research in the United States and abroad*. (FHWA-RD-03-042). McLean, Va.: Federal Highway Administration. Retrieved from http://www.walkinginfo.org/pdf/PedSynth/Ped_Synthesis_Report.pdf
19. Carter, D. L., Hunter, W. W., Zegeer, C. V., Stewart, J. R., & Huang, H. F. (2006). *Pedestrian and bicyclist intersection safety indices: Final report*. (FHWA-HRT-06-125). McLean, VA: Federal Highway Administration. Retrieved from <http://www.tfhr.gov/safety/pedbike/pubs/06125/06125.pdf>
20. Chang, D. (2008). *National Pedestrian Crash Report (DOT HS 810 968)*. Washington, DC: National Highway Traffic Safety Administration. Retrieved from <http://www.walkinginfo.org/library/details.cfm?id=4396>

21. Christie, N., Ward, H., Kimberlee, R., Towner, E., & Sleney, J. (2007). Understanding high traffic injury risks for children in low socioeconomic areas: a qualitative study of parents' views. *Injury Prevention*, 13(6), 394-397. Retrieved from <http://injuryprevention.bmj.com/cgi/content/abstract/13/6/394>
22. Chu, X. & M.R. Baltes. (2001). *Pedestrian mid-block crossing difficulty*. Prepared for the Florida Department of Transportation. National Center for Transit Research, University of South Florida. Retrieved from <http://www.dot.state.fl.us/Planning/systems/sm/los/pdfs/pedestrian.pdf>
23. Chu, X. (2003). *Testing behavioral hypotheses on street crossing*. Presented at the 2003 Annual Meeting of the Transportation Research Board. Washington, DC: Transportation Research Board. Retrieved from http://www.dot.state.fl.us/Safety/ped_bike/handbooks_and_research/research/Why%20People%20Cross.pdf
24. City of Louisville. (2007). *Louisville Metro Complete Streets Manual*. City of Louisville, KY. Retrieved from <http://www.louisvilleky.gov/BikeLouisville/Complete+Streets/>
25. City of Stockton. (2003). *Pedestrian safety and crosswalk installation guidelines*. Stockton, CA: Public Works. Retrieved from <http://www.stocktongov.com/publicworks/publications/PedGuidelines.pdf>
26. Cleven, A. M., & Blomberg, R. D. (2007). *A compendium of NHTSA pedestrian and bicyclist traffic safety research projects, 1969-2007*. (DOT HS 810 793). Washington, D.C.: National Highway Traffic Safety Administration. Retrieved from <http://www.nhtsa.gov/staticfiles/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/HS810793.pdf>
27. Clifton, K., Krizek, K. (2004). The Utility of the NHTS in Understanding Bicycle and Pedestrian Travel. Retrieved from <http://onlinepubs.trb.org/onlinepubs/archive/conferences/nhts/Krizek.pdf>
28. Clifton, K. & Livi, A.D. (2005). Gender differences in walking behavior, attitudes about walking, and perception of the environment in three Maryland communities. *Research on Women's Issues in Transportation*. Washington, D.C.: Transportation Research Board.
29. Clifton, K.J., Livi Smith, A.D., & Rodriguez, D. (2007). The development and testing of an audit for the pedestrian environment. *Landscape and Urban Planning*, 80, 95–110.
30. Clifton, K.J., & Kreamer-Fults, K. (2007). An examination of the environmental attributes associated with pedestrian-vehicular crashes near public schools. *Accident*

- Analysis & Prevention*, 39(4), 708-715. Retrieved from <http://www.sciencedirect.com/science/article/B6V5S-4MK614M-2/1/71675f009126ca99ab3e7eb0509fe738>
31. Corben, B.F., Logan, D.B. & Oxley, J.A. (2008). *Star rating school walking routes*. Report 275. Victoria, Australia: Monash University Accident Research Centre. Retrieved from <http://www.monash.edu.au/muarc/reports/muarc275.pdf>
 32. Cradock, A. (2009). Factors associated with federal transportation funding for local pedestrian and bicycle programming and facilities. *Journal of Public Health Policy*, 30, S38-S72.
 33. Dewey, J. F., Demslow, D., Lenze, D., Holt, L., & Lotfinia, B. (2003). *Transportation issues: pedestrian safety*. University of Florida. Florida Department of Transportation. Retrieved from http://www.dot.state.fl.us/research-center/Completed_Proj/Summary_PL/FDOT_BC354_44_Ped_rpt.pdf
 34. Eccles, K. A., Tao, R., & Mangum, B. C. (2004). *Evaluation of pedestrian countdown signals in Montgomery County, Maryland*. Presented at the 2004 Annual Meeting of the Transportation Research Board. Washington, D.C.: Transportation Research Board.
 35. Ellis, R., Van Houten, R., & Kim, J-L. (2007). In-roadway "Yield to Pedestrians" signs: Placement distance and motorist yielding. *Journal of the Transportation Research Board*, Number 2002, 84-89.
 36. Elvik, R. & Vaa, T. (2004). *Handbook of road safety measures*. Oxford, United Kingdom: Elsevier.
 37. Erke, A. & Elvik, R. (2007). *Making vision zero real: Preventing pedestrian accidents and making them less severe*. Oslo, Norway: Institute of Transport Economics.
 38. Ernst, M., & Shoup, L. (2009). *Dangerous by Design*. Transportation for America. Washington, D.C. Retrieved from http://t4america.org/docs/dangerousbydesign/dangerous_by_design.pdf
 39. Fatality Analysis Reporting System (FARS). (2008). *National Rates: Fatalities*. Retrieved from <http://www-fars.nhtsa.dot.gov/Main/index.aspx>.
 40. Fayish, A.C. & Gross, F. (2009). *Safety effectiveness of leading pedestrian intervals using the empirical Bayes method*. Presented at the 2009 Annual Meeting of the Transportation Research Board. Washington, D.C.: Transportation Research Board.
 41. Federal Highway Administration (FHWA). (nd). *Travel analysis framework: Profile of the United States*. Washington, DC: Author. Retrieved from

- http://nhts.ornl.gov/2001/pub/Profile_United_States.pdf
42. Federal Highway Administration. (2009a). *Pedestrian & bicycle program*. Washington, D.C.: Author. Retrieved from <http://www.fhwa.dot.gov/environment/bikeped/index.htm>.
 43. Federal Highway Administration. (2009b). *Pedestrian & bicycle safety*. Washington, D.C.: Author. Retrieved from http://safety.fhwa.dot.gov/ped_bike/.
 44. Federal Highway Administration. (2009c). *Pedestrian forum newsletter*. Washington, D.C.: Author. Retrieved from http://safety.fhwa.dot.gov/ped_bike/pedforum/
 45. Federal Highway Administration. (2009d). *Pedestrian safety focus cities/states webconference*. Washington, D.C.: Author. Retrieved from http://safety.fhwa.dot.gov/ped_bike/ped_focus/webinar.cfm
 46. Federal Highway Administration. (2008). *Toolbox of countermeasures and their potential effectiveness for pedestrian crashes. Issue Briefs*. (FHWA-SA-014). Washington, D.C.: Author. Retrieved from http://safety.fhwa.dot.gov/ped_bike/tools_solve/ped_tctpepc/index.cfm
 47. Federal Highway Administration. (2007). *Traffic Safety Facts: Rural/Urban Comparison*. Washington, DC: NHTSA National Center for Statistical Analysis. Retrieved from <http://www-nrd.nhtsa.dot.gov/Pubs/810996.PDF>.
 48. Federal Highway Administration. (2006a). *Highway Statistics: Finance*. Retrieved from <http://www.fhwa.dot.gov/policy/ohim/hs06/finance.htm>.
 49. Federal Highway Administration. (2006b). *Travel characteristics of new immigrants. NHTS Brief*. Washington, DC: Author. Retrieved from <http://nhts.ornl.gov/briefs/Immigrant%20Travel.pdf>
 50. Federal Highway Administration. (2004). *The National Bicycling and Walking Study, Ten Year Status Report*. Washington, D.C.: Author. Retrieved from <http://www.bicyclinginfo.org/library/details.cfm?id=5>
 51. Federal Highway Administration. (2003). *Pedestrian safety campaign*. Washington, D.C.: Author. Retrieved from http://safety.fhwa.dot.gov/local_rural/pedcampaign/
 52. Federal Highway Administration. (2001). *Traffic Safety Facts: Rural/Urban Comparison*. Washington, DC: NHTSA National Center for Statistical Analysis. Retrieved from <http://www-nrd.nhtsa.dot.gov/Pubs/809524.PDF>
 53. Federal Highway Administration. (1999). *The National Bicycling and Walking Study, Five Year Status Report*. Washington, D.C.: Author. Retrieved from <http://www.fhwa.dot.gov/environment/bikeped/study.htm#s1>

54. Federal Highway Administration. (1994). *The National Bicycling and Walking Study: Transportation Choices for a Changing America*. Washington, DC: Author.
55. Federal Transit Administration. *Grants and Financing: Historical Data*. Washington, DC: Author. Retrieved from http://www.fta.dot.gov/funding/data/grants_financing_1090.html
56. Fitzpatrick, K., Turner, S., Brewer, M., Carlson, P., Ullman, B., Trout, N., et al. (2006). *Improving pedestrian safety at unsignalized crossings*. (TCRP Report 112/NCHRP Report 562). Washington, D.C.: Transportation Research Board. Retrieved from http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w91.pdf
57. Fitzpatrick, K. & Park, E.S. (2009). *Safety effectiveness of the HAWK pedestrian treatment*. Presented at the 2009 Annual Meeting of the Transportation Research Board. Washington, D.C.: Transportation Research Board.
58. Foley, D.J., Heimovitz, H.K., Guralnik, J.M. & Brock D.B. (2002). Driving life expectancy of persons aged 70 years and older in the United States. *American Journal of Public Health*, 92(8), 1284-1289.
59. Frey, W.H. (2007). Mapping the growth of older America: Seniors and boomers in the early 21st century. Washington, DC: *The Brookings Institution*. Retrieved from http://www.brookings.edu/~media/Files/rc/papers/2007/0612demographics_frey/0612demographics_frey.pdf
60. Frey, W.H. (2008, August 18). The census projects minority surge. *The Brookings Institution*. Retrieved from http://www.brookings.edu/opinions/2008/0818_census_frey.aspx
61. Frey, W.H., Berube, A., Singer, A., Wilson, J.H. (2009). Getting current: Recent demographic changes in metropolitan America. Washington, DC: *The Brookings Institution*. Retrieved from http://www.brookings.edu/reports/2009/~media/Files/rc/reports/2009/03_metro_demographic_trends/03_metro_demographic_trends.pdf
62. Garder, P.E. (2004). The impact of speed and other variables on pedestrian safety in Maine. *Accident Analysis & Prevention*, 36(4), 533-542.
63. Gates, T.J., Noyce, D.A., Bill, A.R., and Van Ee, N. (2006). Recommended walking speeds for timing of pedestrian clearance intervals based on characteristics of the pedestrian population. *Journal of the Transportation Research Board*, Number 1982. Washington, D.C.: Transportation Research Board.
64. Geyer, J., Radford, N., Pham, T., & Ragland, D.R. (2006). Safety in numbers: Data from Oakland, California. *Journal of the Transportation Research Board*, Number 1982, 150-154. Washington, D.C.: Transportation Research Board.

65. Gibbons, R. B., & Hankey, J. M. (2006). Influence of vertical illuminance on pedestrian visibility in crosswalks. *Journal of the Transportation Research Board*, Number 1973, 105-112. Washington, D.C.: Transportation Research Board. Retrieved from <http://trb.metapress.com/content/f10175160450207r/>
66. Gibbons, R. B., Edwards, C. J., Williams, B., & Andersen, C. K. (2008). *Informational report on lighting design for midblock crosswalks*. (FHWA-HRT-08-053). McLean, VA: Federal Highway Administration. Retrieved from <http://www.walkinginfo.org/library/details.cfm?id=4290>
67. Glang, A., Noell, J., Ary, D., & Swartz, L. (2005). Using interactive multimedia to teach pedestrian safety: An exploratory study. *American Journal of Healthy Behavior*, 29(5), 435-442. Retrieved from <http://web.ebscohost.com/ehost/detail?vid=1&hid=6&sid=8d3edd84-7821-4e9d-acb9-6a0f1b87eb19%40sessionmgr14&bdata=JnNpdGU9ZWhvc3QtbGl2ZQ%3d%3d#db=aph&AN=18102098>
68. Goodwin, A.H., Hall, W.L., Raborn, J.C., Thomas, L.J., Masten, S.V., Tucker, M.E. (2008). *Countermeasures That Work: A Highway Safety Countermeasure Guide For State Highway Safety Offices*. Third Edition. Washington, DC: National Highway Traffic Safety Administration. Retrieved from <http://www.nhtsa.dot.gov/staticfiles/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811081.pdf>
69. Gorrie, C.A. Brown, J., & Waite, P.M.E. (2008). Crash characteristics of older pedestrian fatalities: Dementia pathology may be related to ‘at risk’ traffic situations. *Accident Analysis & Prevention*, 40(3), 912-919.
70. Guttenplan, M., Crider, L.B., Petritsch, T.A., Landis, B.W., McLeod, P.S., & Munroe, M. (2008). *Updating multimodal level-of-service calculations to incorporate latest FDOT research since 2001*. University of Florida at Gainesville. Florida Department of Transportation. Retrieved from http://www.dot.state.fl.us/research-center/Completed_Proj/Summary_PL/FDOT_BD545_81_rpt.pdf
71. Hakkert, A. S., Gitelman, V., & Ben-Shabat, E. (2002). An evaluation of crosswalk warning systems: Effects on pedestrian and vehicle behaviour. *Transportation Research Part F: Traffic Psychology and Behaviour*, 5(4), 275-292.
72. Harkey, D.L.. & Zegeer, C.V. (2004). *PEDSAFE: The pedestrian safety guide and countermeasure selection system*. Washington, D.C.: Federal Highway Administration. Retrieved from <http://www.walkinginfo.org/pedsafe/>
73. Harkey, D.L., Tsai, S., Thomas, L., & Hunter, W. (2006). Pedestrian and Bicycle Crash Analysis Tool (PBCAT) (Version 2.11) [Software]. Washington, D.C.: Federal

- Highway Administration. Retrieved from
<http://www.bicyclinginfo.org/facts/pbcat/index.cfm>
74. Harkey, D.L., Carter, D., Barlow, J., & Bentzen, B.L. (2007). *Accessible pedestrian signals: A guide to best practices*. National Cooperative Highway Research Program. Washington, DC: Transportation Research Board. Retrieved from
http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_w117a.pdf
 75. Harkey, D.L., Srinivasan, R., Baek, J., Council, F.M., Eccles, K.A., Lefler, N.X., et al. (2008). *Accident modification factors for traffic engineering and ITS improvements*. National Cooperative Highway Research Program (NCHRP) Report, Number 617. Washington, D.C.: Transportation Research Board.
 76. Harré, N., & Wrapson, W. (2004). The evaluation of a central-city pedestrian safety campaign. *Transportation Research Part F: Traffic Psychology and Behaviour*, 7(3), 167-179. Retrieved from <http://dx.doi.org/10.1016/j.trf.2004.07.002>
 77. Harwood, D.W., Bauer, K.M., Richard, K.B., Gilmore, D.K., Graham, J.L., Potts, I.B., et al. (2007). *Methodology to predict the safety performance of urban and suburban arterials*. NCHRP Project 17-26. National Cooperative Highway Research Program (NCHRP). Washington, D.C.: Transportation Research Board.
 78. Hatfield, J., Fernandes, R., Job, R.F.s., & Smith, K. (2007) Misunderstanding of right-of-way rules at various pedestrian crossing types: Observational study and survey. *Accident Analysis & Prevention*, 39(4), 833-842. Retrieved from
<http://www.sciencedirect.com/science/article/B6V5S-4MX4VY7-1/1/b0c94bda734c45d61b6039d543bf6289>
 79. Hebert Martinez, K.L. & Porter, B.E. (2004). The likelihood of becoming a pedestrian fatality and drivers' knowledge of pedestrian rights and responsibilities in the Commonwealth of Virginia. *Transportation Research Part F: Traffic Psychology and Behaviour*, 7(1), 43-58. Retrieved from
<http://ntlsearch.bts.gov/tris/record/tris/00969758.html>
 80. Hua, J., Gutierrez, N., Banerjee, I., Markowitz, F., & Ragland, D. (2009). *San Francisco Pedsafe II project outcomes and lessons learned*. Presented at the 2009 Annual Meeting of the Transportation Research Board. Washington, DC: Transportation Research Board.
 81. Huang, H. (2000). *An evaluation of flashing crosswalks in Gainesville and Lakeland*. Tallahassee, FL: Florida Department of Transportation. Retrieved from
http://www.dot.state.fl.us/Safety/ped_bike/handbooks_and_research/research/FLASH_XW%20in%20gville%20lakeland.pdf
 82. Huang H.F., & Cynecki, M.J. (2001). *The effects of traffic calming measures on pedestrian and motorist behavior*. (FHWA-RD-00-104). McLean, VA: Federal

- Highway Administration. Retrieved from
<http://www.tfhr.gov/safety/pedbike/pubs/0104.pdf>
83. Huang, H.F., Zegeer, C.V., Nassi, R., and Fairfax, B. (2000) *The effects of innovative pedestrian signs at unsignalized locations: A tale of three treatments*. (FHWA-RD-00-098). McLean, Va.: Federal Highway Administration. Retrieved from
<http://www.walkinginfo.org/library/details.cfm?id=55>
 84. Huang, S., Yang, J., & Eklund, F. (2008). Evaluation of remote pedestrian sensor system based on the analysis of car-pedestrian accident scenarios. *Safety Science*, 46(9), 1345-1355. Retrieved from
<http://www.sciencedirect.com/science/article/B6VF9-4PYMWPS-4/1/17894b0cdf99c8fff212ea21803a57ec>
 85. Hummer, J.E., Roupail, N.M., Toole, J.L., Patten, R.S., Schneider, R.J., Green, J.S., ... Fain, S.J. (2006). *Evaluation of safety, design and operation of shared use paths: Final report*. (FHWA-HRT-05-137). McLean VA: Federal Highway Administration Retrieved from <http://www.tfhr.gov/safety/pedbike/pubs/05137/index.htm>
 86. Institute of Transportation Engineers (ITE). (1998). *Design and safety of pedestrian facilities: A recommended practice of the Institute of Transportation Engineers*. Washington, D.C.: Author. Retrieved from
http://safety.fhwa.dot.gov/ped_bike/docs/designsafety.pdf
 87. Institute of Transportation Engineers (ITE). (2001). *The Traffic Control Devices Handbook*. Washington, D.C.: Author.
 88. Institute of Transportation Engineers (ITE). (2001). *Alternative treatments for at-grade pedestrian crossings*. ITE Pedestrian and Bicycle Task Force. Washington, D.C.: Author. Retrieved from
<http://www.ite.org/emodules/scriptcontent/Orders/ProductDetail.cfm?pc=LP-629>
 89. Institute of Transportation Engineers (ITE). (2008). *ITE Collisions Reporting Research: Assessing the Collision Reporting Data Needs of Transportation Engineers*. ITE Pedestrian and Bicycle Council. Washinton D.C.: Author.
 90. Jacobsen, P.L. (2003). Safety in numbers: More walkers and bicyclists, safer walking and bicycling. *Injury Prevention*, 9, 205-209.
 91. Jagannathan, R. & Bared, J.G. (2005). *Design and performance analysis of pedestrian crossing facilities for continuous flow intersections*. Journal of the Transportation Research Board, Number 1939, 133-144.
 92. Jensen, S.O. (2008). How to obtain a healthy journey to school. *Transportation Research Part A: Policy and Practice*, 42(3), 475-486. Retrieved from
<http://www.sciencedirect.com/science/article/B6VG7-4RTCV6B->

[1/1/eb636b2793e2e65e6675cf3415e72da5](http://www.oregon.gov/ODOT/TD/TP_RES/docs/Reports/PedestrianSafetyCurbExt.pdf)

93. Johnson, R. S. (2005). *Pedestrian safety impacts of curb extensions: A case study*. (Report no. SPR 304-321). Washington, D.C.: Federal Highway Administration. Retrieved from http://www.oregon.gov/ODOT/TD/TP_RES/docs/Reports/PedestrianSafetyCurbExt.pdf
94. Johnston, L., & Peace, V. (2007). Where did that car come from?: Crossing the road when the traffic comes from an unfamiliar direction. *Accident Analysis & Prevention*, 39(5), 886-893. Retrieved from <http://www.sciencedirect.com/science/article/B6V5S-4MY0V0S-1/1/a1bad1d898bfa27c8af08d0a72f7f9a4>
95. Kim, K.I., Brunner, M., & Yamashita, E. (2008a). Modeling violation of Hawaii's crosswalk law. *Accident Analysis & Prevention*, 40(3), 894-904.
96. Kim, K.I., Brunner, M., & Yamashita, E. (2008b). Modeling fault among accident-involved pedestrians and motorists in Hawaii. *Accident Analysis & Prevention*, 40(6), 2043-2049.
97. Kirschbaum, J.B., Axelson, P.W., Longmuir, P.E., Mispagel, K.M., Stein, J.A., & Yamada, D.A. (2001). *Designing sidewalks and trails for access, part II: Best practices design guide*. Washington, D.C.: Federal Highway Administration. Retrieved from <http://www.fhwa.dot.gov/Environment/sidewalk2/>
98. Knoblauch, R.L., Pietrucha, M.T., & Nitzburg, M. (1996). Field studies of pedestrian walking speed and start-up time. *Journal of the Transportation Research Board*, Number 1538. Washington, D.C.: Transportation Research Board.
99. Kwan, I., & Mapstone, J. (2004). Visibility aids for pedestrians and cyclists: A systematic review of randomised controlled trials. *Accident Analysis & Prevention*, 36(3), 305-312. Retrieved from [http://dx.doi.org/10.1016/S0001-4575\(03\)00008-3](http://dx.doi.org/10.1016/S0001-4575(03)00008-3)
100. Kwan, I. & Mapstone, J. (2006). Interventions for increasing pedestrian and cyclist visibility for the prevention of death and injuries. *Cochrane Database of Systematic Reviews*, 4.
101. Landis, B.W., Vattikuti, V.R., Ottenberg, R. M., McLeod, D.S., & Guttenplan, M. (2001). Modeling the roadside walking environment: Pedestrian level of service. *Journal of the Transportation Research Board*, Number 1773, 88-92. Washington, D.C.: Transportation Research Board.
102. Langham, M. P., & Moberly, N. J. (2003). Pedestrian conspicuity research: A review. *Ergonomics*, 46(4), 345-363. Retrieved from <http://search.ebscohost.com/login.aspx?direct=true&db=c8h&AN=2009458482&site=ehost-live>

103. Laplante, J., & McCann, B. (2008). Complete streets: We can get there from here. *ITE Journal*, 78(5), 24-28. Retrieved from http://www.completestreets.org/documents/CompleteStreets_ITEMay2008.pdf
104. Lassarre, S., Papadimitriou, E., Yannis, G., & Golias, J. (2007). Measuring accident risk exposure for pedestrians in different micro-environments. *Accident Analysis & Prevention*, 39(6), 1226-1238.
105. Leaf, W.A., & Preusser, D.F. (1999). Literature review on vehicle travel speeds and pedestrian injuries among selected racial/ethnic groups. Publication No. DOT HS 809 021. Washington, DC: National Highway Traffic Safety Administration. Retrieved from www.nhtsa.dot.gov/people/injury/research/pub/HS809012.html
106. Leden, L., Gårder, P., & Johansson, C. (2006a). Safe pedestrian crossings for children and elderly. *Accident Analysis & Prevention*, 38(2), 289-294. Retrieved from <http://dx.doi.org/10.1016/j.aap.2005.09.012>
107. Leden, L., Wikstrom, P., Garder, P., & Rosander, P. (2006b). Safety and accessibility effects of code modifications and traffic calming of an arterial road. *Accident Analysis & Prevention*, 38(3), 455-461.
108. Lenne, M.G., Corben, B.F., & Stephan, K. (2007). Traffic signal phasing at intersections to improve safety for alcohol-affected pedestrians. *Accident Analysis & Prevention*, 39(4), 751-756. Retrieved from <http://www.sciencedirect.com/science/article/B6V5S-4MR1K7N-1/1/099b072f95453bdd322fad80cb329bf7>
109. Leslie, E., Coffee, N., Frank, L., Owen, N., Bauman, A., & Hugo, G. (2007). Walkability of local communities: Using geographic information systems to objectively assess relevant environmental attributes. *Health & Place*, 13, 111-122.
110. Litman, T. (2008). Appropriate response to rising fuel prices. Victoria, BCL Victoria Transport Policy Institute. Retrieved from <http://www.vtpi.org/fuelprice.pdf>
111. Litman, T. (2009a). *The future isn't what it used to be: Changing trends and their implications for transportation planning*. Victoria, BC: Victoria Transport Policy Institute. Retrieved 2009 from <http://www.vtpi.org/future.pdf>
112. Litman, T. (2009b) Travel demands are a-changing: So should our spending. *Planetizen*. Retrieved from <http://www.planetizen.com/node/38283>
113. Lobb, B. (2006). Trespassing on the tracks: A review of railway pedestrian safety research. *Journal of Safety Research*, 37(4), 359-365.
114. Lord, D. (2003). *Synthesis on the safety of right turn on red in the United States and*

- Canada. Presented at the 2003 Annual Meeting of the Transportation Research Board. Washington, D.C.: Transportation Research Board.
115. Lovette, B. (2007). Back-up detection devices: What do we all need to know? Dangerous blind zones. *Journal of Pediatric Health Care*, 21(2), 123-128. Retrieved from <http://dx.doi.org/10.1016/j.pedhc.2006.12.010>
 116. Lynott, J., Haase, J., Nelson, K., Taylor, A. Twaddell, H, Ulmer, J. et al. (2009). *Planning complete streets for an aging America*. Washington, DC: American Association of Retired Persons. Retrieved from http://assets.aarp.org/rgcenter/il/2009_02_streets.pdf.
 117. Lu, G. & Noyce, D.A. (2009). *Intersection signal systems with intelligent pedestrian accommodation: Dynamic pedestrian timing*. Presented at the 2009 Annual Meeting of the Transportation Research Board. Washington, D.C.: Transportation Research Board.
 118. Macbeth, A.G., Boulter, R. & Ryan, P.S. (2005). New Zealand walking and cycling strategies – best practice. *Land Transport New Zealand Research Report 274*. Wellington: Land Transport New Zealand. Retrieved from <http://www.landtransport.govt.nz/research/reports/274.pdf>
 119. McCann, B. (2006). *Completing the streets for transit: A planning workshop report*. Transportation Planning Capacity Building Program Peer Workshop, Railvolution Annual Meeting. Chicago, IL. Retrieved from http://www.planning.dot.gov/Peer/Chicago/chicago_2007.htm
 120. McDonald, N.C. (2008). Children’s mode choice for the school trip: The role of distance and school location in walking to school,” *Transportation*, 35(1), .23-35.
 121. McMahon, P.J., Zegeer, C.V., Duncan, C., Knoblauch, R.L., Stewart, J.R., & Khattak, A.J. (2001). *An analysis of factors contributing to “walking along roadway” crashes: Research study and guidelines for sidewalks and walkways*. (FHWA-RD-01-101). McLean, VA: Federal Highway Administration. Retrieved from http://drusilla.hsrc.unc.edu/cms/downloads/WalkingAlongRoadways_Study_Guidelines.pdf
 122. McMillan, T., Day, K., Boarnet, M., Alfonzo, M., & Anderson, C. (2006). Johnny Walks to School – Does Jane? Sex Difference in Children’s Active Travel to School. *Child Youth Environment*, 16, 75-86.
 123. Mellifont, D., Ker, I., Huband, A., Veith, G., & Taylor, J. (2006). *Pedestrian-cyclist conflict minimisation on shared paths and footpaths*. (AP-R287/06). Sydney: Austroads, Inc. Retrieved from http://www.austroads.com.au/documents/Pedcyclist_conflict_minimisation_on_shared_paths.pdf

124. Metropolitan Transportation Commission. (2003). *Bicyclist and pedestrian data collection and analysis project: Final report*. Oakland, CA: Author. Retrieved from <http://www.mtc.ca.gov/library/Bike-Ped-Data-Collection.pdf>
125. Metropolitan Transportation Commission. (2006). *Pedestrian districts study*. Berkeley, CA: Design, Community, and Environment. Oakland, CA: Author. Retrieved from http://www.mtc.ca.gov/planning/bicyclespedestrians/Ped_Districts/
126. Mitman, M.F., & Ragland, D.R. (2007). Crosswalk confusion: More evidence why pedestrian and driver knowledge of the vehicle code should not be assumed. *Journal of the Transportation Research Board*, Number 2002, 55-63. Retrieved from <http://trb.metapress.com/content/b1kn25n427865535/>
127. Mitman, M.F., Ragland, D.R., & Zegeer, C.V. (2008). *The marked crosswalk dilemma: Uncovering some missing links in a 35-year debate*. Presented at the 2008 Annual Meeting of the Transportation Research Board. Washington, D.C.: Transportation Research Board.
128. Montufar J., Arango, J., Porter, M., & Nakagawa, S. (2007). Pedestrians' normal walking speed and speed when crossing a street. *Journal of the Transportation Research Board*, Number 2002. Washington, D.C.: Transportation Research Board.
129. Mueller, B.A., Rivara, F., Bergman, A. (1988). Urban-rural Location and the Risk of Dying in a Pedestrian-vehicle Collision. *Journal of Trauma*. Baltimore, MD: The Williams & Wilkins Co. Retrieved from PubMed database.
130. Muhlrad N. (2007). *A short history of pedestrian safety policies in Western Europe*. ICTCT Workshop 2007 in Beijing. Vienna, Austria: International Cooperation on Theories and Concepts in Traffic Safety. Retrieved from <http://www.walkeurope.org/uploads/File/background/Beijing-2007-NM-Rev.pdf>
131. Murphy, B. & Hummer, J. E. (2007). *Development of crash reduction factors for overhead flashing beacons at rural intersections in North Carolina*. Presented at the 2007 Annual Meeting of the Transportation Research Board. Washington, D.C.: Transportation Research Board.
132. Nabors, D., Gibbs, M., Sandt, L., Rocchi, S., Wilson E., & Lipinski, M. (2007). *Pedestrian road safety audit guidelines and prompt lists*. (FHWA-SA-07-007). Washington, D.C.: Federal Highway Administration. Retrieved from <http://drusilla.hsrc.unc.edu/cms/downloads/PedRSA.reduced.pdf>
133. Nabors, D., Schneider, R.J., Leven, D., Lieberman, K., & Mitchell, C. (2008). *Pedestrian safety guide for transit agencies*. (FHWA-SA-07-017). Washington, D.C.: Federal Highway Administration. Retrieved from <http://www.walkinginfo.org/library/details.cfm?id=4231>

134. Nambisan, S.S., Pulugurtha, S.S., & Karkee, G. (2006). *An evaluation of the effectiveness of an in-pavement flashing light system*. Presented at the 2006 Annual Meeting of the Transportation Research Board. Washington, D.C.: Transportation Research Board.
135. Nambisan, S.S., Vasudevan, V., Dangeti, M., & Virupaksha, V. (2008). *Advanced yield markings and pedestrian safety: Analyses of use with danish offsets and median refuge islands*. Presented at the 2008 Annual Meeting of the Transportation Research Board. Washington, D.C.: Transportation Research Board. Retrieved from <http://pubsindex.trb.org/view.aspx?id=848875>
136. Nance, M.L., Hawkins, L.A., Branas, C.C., Vivarelli-O'Neill, C., & Winston, F.K. (2004). Optimal driving conditions are the most common injury conditions for child pedestrians. *Pediatric Emergency Care*, 20(9), 569-573.
137. Natarajan, S., Demetsky, M.J., & Lantz, K.E. (2008). *Framework for selection and evaluation of bicycle and pedestrian safety projects in Virginia*. (FHWA/VTRC 08-R8). Charlottesville, VA: Virginia Transportation Research Council. Retrieved from http://www.virginiadot.org/vtrc/main/online_reports/pdf/08-r8.pdf
138. National Center for Bicycling & Walking. (2010). *Centerlines Newsletter*. Retrieved from <http://www.bikewalk.org/newsletter.php>.
139. National Committee on Uniform Traffic Control Devices. (2003). *The Manual on Uniform Traffic Control Devices for Streets and Highways*. Washington, D.C.: Federal Highway Administration. Retrieved from <http://mutcd.fhwa.dot.gov/pdfs/2003r1/pdf-index.htm>
140. National Highway Traffic Safety Administration. (2008a). Traffic Safety Facts, 2007 Data: Pedestrians. Washington, DC: Author. Retrieved from <http://www-nrd.nhtsa.dot.gov/Pubs/810994.PDF>
141. National Highway Traffic Safety Administration. (2008b). Traffic Safety Facts, 2007 Data: Race and Ethnicity. Washington, DC: Author. Retrieved from <http://www-nrd.nhtsa.dot.gov/Pubs/810995.PDF>
142. National Transportation Safety Board (NTSB). (2002). Safety Report: Transportation Safety Databases. Washington, DC. Retrieved from <http://www.nts.gov/publictn/2002/SR0202.pdf>.
143. Parks, J.R. & Schofer, J.L. (2006). Characterizing neighborhood pedestrian environments with secondary data. *Transportation Research Part D*, 11, 250-263, 2006.
144. Pecheux, K.K., Bauer, J.K., Miller, S., Rephlo, J., Saporta, H., Samantha, E., ...

- Quan, J. (2008). Guidebook for mitigating fixed-route bus-and-pedestrian collisions. *Transit Cooperative Research Program*, Report No. 125. Washington, DC: Transportation Research Board. Retrieved from http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_125.pdf
145. Petritsch, T.A., Landis, B.W., McLeod, P.S., Huang, H.F., Challa, S., & Guttenplan, M. (2005). Level-of-service model for pedestrians at signalized intersections. *Journal of the Transportation Research Board*, Number 1939, 53-62. Washington, D.C.: Transportation Research Board. Retrieved from <http://trb.metapress.com/content/t877264240799175/>
 146. Petritsch, T.A., Landis, B.W., McLeod, P.S., Huang, H.F., Challa, S., Skaggs, C.L., et al. (2006). Pedestrian level-of-service model for urban arterial facilities with sidewalks. *Journal of the Transportation Research Board*, Number 1982, 84-89. Washington, D.C.: Transportation Research Board. Retrieved from <http://pubsindex.trb.org/view.aspx?id=776384>
 147. Plainis, S.; Murray, I.J., Charman, W.N. (2005). The role of retinal adaptation in night driving. *Optometry and Vision Science*, Volume 82, Issue 8, 682-688. Retrieved from http://journals.lww.com/optvissci/Abstract/2005/08000/The_Role_of_Retinal_Adaptation_in_Night_Driving.10.aspx.
 148. Plainis, S.; Murray, I.J., Pallikaris, I.G. (2006). Road traffic casualties: understanding the night-time death toll. *Injury Prevention*, 12, 125-138. Retrieved from <http://injuryprevention.bmj.com/content/12/2/125.abstract>.
 149. Potts, I.B., Harwood, D.W., & Richard, K.R. (2007). Relationship of lane width to safety for urban and suburban arterials. *Journal of the Transportation Research Board*, Number 2023, 63-82. Washington, D.C.: Transportation Research Board.
 150. Pucher, J. & Renne, J.L. (2003). Socioeconomics of urban travel: Evidence from the 2001 NHTS. *Transportation Quarterly*, 57(3), 49-77.
 151. Puentes, R. & Tomer, A. (2008). The road...less traveled: An analysis of vehicle miles traveled trends in the U.S. *The Brookings Institution Metropolitan Infrastructure Initiative Series*. Retrieved from http://www.brookings.edu/~media/Files/rc/reports/2008/1216_transportation_tomer_puentes/vehicle_miles_traveled_report.pdf
 152. Pulugurtha, S.S., Krishnakumar, V.K., & Nambisan, S.S. (2007). New methods to identify and rank high pedestrian crash zones: An illustration. *Accident Analysis & Prevention*, 39(4), 800-811. Retrieved from <http://www.sciencedirect.com/science/article/B6V5S-4MV1H56-1/1/949be817b60868c88388c3c6d7403ec2>

153. Qingfeng L., Zhaoan W., Jianguo Y., & Jinmei W. (2005). Pedestrian delay estimation at signalized intersections in developing cities. *Transportation Research Part A: Policy and Practice*, 39(1), 61-73.
154. Rasanen, M., Lajunen, T., Alticafarbay, F., & Aydin, C. (2007). Pedestrian self-reports of factors influencing the use of pedestrian bridges. *Accident Analysis & Prevention*. 39(5), 969-973. Retrieved from <http://www.sciencedirect.com/science/article/B6V5S-4N3H10Y-1/1/72caa25622ab79d6337c3aa22206b516>
155. Ray, B., Kittelson, W., Knudsen, J., Nevers, B., Ryus, P., & Sylvester, K. (2007). Guidelines for selection of speed reduction treatments at high-speed intersections: Supplement to NCHRP Report 613. National Cooperative Highway Research Program (NCHRP), Number 124. Washington, D.C.: Transportation Research Board.
156. Retting, R.A., Ferguson, S.A., & McCartt, A.T. (2003). A review of evidence-based traffic engineering measures designed to reduce pedestrian-motor vehicle crashes. *American Journal of Public Health*, 93(9), 1456-1463. Retrieved from <http://search.ebscohost.com/login.aspx?direct=true&db=hch&AN=10737615&site=ehost-live>
157. Rosenbloom, T., Ben-Eliyahu, A., & Nemrodov, D. (2008). Children's crossing behavior with an accompanying adult. *Safety Science*, 46(8), 1248-1254. Retrieved from <http://www.sciencedirect.com/science/article/B6VF9-4PMT5JN-1/1/0007d28429fc1a4a98a8df9add375b42>
158. Roudsari, B., Kaufman, R., & Koepsell, T. (2006). Turning at intersections and pedestrian injuries. *Traffic Injury Prevention*, 7(3), 283-289.
159. Rousseau, G.K., Tucker, S.M., & Do, A. (2004). The effects on safety of in-roadway warning lights at crosswalks: Novelty or longevity? *ITE Annual Meeting And Exhibit*. Washington, D.C.: Institute of Transportation Engineers. Retrieved from <http://ntlsearch.bts.gov/tris/record/tris/00981520.html>
160. Ryb, G.E., Dischinger, P.C., Kufera, J.A., & Soderstrom, C.A. (2007). Social, behavioral and driving characteristics of injured pedestrians: A comparison with other unintentional trauma patients. *Accident Analysis & Prevention*, 39(2), 313-318.
161. Sacramento Transportation and Air Quality Collaborative. (2005). *Best practices for complete streets*. Sacramento, CA: Author. Retrieved from <http://www.completestreets.org/webdocs/resources/cs-bestpractices-sacramento.pdf>
162. Sandt, L.S., & Zegeer, C.V. (2006). Characteristics related to midblock pedestrian-vehicle crashes and potential treatments. *Journal of the Transportation Research Board*, Number 1982, 113-121. Washington, D.C.: Transportation Research Board. Retrieved from <http://www.walkinginfo.org/library/details.cfm?id=2589>

163. Sandt, L.S., Gelinne, D.J., & Zegeer, C.V. (2008). Developing and implementing a pedestrian safety action plan. Progress report: September 2004 – December 2007. Prepared for the Federal Highway Administration. Chapel Hill, NC: UNC Highway Safety Research Center. Retrieved from http://www.walkinginfo.org/training/collateral/PSAPReport_noAppendix.pdf
164. Sandt, L.S., Schneider, R.J., Nabors, D., Thomas, L., Mitchell, C., & Eldridge, R.J. (2008) . *A resident's guide for creating safe and walkable communities*. (FHWA-SA-07-016). Washington, D.C.: Federal Highway Administration. Retrieved from <http://www.walkinginfo.org/library/details.cfm?id=4163>
165. Sayer, J.R., & Buonarosa, M.L. (2008). The roles of garment design and scene complexity in the daytime conspicuity of high-visibility safety apparel. *Journal of Safety Research*, 39(3), 281-286. Retrieved from <http://www.sciencedirect.com/science/article/B6V6F-4S97H4F-1/1/c1bf76f4ee808e33718807d07b762d73>
166. Schlossberg, M. & Brown, N. (2004). Comparing transit-oriented development sites by walkability indicators. *Journal of the Transportation Research Board*, Number 1887. Washington, D.C.: Transportation Research Board.
167. Schneider, R.J., Khattak, A.J., & Zegeer, C.V. (2001) Method of improving pedestrian safety proactively with geographic information systems: Example from a college campus. *Journal of the Transportation Research Board*, Number 1977. Washington, D.C.: Transportation Research Board.
168. Schneider, R.J., Ryznar, R.M., & Khattak, A.J. (2004). An accident waiting to happen: A spatial approach to proactive pedestrian planning. *Accident Analysis & Prevention*, 36(2), 193-211.
169. Schrock, S.D. & Bundy, B. (2008). Pedestrian countdown timers: Do drivers use them to increase safety or increase risk taking? Presented at the 2008 Annual Meeting of the Transportation Research Board. Washington, D.C.: Transportation Research Board.
170. Schroeder, B.J., Roupail, N.M., & Emerson, R.S.W. (2006). Exploratory analysis of crossing difficulties for blind and sighted pedestrians at channelized turn lanes. *Journal of the Transportation Research Board*, Number 1956, 94-102. Washington, D.C.: Transportation Research Board.
171. Shinar, D. (2007). Pedestrians. In *Traffic Safety and Human Behavior*. Amsterdam: Elsevier.
172. Shrestha, L.B. (2006). *The changing demographic profile of the United States (RL32701)*. Washington, DC: Congressional Research Service. Retrieved from

<http://fas.org/sgp/crs/misc/RL32701.pdf>

173. Siddiqui, N.A. Chu, X.H., & Guttenplan, M. (2006). Crossing locations, light conditions, and pedestrian injury severity. *Journal of the Transportation Research Board*, Number 1982, 141-149. Washington, D.C.: Transportation Research Board. Retrieved from <http://pubsindex.trb.org/view.aspx?id=776985>
174. Singer, A. (2009). The new geography of United States immigration. Brookings Immigration Series, 3. Washington, DC: *The Brookings Institution*. Retrieved from http://www.brookings.edu/~media/Files/rc/papers/2009/07_immigration_geography_singer/07_immigration_geography_singer.pdf
175. Sisiopiku, V.P., & Byrd, J.E. (2006). *Comparison of level-of-service methodologies for pedestrian sidewalks*. Presented at the 2006 Annual Meeting of the Transportation Research Board. Washington, DC: Transportation Research Board. Retrieved from <http://pubsindex.trb.org/view.aspx?id=776584>
176. Shurbutt, J., Van Houten, R., & Turner, S. (2008). *An analysis of the effects of stutter flash LED beacons to increase yielding to pedestrians using multilane crosswalks*. Presented at the 2008 Annual Meeting of the Transportation Research Board. Washington, D.C.: Transportation Research Board.
177. Spainhour, L. K., Wootton, I. A., Sobanjo, J. O., & Brady, P. A. (2006). Causative factors and trends in Florida pedestrian crashes. *Journal of the Transportation Research Board*, Number 1982, 90-98. Washington, D.C.: Transportation Research Board. Retrieved from <http://pubsindex.trb.org/view.aspx?id=776589>
178. Staplin, L., Lococo, K., Byington, S., & Harkey, D.L. (2001). *The highway design handbook for older drivers and pedestrians*. (FHWA-RD-01-103). McLean, VA: Federal Highway Administration. Retrieved from <http://www.tfhrc.gov/humanfac/01103/coverfront.htm>
179. Stollof, E.R., McGee, H., & Eccles, K.A. (2007). *Pedestrian signal safety for older persons*. Washington, DC: AAA Foundation for Traffic Safety. Retrieved from <http://www.aaafoundation.org/pdf/PEDsigtiming.pdf>
180. Stutts, J.C. & Hunter, W.W. (1998). Police-reporting of pedestrians and bicyclists treated in hospital emergency rooms. *Journal of the Transportation Research Board*, Number 1635, 88-92.
181. Sullivan, J.M., & Flannagan, M.J. (2007). Determining the potential safety benefit of improved lighting in three pedestrian crash scenarios. *Accident Analysis & Prevention*, 39(3), 638-647. Retrieved from <http://www.sciencedirect.com/science/article/B6V5S-4MFJJCK-1/2/5248764fc8cd50a170b9d117248438e1>

182. Traffic Advisory Unit (TAU), Department of Transport. Traffic calming regulations. Traffic Advisory Leaflet 7/93, August 1993.
183. Transportation Research Board (TRB). (2010). *NCHRP 08-78 (Pending): Estimating Bicycling and Walking for Planning and Project Development*. Retrieved from <http://144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2707>.
184. Transportation Research Board. (2005). Crash reduction factors for traffic engineering and intelligent transportation system (ITS) improvements: State-of-knowledge report. *NCHRP Research Results Digest*, Number 299. Washington, D.C.: Author.
185. Transportation Research Board. (2000). Chapter 11 – Pedestrian and bicycle concepts, and Chapter 18 – Pedestrians in *Highway Capacity Manual (HCM 2000)*. Washington, D.C.: Author.
186. Transportation Research Board (TRB). (1998). Special report 254 - Managing speed: Review of current practice for setting and enforcing speed limits - Overview of issues related to setting speed limits. Washington, D.C.: National Academy Press.
187. Turner, P.A., Ferraro, A.J., McGovern, B., Malenfont, L., & Van Houten, R. (2000) *Making crosswalks safer for pedestrians: Application of a multidisciplinary approach to improve pedestrian safety at crosswalks in St. Petersburg, Florida*. Prepared for Florida Department of Transportation.. Tampa, FL: Center for Urban Transportation Research. Retrieved from http://www.dot.state.fl.us/Safety/ped_bike/handbooks_and_research/research/pedycl.pdf
188. Turner, S., Fitzpatrick, K., Brewer, M.A., & Park, E.S. (2006a). Motorist yielding to pedestrians at unsignalized intersections: Findings from a national study on improving pedestrian safety. *Journal of the Transportation Research Board*, Number 1982, 1-12. Washington, D.C.: Transportation Research Board. Retrieved from <http://www.walkinginfo.org/library/details.cfm?id=3279>
189. Turner, S., Sandt, L., Toole, J., Benz, R., & Patten, R. (2006b). FHWA university course on bicycle and pedestrian transportation. (FHWA-HRT-05-133). Washington, D.C.: Federal Highway Administration. Retrieved from <http://www.tfhr.gov/safety/pedbike/pubs/05085/pdf/combinedlo.pdf>
190. Tyrrell, R. A., Patton, C.W., & Brooks. J. O. (2004). Educational interventions successfully reduce pedestrians' overestimates of their own nighttime visibility. *Human Factors*, 46(1), 170-182. Retrieved from <http://hfs.sagepub.com/cgi/content/abstract/46/1/170>
191. U.K. Department of Transportation, *Killing Speed and Saving Lives*, London, 1987.

192. U.S. Census Bureau. (2000). *United States decennial census 2000*. Washington, DC: Author. Retrieved from <http://factfinder.census.gov>
193. U.S. Census Bureau. (2004). *U.S. interim projections by age, sex, race, and Hispanic origin*. Retrieved from <http://www.census.gov/population/www/projections/usinterimproj/>
194. U.S. Census Bureau. (2006). *United States population estimate 2006*. Washington, DC: Author. Retrieved from <http://factfinder.census.gov>
195. U.S. Census Bureau. (2007). *United States population estimate 2007*. Washington, DC: Author. Retrieved from <http://factfinder.census.gov>
196. U.S. Census Bureau. (2008). *Commute to Work 2006-2008*. Washington, DC: Author. Retrieved from <http://factfinder.census.gov>
197. U.S. Census Bureau. (2008). *United States population estimate 2008*. Washington, DC: Author. Retrieved from <http://www.census.gov/>
198. U.S. Census Bureau. (2009). *Facts for features: Hispanic heritage month 2009*. Retrieved from http://www.census.gov/Press-Release/www/releases/archives/facts_for_features_special_editions/013984.html
199. U.S. Census Bureau. (2009). *Population estimates: Metropolitan and micropolitan statistical area estimates population change and rankings*. Retrieved from <http://www.census.gov/popest/metro/CBSA-est2008-pop-chg.html>
200. U.S. Census Bureau. (2009, March 19). Raleigh and Austin are fastest growing metro areas. *U.S. Census Bureau News*. Washington, DC: United States Department of Commerce. Retrieved from <http://www.census.gov/Press-Release/www/releases/archives/population/013426.html>
201. U.S. Department of Transportation. (2009, March 18). HUD and DOT partnership: Sustainable communities. Press Release. Washington, DC: Office of Public Affairs. Retrieved from <http://www.dot.gov/affairs/dot3209.htm>
202. US Department of Transportation. (2002). *National Survey of Pedestrian and Bicyclist Attitudes and Behaviors*. Washington, D.C.: National Highway Traffic Safety Administration and Bureau of Transportation Statistics. Retrieved from http://www.bts.gov/programs/omnibus_surveys/targeted_survey/2002_national_survey_of_pedestrian_and_bicyclist_attitudes_and_behaviors/
203. US Department of Transportation. (2008a). Accommodating bicycle and pedestrian travel: A recommended approach. US DOT Policy Statement. Washington, D.C: Author. Retrieved from <http://www.fhwa.dot.gov/environment/bikeped/design.htm>

204. US Department of Transportation. (2008b). *Safe routes to school guide*. Washington, D.C.: National Highway Transportation Safety Administration, Federal Highway Administration, Centers for Disease Control and Prevention, and Institute of Transportation Engineers. Retrieved from <http://www.saferoutesinfo.org/guide/>
205. Van Houten, R., Ellis, R., & Kim, J. (2007). Effects of various minimum green times on percentage of pedestrians waiting for midblock “walk” signal. *Journal of the Transportation Research Board*, Number 2002, 78-83. Washington, D.C.: Transportation Research Board.
206. Van Houten, R., & Malenfant, J.E.L. (2004). Effects of a driver enforcement program on yielding to pedestrians. *Journal of Applied Behavior Analysis*, 37(3), 351-363. Retrieved from <http://dx.doi.org/10.1901/jaba.2004.37-351>
207. Wall, R., Ashmead, D., Bentzen, B.L., & Barlow, J. (2005a). Audible pedestrian signals as directional beacons. *International Congress Series Volume 1282*, 1089-1093.
208. Wall, R., Long, R., Guth, D., Ashmead, D., Ponchillia, P. (2005b) Blind and Sighted Pedestrians' Judgments of Gaps in Traffic at Roundabouts. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, 47(2), 314-331.
209. Wall, R., Long, R., Guth, D., Ashmead, D., & Ponchillia, P. (2005c) Roundabouts: Problems of and strategies for access. *International Congress Series Volume 1282*, 1085-1088.
210. Wilken, D., Ananthanarayanan, B., Hasson, P., Lutkevich, P. J., Watson, C. P., Burkett, K., et al. (2001). *European road lighting technologies*. (Report No. FHWA-PL-01-034). Washington, D.C.: Federal Highway Administration. Retrieved from <http://international.fhwa.dot.gov/Pdfs/Euroroadlighting.pdf>
211. Wilson, J.H. (2009). *Trends in U.S. immigration* [PDF Document]. Presentation given at the American Society of Public Administrators National Conference. Retrieved from http://www.brookings.edu/~media/Files/rc/speeches/2009/0324_immigration_wilson/0324_immigration_wilson.pdf
212. Xuemei, Z., & Chanam, L. (2008). Walkability and safety around elementary schools: Economic and ethnic disparities. *American Journal of Preventive Medicine*, 34(4), 282-290. Retrieved from <http://www.sciencedirect.com/science/article/B6VHT-4S4SK8D-4/1/0dd904e13e969dad5eba177995360673>
213. Yannis, G., Kanellaidis, G., Dimitropoulos, J., & Muhlad, N. (2007). Assessment of pedestrian safety measures in Europe. *ITE Journal*, 77(12), 40-47.

214. Zeedyk, M.S. & Kelly, L. (2003). Behavioural observations of adult-child pairs at pedestrian crossings. *Accident Analysis & Prevention*, 35(5), 771-776.
215. Zegeer, C.V., Stutts, J., Hunter, B., Pein, W., Feske, D., Cheeney, D., et al. (1994). The National Bicycling and Walking Study, Transportation Choices for a Changing America. Washington, D.C.: Federal Highway Administration. Retrieved from <http://www.bicyclinginfo.org/library/details.cfm?id=4311>
216. Zegeer, C.V., Stutts, J.C., & Huang, H. (2004). Guidance for implementation of the AASHTO strategic highway safety plan. Volume 10: A guide for reducing collisions involving pedestrians. *NCHRP Report 500*. Washington, D.C.: Transportation Research Board. Retrieved from http://gulliver.trb.org/publications/nchrp/nchrp_rpt_500v10.pdf
217. Zegeer, C.V., Stewart, J.R., Huang, H., Lagerwey, P.A., Feagan, J., & Campbell, B. J. (2005). *Safety effects of marked versus unmarked crosswalks at uncontrolled locations: Final report and recommended guidelines*. (FHWA-HRT-04-100). Washington, D.C.: Federal Highway Administration. Retrieved from <http://www.tfhr.gov/safety/pubs/04100/04100.pdf>
218. Zegeer, C.V., & Sandt, L.S. (2006). *How to develop a pedestrian safety action plan*. Washington, D.C.: Federal Highway Safety Administration. Retrieved from <http://www.walkinginfo.org/library/details.cfm?id=229>
219. Zegeer, C. V., Henderson, D., Blomberg, R., Marchetti, L., Masten, S. V., Fan, Y., et al. (2008a). *Evaluation of the Miami-Dade pedestrian safety demonstration project*. (Report No. DOT HS 810 964). Washington, D.C.: National Highway Traffic Safety Administration. Retrieved from http://www.nhtsa.dot.gov/portal/nhtsa_static_file_downloader.jsp?file=/staticfiles/DO T/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/810964.pdf
220. Zegeer, C.V., Seiderman, C., Lagerwey, P., Cynecki, M.J., Ronkin, M., & Schneider, R. (2008b). *Pedestrian facilities users guide: Providing safety and mobility*. (FHWA-RD-01-102). McLean, Va.: Federal Highway Administration. Retrieved from <http://www.walkinginfo.org/library/details.cfm?id=2096>
221. Zhu, M., Cummings, P., Chu, H., & Xiang, H. (2008). Urban and rural variation in walking patterns and pedestrian crashes. *Injury Prevention*, 14:377-380.

APPENDIX I: FHWA PRODUCT EVALUATION SURVEY

Page 1 - Question 1 - Choice - One Answer (Bullets)

[Mandatory]

In what type of area do you LIVE?

- ☐ Large metropolitan city and surrounding areas (greater than 500,000)
- ☐ Medium city (100,000 to 500,000)
- ☐ Small city (less than 100,000)
- ☐ Rural
- ☐ Other, please specify

Page 1 - Question 2 - Choice - One Answer (Bullets)

[Mandatory]

In what type of area do you WORK?

- ☐ Large metropolitan city and surrounding areas (greater than 500,000)
- ☐ Medium city (100,000 to 500,000)
- ☐ Small city (less than 100,000)
- ☐ Rural
- ☐ Other, please specify

Page 1 - Question 3 - Choice - One Answer (Drop Down)

[Mandatory]

In what state do you LIVE?

- ☐ ALABAMA
- ☐ ALASKA
- ☐ ARIZONA
- ☐ ARKANSAS
- ☐ CALIFORNIA
- ☐ COLORADO
- ☐ CONNECTICUT
- ☐ DELAWARE
- ☐ DISTRICT OF COLUMBIA
- ☐ FLORIDA
- ☐ GEORGIA
- ☐ HAWAII
- ☐ IDAHO
- ☐ ILLINOIS
- ☐ INDIANA
- ☐ IOWA
- ☐ KANSAS
- ☐ KENTUCKY
- ☐ LOUISIANA
- ☐ MAINE
- ☐ MARYLAND
- ☐ MASSACHUSETTS
- ☐ MICHIGAN
- ☐ MINNESOTA
- ☐ MISSISSIPPI

- ☐ MISSOURI
- ☐ MONTANA
- ☐ NEBRASKA
- ☐ NEVADA
- ☐ NEW HAMPSHIRE
- ☐ NEW JERSEY
- ☐ NEW MEXICO
- ☐ NEW YORK
- ☐ NORTH CAROLINA
- ☐ NORTH DAKOTA
- ☐ OHIO
- ☐ OKLAHOMA
- ☐ OREGON
- ☐ PENNSYLVANIA
- ☐ PUERTO RICO
- ☐ RHODE ISLAND
- ☐ SOUTH CAROLINA
- ☐ SOUTH DAKOTA
- ☐ TENNESSEE
- ☐ TEXAS
- ☐ UTAH
- ☐ VERMONT
- ☐ VIRGIN ISLANDS
- ☐ VIRGINIA
- ☐ WASHINGTON
- ☐ WEST VIRGINIA
- ☐ WISCONSIN
- ☐ WYOMING
- ☐ OTHER
- ☐ CHOOSE NOT TO ANSWER

Page 1 - Question 4 - Choice - One Answer (Drop Down)

[Mandatory]

In what state do you WORK?

- ☐ ALABAMA
- ☐ ALASKA
- ☐ ARIZONA
- ☐ ARKANSAS
- ☐ CALIFORNIA
- ☐ COLORADO
- ☐ CONNECTICUT
- ☐ DELAWARE
- ☐ DISTRICT OF COLUMBIA
- ☐ FLORIDA
- ☐ GEORGIA
- ☐ HAWAII
- ☐ IDAHO
- ☐ ILLINOIS
- ☐ INDIANA
- ☐ IOWA

- ☐ KANSAS
- ☐ KENTUCKY
- ☐ LOUISIANA
- ☐ MAINE
- ☐ MARYLAND
- ☐ MASSACHUSETTS
- ☐ MICHIGAN
- ☐ MINNESOTA
- ☐ MISSISSIPPI
- ☐ MISSOURI
- ☐ MONTANA
- ☐ NEBRASKA
- ☐ NEVADA
- ☐ NEW HAMPSHIRE
- ☐ NEW JERSEY
- ☐ NEW MEXICO
- ☐ NEW YORK
- ☐ NORTH CAROLINA
- ☐ NORTH DAKOTA
- ☐ OHIO
- ☐ OKLAHOMA
- ☐ OREGON
- ☐ PENNSYLVANIA
- ☐ PUERTO RICO
- ☐ RHODE ISLAND
- ☐ SOUTH CAROLINA
- ☐ SOUTH DAKOTA
- ☐ TENNESSEE
- ☐ TEXAS
- ☐ UTAH
- ☐ VERMONT
- ☐ VIRGIN ISLANDS
- ☐ VIRGINIA
- ☐ WASHINGTON
- ☐ WEST VIRGINIA
- ☐ WISCONSIN
- ☐ WYOMING
- ☐ OTHER
- ☐ CHOOSE NOT TO ANSWER

Page 2 - Question 5 - Yes or No

[Mandatory]

Have you heard of or are you familiar with BICYCLE SAFER JOURNEY, which is a product/deployment from the Federal Highway Administration?

- ☐ Yes
- ☐ No **[Skip to 6]**

Page 3 - Question 6 - Yes or No

[Mandatory]

Have you used BICYCLE SAFER JOURNEY in the last 3 years?

- ☐ Yes
- ☐ No [Skip to 6]

Page 4 - Question 7 - Choice - Multiple Answers (Bullets)

[Mandatory]

In what ways did you use BICYCLE SAFER JOURNEY? Check all that apply.

- ☐ Direct application as part of job (field application, etc.)
- ☐ Educating self (continuing credit, professional development, etc.)
- ☐ Educating others (teaching, information dissemination, etc.)
- ☐ Obtained as reference material (e.g., library)
- ☐ Research project
- ☐ Occupational development
- ☐ Personal interest
- ☐ Other, please specify

Page 4 - Question 8 - Rating Scale - Matrix

[Mandatory]

How easy was BICYCLE SAFER JOURNEY to use?

	Extremely difficult to use	2	3	4	5	6	7	8	Extremely easy to use	Did not use myself
Ease of use	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Page 4 - Question 9 - Rating Scale - Matrix

[Mandatory]

How useful was BICYCLE SAFER JOURNEY in helping you carry out your work?

	Extremely unuseful	2	3	4	5	6	7	8	Extremely useful	Did not use myself
Usefulness	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Page 5 - Question 10 - Yes or No

[Mandatory]

Did BICYCLE SAFER JOURNEY give you knowledge that contributed to a reduction of crashes, injuries, and/or fatalities in your state/locality?

- ☐ Yes
- ☐ No
- ☐ Why or why not?

Page 5 - Question 11 - Rating Scale - Matrix

[Mandatory]

How much of an impact did BICYCLE SAFER JOURNEY have on the way you carried out your work?

	Extremely weak impact	2	3	4	5	6	7	8	Extremely strong impact	Did not use myself
Strength of impact	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

 Additional Comment

Page 5 - Question 12 - Yes or No

[Mandatory]

Will BICYCLE SAFER JOURNEY play an important role in reducing crashes, injuries, and/or fatalities in the FUTURE?

- ☐ Yes
☐ No
☐ Why or why not?

Page 6 - Question 13 - Yes or No

[Mandatory]

Have you heard of or are you familiar with the BICYCLE COMPATIBILITY INDEX, which is a product/deployment from the Federal Highway Administration?

- ☐ Yes
☐ No [Skip to 10]

Page 7 - Question 14 - Yes or No

[Mandatory]

Have you used the BICYCLE COMPATIBILITY INDEX in the last 3 years?

- ☐ Yes
☐ No [Skip to 10]

Page 8 - Question 15 - Choice - Multiple Answers (Bullets)

[Mandatory]

In what ways did you use the BICYCLE COMPATIBILITY INDEX? Check all that apply.

- ☐ Direct application as part of job (field application, etc.)
☐ Educating self (continuing credit, professional development, etc.)
☐ Educating others (teaching, information dissemination, etc.)
☐ Obtained as reference material (e.g., library)
☐ Research project
☐ Occupational development
☐ Personal interest
☐ Other, please specify

Page 8 - Question 16 - Rating Scale - Matrix

[Mandatory]

How easy was the BICYCLE COMPATIBILITY INDEX to use?

	Extremely difficult to use	2	3	4	5	6	7	8	Extremely easy to use	Did not use myself
Ease of use	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

 Additional Comment

Page 8 - Question 17 - Rating Scale - Matrix

[Mandatory]

How useful was the BICYCLE COMPATIBILITY INDEX in helping you carry out your work?

	Extremely unuseful	2	3	4	5	6	7	8	Extremely useful	Did not use myself
--	--------------------	---	---	---	---	---	---	---	------------------	--------------------

elf

○ ○ ○ ○ ○ ○ ○ ○ ○ ○

[Mandatory]

- ☐ Yes
- ☐ No
- ☐ Why or why not?

[Mandatory]

[illegible]

[Mandatory]

- ☐ Yes
- ☐ No
- ☐ Why or why not?

[Mandatory]

☐ Yes

☐ No [Skip to 14]

[Mandatory]

☐ Yes

☐ No [Skip to 14]

[Mandatory]

- ☐ Direct application as part of job (field application, etc.)
- ☐ Educating self (continuing credit, professional development, etc.)
- ☐ Educating others (teaching, information dissemination, etc.)

- ☐ Obtained as reference material (e.g., library)
- ☐ Research project
- ☐ Occupational development
- ☐ Personal interest
- ☐ Other, please specify

Page 12 - Question 24 - Rating Scale - Matrix

[Mandatory]

How easy was BIKESAFE: BICYCLE SAFETY GUIDE AND COUNTERMEASURE SELECTION SYSTEM to use?

	Extre mely diffic ult to use	2	3	4	5	6	7	8	Extre mely easy to use	Did not use mys elf
Ease of use	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

 Additional Comment

Page 12 - Question 25 - Rating Scale - Matrix

[Mandatory]

How useful was BIKESAFE: BICYCLE SAFETY GUIDE AND COUNTERMEASURE SELECTION SYSTEM in helping you carry out your work?

	Extre mely unus eful	2	3	4	5	6	7	8	Extre mely usef ul	Did not use mys elf
Usefulness	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

 Additional Comment

Page 13 - Question 26 - Yes or No

[Mandatory]

Did BIKESAFE: BICYCLE SAFETY GUIDE AND COUNTERMEASURE SELECTION SYSTEM give you knowledge that contributed to a reduction of crashes, injuries, and/or fatalities in your state/locality?

- ☐ Yes
- ☐ No
- ☐ Why or why not?

Page 13 - Question 27 - Rating Scale - Matrix

[Mandatory]

How much of an impact did BIKESAFE: BICYCLE SAFETY GUIDE AND COUNTERMEASURE SELECTION SYSTEM have on the way you carried out your work?

	Extre mely weak impa ct	2	3	4	5	6	7	8	Extre mely stron g impa ct	Did not use mys elf
Strength of impact	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

 Additional Comment

Page 13 - Question 28 - Yes or No

[Mandatory]

Will BIKESAFE: BICYCLE SAFETY GUIDE AND COUNTERMEASURE SELECTION SYSTEM play an important role in reducing crashes, injuries, and/or fatalities in the FUTURE?

- ☐ Yes

- ☐ No
- ☐ Why or why not?

Page 14 - Question 29 - Yes or No

[Mandatory]

Have you heard of or are you familiar with HOW TO DEVELOP A PEDESTRIAN SAFETY ACTION PLAN, which is a product/deployment from the Federal Highway Administration?

- ☐ Yes
- ☐ No [Skip to 18]

Page 15 - Question 30 - Yes or No

[Mandatory]

Have you used HOW TO DEVELOP A PEDESTRIAN SAFETY ACTION PLAN in the last 3 years?

- ☐ Yes
- ☐ No [Skip to 18]

Page 16 - Question 31 - Choice - Multiple Answers (Bullets)

[Mandatory]

In what ways did you use HOW TO DEVELOP A PEDESTRIAN SAFETY ACTION PLAN? Check all that apply.

- ☐ Direct application as part of job (field application, etc.)
- ☐ Educating self (continuing credit, professional development, etc.)
- ☐ Educating others (teaching, information dissemination, etc.)
- ☐ Obtained as reference material (e.g., library)
- ☐ Research project
- ☐ Occupational development
- ☐ Personal interest
- ☐ Other, please specify

Page 16 - Question 32 - Rating Scale - Matrix

[Mandatory]

How easy was HOW TO DEVELOP A PEDESTRIAN SAFETY ACTION PLAN to use?

	Extremely difficult to use	2	3	4	5	6	7	8	Extremely easy to use	Did not use myself
Ease of use	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Page 16 - Question 33 - Rating Scale - Matrix

[Mandatory]

How useful was HOW TO DEVELOP A PEDESTRIAN SAFETY ACTION PLAN in helping you carry out your work?

	Extremely unuseful	2	3	4	5	6	7	8	Extremely useful	Did not use myself
Usefulness	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Did HOW TO DEVELOP A PEDESTRIAN SAFETY ACTION PLAN give you knowledge that contributed to a reduction of crashes, injuries, and/or fatalities in your state/locality?

- ☐ Yes
☐ No
☐ Why or why not?

How much of an impact did HOW TO DEVELOP A PEDESTRIAN SAFETY ACTION PLAN have on the way you carried out your work?

	Extre mely weak impa ct	2	3	4	5	6	7	8	Extre mely stron g impa ct	Did not use mys elf
Strength of impact	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
 Additional Comment										

Will HOW TO DEVELOP A PEDESTRIAN SAFETY ACTION PLAN play an important role in reducing crashes, injuries, and/or fatalities in the FUTURE?

- ☐ Yes
☐ No
☐ Why or why not?

Have you heard of or are you familiar with the PED/BIKE CRASH ANALYSIS TOOL, which is a product/deployment from the Federal Highway Administration?

- ☐ Yes
☐ No **[Skip to 22]**

Have you used the PED/BIKE CRASH ANALYSIS TOOL in the last 3 years?

- ☐ Yes
☐ No **[Skip to 22]**

In what ways did you use the PED/BIKE CRASH ANALYSIS TOOL? Check all that apply.

- ☐ Direct application as part of job (field application, etc.)
☐ Educating self (continuing credit, professional development, etc.)
☐ Educating others (teaching, information dissemination, etc.)
☐ Obtained as reference material (e.g., library)
☐ Research project

- ☐ Occupational development
- ☐ Personal interest
- ☐ Other, please specify

Page 20 - Question 40 - Rating Scale - Matrix

[Mandatory]

How easy was the PED/BIKE CRASH ANALYSIS TOOL to use?

	Extre mely diffic ult to use	2	3	4	5	6	7	8	Extre mely easy to use	Did not use mys elf
Ease of use	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

 Additional Comment

Page 20 - Question 41 - Rating Scale - Matrix

[Mandatory]

How useful was the PED/BIKE CRASH ANALYSIS TOOL in helping you carry out your work?

	Extre mely unus eful	2	3	4	5	6	7	8	Extre mely usef ul	Did not use mys elf
Usefulness	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

 Additional Comment

Page 21 - Question 42 - Yes or No

[Mandatory]

Did the PED/BIKE CRASH ANALYSIS TOOL give you knowledge that contributed to a reduction of crashes, injuries, and/or fatalities in your state/locality?

- ☐ Yes
- ☐ No
- ☐ Why or why not?

Page 21 - Question 43 - Rating Scale - Matrix

[Mandatory]

How much of an impact did the PED/BIKE CRASH ANALYSIS TOOL have on the way you carried out your work?

	Extre mely weak impa ct	2	3	4	5	6	7	8	Extre mely stron g impa ct	Did not use mys elf
Strength of impact	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

 Additional Comment

Page 21 - Question 44 - Yes or No

[Mandatory]

Will the PED/BIKE CRASH ANALYSIS TOOL play an important role in reducing crashes, injuries, and/or fatalities in the FUTURE?

- ☐ Yes
- ☐ No
- ☐ Why or why not?

Page 22 - Question 45 - Yes or No[Mandatory]

Have you heard of or are you familiar with PEDESTRIAN AND BICYCLE SAFETY MATERIALS FOR HISPANIC AUDIENCES, which is a product/deployment from the Federal Highway Administration?

☐ Yes

☐ No [Skip to 26]

Page 23 - Question 46 - Choice - Multiple Answers (Bullets)[Mandatory][Randomize]

Have you used PEDESTRIAN AND BICYCLE SAFETY MATERIALS FOR HISPANIC AUDIENCES in the last 3 years? Check all that apply.

☐ FLYERS

☐ BROCHURES

☐ POSTERS

☐ NONE/DID NOT USE [Skip to 26]

☐ Additional Comment

Page 24 - Question 47 - Choice - Multiple Answers (Bullets)[Mandatory]

In what ways did you use PEDESTRIAN AND BICYCLE SAFETY MATERIALS FOR HISPANIC AUDIENCES? Check all that apply.

☐ Direct application as part of job (field application, etc.)

☐ Educating self (continuing credit, professional development, etc.)

☐ Educating others (teaching, information dissemination, etc.)

☐ Obtained as reference material (e.g., library)

☐ Research project

☐ Occupational development

☐ Personal interest

☐ Other, please specify

Page 24 - Question 48 - Rating Scale - Matrix[Mandatory]

How easy was PEDESTRIAN AND BICYCLE SAFETY MATERIALS FOR HISPANIC AUDIENCES to use?

	Extremely difficult to use	2	3	4	5	6	7	8	Extremely easy to use	Did not use myself
Ease of use	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Page 24 - Question 49 - Rating Scale - Matrix[Mandatory]

How useful was PEDESTRIAN AND BICYCLE SAFETY MATERIALS FOR HISPANIC AUDIENCES in helping you carry out your work?

	Extremely unuseful	2	3	4	5	6	7	8	Extremely useful	Did not use myself
Usefulness	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Did PEDESTRIAN AND BICYCLE SAFETY MATERIALS FOR HISPANIC AUDIENCES give you knowledge that contributed to a reduction of crashes, injuries, and/or fatalities in your state/locality?

- ☐ Yes
☐ No
☐ Why or why not?

How much of an impact did PEDESTRIAN AND BICYCLE SAFETY MATERIALS FOR HISPANIC AUDIENCES have on the way you carried out your work?

	Extremely weak impact	2	3	4	5	6	7	8	Extremely strong impact	Did not use myself
Strength of impact	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Will PEDESTRIAN AND BICYCLE SAFETY MATERIALS FOR HISPANIC AUDIENCES play an important role in reducing crashes, injuries, and/or fatalities in the FUTURE?

- ☐ Yes
☐ No
☐ Why or why not?

Have you heard of or are you familiar with PEDESTRIAN AND BICYCLE INTERSECTION SAFETY INDICES, which is a product/deployment from the Federal Highway Administration?

- ☐ Yes
☐ No **[Skip to 30]**

Have you used PEDESTRIAN AND BICYCLE INTERSECTION SAFETY INDICES in the last 3 years?

- ☐ Yes
☐ No **[Skip to 30]**

In what ways did you use PEDESTRIAN AND BICYCLE INTERSECTION SAFETY INDICES? Check all that apply.

- ☐ Direct application as part of job (field application, etc.)
☐ Educating self (continuing credit, professional development, etc.)
☐ Educating others (teaching, information dissemination, etc.)
☐ Obtained as reference material (e.g., library)

- ☐ Research project
- ☐ Occupational development
- ☐ Personal interest
- ☐ Other, please specify

Page 28 - Question 56 - Rating Scale - Matrix

[Mandatory]

How easy was PEDESTRIAN AND BICYCLE INTERSECTION SAFETY INDICES to use?

	Extre mely diffic ult to use	2	3	4	5	6	7	8	Extre mely easy to use	Did not use mys elf
Ease of use	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Page 28 - Question 57 - Rating Scale - Matrix

[Mandatory]

How useful was PEDESTRIAN AND BICYCLE INTERSECTION SAFETY INDICES in helping you carry out your work?

	Extre mely unus eful	2	3	4	5	6	7	8	Extre mely usef ul	Did not use mys elf
Usefulness	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Page 29 - Question 58 - Yes or No

[Mandatory]

Did PEDESTRIAN AND BICYCLE INTERSECTION SAFETY INDICES give you knowledge that contributed to a reduction of crashes, injuries, and/or fatalities in your state/locality?

- ☐ Yes
- ☐ No
- ☐ Why or why not?

Page 29 - Question 59 - Rating Scale - Matrix

[Mandatory]

How much of an impact did PEDESTRIAN AND BICYCLE INTERSECTION SAFETY INDICES have on the way you carried out your work?

	Extre mely weak impa ct	2	3	4	5	6	7	8	Extre mely stron g impa ct	Did not use mys elf
Strength of impact	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Page 29 - Question 60 - Yes or No

[Mandatory]

Will PEDESTRIAN AND BICYCLE INTERSECTION SAFETY INDICES play an important role in reducing crashes, injuries, and/or fatalities in the FUTURE?

- ☐ Yes
- ☐ No
- ☐ Why or why not?

Have you heard of or are you familiar with the PEDESTRIAN AND BICYCLIST UNIVERSITY COURSE, which is a product/deployment from the Federal Highway Administration?

- ☐ Yes
☐ No **[Skip to 34]**

Have you used the PEDESTRIAN AND BICYCLIST UNIVERSITY COURSE in the last 3 years?

- ☐ Yes
☐ No **[Skip to 34]**

In what ways did you use the PEDESTRIAN AND BICYCLIST UNIVERSITY COURSE? Check all that apply.

- ☐ Direct application as part of job (field application, etc.)
☐ Educating self (continuing credit, professional development, etc.)
☐ Educating others (teaching, information dissemination, etc.)
☐ Obtained as reference material (e.g., library)
☐ Research project
☐ Occupational development
☐ Personal interest
☐ Other, please specify

How easy was the PEDESTRIAN AND BICYCLIST UNIVERSITY COURSE to use?

	Extremely difficult to use	2	3	4	5	6	7	8	Extremely easy to use	Did not use myself
Ease of use	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

How useful was the PEDESTRIAN AND BICYCLIST UNIVERSITY COURSE in helping you carry out your work?

	Extremely unuseful	2	3	4	5	6	7	8	Extremely useful	Did not use myself
Usefulness	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Did the PEDESTRIAN AND BICYCLIST UNIVERSITY COURSE give you knowledge that contributed to a reduction of crashes, injuries, and/or fatalities in your state/locality?

- ☐ Yes
☐ No
☐ Why or why not?

Page 33 - Question 67 - Rating Scale - Matrix

[Mandatory]

How much of an impact did the PEDESTRIAN AND BICYCLIST UNIVERSITY COURSE have on the way you carried out your work?

	Extremely weak impact	2	3	4	5	6	7	8	Extremely strong impact	Did not use myself
Strength of impact	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Page 33 - Question 68 - Yes or No

[Mandatory]

Will the PEDESTRIAN AND BICYCLIST UNIVERSITY COURSE play an important role in reducing crashes, injuries, and/or fatalities in the FUTURE?

- ☐ Yes
☐ No
☐ Why or why not?

Page 34 - Question 69 - Yes or No

[Mandatory]

Have you heard of or are you familiar with the PEDESTRIAN FORUM NEWSLETTER, which is a product/deployment from the Federal Highway Administration?

- ☐ Yes
☐ No **[Skip to 38]**

Page 35 - Question 70 - Yes or No

[Mandatory]

Have you used the PEDESTRIAN FORUM NEWSLETTER in the last 3 years?

- ☐ Yes
☐ No **[Skip to 38]**

Page 36 - Question 71 - Choice - Multiple Answers (Bullets)

[Mandatory]

In what ways did you use the PEDESTRIAN FORUM NEWSLETTER? Check all that apply.

- ☐ Direct application as part of job (field application, etc.)
- ☐ Educating self (continuing credit, professional development, etc.)
- ☐ Educating others (teaching, information dissemination, etc.)
- ☐ Obtained as reference material (e.g., library)
- ☐ Research project
- ☐ Occupational development
- ☐ Personal interest
- ☐ Other, please specify

How easy was the PEDESTRIAN FORUM NEWSLETTER to use?

	Extremely difficult to use	2	3	4	5	6	7	8	Extremely easy to use	N/A
Ease of use	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

 Additional Comment

How useful was the PEDESTRIAN FORUM NEWSLETTER in helping you carry out your work?

	Extremely unus-ful	2	3	4	5	6	7	8	Extremely use-ful	Did not use myself
Usefulness	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

 Additional Comment

Did the PEDESTRIAN FORUM NEWSLETTER give you knowledge that contributed to a reduction of crashes, injuries, and/or fatalities in your state/locality?

- ☐ Yes
☐ No
☐ Why or why not?
-

How much of an impact did the PEDESTRIAN FORUM NEWSLETTER have on the way you carried out your work?

	Extremely weak impact	2	3	4	5	6	7	8	Extremely strong impact	Did not use myself
Strength of impact	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

 Additional Comment

Will the PEDESTRIAN FORUM NEWSLETTER play an important role in reducing crashes, injuries, and/or fatalities in the FUTURE?

- ☐ Yes
☐ No
☐ Why or why not?
-

Have you heard of or are you familiar with the PEDESTRIAN SAFETY CAMPAIGN, which is a product/deployment from the Federal Highway Administration?

- ☐ Yes
☐ No [Skip to 42]

Page 39 - Question 78 - Yes or No

[Mandatory]

Have you used the PEDESTRIAN SAFETY CAMPAIGN in the last 3 years?

- ☐ Yes
☐ No [Skip to 42]

Page 40 - Question 79 - Choice - Multiple Answers (Bullets)

[Mandatory]

In what ways did you use the PEDESTRIAN SAFETY CAMPAIGN? Check all that apply.

- ☐ Direct application as part of job (field application, etc.)
☐ Educating self (continuing credit, professional development, etc.)
☐ Educating others (teaching, information dissemination, etc.)
☐ Obtained as reference material (e.g., library)
☐ Research project
☐ Occupational development
☐ Personal interest
☐ Other, please specify

Page 40 - Question 80 - Rating Scale - Matrix

[Mandatory]

How easy was the PEDESTRIAN SAFETY CAMPAIGN to use?

	Extremely difficult to use	2	3	4	5	6	7	8	Extremely easy to use	Did not use myself
Ease of use	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Page 40 - Question 81 - Rating Scale - Matrix

[Mandatory]

How useful was the PEDESTRIAN SAFETY CAMPAIGN in helping you carry out your work?

	Extremely unuseful	2	3	4	5	6	7	8	Extremely useful	Did not use myself
Usefulness	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Page 41 - Question 82 - Yes or No

[Mandatory]

Did the PEDESTRIAN SAFETY CAMPAIGN give you knowledge that contributed to a reduction of crashes, injuries, and/or fatalities in your state/locality?

- ☐ Yes
☐ No
☐ Why or why not?

How much of an impact did the PEDESTRIAN SAFETY CAMPAIGN have on the way you carried out your work?

	Extremely weak impact	2	3	4	5	6	7	8	Extremely strong impact	Did not use myself
Strength of impact	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

 Additional Comment

Will the PEDESTRIAN SAFETY CAMPAIGN play an important role in reducing crashes, injuries, and/or fatalities in the FUTURE?

- ☐ Yes
☐ No
☐ Why or why not?

Have you heard of or are you familiar with PEDESTRIAN SAFER JOURNEY, which is a product/deployment from the Federal Highway Administration?

- ☐ Yes
☐ No **[Skip to 46]**

Have you used PEDESTRIAN SAFETY SAFER JOURNEY in the last 3 years?

- ☐ Yes
☐ No **[Skip to 46]**

In what ways did you use PEDESTRIAN SAFER JOURNEY? Check all that apply.

- ☐ Direct application as part of job (field application, etc.)
☐ Educating self (continuing credit, professional development, etc.)
☐ Educating others (teaching, information dissemination, etc.)
☐ Obtained as reference material (e.g., library)
☐ Research project
☐ Occupational development
☐ Personal interest
☐ Other, please specify

How easy was PEDESTRIAN SAFER JOURNEY to use?

Extremely difficult to use	2	3	4	5	6	7	8	Extremely easy to use	Did not use myself

Ease of use

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

 Additional Comment

Page 44 - Question 89 - Rating Scale - Matrix

[Mandatory]

How useful was PEDESTRIAN SAFER JOURNEY in helping you carry out your work?

	Extremely unuseful	2	3	4	5	6	7	8	Extremely useful	Did not use myself
Usefulness	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

 Additional Comment

Page 45 - Question 90 - Yes or No

[Mandatory]

Did PEDESTRIAN SAFER JOURNEY give you knowledge that contributed to a reduction of crashes, injuries, and/or fatalities in your state/locality?

- ☐ Yes
☐ No
☐ Why or why not?

Page 45 - Question 91 - Rating Scale - Matrix

[Mandatory]

How much of an impact did PEDESTRIAN SAFER JOURNEY have on the way you carried out your work?

	Extremely weak impact	2	3	4	5	6	7	8	Extremely strong impact	Did not use myself
Strength of impact	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

 Additional Comment

Page 45 - Question 92 - Yes or No

[Mandatory]

Will PEDESTRIAN SAFER JOURNEY play an important role in reducing crashes, injuries, and/or fatalities in the FUTURE?

- ☐ Yes
☐ No
☐ Why or why not?

Page 46 - Question 93 - Yes or No

[Mandatory]

Have you heard of or are you familiar with PEDSAFE: PEDESTRIAN SAFETY GUIDE AND COUNTERMEASURE SELECTION SYSTEM, which is a product/deployment from the Federal Highway Administration?

- ☐ Yes
☐ No [Skip to 50]

Page 47 - Question 94 - Yes or No

[Mandatory]

Have you used PEDSAFE: PEDESTRIAN SAFETY GUIDE AND COUNTERMEASURE SELECTION SYSTEM, in the last 3 years?

- ☐ Yes

☐ No [Skip to 50]

Page 48 - Question 95 - Choice - Multiple Answers (Bullets)

[Mandatory]

In what ways did you use PEDSAFE: PEDESTRIAN SAFETY GUIDE AND COUNTERMEASURE SELECTION SYSTEM? Check all that apply.

- ☐ Direct application as part of job (field application, etc.)
- ☐ Educating self (continuing credit, professional development, etc.)
- ☐ Educating others (teaching, information dissemination, etc.)
- ☐ Obtained as reference material (e.g., library)
- ☐ Research project
- ☐ Occupational development
- ☐ Personal interest
- ☐ Other, please specify

Page 48 - Question 96 - Rating Scale - Matrix

[Mandatory]

How easy was PEDSAFE: PEDESTRIAN SAFETY GUIDE AND COUNTERMEASURE SELECTION SYSTEM to use?

	Extremely difficult to use	2	3	4	5	6	7	8	Extremely easy to use	Did not use myself
Ease of use	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Page 48 - Question 97 - Rating Scale - Matrix

[Mandatory]

How useful was PEDSAFE: PEDESTRIAN SAFETY GUIDE AND COUNTERMEASURE SELECTION SYSTEM in helping you carry out your work?

	Extremely unuseful	2	3	4	5	6	7	8	Extremely useful	Did not use myself
Usefulness	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Page 49 - Question 98 - Yes or No

[Mandatory]

Did PEDSAFE: PEDESTRIAN SAFETY GUIDE AND COUNTERMEASURE SELECTION SYSTEM give you knowledge that contributed to a reduction of crashes, injuries, and/or fatalities in your state/locality?

- ☐ Yes
- ☐ No
- ☐ Why or why not?

Page 49 - Question 99 - Rating Scale - Matrix

[Mandatory]

How much of an impact did PEDSAFE: PEDESTRIAN SAFETY GUIDE AND COUNTERMEASURE SELECTION SYSTEM have on the way you carried out your work?

	Extremely weak impact	2	3	4	5	6	7	8	Extremely strong impact	Did not use myself

Strength of impact

☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☒ ☐

 Additional Comment

Page 49 - Question 100 - Yes or No

[Mandatory]

Will PEDSAFE: PEDESTRIAN SAFETY GUIDE AND COUNTERMEASURE SELECTION SYSTEM play an important role in reducing crashes, injuries, and/or fatalities in the FUTURE?

- ☐ Yes
☐ No
☐ Why or why not?

Page 50 - Question 101 - Yes or No

[Mandatory]

Have you heard of or are you familiar with SAFETY EFFECTS OF MARKED VERSUS UNMARKED CROSSWALKS AT UNCONTROLLED LOCATIONS, which is a product/deployment from the Federal Highway Administration?

- ☐ Yes
☐ No [Skip to 54]

Page 51 - Question 102 - Yes or No

[Mandatory]

Have you used SAFETY EFFECTS OF MARKED VERSUS UNMARKED CROSSWALKS AT UNCONTROLLED LOCATIONS, in the last 3 years?

- ☐ Yes
☐ No [Skip to 54]

Page 52 - Question 103 - Choice - Multiple Answers (Bullets)

[Mandatory]

In what ways did you use SAFETY EFFECTS OF MARKED VERSUS UNMARKED CROSSWALKS AT UNCONTROLLED LOCATIONS? Check all that apply.

- ☐ Direct application as part of job (field application, etc.)
☐ Educating self (continuing credit, professional development, etc.)
☐ Educating others (teaching, information dissemination, etc.)
☐ Obtained as reference material (e.g., library)
☐ Research project
☐ Occupational development
☐ Personal interest
☐ Other, please specify

Page 52 - Question 104 - Rating Scale - Matrix

[Mandatory]

How easy was SAFETY EFFECTS OF MARKED VERSUS UNMARKED CROSSWALKS AT UNCONTROLLED LOCATIONS to use?

Ease of use

	Extremely difficult to use	2	3	4	5	6	7	8	Extremely easy to use	Did not use myself
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

 Additional Comment

How useful was SAFETY EFFECTS OF MARKED VERSUS UNMARKED CROSSWALKS AT UNCONTROLLED LOCATIONS in helping you carry out your work?

	Extre mely unus eful	2	3	4	5	6	7	8	Extre mely usef ul	Did not use mys elf
Usefulness	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
 Additional Comment										

Did SAFETY EFFECTS OF MARKED VERSUS UNMARKED CROSSWALKS AT UNCONTROLLED LOCATIONS give you knowledge that contributed to a reduction of crashes, injuries, and/or fatalities in your state/locality?

- ☐ Yes
☐ No
☐ Why or why not?
-

How much of an impact did SAFETY EFFECTS OF MARKED VERSUS UNMARKED CROSSWALKS AT UNCONTROLLED LOCATIONS have on the way you carried out your work?

	Extre mely weak impa ct	2	3	4	5	6	7	8	Extre mely stron g impa ct	Did not use mys elf
Strength of impact	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
 Additional Comment										

Will SAFETY EFFECTS OF MARKED VERSUS UNMARKED CROSSWALKS AT UNCONTROLLED LOCATIONS play an important role in reducing crashes, injuries, and/or fatalities in the FUTURE?

- ☐ Yes
☐ No
☐ Why or why not?
-

Have you heard of or are you familiar with the WALKABILITY CHECKLIST, which is a product/deployment from the Federal Highway Administration?

- ☐ Yes
☐ No [Skip to 58]

Have you used the WALKABILITY CHECKLIST, in the last 3 years?

- ☐ Yes
☐ No [Skip to 58]

In what ways did you use the WALKABILITY CHECKLIST? Check all that apply.

- ☐ Direct application as part of job (field application, etc.)
- ☐ Educating self (continuing credit, professional development, etc.)
- ☐ Educating others (teaching, information dissemination, etc.)
- ☐ Obtained as reference material (e.g., library)
- ☐ Research project
- ☐ Occupational development
- ☐ Personal interest
- ☐ Other, please specify

How easy was the WALKABILITY CHECKLIST to use?

	Extremely difficult to use	2	3	4	5	6	7	8	Extremely easy to use	Did not use myself
Ease of use	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

How useful was the WALKABILITY CHECKLIST in helping you carry out your work?

	Extremely unuseful	2	3	4	5	6	7	8	Extremely useful	Did not use myself
Usefulness	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Did the WALKABILITY CHECKLIST give you knowledge that contributed to a reduction of crashes, injuries, and/or fatalities in your state/locality?

- ☐ Yes
- ☐ No
- ☐ Why or why not?

How much of an impact did the WALKABILITY CHECKLIST have on the way you carried out your work?

	Extremely weak impact	2	3	4	5	6	7	8	Extremely strong impact	Did not use myself
Strength of impact	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Will the WALKABILITY CHECKLIST play an important role in reducing crashes, injuries, and/or fatalities in the FUTURE?

- ☐ Yes
☐ No
☐ Why or why not?

Have you heard of or are you familiar with the RESIDENT'S GUIDE FOR CREATING SAFE AND WALKABLE COMMUNITIES, which is a product/deployment from the Federal Highway Administration?

- ☐ Yes
☐ No [Skip to 62]

Have you used the RESIDENT'S GUIDE FOR CREATING SAFE AND WALKABLE COMMUNITIES, in the last 3 years?

- ☐ Yes
☐ No [Skip to 62]

In what ways did you use the RESIDENT'S GUIDE FOR CREATING SAFE AND WALKABLE COMMUNITIES? Check all that apply.

- ☐ Direct application as part of job (field application, etc.)
☐ Educating self (continuing credit, professional development, etc.)
☐ Educating others (teaching, information dissemination, etc.)
☐ Obtained as reference material (e.g., library)
☐ Research project
☐ Occupational development
☐ Personal interest
☐ Other, please specify

How easy was the RESIDENT'S GUIDE FOR CREATING SAFE AND WALKABLE COMMUNITIES to use?

	Extremely difficult to use	2	3	4	5	6	7	8	Extremely easy to use	Did not use myself
Ease of use	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

How useful was the RESIDENT'S GUIDE FOR CREATING SAFE AND WALKABLE COMMUNITIES in helping you carry out your work?

	Extremely unuseful	2	3	4	5	6	7	8	Extremely useful	Did not use myself
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

○ ○ ○ ○ ○ ○ ○ ○ ○ ○

[Mandatory]

Did the RESIDENT'S GUIDE FOR CREATING SAFE AND WALKABLE COMMUNITIES give you knowledge that contributed to a reduction of crashes, injuries, and/or fatalities in your state/locality?

-

[Mandatory]

How much of an impact did the RESIDENT'S GUIDE FOR CREATING SAFE AND WALKABLE COMMUNITIES have on the way you carried out your work?

[illegible]

[Mandatory]

Will the RESIDENT'S GUIDE FOR CREATING SAFE AND WALKABLE COMMUNITIES play an important role in reducing crashes, injuries, and/or fatalities in the FUTURE?

- 

[Mandatory]

Have you heard of or are you familiar with PEDESTRIAN ROAD SAFETY AUDIT GUIDELINES AND PROMPT LISTS, which is a product/deployment from the Federal Highway Administration?

-

[Mandatory]

Have you used PEDESTRIAN ROAD SAFETY AUDIT GUIDELINES AND PROMPT LISTS, in the last 3 years?

-

[Mandatory]

In what ways did you use PEDESTRIAN ROAD SAFETY AUDIT GUIDELINES AND PROMPT LISTS? Check all that apply.

-

- ☐ Educating others (teaching, information dissemination, etc.)
- ☐ Obtained as reference material (e.g., library)
- ☐ Research project
- ☐ Occupational development
- ☐ Personal interest
- ☐ Other, please specify

Page 64 - Question 128 - Rating Scale - Matrix

[Mandatory]

How easy was PEDESTRIAN ROAD SAFETY AUDIT GUIDELINES AND PROMPT LISTS to use?

	Extremely difficult to use	2	3	4	5	6	7	8	Extremely easy to use	Did not use myself
Easy of use	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Page 64 - Question 129 - Rating Scale - Matrix

[Mandatory]

How useful was PEDESTRIAN ROAD SAFETY AUDIT GUIDELINES AND PROMPT LISTS in helping you carry out your work?

	Extremely unuseful	2	3	4	5	6	7	8	Extremely useful	Did not use myself
Usefulness	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Page 65 - Question 130 - Yes or No

[Mandatory]

Did PEDESTRIAN ROAD SAFETY AUDIT GUIDELINES AND PROMPT LISTS give you knowledge that contributed to a reduction of crashes, injuries, and/or fatalities in your state/locality?

- ☐ Yes
- ☐ No
- ☐ Why or why not?

Page 65 - Question 131 - Rating Scale - Matrix

[Mandatory]

How much of an impact did PEDESTRIAN ROAD SAFETY AUDIT GUIDELINES AND PROMPT LISTS have on the way you carried out your work?

	Extremely weak impact	2	3	4	5	6	7	8	Extremely strong impact	Did not use myself
Strength of impact	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Page 65 - Question 132 - Yes or No

[Mandatory]

Will PEDESTRIAN ROAD SAFETY AUDIT GUIDELINES AND PROMPT LISTS play an important role in reducing crashes, injuries, and/or fatalities in the FUTURE?

- ☐ Yes

- ☐ No
- ☐ Why or why not?

Page 66 - Question 133 - Yes or No

[Mandatory]

Have you heard of or are you familiar with the PEDESTRIAN SAFETY GUIDE FOR TRANSIT AGENCIES, which is a product/deployment from the Federal Highway Administration?

- ☐ Yes
- ☐ No [Skip to 70]

Page 67 - Question 134 - Yes or No

[Mandatory]

Have you used the PEDESTRIAN SAFETY GUIDE FOR TRANSIT AGENCIES, in the last 3 years?

- ☐ Yes
- ☐ No [Skip to 70]

Page 68 - Question 135 - Choice - Multiple Answers (Bullets)

[Mandatory]

In what ways did you use the PEDESTRIAN SAFETY GUIDE FOR TRANSIT AGENCIES? Check all that apply.

- ☐ Direct application as part of job (field application, etc.)
- ☐ Educating self (continuing credit, professional development, etc.)
- ☐ Educating others (teaching, information dissemination, etc.)
- ☐ Obtained as reference material (e.g., library)
- ☐ Research project
- ☐ Occupational development
- ☐ Personal interest
- ☐ Other, please specify

Page 68 - Question 136 - Rating Scale - Matrix

[Mandatory]

How easy was the PEDESTRIAN SAFETY GUIDE FOR TRANSIT AGENCIES to use?

	Extremely difficult to use	2	3	4	5	6	7	8	Extremely easy to use	Did not use myself
Ease of use	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Page 68 - Question 137 - Rating Scale - Matrix

[Mandatory]

How useful was the PEDESTRIAN SAFETY GUIDE FOR TRANSIT AGENCIES in helping you carry out your work?

	Extremely unuseful	2	3	4	5	6	7	8	Extremely useful	Did not use myself
Usefulness	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Did the PEDESTRIAN SAFETY GUIDE FOR TRANSIT AGENCIES give you knowledge that contributed to a reduction of crashes, injuries, and/or fatalities in your state/locality?

- ☐ Yes
☐ No
☐ Why or why not?

How much of an impact did the PEDESTRIAN SAFETY GUIDE FOR TRANSIT AGENCIES have on the way you carried out your work?

	Extre mely weak impa ct	2	3	4	5	6	7	8	Extre mely stron g impa ct	Did not use mys elf
Strength of impact	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
 Additional Comment										

Will the PEDESTRIAN SAFETY GUIDE FOR TRANSIT AGENCIES play an important role in reducing crashes, injuries, and/or fatalities in the FUTURE?

- ☐ Yes
☐ No
☐ Why or why not?

Have you heard of or are you familiar with OTHER PEDESTRIAN SAFETY PRODUCTS OR DEPLOYMENTS from the Federal Highway Administration?

- ☐ Yes
☐ No **[Skip to 74]**
☐ Please give the name of "Other" product or deployment

Have you used OTHER PEDESTRIAN SAFETY PRODUCTS OR DEPLOYMENTS, in the last 3 years?

- ☐ Yes
☐ No **[Skip to 74]**

In what ways did you use these OTHER PEDESTRIAN SAFETY PRODUCTS OR DEPLOYMENTS? Check all that apply.

- ☐ Direct application as part of job (field application, etc.)
☐ Educating self (continuing credit, professional development, etc.)
☐ Educating others (teaching, information dissemination, etc.)

- ☐ Obtained as reference material (e.g., library)
- ☐ Research project
- ☐ Occupational development
- ☐ Personal interest
- ☐ Other, please specify

Page 72 - Question 144 - Rating Scale - Matrix

[Mandatory]

How easy were these OTHER PEDESTRIAN SAFETY PRODUCTS OR DEPLOYMENTS to use?

	Extre mely diffic ult to use	2	3	4	5	6	7	8	Extre mely easy to use	Did not use mys elf
Ease of use	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Page 72 - Question 145 - Rating Scale - Matrix

[Mandatory]

How useful were the OTHER PEDESTRIAN SAFETY PRODUCTS OR DEPLOYMENTS in helping you carry out your work?

	Extre mely unus eful	2	3	4	5	6	7	8	Extre mely usef ul	Did not use mys elf
Usefulness	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Page 73 - Question 146 - Yes or No

[Mandatory]

Did OTHER PEDESTRIAN SAFETY PRODUCTS OR DEPLOYMENTS give you knowledge that contributed to a reduction of crashes, injuries, and/or fatalities in your state/locality?

- ☐ Yes
- ☐ No
- ☐ Why or why not?

Page 73 - Question 147 - Rating Scale - Matrix

[Mandatory]

How much of an impact did OTHER PEDESTRIAN SAFETY PRODUCTS OR DEPLOYMENTS have on the way you carried out your work?

	Extre mely weak impa ct	2	3	4	5	6	7	8	Extre mely stron g impa ct	Did not use mys elf
Strength of impact	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Additional Comment										

Page 73 - Question 148 - Yes or No

[Mandatory]

Will OTHER PEDESTRIAN SAFETY PRODUCTS OR DEPLOYMENTS play an important role in reducing crashes, injuries, and/or fatalities in the FUTURE?

- ☐ Yes
- ☐ No

☐ Why or why not?

Page 74 - Question 149 - Yes or No

[Mandatory]

Did you share any PEDESTRIAN AND BICYCLE SAFETY products or deployments with coworkers or others?

- ☐ Yes
☐ No **[Skip to 76]**

Page 75 - Question 150 - Choice - Multiple Answers (Bullets)

Which ones did you share? Check all that apply.

- ☐ Bicycle Safer Journey
- ☐ Bicycle Compatibility Index
- ☐ Bikesafe: Bicycle Safety Guide and Countermeasure Selection System
- ☐ How to Develop a Pedestrian Safety Action Plan
- ☐ Ped/Bike Crash Analysis Tool
- ☐ Pedestrian and Bicycle Safety Materials for Hispanic Audiences ("Sabia Usted?")--FLYER
- ☐ Pedestrian and Bicycle Safety Materials for Hispanic Audiences ("Sabia Usted?")--BROCHURE
- ☐ Pedestrian and Bicycle Safety Materials for Hispanic Audiences ("Sabia Usted?")--POSTER
- ☐ Pedestrian and Bicycle Intersection Safety Indices
- ☐ Pedestrian and Bicyclist University Course
- ☐ Pedestrian Forum Newsletter
- ☐ Pedestrian Safety Campaign
- ☐ Pedestrian Safer Journey
- ☐ Pedsafe: Pedestrian Safety Guide and Countermeasure Selection System
- ☐ Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations
- ☐ Walkability Checklist
- ☐ Resident's Guide for Creating Safe and Walkable Communities
- ☐ Pedestrian Road Safety Audit Guidelines and Prompt Lists
- ☐ Pedestrian Safety Guide for Transit Agencies
- ☐ Not Applicable (did not share with anyone)
- ☐ Other, please specify

Page 75 - Question 151 - Choice - Multiple Answers (Bullets)

With whom did you share this product? Check all that apply.

- ☐ Other professionals in your field
- ☐ Coworkers at your place of employment
- ☐ Not applicable (did not share with anyone)
- ☐ Other, please specify

Page 76 - Question 152 - Choice - Multiple Answers (Bullets)

[Mandatory]

How do you prefer to receive information from the Federal Highway Administration (FHWA)? Check all that apply.

- ☐ Website
- ☐ Mail (Postal service, UPS, FedEx, etc.)
- ☐ Conference

- ☐ Webconference/webinar
 - ☐ RSS feed (Really Simple Syndication--e.g., Google Reader)
 - ☐ Email
 - ☐ Other, please specify
-

Page 77 - Heading

The following questions are for classification purposes only. All information will be kept strictly confidential.

Page 77 - Question 153 - Open Ended - One Line

What is the zip code where you LIVE?

Page 77 - Question 154 - Open Ended - One Line

What is the zip code where you WORK?

Page 77 - Question 155 - Open Ended - One Line

What is your age?

Page 77 - Question 156 - Choice - Multiple Answers (Bullets)

What is your race? Choose all that apply.

- ☐ Caucasian/White
 - ☐ African-American/Black
 - ☐ Asian/Pacific-Islander
 - ☐ Native American
 - ☐ Hispanic/Latino
 - ☐ Other, please specify
-

Page 77 - Question 157 - Choice - One Answer (Bullets)

What is the highest level of education you have obtained?

- ☐ High School
 - ☐ Trade or technical school
 - ☐ Some college
 - ☐ 4 year college degree (e.g., Bachelor's)
 - ☐ Some graduate work
 - ☐ Master's degree
 - ☐ Professional degree (e.g., MD, JD)
 - ☐ Doctorate (e.g., Ph.D.)
 - ☐ Other, please specify
-

Page 77 - Question 158 - Choice - One Answer (Bullets)

[Mandatory]

What is your primary occupation?

- ☐ City Planner
- ☐ Traffic Engineer
- ☐ Researcher (professor, research scientist, etc.)
- ☐ Educator (teacher, etc.)
- ☐ Student [\[Skip to 79\]](#)
- ☐ Consultant
- ☐ Law enforcement
- ☐ Legal professional (lawyer, paralegal, etc.)
- ☐ Advocate (policy lobbyist, enthusiast, coordinator, etc.)
- ☐ Policymaker
- ☐ Material vendor (traffic control device vendor, etc.)
- ☐ Government employee (not listed above)
- ☐ None/Retired [\[Skip to 79\]](#)
- ☐ Other, please specify

Page 77 - Question 159 - Choice - One Answer (Drop Down)

[Mandatory]

How many years have you been in this occupation?

- ☐ N/A--none/retired
- ☐ 1
- ☐ 2
- ☐ 3
- ☐ .
- ☐ .
- ☐ .
- ☐ 75

Page 78 - Question 160 - Choice - One Answer (Bullets)

[Mandatory]

What type of organization do you work for?

- ☐ Federal government
- ☐ State government
- ☐ Local government
- ☐ For profit company
- ☐ Metropolitan planning organization
- ☐ Self-employed (independent consultant/contractor)
- ☐ University
- ☐ Non-profit organization
- ☐ Other, please specify

Page 78 - Question 161 - Choice - One Answer (Bullets)

[Mandatory]

What is the size of your organization?

- ☐ 1-10 employees
- ☐ 11-100 employees
- ☐ 101-1000 employees
- ☐ 1001-5000 employees
- ☐ >5000 employees
- ☐ Other, please specify

What is your role in the organization?

- ☐ Executive/Owner
- ☐ Senior management
- ☐ Middle management
- ☐ Professional staff (engineer, scientist, consultant, etc.)
- ☐ Support staff (research assistant, secretarial, etc.)
- ☐ Other, please specify

Do you have a colleague who has used any of the materials mentioned and would be interested in taking this online survey?

- ☐ Yes
- ☐ No
- ☐ If yes, please enter their email address:

Are you willing to participate in a short (approximately 15 minutes) follow-up phone interview regarding materials that you have currently used? This will allow us to discuss likes/dislikes and suggestions for further product development. If yes, then please enter information in the boxes below.

- Email address: _____
- Telephone number: _____
- Best time to call (morning, afternoon, evening)? _____

Do you have any other comments about this survey or FHWA products and deployments?

Thank you for taking our survey! If you provided contact information for a follow-up interview, then you will be contacted shortly.

APPENDIX II: FHWA PRODUCT EVALUATION SURVEY RESULTS

Respondent Characteristics

The survey was sent to 2,452 individuals who have ordered products/deployments from FHWA's Web site and are based in the United States. Of those emailed, 478 completed the survey. Those respondents were asked several demographic questions and their information is presented below.

- Place of employment (in order of percentage): 36 percent worked in a large metropolis (greater than 500K), 26 percent in a medium city (100K to 500K), 23 percent in a small city (less than 100K), 10 percent rural, and 5 percent other. Places where respondents lived had a similar distribution. There were a wide variety of states represented, with none accounting for more than 11 percent of overall responses (most were in the 4 percent range).
- Race (in order of percentage): Caucasian/White (88 percent), followed by Asian/Pacific-Islander (4 percent), Hispanic/Latino (4 percent), African-American/Black (2 percent), other (2 percent), and Native American (1 percent). Respondents were able to select more than one response.
- Education (in order of percentage): Master's (36 percent), followed by a four year degree (Bachelor's) (28 percent), some college (11 percent), some graduate work (10 percent), Doctorate (6 percent), professional degree (3 percent), other (3 percent), high school (1 percent), and trade/technical (1 percent).
- Primary Occupation (in order of percentage): Other (25 percent), Government employee (not listed in other options) (19 percent), Traffic engineer (13 percent), City planner (10 percent), Consultant (8 percent), Advocate (7 percent), Educator (6 percent), Researcher (4 percent), Law enforcement (4 percent), None/Retired (3 percent), Policy maker (2 percent), Student (1 percent). Respondents were only given one option.
- Type of organization (in order of percentage): Local government (23 percent), State government (20 percent), For profit company (12 percent), Non-profit organization (12 percent), other (9 percent), Federal government (7 percent), University (7 percent), Metropolitan planning organization (6 percent), Self-employed (consultant, contractor, etc.) (4 percent). Respondents were only given one option
- Role in organization (in order of percentage): Professional staff (scientist, engineer, etc.) (50 percent), Middle management (17 percent), Executive/Owner (10 percent), Senior management (9 percent), other (9 percent), Support staff (research assistant, secretarial, etc.) (6 percent).

Familiarity, Recent Usage, and Types of Use

A portion of the open-ended responses at the end of the Web-survey addressed this issue of familiarity. These statements were given in response to the question "Do you have any other comments about this survey or FHWA products and deployments?":

- "You don't do a good job of marketing the materials. I wasn't aware of some of them."
- "Total lack of awareness of these products."
- "Please keep up the good work. Please try to market your materials better through e-

- mail so people are aware of all your products. Thanks!”
- “I wish I know about these products. I will have to search the FHWA Web site more thoroughly I guess.”
 - “It upsets me that there are many products out there from the FHWA that seem to be quite useful that I've never heard of. I've designed many bike/ped paths and I wished I knew they existed.”
 - “No - but now I think I need to visit the Web site to see if I can find some of the items mentioned. Maybe the Web site design and layout of the newsletter need to be better to improve exposure.”
 - “You should send a follow-up e-mail to all survey participants that includes a list of all the materials included in this survey and how to get them.”
 - “To make your materials more readily available, you should email it to as many professionals as possible. E-mail to APA, ITE members.”
 - “Would love to be able to be on notification lists; mostly find out about FHWA materials by ‘accident’.”
 - “I have not heard of some of the publications that were mentioned. I try to keep bike and pedestrian materials for reference by our staff and for my own information. I would like a better idea of what publications are available. Possibly they could be listed by topic on the alternative transportation Web site with a direct link.”

These responses indicate the need for better dissemination of information about current products/deployments that are available.

Table 17 presents categories of usage for products/deployments in the last three years. Note that responses for each product/deployment were only given by users who have used it the last three years (not all respondents). Also, note that totals will not equal 100—respondents were able to choose more than one category. The major uses for all products/deployments were: Direct application as part of the job, Educating Self, Educating Others, and Reference Materials.

Table 17. Product/Deployment Usage in the Last Three Years (Percentages).

Product or deployment	Job	Ed self	Ed other	Ref mat	Res	Occp devel	Pers Int	Oth
Bicycle Compatibility Index	48	41	52	36	16	7	16	16
Bicycle Safer Journey	26	44	80	42	5	7	21	9
Bikesafe: Bicycle Safety Guide and Countermeasure Selection System	43	62	63	52	13	12	26	7
How to Develop a Pedestrian Safety Action Plan	49	66	69	66	15	15	8	8
Ped/Bike Crash Analysis Tool	62	41	62	49	15	15	21	0
Pedestrian and Bicycle Safety Materials for Hispanic Audiences	35	14	89	22	3	5	5	5
Pedestrian and Bicyclist Intersection Safety Indices	48	48	64	36	6	15	24	6
Pedestrian and Bicyclist University Course	34	66	62	34	14	17	21	10
Pedestrian Forum Newsletter	36	73	49	33	2	19	26	3
Pedestrian Road Safety Audit Guidelines and Prompt Lists	70	54	68	59	8	11	19	0
Pedestrian Safety Campaign	60	47	80	33	3	13	7	3
Pedestrian Safer Journey	31	49	72	46	4	7	22	3
Pedestrian Safety Guide for Transit Agencies	57	67	63	50	13	17	7	0

Product or deployment	Job	Ed self	Ed other	Ref mat	Res	Occp devel	Pers Int	Oth
Pedsafe: Pedestrian Safety Guide and Countermeasure Selection System	54	65	64	57	12	13	16	5
Resident's Guide for Creating Safe and Walkable Communities	46	68	67	46	11	17	24	5
Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations	57	60	65	53	15	14	14	3
Walkability Checklist	54	56	73	37	10	7	16	9

Note: Job = Direct application as part of job, Ed self = Educating Self, Ed other = Educating Others, Res = Research Project, Occp devel = Occupational Development, Pers Int = Personal Interest, Oth = Other.

Miscellaneous Product Comments

A subset of participants who volunteered for a short follow-up telephone interview was contacted following completion of the Web survey. Three to five participants were interviewed about each product/deployment (and each person was interviewed about one product). The following comments were given either within open-ended Web survey responses or during follow-up interviews. In addition to these telephone interviews, Web survey participants were able to leave additional comments about each product during the web survey. The following list is a sample of comments derived from these two sources. Note that due to space restrictions, only a small, but generally representative, portion of the comments made are included.

- Bicycle Compatibility Index (BCI)
 - “Data requirements are extensive (i.e., not all necessary data is available).”
 - “The BCI was much easier to use than another model Bicycle Level of Service (BLOS).”
 - “Moderately useful. However, when compared to the BLOS, it was much more difficult to get a LOS greater than C. It also consistently gave lower LOS than the BLOS model. But it did serve to stimulate discussion among stakeholders regarding possible bicycle accommodations and at least a starting point of reference.”
 - “Concern about getting a level of service of C or higher tied to traffic volume sensitivity. Sensitive to traffic volume.”
 - “It has made it harder to advocate for safer efficient cycling because it emphasizes the accommodation of the irrational fears of inexperienced cyclists rather than on factors that actually affect safety.”
 - “...it addresses the fundamentals of space, speed, and traffic volume and mix. However, trying to use crashes to assess the effectiveness of the tool may not be feasible.”
 - “I think that better educated practitioners will ultimately lead to fewer crashes in the future. Specifically, this is a tool that can be used to objectively assess roadways according to the level of comfort that bicyclists experience. It is one tool that can help practitioners prioritize where safety improvements should be made.”
 - “Can be difficult to implement on a regional basis because of lack of regional

data.”

- Bicycle Safer Journey
 - “I am a K-8 School Guidance Counselor and the students loved the interactive nature of the materials!”
 - “Some buttons were not larger enough, it took several tries to click on some and get the desired result.”
 - “Overall, content was informative, turn into iphone app or flash Web site for ease of distribution.”
 - “I have found it useful for health professional who are not ardent bicyclists to significantly improve their education and their ability to educate others on bicycle safety. No regional effect on injury but the knowledge clearly makes a difference with educated individuals”
 - “It was very well thought out and presented.”
 - “Helped us to win a major judgment in Federal Court for failure to provide accessible curb ramps for recently developed streets.”
 - “I believe you should consider a DVD version, as libraries (at least my community library) will not catalog CD's. Please consider a product you can put on an intranet - and for example show on school closed circuit systems.” Several respondents mentioned having a CD or downloadable format.
 - Some respondents would prefer a less idealized (“more of a real-world”) version of the information. “Sesame Street like.” “Felt like I was watching Leave it to Beaver.”
- Bikesafe: Bicycle Safety Guide and Countermeasure Selection System
 - “The online version was extremely helpful.”
 - “It was useful to see a range of examples with cost information. The images also helped to convey the concepts to other professionals.”
 - “Many countermeasures are not easily implemented.”
 - “Harmful. It doesn't recognize that most roads are just fine without any special markings for cyclists. It also encourages dangerous cycling practices, like passing on the right. It does not emphasize the need to maintain the cyclists' right to use the roadway when bike lanes are present, which puts traffic cyclists at legal risk. It is an advocacy document, not an engineering document.”
 - “Useful, primarily as reference. I have distributed copies to local government staff and regional bicycle advisory committee members and the document seems to get referenced quite often and serve as a starting point for planning and/or engineering staff.”
 - “However, as a Central Office staff resource person, I have used it to support knowledge that I already had that has probably been helpful in this regard. Case study and estimated cost information has been helpful in answering questions and supporting recommendations.”
 - “It provides an easy-to-use method for listing potential countermeasures in dangerous roadway sections. Without it, countermeasures are often recommended by advocates, planners or engineers that may not reflect the best state-of-the-practice.”

- “Too technical for most users. It impacts knowledge for teachers/experts but doesn't lay out an educational program for the public.”
- “I think it is useful information for all new planners and DOT workers.”
- “The city and the region are committed to bike transportation and these measures will be incorporated into street/highway projects as they come forward.”
- Respondent felt it was important not to lose sight of application to rural or smaller communities.
- Ped/Bike Crash Analysis Tool
 - “This could use better graphics and diagrams.”
 - “Crashes often, data files not easily placed in servers, folders.”
 - “I've been involved in numerous projects where PBCAT is used. In all of them, we wind up in the field with crash reports to determine how to solve the problems. In the Miami study, PBCAT originally led us to a wrong conclusion about the crash problem. Overall, I'd say PBCAT is fine for identifying intervention type countermeasures, but not so good for identifying engineering countermeasures.”
 - “Data helps with educational efforts more than site-specific recommendations due to the nature of the data.”
 - No other format needed because “tools are great and not the inherent problem.”
- Pedestrian and Bicycle Intersection Safety Indices
 - “Describing any type of pedestrian and bicycle suitability model is difficult, but this report does a good job of summarizing the model formulas. It does take some time to read through the report to understand the limitations of the study methodology.”
 - “I frequently receive inquiries related to ped/bike safety at intersections. This is a useful tool for engineers and planners.”
 - “Product does not have a high profile, is not easy to find online (separate report, user guide, and calculators), and most location-specific pedestrian and cycle safety activities are still conducted retroactively.”
 - “Model is not robust enough and doesn't account for a number of scenarios and conditions.”
 - “This is a safety-based analysis model, which will have an even more direct effect on pedestrian and bicycle safety than other (also important) comfort-based level of service models.”
 - It could be “more user friendly for community groups who advocate for better intersection safety.” Some disliked that it was too technical.
 - “If cost was not a concern could be produced in spreadsheet format similar to Bicycle Compatibility Index.”
- Pedestrian and Bicycle Safety Materials for Hispanic Audiences
 - “I ordered and used the posters. The large size caused rejection of the posters (in Spanish or English) in many situations. I would like to get them in letter size, though I admit I haven't checked the Web site to see if I can order them in that size.” “The posters were so large that few people wanted to give up that much space for them.” Other respondents also mentioned large size of the posters being

- a difficulty for storage.
 - “I don't speak Spanish but the message on the posters was very clear even if you do not speak or read Spanish.”
 - “I am unaware of whether the education outreach of posting the posters had an effect. Our crash rates aren't all that high.”
 - “They were an easy resource for distribution.”
 - “I used these for safety-education along with other materials and they helped save money that i could use on other items than a Spanish translator.”
 - “They are easy to use materials with great visuals and simple messages. They are great handouts and I like that they are bilingual.”
 - “Will play a role, but materials could benefit from further development.”
 - “Something smaller might be very useful. Maybe handbills that could be used on the street, public service announcements for Spanish radio or TV, short videos that could be played in doctors' waiting rooms, etc.”
 - Respondent mentioned that photos are not very clear for which direction one should be facing on the bicycle.
 - Respondent mentioned other formats: literature and additional pamphlets that could be passed out to parents and community partners. Also, hard copies or videos could be used for training.
- Pedestrian and Bicyclist University Course
 - “I loved it!” “I think it's a great reference.”
 - “The university course is a great reference that provides links to many other key pedestrian and bicycle planning/engineering/design references. However, it is very long and can sometimes be difficult to find the exact information that you are looking for.”
 - “Helpful because this information is extremely difficult to access through any other means.”
 - “An excellent package of reference materials and assignments.I added more assignments so that students would use the materials locally to make them more real-life.”
 - “Helped me in advocacy with local government and DOT officials. They saw me as a peer when it came to bike and ped infrastructure...loved it!”
 - “Provided a good reference/readings for our students. A nice package and virtually free for the students.”
 - “I already knew most of the information, but it is all important and the course has it organized very well.”
 - “It should be required reading for all planners and engineers!”
 - “We contacted universities in our state; regrettably, there is not much interest in offering such courses. I also have the impression that instructors who do teach courses on this subject prefer to use their own materials.”
 - Respondent mentioned that materials did not provide as much information about pedestrian issues related to snow.
 - Liked powerpoint as a resource that can also be modified to suit one's style.
 - Respondent suggested a PDF format and an indexed Web page (both of which can be printed).

- Respondent liked photos and searchable index.
- Pedestrian Forum Newsletter
 - “I like that it comes electronically and I can easily share it with others.”
 - “I don't think I get it directly, so I suppose that would make it easier to use. I know it would be prohibitively expensive, but getting it in the mail would make it easier to use, since I could carry it with me and read between meetings.”
 - “Like most newsletters it’s too wordy, too long and short on good info that I can learn from.”
 - “Great resource, well written and includes wonderful information.” “Very good useful information.” “Innovative, current.” “I presume that I will be learning about more applications in the future. This is an excellent informational tool.” Respondent said it gives good information about what is accepted practice. Felt that the pictures are well-done and details give good examples.
 - “It provided information that i have been able to use to try to raise the knowledge base of local engineers. “
 - “It could (be important in the future) if it were streamlined to get the message to the users in a quick and easy to read format that provides easy to glean gems of ped safety wisdom.”
 - “Could be expanded to include more state DOT/local news.”
 - “This publication should be sent out to local governments, interest groups and advocacy organizations. It is part of the whole complete streets and livability agendas.”
 - Respondent suggested having smaller captions embedded in the email so that it is not necessary to open the link to see what is inside the newsletter.
 - Respondent says does not do a good job of consulting other members in the field—often safety and infrastructure committees end up giving conflicting messages.
- Pedestrian Road Safety Audit Guidelines and Prompt Lists
 - “It is way too complicated and too long.”
 - “It is useful in dealing with the public on items that get reviewed and a good reminder of what to look at.”
 - “It is an important addition to the body of knowledge about pedestrian safety.”
 - “We hope to continue to use this document as a part of our studies and to educate and train new staff.”
 - “Great concept that was obviously created by a worried committee that threw in everything including the kitchen sink.”
 - “The process does not have empirical data of sufficient length to document the benefit with clear evidence.”
 -
- Pedestrian Safer Journey
 - “Does not run on all operating systems. Not sure if it is dated or just not compatible.”
 - “CD-ROM format can be difficult to use when the CD is old, as the software platform can be hard for computers to run.”

- “The XP/Vista issue on some CD needs to be addressed.”
- “The game portion is easy to use and to explain to others. However, the library portion is a bit difficult although it contains really good info.”
- “Too basic. Really best for kids. It's very slow moving.”
- “However, I think it could if it were renewed, like making the library section easier to use. Making the game something that would be interesting to play over and over again. Think about it, video games don't stop the action to make you take a quiz. That kills the excitement and momentum of the game. Maybe the player needs to actively navigate Johnny through the streets and actively look at the crossing signals and cross in the correct way. If they don't walk signal is on they should search for the push button. Crossings that are conducted correctly are rewarded with point and unsafe behaviors results in injury or loss of life. In video games the players' characters get injured and die all the time. As for the educational aspect some correct street wise ped behavior could be learned just by playing. Some may need some form of recap maybe even quiz at the end that might ask if the player know why they lost point for actions like walking with traffic rather than facing traffic. What if the player could build the streetscape, then try to navigate it. Designers might learn why their roads are not so ped friendly.”
- Respondent would like to see accompanying materials—had to create own posters based on the DVD.
- Respondent did not like the young age of the character (older students dismissed it), and the high pitched voice.
- Respondent felt it was too slow for this generation of younger children (“kinda put you to sleep”). Also, felt great for urban areas, but rural were not dealt with.
- Respondent felt it was very user friendly and interactive.
- Respondent disliked that it was not pre-school specific.
- Respondent mentioned a video format, along with a CD or online version.
- Pedestrian Safety Guide for Transit Agencies
 - “Most publications do not include public transit/bus stops. This guide covers this subject in detail.”
 - “I think some additional consultation with the American Public Transit Association to make additional improvements to this document would be useful. “
 - “...it helped us to provide design guidance to the local transit agency.”
 - “It enables us to insure safer designs for new transit stops or modified transit stops. The transit agency seems to "buy into" the value of the report's recommendations, so when they are locating or relocating or revising stops, they consider the information in the report.”
 - Respondent liked the emphasis on coordinating efforts when agency does not have the resources to project independently.
 - Respondent suggested online version and power point slides would be helpful.
 - Respondent liked the case studies and felt pictures are critical.
 - Respondent found examples conflicting and misleading. Found that the examples would focus on occasions where the suggestion worked but would not address where it did not work.

- How to Develop a Pedestrian Safety Action Plan
 - “It contains good info. The associated training provided by the FHWA Resource Center is also good, but it is difficult to move communities, cities and the state to actually develop an action plan.”
 - “Excellent resource guide.” “Very helpful.” “Provided good processes and best practices.” “It is very useful to pedestrian safety advocates.” “This is a great reference that summarizes existing literature, and it offers practical advice for improving pedestrian safety.”
 - “Recommend to have a summary table/tip card to summarize all strategies.”
 - “Helped me identify risks and apply knowledge to get a Safe Routes to School grant for some communities.”
 - “Contains useful ideas to help advocacy groups and sponsoring agencies that should promote safety.”
 - “City planner now including Bike-Ped in future goals.”
 - “It has a lot of good info on how to design and layout the streetscape for peds. However, in many ways I felt the document and training were misnamed in that it lead the user to think that an outcome of using the info will lead to the development of an action plan, but as noted in other answers it’s difficult to get the governmental agencies to the point of developing one.”
 - “I think the concept of PSAP, which has taken on more prominence, will play such a role; I’m not sure the current document itself will play such a role.”
 - “The local public works departments and university staff now have the information and training they needed to improve pedestrian safety. The impact is dramatic on campus.”
 - “It will really make an impact if we can get some ped safety action plans developed and implemented at various levels especially at the Metropolitan Planning Organization (MPO) and state levels. It will provide a strategic framework for addressing ped safety, rather than chasing the high media profile fatalities where emotions become the driving force rather than data.”
 - “Needs to be more widely disseminated and part of public relations and local government educational campaigns to educate officials and the public about the huge numbers of injuries and fatalities and how to prevent them.”
 - Respondent felt it was a wonderful guide in helping to create materials for parents, students and to raise awareness of staff members.
 - Respondent suggested having an email/text format to gain more attention of recipients.
 - Respondent really liked the encyclopedia (“cook book”) of moving people to and from center and bus stops. Also, liked cost estimates (even if not fully scaled to different areas).
- Pedestrian Safety Campaign
 - “There was a substantial delay in getting the TV and radio spots used in the previous state where I worked, as they would not use it without their logo and tag at the end. When the tagging finally got done they erased the FHWA tags. Other than that the whole campaign kit was easy to use and tailor to the state's needs.”

- “This kit was an extremely useful tool. However it is no longer being used as it is no longer a fresh new campaign. In media if an audience sees something too many times it becomes stale and they no longer pay attention to it. Ideally it would be great if this campaign kit could be periodically updated (probably annually) with fresh spots. The spots also need to get good viewing and listening time slots. PSAs often get the late night slots. Web sharing videos is the next step that needs to be taken, considering the changing ways that info is now shared.”
- “It laid out in simple steps how to approach the media, an area many are not used to.”
- “In one location we found people had actually retained some of the info from the campaign.”
- “When we first got the kit it made it really easy to tailor a ped safety campaign for use in radio and TV. Now that impact has definitely dropped as the spots are no longer being used. There is no time or resources to develop new tv or radio spots. There is barely enough time to develop print materials and putting together training for the other ped efforts that happen more internally within the ped working groups, like the engineers, planners and even enforcement. But there really isn't anything for the public.”
- Locations used: rural, tribal, counties in Northeast
- Comments back from the general public
 - A lot of comments back, mainly from 25-64 year olds.
- Materials used for campaign
 - Relied heavily on FHWA materials, e.g., Pedestrian Safer Journey
- Used to develop campaign?
 - As part of campaign school children drew how to safely walk down the road from their perspective. This was one activity.
 - Respondent did not use these materials to run a campaign, only used as a reference.
- Respondent would like to see a resource on how to get materials for campaigns such as “Be Seen” campaign to avoid spending large amounts of time trying to create something. Would like a resource where someone could click to see products, etc.
- Respondent suggested a PDF or online format instead of a CD.
- Respondent would like to see smaller posters (8.5X11) and radio ads because cheaper.
- “Love the tagline ‘Think of the Impact’.”
- Pedsafe: Pedestrian Safety Guide and Countermeasure Selection System
 - “It would be helpful if the material were provided in a format that could be printed for distribution at meetings and forums.”
 - “Online version very helpful.” “Great graphics.” “Great classroom tool.” “This document provides quick summaries of relevant research on specific countermeasures, so it is very useful.” Respondent liked in the printed format to flip through and read.
 - “The guide provides great descriptions of pedestrian safety treatments, a matrix of problems and possible countermeasures, and case studies. The TOC makes it easy

to find what you need, and the information in each section is short and to the point.”

- “Needs to be associated with training to use the program. The book is a good reference.”
 - “Primary value is that it is solid information backed by research and the uncertainties are explicit.”
 - “Confirmed using best practices and reinforced continued use. We have seen a decrease in ped crashes.”
 - “Information in booklet used to campaign city to change intersection and traffic flow at a high risk intersection near my house. Few crashes in the past 2 years.”
 - “Associated crashes with crash types. State implemented countermeasures to reduce the midblock crossing type crashes.”
 - “Gave me information on identifying potential problems and how I can work with engineers and other to solve them.”
 - “The guidelines help keep the pedestrian in mind during the design and construction processes.” “Research helpful in giving planner ideas.”
 - Respondent not sure about the cost of this product but stated that it would be nice if FHWA started a distribution to the advocates of the world, for a reasonable price so that the information can be passed out to the public.
 - Respondent (consultant) said well received by municipalities when made available.
- Resident’s Guide for Creating Safe and Walkable Communities
 - “This is designed for community members, so it is easy to read and easy to find what you are looking for.”
 - “It provides a simple summary of key research findings over the last 15 years, so it is a valuable resource.”
 - “It is a useful tool for community advocates and planners.”
 - Respondent said would like it available in alternative formats, works with blind community and it would be nice if these materials were available easily for them as well.
 - Respondent would like to see a PDF format.
 - Respondent mentioned difficult to find on the FHWA Web site—took 20 minutes to find it while trying to show someone.
 - Respondent likes that it is written for the novice in a way that is clear, concise and easy to read. Nice break out blocks with community success stories. Not overly jargoned or technical that would intimidate the civilian.
 - Respondent suggested make Designing Sidewalks and Trails more accessible (right now you have to download all PDFs files separately) put them all together as one book. If it was made into one file it would be much easier to read and pass out.
 - Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations
 - “This document has a great summary and a matrix that shows when marked crosswalks are "compliant", "possibly compliant", or "not compliant" with the research recommendations.”

- “The tables were useful and easy to understand. It associated volumes and roadway types to crosswalk applications.”
- “Excellent study.”
- “This is arguably the best study and most useful report to come from FHWA in the last decade. I refer to it and use it all the time, whether in the classroom, conducting research, or advising practitioners.”
- “...this report has probably saved many lives and will continue to benefit pedestrian safety many years into the future.”
- “It is the key study to which I refer clients of the state's Pedestrian Safety Assessment program.”
- “New crosswalks and several pedestrian refuge islands have now been installed at key locations in the community. Additionally, a HAWK and other improvements are being installed at a location where a developmentally disabled adult was struck and killed because a crosswalk had been painted on a 4-lane high speed arterial where the clients of a disability training center needed to cross the street to get to the bus stop. The guide was used by staff to convince city council members to spend the money to improve this location.”
- “If this study hadn't been done, I wouldn't know what to say about when marked crosswalks are sufficient on their own or when they need to be supported by additional treatments to improve pedestrian safety. Now I do.”
- “Its 3-variable findings (volume, number of lanes, presence of median), and suggestions for doing more than crosswalk striping, are easy to explain to clients.”
- “Too much of the content is weak, misleading, and/or simplistic.”
- “This is excellent research and we need more of this type.”
- Respondent said it was used as a reference as to where to mark and not mark crosswalks, and information has been very influential in determining of marking or not marking crosswalks in the area.
- Respondent suggested presenting the information in a webinar to clarify any misinterpretations.
- Walkability Checklist
 - “Seems to be well thought out.” “Very easy to use for practitioners and community members.” “This document was a valuable part of a program to teach aspects of pedestrian safety.”
 - “Need in a large print format or as an audio file.”
 - “We have shortened and adapted it for use on Walk and Roll to School Day to be a 1-page checklist.”
 - “It does not provide any kind of substantive information or experience for the user.”
 - “Very frustrating that it does not better address needs of pedestrians with disabilities at intersections. Seems to leave off some important issues such as accessible (audible) signals.”
 - “This product should be pulled.”
 - “Good for analyzing walkability but didn't prevent injuries or crashes that I know about.”
 - “The data we have collected from the use of the checklists during Walk to School

Day has been used to create a report on needed improvements for Safe Routes to School and the cities and school districts are using the data to allocate funding to make needed improvements.”

- “Very helpful in getting groups to focus on the problems they faced, instead of leaping to (inexpert) solutions.” “Got students thinking about walkability issues.” “Helped in decision making regarding design elements of projects.”
- “I think it will (have an important future role) because community-based assessments can use this approach with a limited amount of professional knowledge.”
- “It is simple enough to be used by a layman, and has the basic information to help laymen and professionals improve pedestrian infrastructure.”
- “It is a simple and understandable approach and useful to use in community discussions.”
- Respondent felt that from a negotiation standpoint, product was not “touchy-feely”, which was helpful.

APPENDIX III: STAKEHOLDER PARTICIPANTS IN WORKSHOP I

Andrew Dannenberg, Centers for Disease Control
Anne Marie Doherty, NYC Pedestrian Coordinator
Dan Burden, Walkable Communities, Inc.
David Levinger, America Walks
Dennis Cannon, U.S. Access Board
Dennis Scott, FL DOT
Jana Lynott, American Association of Retired Persons (AARP)
Janet Barlow, Accessible Design for the Blind
John LaPlante, AASHTO Non-Motorized Committee
Laura Fraade-Blamar, Insurance Institute for Highway Safety
Lauren Marchetti, National Center for Safe Routes to School
Lois Thibault, U.S. Access Board
Kit Keller, Association of Pedestrian and Bicycle Professionals
Kristen Grove, Chicago Ped/Bike Coordinator
Marsha Mason, CALTRANS
Matthew Ridgway, ITE Non-Motorized Committee
Michael Cynecki, City of Phoenix Traffic Engineer
Richard F. Pain, Transportation Research Board
Richard Nassi, City of Tucson Traffic Engineer (retired)
Ron Van Houten, Western Michigan University
Sharon Roerty, National Center for Bicycling and Walking
Shawn Turner, Texas Transportation Institute/TRB Pedestrian Committee Chair
Stephen Krest, Farmington, NM Ped/Bike Coordinator
Thomas Huber, WI State Ped/Bike Coordinator

APPENDIX IV: WORKSHOP I DISCUSSION QUESTIONS

Discussion I: Vision, Goals, and Measurable Objectives of the Strategic Plan

- Does your agency have pedestrian safety goals and objectives? If so, what are they? If not, what types of goals and objectives would be reasonable and potentially achievable?
- What solutions do you typically employ to meet your goals?
- What resources do you have the greatest need for in order to implement your goals and objectives (expertise/staff/resources to collect data and monitor conditions, implement new projects, maintain pedestrian facilities, or ordinances/standards/laws to assure good design standards are implemented)?
- Do the political and community leaders in your jurisdiction place a high priority on pedestrian safety and accessibility? Do they have a good appreciation for pedestrian accessibility, needs and design considerations?
- What performance measures do you use to evaluate your success in achieving goals and objectives?
- Do you have the resources (time/manpower) to evaluate the safety effects of specific projects or new designs you have implemented?
- If so, what evaluation measures are typically used? Are reports prepared to document the results?
- What do you think FHWA's key pedestrian safety goals should be?
- Are there any major thrust areas or key goals not currently present that FHWA should consider when developing its strategic plan?

Discussion II: Prioritizing Recommended Research Initiatives and Activities

- What are the predominate types of pedestrian safety problems in your community or jurisdiction?
- What are the missing components (i.e., research or other tools) that are needed to help reduce pedestrian fatalities and injuries?
- If no new research takes place, what is the most likely list of solutions/countermeasures/program activities that you will implement?
- If new research becomes available, how likely will it be to change your program?
- Is there an area of research that you would like to learn more about?
- Are there any emerging issues that you believe will become a concern for pedestrian safety in the future?
- What products that could come out of research would be most helpful to you?
- What are the recommended initiatives and research needs in the following areas:
 - Problem identification and data collection
 - Collecting data related to pedestrian exposure/activity, facilities, and crashes
 - Demand management, generators, and forecasting
 - Performing comprehensive and strategic risk assessment
 - Integrating pedestrian safety issues into planning and engineering processes

- Analysis and decision making
 - Safety planning, processes, and decision-making tools
- Development and evaluation of countermeasures
 - Facility design, operations, and innovative treatments
 - Transportation and land use planning processes and policies
 - Behavioral issues as related to the built environment
 - ITS solutions
 - Project, program, and product evaluation
- Product delivery and technology transfer
 - Training courses and workshops
 - Marketing and outreach
 - Conference support
 - Technical assistance
- For the solutions you listed above, which ones do you feel will have the biggest impact on reducing pedestrian fatalities and injuries?
- Which activities or topics are critical, high, medium, or low priority in terms of assisting you in reducing pedestrian fatalities and improving pedestrian access and mobility? Why?
- Which research projects do you think are most feasible to conduct? Why?
- If a research project evaluated a countermeasure or produced a new tool, how likely would you be to implement the countermeasure or use the tool?
- What major activities or focus areas should be undertaken in the first five years? In 5-10 years? In 10 to 15 years?
- How can these activities be monitored, evaluated, and measured against performance objectives? In other words, how will we know when we've met our goals?

Discussion III: Other Elements of the Plan

- What stakeholder participation opportunities should be incorporated into the plan, and when?
- For the pedestrian issues you consider important, are there opportunities for FHWA to partner with your organization to develop key products/programs or disseminate information?
- Can you think of any potential barriers to implementing this plan? How can these barriers be addressed?
- Does your agency/organization feel too restricted in terms of testing new approaches/treatments? How could this be improved?
- Are there legal barriers to implementing new or innovative approaches to pedestrian safety?
- How should the plan be evaluated and updated? How often?

APPENDIX V: LITERATURE REVIEW OF PUBLICATIONS AND GUIDES

This review focuses on selected comprehensive studies, broad-based syntheses, literature reviews, and meta-analyses of the pedestrian safety research literature for the years 2000-2008. It also cites major pedestrian design technical references published during these years. References to U.S.-developed software systems, including expert systems for countermeasure selection and pedestrian crash typing are provided. The review covers three major topic areas: 1) Problem identification and assessment, 2) Analysis and decision making tools, 3) Development and evaluation of countermeasures, and 4) Product delivery and technology transfer. Section 3 is further divided into the following subsections to properly categorize the countermeasures: General, Intersections, Midblock Crossings, Transit & Multimodal, Speed Management, Traffic Calming, Roadway Design, Visibility & Nighttime Issues, Education, Enforcement, Pedestrians With Disabilities, and Other. These categories were selected to be consistent with the framework and organization of research determined in the first stakeholder meeting. Selected Internet sites containing extensive content pertinent to the topic areas are listed with links in the reference section. Sources for citations include TRIS, ScienceDirect, and the ISI Web of Science, as well as a series of targeted Internet searches. Additionally, the listing of resources was combined with other appropriate literature review efforts, such as those supporting Highway Safety Manual (HSM) development. Wherever available, links to full text are provided in the reference section.

This preliminary review does not cite all of the pedestrian research literature published during the period, especially the numerous articles which appear in Transportation Research Records and other transportation research journals. Only limited citations are given to the extensive literature of conference papers, especially those presented at the Transportation Research Board (TRB) and Institute of Transportation Engineers (ITE) conferences held during the period of coverage. Foreign pedestrian research literature was selectively considered. These international sources have been mostly incorporated into the aforementioned sections depending on the topic.

Problem Identification and Data Collection

Dewey, Demslow, et al. (33) examined in their paper, “Transportation Issues: Pedestrian Safety,” why Florida’s pedestrian fatality rates have consistently been among the highest in the nation. One view is that the high rate results from a combination of urban sprawl and low investment in safety capital. Since sprawling communities tend to have an abundance of high-speed arterials, pedestrian safety can be more of a problem. A competing view is that the conventional measures of fatality rates inadequately control for exposure, or the amount of time people walk near traffic.

Leden, Gårder, and Johansson (106) performed a crash analysis in their study entitled “Safe Pedestrian Crossing for Children and Elderly” that suggests that injury risk to children and the elderly is improved at crosswalks where visibility, orientation, and clarity are sufficient. Marking crosswalks may increase yield rates towards pedestrians. Speed cushions situated at a longer distance from the marked crosswalk increase yield rates towards pedestrians and cyclists compared to speed cushions closer by.

In a paper entitled “An Analysis of Factors Contributing to “Walking Along Roadway” Crashes: Research Study and Guidelines for Sidewalks and Walkways,” McMahon, Zegeer, et al. (121)

used a case-control methodology to apply logistic models to determine the association of roadway design attributes and socioeconomic and other census block group data with the likelihood of locations to be pedestrian crash sites. Roadway design factors associated with a higher likelihood of being crash sites were higher traffic volume, higher speed limit, the lack of wide grassy walkable areas, and the absence of sidewalks. When roadway factors were controlled for, non-geometric factors that were associated with higher crash likelihoods included high levels of unemployment, older housing stock, lower proportions of families within households, and more single-parent households.

Nance, Hawkins, et al. (136) examined police accident data to determine the role of driving conditions (such as weather conditions, time of day, location, and others) on the occurrence of motor vehicle crashes involving child pedestrians in urban residential areas. This research was presented in an article entitled “Optimal Driving Conditions Are the Most Common Injury Conditions for Child Pedestrians.” The authors conclude that child pedestrian crashes are related to the saturation of the streets with children at play, and are compounded by poor street-crossing behavior. Countermeasures must address the fact that optimal driving conditions may not provide the best locations for children playing near the road, since the optimal roadway design may in fact increase exposure for children.

Siddiqui, Chu, and Guttenplan (173) examined the role of crossing locations and light conditions in the severity of pedestrian injuries in their article “Crossing Locations, Light Conditions, and Pedestrian Injury Severity” through a multivariate regression analysis by application of the ordered probit model to the KABCO severity scale (e.g. Killed, A-type injury, B-type possible injury, C-type no injury, and Property damage only). Using injury data from Florida during the period of 1986-2003, the results showed that “the odds of sustaining a fatal injury are 49 percent lower at intersections than at midblock locations under daylight conditions, 24 percent lower under dark-with-street-lighting conditions, and 5 percent lower under dark-without-street-lighting conditions. Relative to dark conditions without street lighting, daylight reduces the odds of a fatal injury by 75 percent at midblock locations and by 83 percent at intersections, whereas street lighting reduces the odds by 42 percent at midblock locations and by 54 percent at intersections.”

In an article “Causative Factors and Trends in Florida Pedestrian Crashes,” Spainhour, Wootton, et al. (177) conducted a case study review of 353 fatal pedestrian crashes that occurred in Florida, primarily in 2000. They identified contributing causes and trends of predominant pedestrian crash types. Results indicate that the most significant non-roadway related causes of pedestrian crashes are pedestrian behavior, alcohol use by pedestrians and drivers, poor pedestrian visibility at night coupled with violation of driver expectation, and lack of compliance with state laws.

Shinar (171) examined risks of pedestrian involvement in crashes, and safety issues unique to pedestrians, including crash characteristics, how pedestrian behavior affects involvement in crashes, and both behavioral interventions and engineering countermeasures effective in reducing pedestrian injuries and preventing crashes. Research studies of vulnerable pedestrian road users, including young children and the elderly, are described in this study, entitled “Pedestrians.”

Langham and Moberly (102) evaluated the ways in which pedestrian conspicuity has been defined and measured in their paper “Pedestrian Conspicuity Research: A Review.” They consider the environments where pedestrian conspicuity has been studied and review research from the psychological and human factors literature. The researchers made several general conclusions, noting that there may be little difference between the attentiveness of an individual while driving as opposed to viewing a scene passively. Some literature also suggests that pedestrians may often believe they are more conspicuous than they actually are. Additionally, they pointed out that there is little research that concerns how pedestrian conspicuity varies with location. Suggestions are made for improving study validity and establishing a unified framework for future research in this area.

In the article “The Likelihood of Becoming a Pedestrian Fatality and Drivers’ Knowledge of Pedestrian Rights and Responsibilities in the Commonwealth of Virginia,” Hebert, Martinez, and Porter (79) studied fatal pedestrian–vehicle crashes in Virginia occurring in the years 1990–1999 and investigated variables believed to predict these crashes. They analyzed pedestrian crash trends such as location (urban versus rural setting), sex, age, pedestrian drinking, driver drinking, driver violation, and time of day. A logistic regression analysis, controlling for year, found all of these variables significantly predicted the odds of dying versus being injured in a pedestrian crash. Typically, fatality victims were older males who had been drinking and walking in rural areas between 12:00 and 5:59 a.m. Drivers who had been drinking but would not be cited for a violation were more likely to strike these pedestrians. A telephone survey of licensed Virginia drivers was conducted to assess knowledge of state laws regarding pedestrian right-of-way. Survey results showed that the majority of respondents believed that pedestrians had right-of-way most of the time, even when not crossing in legal crosswalks. Even though most respondents also indicated that they believed they were well aware of Virginia’s laws regarding driver yielding, Virginia’s laws do not yield right-of-way to pedestrians in all cases.

Presented in the article entitled “Visibility Aids for Pedestrians and Cyclists: A Systematic Review of Randomised Controlled Trials,” Kwan and Mapstone (99) conducted a systematic review of the effect of visibility aids on pedestrian- and cyclist–motor vehicle collisions and injuries, and drivers’ responses in detection and recognition. Trial reports were reviewed according to predefined eligibility criteria. The trials included such visibility aids as reflectors and lights, fluorescent and non-fluorescent colors, flashlights, leg lamps, flashing lights, and biomotion markings. For daytime, fluorescent materials in yellow, red, and orange colors enhanced detection and recognition. Lamps, flashing lights, and red and yellow retroreflective materials were found to be effective at night. ‘Biomotion’ markings enhanced recognition in both daytime and nighttime scenarios. The authors conclude that the impact of visibility aids on pedestrian and cyclist safety is unknown and needs to be determined.

Chu (23) tested several hypotheses on the street crossing behavior of pedestrians, which were presented in the article “Testing Behavioral Hypotheses on Street Crossing.” These hypotheses relate to pedestrians’ tradeoff between direct attributes such as time and safety, the role of the street environment, the role of pedestrian laws, and pedestrians’ false sense of security for crossing at a marked crosswalk. Researchers in Tampa Bay, Florida, placed subjects in various

traffic situations and surveyed them on their crossing decisions. Findings suggest that engineering measures are indirect attributes to crossing decisions, while perceived safety is a direct attribute. The evidence is consistent with the hypothesis that pedestrians have a “false sense of security” in a marked crosswalk at uncontrolled locations. On the other hand, there is no evidence that knowledge of street-crossing law affects how pedestrians cross streets.

Xuemei and Chanam (212) explore the ethnic and economic disparities between populations in Austin, TX, and the ways in which these differences impact levels of walking to school among local children. This research was advanced in the article “Walkability and Safety Around Elementary Schools: Economic and Ethnic Disparities.” Using a cross-sectional study design, the researchers used GIS to measure safety and neighborhood walkability around 73 elementary schools in the Austin area by identifying features such as sidewalk availability, connectivity, sidewalk maintenance and quality, and demographic and socioeconomic data. It was shown that some of the areas with highest poverty levels contained more sidewalks, and more complete networks, than other areas. However, these areas also experienced higher crash and crime rates, lower levels of sidewalk maintenance, and lower perceived safety. In conclusion, the researchers determined that tailored interventions were needed in areas where the potential for walking and physical activity is high, but unsafe environments limited walking to school.

To understand how parents view their children’s exposure to traffic injuries in low socioeconomic areas, Christie et al. (21) conducted a series of focus groups within several communities. The focus of the study, which is entitled “Understanding High Traffic Injury Risks for Children in Low Socioeconomic Areas; A Qualitative Study of Parents’ Views,” was on parents of children age 9 to 14 years who live in low socioeconomic areas. The researchers gained an understanding of the views that parents have of why their children choose to play in local streets, and showed that parents have an understanding of some traffic safety risks to their children. Specifically, parents believe that their children play in local streets because there are few safe and secure public spaces for children. Parents identified several key sources of risk, such as the speed and volume of traffic, illegal parking, and poorly educated drivers.

In the article “Where Did That Car Come From?: Crossing the Road When the Traffic Comes from an Unfamiliar Direction,” Johnston and Peace (94) sought to examine the differences in crossing patterns among individuals who were both familiar and unfamiliar with the direction of approaching traffic. The researchers observed male pedestrians in situations where the individuals were both familiar and unfamiliar with the traffic directions as they crossed the street (i.e. traffic flows in opposite directions from what they are used to). A lower margin of crossing error (looking in the wrong direction for oncoming traffic) was shown among pedestrians who were crossing roads where the traffic directions were unfamiliar, rather than familiar. This suggests that pedestrians in unfamiliar situations are more aware of the potential risk for a crash caused by a change in traffic direction.

In their study on crashes near public schools, “An Examination of the Environmental Attributes Associated With Pedestrian-Vehicular Crashes Near Public Schools,” Clifton and Kreamer-Fults (30) examined how the physical and social qualities of the area surrounding schools can influence crash occurrence and injury severity. Using crash severity and risk exposure models, the researchers identified characteristics that were associated with decreased crash occurrence

and severity (e.g., turning bay at entrance) and those that were positively associated with crash occurrence and severity (e.g., presence of recreational equipment on school property). The results are applicable to safe routes to school projects and other school-focused pedestrian efforts.

Barton et al. (9) explored the ways in which children select walking routes, based on the influences of age, gender, ethnicity, and other demographic and individual characteristics in their study “The Influences of Demographics and Individual Differences on Children’s Selection of Risky Pedestrian Routes.” Using parent report questionnaires, child report questionnaires, and a structured behavioral battery with 122 children and their parents, researchers found that children were more likely to select risky walking routes if they were from lower-income families, exhibited less temperamental control, were younger, or had an ethnic minority background. Recommendations are then made for applying these findings to injury prevention.

In the article “Turning at Intersections and Pedestrian Injuries,” Roudsari et al. (158) present their research on the impacts of pre-crash vehicle movements on pedestrian injury severity. Using the Pedestrian Crash Data Study by the National Highway Traffic Safety Administration as a template, the researchers determined that almost half of pedestrians were injured in straight movement crashes, where they were likely to be struck on either the left or right side. In most of the left-turning and right-turning crashes, however, pedestrians were most likely to be struck on their left sides. This research is intended to inform countermeasure development, signal placement, and intersection analyses.

Schroeder et al. (170) present the results of a study of how blind and sighted pedestrians are able to judge crossing opportunities in traffic at channelized turn lane (CTL) locations. Their research was presented in the article “Exploratory Analysis of Crossing Difficulties for Blind and Sighted Persons at Channelized Turn Lanes.” It is believed that CTL locations, combined with a lack of signal control, negatively impact safety for blind pedestrians. The research findings showed that sighted pedestrians could cross at CTL locations with relative ease when compared to the blind pedestrians, who found the crossing significantly more difficult. It was also determined that a noise-generating background had little to no effect on the crossing ability of blind pedestrians. Likewise, the location of the crosswalk relative to the CTL was not significantly associated with an increase in crossing difficulty.

Using the 2001 National Household Travel Survey data, McDonald (120) studies the role that distance plays in a child’s ability or decision to walk to school in her article, “Children’s Mode Choice for the School Trip: The Role of Distance and School Location in Walking to School.” There was a significant drop in the number of students who walk to school between 1969 (42 percent) and 2001 (15 percent). Instead, many of these children are now riding to and from school in automobiles. The students who do still walk to school are more likely to be older (or have older siblings), or live in low-income households. “The analysis shows that walk travel time is the most policy relevant factor affecting the decision to walk to school with an estimated direct elasticity of -0.75.” McDonald points out that shortening the distance between a child’s home and his or her school could prove to be an effective way to get more children to walk to school.

In their report with the title “Police-Reporting of Pedestrians and Bicyclists Treated in Hospital

Emergency Rooms,” Stutts and Hunter (180) used hospital data from three states to study underreporting of pedestrian and bicyclist injuries in crash reports. “The analysis showed that only 56 percent of the pedestrians and 48 percent of the bicyclists treated in emergency rooms were successfully linked to crash records in their respective state motor vehicle crash files.” This study has played an important role in warning researchers and practitioners against relying too heavily on estimates of pedestrian and bicyclist injuries based on police crash reports, as the actual numbers are very likely to be much higher.

Knoblauch, Pietrucha, and Nitzburg (98) provide one of the first in-depth studies of pedestrian walking speeds for different groups of people in the article “Field Studies of Pedestrian Walking Speed and Start-Up Time.” Observing crosswalks at signalized intersections in four urban areas, the researchers recorded walking speeds and some demographic assumptions. It was determined that “the 15th-percentile walking speed for younger pedestrians (ages 14 to 64) was 1.25 m/sec (4.09 ft/sec); for older pedestrians (ages 65 and over) it was 0.97 m/sec (3.19 ft/sec).” Though these conclusions could be widely applied, many other factors (including road type, traffic volumes, weather conditions, etc.) contributed to walking speeds.

Gates et al. (63) sought to update previous research on walking speeds by observing pedestrians, particularly pedestrians with specific demographic characteristics. This research is published in the article entitled “Recommended Walking Speeds for Timing of Pedestrian Clearance Intervals Based on Characteristics of the Pedestrian Population.” The study identified factors such as age and disability, and documented the walking speeds of these populations, among others. It was found that “pedestrians older than 65 were the slowest of all age groups, with mean and 15th percentile walking speeds of 3.81 and 3.02 ft/s, respectively, and typically would not be accommodated by pedestrian clearance intervals based on the commonly used 4.0-ft/s walking speed.” The researchers then made recommendations for signal timing based on the results.

Montufar et al. (128) studied the effects of age, gender, and weather conditions on pedestrian walking speeds in the article “Pedestrians’ Normal Walking Speed and Speed When Crossing a Street.” Examining walking speeds along roadways and at crossings in Winnipeg, they were able to observe 1,792 pedestrians, and determined that the walking speed along a roadway is almost always slower than walking speed through an intersection. The 15th percentile walking speed for younger pedestrians was 4.46 ft/s, and for older pedestrians the 15th percentile walking speed was 3.47 ft/s. Among the other results, the researchers concluded that younger pedestrians almost always walk faster than older pedestrians, and females walk more slowly than men. In situations where the majority of pedestrians are young or old, or where adverse weather conditions are often present, these findings can assist engineers in developing facilities and signal timing that meet the needs of the local population.

Presented in the study entitled “Safety in Numbers: More Walkers and Bicyclists, Safer Walking and Bicycling,” Jacobsen (90) used pedestrian and bicyclist injury and fatality rates to assess the relationship between the numbers of bicyclists/pedestrians and the number of injuries and fatalities. He found “communities with twice as much walking as other communities tend to have only 32 percent more pedestrian injuries.” From these results, Jacobsen presents the “safety in numbers” effect: as the numbers of bicyclists and pedestrians increase, drivers will begin to drive more carefully around them, decreasing personal or individual crash risk. It should be noted,

however, that the model did not account for various traffic characteristics, such as number of lanes and traffic volume.

In their study “Measuring Accident Risk Exposure for Pedestrians in Different Micro-Environments,” Lassarre, Papadimitriou, et al., (104) developed an approach to study pedestrian accident risk based on the concept of risk exposure used in environmental epidemiology. A basic concept was the high risk likelihood of pedestrian road crashes when crossing in urban areas. Traditionally in the road safety field, the risk of crashes for pedestrians is estimated as a rate of accident involvement per unit of time spent on the road network, an indicator useful for comparing the effects of urban transportation policy scenarios on pedestrian safety. The first step was to create an index of pedestrians' exposure, based on motorized vehicles' 'concentration' by lane. The exposure index took account of traffic speed and time spent to cross. This was applied to two specific micro-environments: intersections and mid-block locations. A model of pedestrians' crossing behavior along a trip was developed, based on a hierarchical choice between intersections and mid-block locations. The exposure index recognized origin and destination, traffic characteristics, and pedestrian facilities. It is determined that “a pedestrian's risk exposure can be weighted in relation to the different crossing options encountered along a trip and to the behaviour of pedestrians when it comes to crossing decisions. These crossing decisions mainly concern ‘primary’ crossings, i.e. crossings that are necessary for the pedestrian in order to reach his or her destination.” Finally, a complete framework was produced for modeling pedestrians' exposure in the light of their crossing behavior. The feasibility of this approach was demonstrated on an artificial network and a first set of results was obtained from the validation of the models in observational studies.

Using pedestrian risk calculations from 247 intersection in Oakland, CA, Geyer et al. (64) analyzed the association of increased volumes of pedestrians on overall pedestrian safety in the study entitled “Safety in Numbers: Data from Oakland, California.” The researchers included several intersection factors, including pedestrian collisions, average annual pedestrian volume, and average annual vehicle volume. It was determined that “intersections with twice as many pedestrians tended to have only 53 percent more reported crashes (rather than 100 percent more crashes, as would be expected if there were a linear relationship).” Several hypotheses could explain this effect: the presence of more pedestrians cause drivers to drive more carefully, the greater numbers could change pedestrian behavior, or the intersections with the most pedestrians have other characteristics that reduce crashes. It is determined that, while evidence exists to support this “safety in numbers” concept, there needs to be more research on its root causes.

McMillan et al. (2006) used surveys of parents/caregivers of third- through fifth-grade students to determine how children travel to school and factors that determine this mode choice. It is determined that boys are 40 percent more likely to walk to school than girls. There was also a relationship seen between the decision to walk by the child and the decision to walk by the caregiver – those parents and caregivers who walk more are more likely to have children who do the same. (122)

Zeedyk and Kelly (214) studied the behaviors of adult-child pairs in real traffic environments as they crossed the road at pedestrian light-controlled crossings. This research was presented in the publication “Behavioural Observations of Adult-Child Pairs at Pedestrian Crossings.” Eight

specific behaviors were coded, including whether or not the pair stopped at the curb, waited for the light to change, and checked to ensure traffic flow had stopped. Results showed that the adults observed provided reasonably good models of pedestrian behavior, but that they rarely treated the crossing event as an opportunity to teach children explicitly about road safety.

In the paper “Pedestrian Signal Safety for Older Persons,” Stollof, McGee, and Eccles (179) studied walking characteristics of older pedestrians and operational conditions at intersections, with the goal of providing supporting research to assist traffic engineers in understanding the walking characteristics of older pedestrians and to examine the extent to which various intersection operational conditions might be able to tolerate additional time for the pedestrian interval without sacrificing substantial efficiencies. The report incorporates a literature review and a survey of agencies to identify the state of the art and state of the practice in pedestrian signal timing and the use of pedestrian signals. It also describes an observational study of pedestrian walking speed and crossing behaviors, a survey of pedestrians at study sites, and the results of a traffic operations simulation conducted to determine how the time allocated for pedestrian intervals affects intersection traffic operations.

Using statewide data from Maine, Garder (62) analyzed pedestrian crashes with an emphasis on how actual travel speeds and characteristics of the locations influence crash numbers in his study entitled “The Impact of Speed and Other Variables on Pedestrian Safety in Maine.” Pedestrian and vehicle volumes were gathered for crash locations throughout Maine. Crash numbers were predicted and compared to outcomes with descriptive crash and behavioral statistics. Because US models are nonexistent, prediction models from Sweden and the UK were used. The author found that high speeds and wide roads were associated with more crashes and that the focus of safety improvement should be on arterials and major collectors. Analysis showed a strong relationship between crash severity and speed.

In a study that examined overrepresentation of pedestrian casualties among older people, Gorrie, Brown, and Waite (69) studied cognitive decline and dementia as potential factors for 52 fatally injured older pedestrians in the Sydney, Australia metropolitan area. This study was presented as “Crash Characteristics of Older Pedestrian Fatalities: Dementia Pathology May Be Related to At-Risk Traffic Situations.” Post-mortem neuro-pathological examinations confirmed presence of neuro-fibrillary tangles (NFT), a hallmark of Alzheimer's disease in the brain, associated with particular fatal crash situations. Compared to older pedestrians with no, or low NFT, those with moderate to high NFT were more likely to be at least partially responsible for certain types of incidents, including injuries occurring in low complexity situations; involvement in impacts with reversing vehicles, impacted in near lanes of traffic, or struck by a vehicle off road.

In the study “Misunderstanding of Right-Of-Way Rules at Various Pedestrian Crossing Types,” Hatfield, Fernandes, et al. (78) researched how misunderstanding of right-of-way rules might contribute to pedestrian trauma, especially at crossings where pedestrian and traffic signals appear to give contradictory messages. Over two thousand pedestrians were observed crossing at signal-controlled intersections in metropolitan Sydney and rural Goulburn, Australia, to compare attention to traffic for different combinations of pedestrian and traffic signals. In addition, a survey was conducted at signal-controlled intersections and nearby parking areas in metropolitan and rural locations. Over five hundred participants took the role of pedestrian or driver when

responding to questions regarding beliefs about pedestrian right-of-way for a range of situations at signal-controlled crossings, zebra crossings, and unmarked sections of road. Results suggest that both pedestrians and drivers erroneously thought that signal-controlled crossings pedestrian right-of-way was influenced by presence of a pedestrian signal. In many situations more than 20 percent of both drivers and pedestrians reported that they would take right-of-way.

In an attempt to define the epidemiology of the pedestrian victim, Ryb, Dischinger, et al (160) published a paper entitled “Social, Behavioral, and Driving Characteristics of Injured Pedestrians: A Comparison with Other Unintentional Trauma Patients.” Over the course of the study, the authors interviewed and evaluated patients with pedestrian trauma admitted to a Baltimore regional adult trauma center. Pedestrians were compared with other unintentional trauma patients with regard to demographics, socioeconomic factors, possession of a driver's license, injury prone behaviors, risk taking dispositions, and elevated blood alcohol content (BAC) levels. Multivariate logistic regression models were built with pedestrian risk factors as the outcome. When compared to the remaining unintentional trauma population, pedestrians were significantly more likely to be black, not married, unemployed, binge drinkers, alcohol dependent, drug dependent, have a high BAC, have a low income, low educational achievement, younger age, and to not have a driver license.

In the paper “Modeling Fault Among Accident-Involved Pedestrians and Motorists in Hawaii,” Kim, Brunner, and Yamashita (96) used a comprehensive database of police-reported accidents in Hawaii to describe the nature of pedestrian accidents over the period 2002-2005. Approximately 36 percent of the accidents occurred in residential areas, while another 34 percent occurred in business areas. About 41.7 percent of the pedestrian accidents occurred at intersections. More pedestrian crashes occurred at non-intersection locations, including midblock locations, driveways, parking lots, and other off roadway locations. Approximately 38.2 percent of the crashes occurred at crosswalk locations, while proportionately more (61.8 percent) of the pedestrian crashes occurred at non-crosswalk locations. Database analysis examined the human, temporal, roadway, and environmental factors associated with being 'at-fault' for both pedestrians and drivers. Using techniques of logistic regression, several different explanatory models were constructed to identify the factors associated with crashes producing fatalities and serious injuries. Finally, two pedestrian models (focusing on drunken males and young boys) and one driver model (male commuters) were developed to provide further understanding of pedestrian accident causation. Drunken male pedestrians who were crossing outside of a legal crosswalk were in excess of 10 times more likely than other groups to be at-fault in pedestrian accidents. Young boys in residential areas were also more likely to be at fault. Male commuters in business areas in the morning were also found to have higher odds of being classified at-fault when involved in pedestrian accidents. Based on their analysis, the authors suggest that a combination of enforcement and educational programs be implemented for both pedestrians and drivers to reduce the overall number of crashes.

Analysis and Decision-Making Tools

Pulugartha, et al. (152) develop a GIS methodology for spatially analyzing patterns of pedestrian crashes for establishing high-priority crash zones in their research released under the title “New Methods to Identify and Rank High Pedestrian Crash Zones: An Illustration.” Additionally, the

team developed a method for ranking these high crash zones. Using variables such as crash frequency, crash density, and crash rate, the team establishes this methodology for ranking priority zones of pedestrian crashes in a given area. These methodologies were shown to reduce subjectivity in establishing priority zones.

Carter, Hunter, et al. (19) developed safety indices to allow engineers, planners, and other practitioners to proactively prioritize intersection crosswalks and intersection approaches with respect to pedestrian and bicycle safety. This study was presented in the paper “Pedestrian and Bicyclist Intersection Safety Indices: Final Report.” The models in this study use easily collected, observable characteristics of an intersection to produce safety index values, which included: traffic volume, speed limit, traffic control, number of through lanes, number of right-turn lanes, crossing width, median island width, crosswalk type, and presence of pedestrian signals, among others.

Shared paths are paved, off-road facilities designed for travel by a variety of nonmotorized users, including bicyclists, pedestrians, and other users. Shared-path planners and designers face challenges in determining how wide paths should be and whether the various modes of travel should be separated. Hummer, Roupail, et al (85) developed a new method to analyze the quality of service provided by shared paths of various widths and the accommodation of various travel-mode splits in their publication “Evaluation of Safety, Design, and Operation of Shared Use Paths: Final Report.” The researchers assembled the new method using new theoretical traffic-flow concepts, a large set of operational data from paths in 10 cities across the United States, and the perceptions of path users. Given a count or estimate of the overall path user volume in the design-hour, the method they describe can provide the level of service for path widths from 2 to 6 meters (8 to 20 ft). (Note: In some countries, shared paths are being adopted as standard designs, especially in Australia. See the section on literature from foreign sources for more references to shared path design.)

In the paper “An Accident Waiting to Happen: A Spatial Approach to Proactive Pedestrian Planning,” Schneider et al. (168) present a spatial strategy for understanding, analyzing, and addressing pedestrian safety needs. A spatial analysis of crash sites can help identify pedestrian crash “hot spots,” and can be combined with safety perception data to address both the real and perceived safety needs in an area.

In a NCHRP report entitled “Guidelines for Selection of Speed Reduction Treatments at High-Speed Intersections: Supplement to NCHRP Report 613,” Ray et al. (155) identified and evaluated treatments and developed guidelines for reducing vehicle speeds on approaches to high-speed intersections. Preceded by a literature review and extensive survey of state agencies, the team conducted field testing of three treatments: transverse pavement markings, rumble strips, and dynamic warning signs. Before and after testing was used to evaluate these treatments under a variety of circumstances in order to establish a set of guidelines for the implementation of similar speed reduction countermeasures.

The Highway Capacity Manual (185), a publication of the Transportation Research Board, includes methods for estimating pedestrian levels of service based on qualitative measures of pedestrian flow in Chapter 11, “Pedestrian and Bicycle Concepts.” This methodology can be

used to assess walkway, stairway, cross flow, and queuing area requirements based on expected pedestrian volumes, all using a square ft. per pedestrian formula. Chapter 18, “Pedestrians,” addresses capacity and level-of-service analysis of pedestrian facilities.

The Metropolitan Transportation Commission of Oakland, California (124) presents the results of their research in a document entitled “Bicyclist and Pedestrian Data Collection and Analysis Project: Final Report,” developed to initiate a bicyclist and pedestrian data collection program for the nine San Francisco Bay Area counties, including bicyclist and pedestrian counts and surveys of users. The data collected and the results of the analysis conducted for this project offer an overview of the current bicyclist and pedestrian characteristics and conditions throughout the region. The database developed by the project is intended to serve as a baseline for future data collection efforts.

Guttenplan et al. (70) used a series of “Ride or Walk for Science” events to gain perspective on real world situations and garner user feedback on the usefulness of a particular facility. This research was presented in the publication “Updating Multimodal Level-Of-Service Calculations to Incorporate Latest FDOT Research since 2001.” The findings were then used to calibrate multimodal level-of-service models and reexamine previously developed LOS models. Using data from six Florida facilities, the researchers tested the models during a two-day workshop. The findings from these sessions were used to recalibrate existing LOS models so that they would incorporate the most current pedestrian safety research.

Landis et al. (101) developed a model in their publication “Modeling the Roadside Walking Environment: Pedestrian Level of Service” to determine pedestrian level of service for a segment of a roadway between intersections. The segment LOS model, developed by collecting data from 75 pedestrians in Pensacola, FL, captures most roadway components influencing pedestrian safety and comfort: sidewalk presence, width of buffer, presence of parking, traffic volume, and number of lanes. Though the segment LOS can be widely applied, the authors caution against applying the model to specific demographics (e.g. older pedestrians), since it has been calculated for the average, or “typical” pedestrian. It should also be noted that the model is especially sensitive to the presence of sidewalks and traffic volumes.

Chu and Baltes (22) developed a model for determining mid-block crossing difficulty for pedestrians by gathering data from sites in Florida presented in the paper “Pedestrian Mid-Block Crossing Difficulty.” Many of the vital roadway characteristics are included in the model, such as traffic volume, presence of crosswalk, presence of signal, and signal length.

In the paper “Pedestrian Level-Of-Service Model for Urban Arterial Facilities With Sidewalks,” Petritsch et al. (146) developed a level-of-service model to calculate a pedestrian’s perception of how well urban arterials with sidewalks meet their needs. Based on traffic volumes on adjacent roadways, exposure and crossing distances, and other conflict points, the model is intended to identify the main factors that influence a pedestrian’s perception of a roadway. It concluded that factors such as the density of conflict points along the facility are a primary factor in determining the LOS for urban arterials with sidewalks.

Sisiopiku & Byrd (175) explored various methodologies for determining level-of-service for the

operation of pedestrian facilities in their paper entitled “Comparison of Level-Of-Service Methodologies for Pedestrian Sidewalks.” Anticipating that pedestrian movements are more multi-faceted and complex when compared with motorized modes, the researchers evaluated the methodologies that are currently employed for determining pedestrian LOS and draw comparisons. After detailed information is presented on each of the methods, case studies explored the impact of the various models in real world scenarios. The study concludes that, since methodologies vary, one sidewalk can be found to have a variety of LOS ratings depending upon the method used. Some methods apply only to sidewalk quality, while others take crosswalks into account as well. Additionally, the study found that the Highway Capacity Manual (HCM) 2000 method typically overestimated LOS, since it disregards factors related to user preference. The outcomes of the study were intended to inform subsequent versions of the HCM.

Petritsch et al. (145) developed a level-of-service model to anticipate the needs and perceptions of pedestrians at signalized intersections, which was outlined in the publication “Level-Of-Service Model for Pedestrians at Signalized Intersections.” Using data from video simulations and field data, the researchers used pedestrian perceptions of safety and comfort to establish a model that would determine how well the needs of users were being met in various facilities at signalized intersections. Many of the factors that were determined to influence pedestrian LOS were the right-turn-on-red volumes for the street being crossed, permissive left turns from the street parallel to the crosswalk, motor vehicle volume on the street being crossed, midblock 85th percentile speed of the vehicles on the street being crossed, number of lanes being crossed, pedestrian's delay, and presence or absence of right-turn channelization islands.

Kim et al. (95) studied the violations of a new crosswalk law in Hawaii by both motorists and pedestrians, and sought to model compliance based on yielding patterns. This research was published under the title “Modeling Violation of Hawaii’s Crosswalk Law.” Using rates of compliance and the characteristics of pedestrians and drivers, the researchers established a model that would predict violations based on these characteristics. It was found that drivers commit more violations than pedestrians, and that a broader range of drivers commit violations than pedestrians. The study makes recommendations for education and enforcement programs that could be used to enhance safety based on the findings.

In a paper entitled “Pedestrian Self-Reports of Factors Influencing the Use of Pedestrian Bridges,” Rasanen et al (154) sought to identify factors that influence use/non-use of pedestrian bridges. The usage rate of five pedestrian bridges was observed in the central business district (CBD) of Ankara, Turkey. After the observations, a survey was conducted among pedestrians using those bridges and crossing contrary to safe practice under them at street level. The frequent use of the bridge for crossing the road, and seeing bridge use as time saving and safe in general were positively related to respondents' bridge use, while frequent visits to CBD decreased the likelihood of using the bridge. It was determined that bridge use is not coincidental behavior, but rather individual habit. Finally, in order to improve the usage rate, the safety benefits and convenience of use must be clearly visible to the pedestrians.

Natarajan et al. (137) developed a four-component framework for administering the Bicycle and Pedestrian Safety (BPS) Program, which is outlined in the publication “Framework for Selection

and Evaluation of Bicycle and Pedestrian Safety Projects in Virginia.” In this framework, analysis procedures were identified for each component that can be used for identifying hazardous locations, determining causal factors, establishing performance measures, and determining potential countermeasures. The framework was then applied to select an appropriate safety treatment and prioritize a set of safety projects requested for funding. To demonstrate the applicability of the framework, five case studies were conducted at locations in and around Charlottesville, Virginia. The prioritization process was demonstrated using the results of the case studies. The study findings showed that the framework synthesizes existing practice into a systematic approach for identifying bicycle and pedestrian hazardous locations and selecting appropriate countermeasures for implementation. The study also established the need for evaluation studies on safety treatments after implementation, as the effectiveness of many bicycle and pedestrian safety countermeasures are not well established.

Corben et al. (31) developed a methodology for rating the safety of individual road crossing points, outlined in the paper “Star Rating School Walking Routes.” This methodology is based on the “star rating” typically assigned by consumers to products or services. Using the main determinants of pedestrian crash and injury risks, the project team developed a model that could be used to assign a rating to a particular route. Though primarily intended for crossing points and taking into account the needs and limitations of child pedestrians, it could be generically used and widely applied.

Murphy and Hummer (131), presenting their research in a paper entitled “Development of Crash Reduction Factors for Overhead Flashing Beacons at Rural Intersections in North Carolina,” sought to develop crash reduction factors for overhead flashing beacons at rural intersections. Using 34 treatment sites, the researchers used several methodologies to calculate the CRFs. The results of the in-depth analysis showed a reduction in crashes on average after the treatments were installed. Specifically, there was a 12 percent reduction in all crashes, a 9 percent reduction in injury crashes, a 40 percent reduction in severe injury crashes, a 9 percent reduction in frontal impact crashes, and a 26 percent reduction in “ran stop sign” crashes.

These interim results from NCHRP Project 17-25 of the Transportation Research Board (183) summarize current research on crash reduction factors for dozens of treatments, including adding raised crosswalks, narrowing lane widths, prohibiting left turns, installing red light cameras, installing curb extensions, and others. This research is presented in the paper, “Crash Reduction Factors for Traffic Engineering and Intelligent Transportation System (ITS) Improvements: State-Of-Knowledge Report.” It also identifies the “best available” crash reduction factors, based on the current research, and draws comparisons to other similar reviews of CRFs that are currently being developed.

In the publication “Method of Improving Pedestrian Safety Proactively With Geographic Information Systems: Example From a College Campus,” Schneider, Khattak, and Zegeer (167) mapped the locations of five years’ of police-reported pedestrian crashes to identify “hot spots,” or locations with high concentrations of crashes in the UNC-Chapel Hill campus area. They supplement these reported crash data with information about locations where campus students, staff, and faculty perceive high-levels of crash risk, collected from surveys. They used Geographic Information Systems (GIS) to map locations with high reported or perceived pedestrian crash risk. These maps can provide a framework for identifying locations in need of

particular countermeasures and engineering treatments, as well as education or enforcement programs.

Leslie et al. (109) describe the development of a walkability index called the Physical Activity in Localities and Community Environments (PLACE) approach in their paper “Walkability of Local Communities: Using Geographic Information Systems to Objectively Assess Relevant Environmental Attributes.” The index can be useful in evaluating the relationship between walking and the built environment, focusing on land use and urban design characteristics. The tool was tested in Australia, but can be widely applied in many cities and towns.

In a publication released as “Characterizing Neighborhood Pedestrian Environments With Secondary Data,” Parks and Schofer (143) studied measures that can be used to evaluate the quality of neighborhood pedestrian environments, quantifying walkability based on network design, pedestrian facilities, and roadside built environment features. The measures were applied in Chicago neighborhoods, and showed a high correlation with walkability, as measured through field surveys and linear regression.

To develop walkability indices for transit-oriented development, Schlossberg and Brown (166) used three primary methods of evaluation: network classification, pedestrian catchment areas, and impedance-based intersection intensities. This research was published under the title “Comparing Transit-Oriented Development Sites by Walkability Indicators.” Classifying the network allows individuals to understand the types and patterns of streets around the transit station. The total walking distance and network around the station determines the catchment area, and identifies the number of people who can access that particular transit stop. Finally, the intersection indices evaluate the differences between different types of intersections as they relate to transit station access. The findings from this research can be used to evaluate existing transit-oriented developments or to plan for future developments.

Clifton, Livi Smith, and Rodriguez (29) describe the Pedestrian Environmental Data Scan (PEDS) – an audit tool designed to evaluate the walkability of roadway or trail segments – in their publication “The Development and Testing of an Audit for the Pedestrian Environment.” Using trail or roadway variables such as adjacent land use, slopes, facility types, and volumes, the PEDS tool can be used to evaluate most aspects of the pedestrian environment, as well as the roadway itself. The authors compare PEDS with similar auditing tools, and state that “the PEDS audit methodology provides a comprehensive method to evaluate pedestrian environments for academics involved with transportation and physical activity research as well as practitioners seeking to an assessment tool for prioritizing investments.”

Development and Evaluation of Countermeasures

Research Compendiums

Several previous projects have sought to synthesize pedestrian safety literature. This literature review incorporates these and focuses on studies conducted since those reviews were published.

This paper by Lobb (113), entitled “Trespassing on the Tracks: A Review of Railway Pedestrian

Safety Research,” synthesizes existing research in the area of pedestrian safety along railways. The major types of pedestrian-rail crashes are identified, along with applicable research in this field. The author then identifies strategies for reducing these types of crashes, and makes recommendations for future applications of behavioral and cognitive psychology in the area of transportation safety.

In the paper “Assessment of Pedestrian Safety Measures in Europe,” Yannis et al. (213) examine the ways in which pedestrian safety measures impact the interaction between pedestrians and traffic. The authors also provide a set of interventions, with an emphasis on technical non-restrictive measures, that have been shown to be especially effective in creating a safe environment for pedestrians. Measures were categorized into four areas: management of vehicle traffic, provision or improvement of pedestrian infrastructure, improvement of road user perception, and education and enforcement. Some of the most effective include refuge, median opening, signal push button at convenient height for wheelchairs, and anti-slip walking path surface.

Retting, Ferguson, and McCartt (156) reviewed engineering modifications to the built environment designed to reduce the risk of pedestrian injuries, based on engineering countermeasures documented in the scientific literature. The title of their paper is “A Review of Evidence-Based Traffic Engineering Measures Designed to Reduce Pedestrian-Motor Vehicle Crashes.” The authors classified countermeasures into three categories: 1) speed control, 2) separation of pedestrians from vehicles, and 3) measures to increase the visibility and conspicuity of pedestrians. They determined the measures and settings with the greatest potential for crash prevention. Emphasis is placed on inclusion of studies with adequate methodological designs.

Elvik and Vaa (36) use a comprehensive approach to assess 124 road safety measures in their publication “Handbook of Road Safety Measures.” Using a broad definition for a road safety measure, the authors include any treatment that intends to reduce the number of crashes, the crash or injury severity, or the rate at which crashes occur. There are other impacts analyzed as well, such as accessibility, mobility, and environmental impacts. This comprehensive overview should provide a thorough background on general road safety treatments.

Erke and Elvik (37), presenting their arguments in “Making Vision Zero Real: Preventing Pedestrian Accidents and Making Them Less Severe,” outlined the accident risks faced by pedestrians, and sought to identify ways that crash numbers, and especially injury severity, can be reduced. They survey literature in the area of pedestrian safety, and draw conclusions based on their review. Pedestrians face a crash risk of about ten times higher than a motorist, according to the authors. They point out that increasing the numbers of pedestrians and cyclists could increase pedestrian and cyclist injuries, but the overall crash risk would decrease for road users.

In “Alternative Treatments for At-Grade Pedestrian Crossings,” the ITE Pedestrian and Bicycle Task Force (88) prepared an informational report which documents studies on crosswalks and warrants, summarizes studies on pedestrian crossings and assembles in a single document the various treatments currently in use by local agencies in the U.S., Canada, Europe, New Zealand, and Australia. The purpose was to improve crossing safety for pedestrians at locations where

marked crosswalks are provided. Studies on pedestrian-related collisions are summarized, including those documenting the results of removing crosswalk markings at uncontrolled locations.

Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Offices by Goodwin et al. (68) is a basic reference to assist State Highway Safety Offices (SHSOs) in selecting effective, science-based traffic safety countermeasures for major highway safety problem areas. The guide: describes major strategies and countermeasures that are relevant to SHSOs; summarizes their use, effectiveness, costs, and implementation time; and provides references to the most important research summaries and individual studies. The guide contains a chapter for each problem area. Each chapter begins with a brief overview of the problem area's size and characteristics, the main countermeasure strategies, a glossary of key terms, and a few general references. Next, a table lists specific countermeasures and summarizes their use, effectiveness, costs, and implementation time. Highway safety problem areas covered include the following: alcohol-impaired driving, seat belts, speeding and aggressive driving, fatigued and distracted driving, motorcycle safety, young drivers, older drivers, pedestrians, and bicyclists. Countermeasures specifically evaluated for pedestrians include reducing speed limits, enhancing pedestrian conspicuity, targeted enforcement, driver training, child supervision, establishing pedestrian safety zones, and communications/outreach.

A Review of Pedestrian Safety Research in the United States and Abroad by Campbell et al. (18) provides an overview of research studies on pedestrian safety in the United States and abroad. The report details pedestrian crash characteristics, measures of pedestrian exposure and hazard, and specific roadway features and their effects on pedestrian safety. Such features include crosswalks and alternative crossing treatments, signalization, signing, pedestrian refuge islands, provisions for pedestrians with disabilities, bus stop locations, school crossing measures, reflectorization and conspicuity, grade-separated crossings, traffic-calming measures, and sidewalks and paths. Pedestrian educational and enforcement programs are also discussed.

This compendium by Cleven & Blomberg (26), entitled *A Compendium of NHTSA Pedestrian and Bicyclist Traffic Safety Research Projects, 1969-2007*, describes the pedestrian and bicyclist safety research conducted by the Office of Behavioral Safety Research and its predecessor organizations during the period 1969–2007. The compendium begins with a description of the structure and philosophy of the National Highway Traffic Safety Administration pedestrian and bicycle research programs. It is followed by a section that describes the research on the development of taxonomies of crash types, since the results of that research formed the foundation for many of the subsequent NHTSA pedestrian and bicycle research studies. A chronological listing of major activities that occurred in the decades spanned by NHTSA's pedestrian and bicyclist research programs is then presented. The final section discusses lessons learned from the pedestrian and bicycle research activities. Appendix A to this compendium contains abstracts of relevant research in a standardized format. Appendix B presents lists of pedestrian and bicyclist crash types as they have evolved over the years.

The National Bicycling and Walking Study, Transportation Choices for a Changing America, a publication by Zegeer et al. (215), includes a series of 24 case studies highlighting model activities conducted with respect to bicycle and pedestrian planning. The Study presents a plan of

action for activities at the federal, state, and local levels for increasing the amount of walking and bicycling in the United States. A five-year status report (FHWA, 1999) and a ten-year status report (FHWA, 2004) were published to track progress toward the goals set out in the original report.

Intersections

Signs and Pavement Markings

Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations: Final Report and Recommended Guidelines by Zegeer et al. (217) presents the results of a study that examined the safety of pedestrians at uncontrolled crosswalks and provides recommended guidelines for pedestrian crossings. Through a large study based on five years of data at uncontrolled intersections, the researchers examined pedestrian safety on two-lane roads, where the presence of a marked crosswalk alone at an uncontrolled location was associated with no difference in pedestrian crash rate. The presence of a raised median (or raised crossing island) was associated with a significantly lower pedestrian crash rate at multi-lane sites with both marked and unmarked crosswalks. Recommended improvements included adding pedestrian signals and providing raised medians.

Nambisan et al. (135) present an evaluation of advanced yield markings when used in combination with Danish offsets and median refuge islands to improve pedestrian safety in their paper “Advanced Yield Markings and Pedestrian Safety: Analyses of Use With Danish Offsets and Median Use Islands.” Observations of pedestrians were made during the two stage countermeasure deployment at both uncontrolled intersections and midblock locations. The researchers found an increase in both pedestrian observing behavior and motorist yielding behavior, as well as a reduction in the number of pedestrians trapped in the roadway. The findings could be widely applied to other cities.

Mitman et al. (127), in a paper entitled “The Marked Crosswalk Dilemma: Uncovering Some Missing Links in a 35 Year Debate,” provided an overview of the literature related to crosswalks (marked and unmarked) and the gaps that need to be addressed by future research. The authors also highlight driver and pedestrian behavior in multiple threat scenarios, a common crash type at uncontrolled locations. The findings from related research are presented, as the authors make recommendations for comprehensive crosswalk safety policies that can be implemented to address these types of crashes.

To evaluate innovative treatments for unsignalized crossing locations, Huang et al. (83) evaluated three separate treatments in several cities for publication in their paper “The Effects of Innovative Pedestrian Signs at Unsignalized Locations: A Tale of Three Treatments.” It was determined that several of the treatments, including an overhead crosswalk sign in Seattle, WA, were effective in increasing yielding by motorists. However, none of the treatments examined showed any effect on whether pedestrians chose to cross within the crosswalk. Finally, the team pointed out that the treatments would only be effective if they were combined with education and enforcement campaigns.

Fitzpatrick, Turner, et al. (56) describe recommended selected engineering treatments to improve safety for pedestrians crossing high volume, high-speed roadways at unsignalized intersections and modifications to the Manual on Uniform Traffic Control Devices (MUTCD) pedestrian traffic signal warrant. They present these recommendations in the paper, “Improving Pedestrian Safety at Unsignalized Crossings.” The primary measure of effectiveness for engineering treatments at unsignalized roadway crossings was motorist compliance.

To evaluate the effect of impactable signs using the 2003 MUTCD yield symbol, Banerjee and Ragland (8) installed these treatments at signalized and unsignalized intersections. Using video recordings and other observation data, the authors determined that a substantial increase in yielding rates followed installation of these countermeasures, which was sustained through the follow-up evaluation period as well. They summarized their research in the publication, “Evaluation of Countermeasures: A Study on the Effect of Impactable Yield Signs Installed at Four Intersections in San Francisco.”

Signalization

Lu and Noyce (117) studied the effects of dynamic signal systems on pedestrian crossings at high-volume intersections and presented their conclusions in a paper entitled “Intersection Signal Systems With Intelligent Pedestrian Accommodation: Dynamic Pedestrian Timing.” Using a dynamic timing system can increase traffic operations and efficiency, while maintaining safety for all users, and the researchers attempted to test this concept with their study. Both of the systems tested were found to significantly improve operations and efficiency by removing the dependence on a design walking speed.

To study the leading pedestrian interval (LPI) and its effects on pedestrian safety, Fayish and Gross (40) looked at specific site characteristics and evaluated the LPI system in State College, Pennsylvania. The results, published under the title “Safety Effectiveness of Leading Pedestrian Intervals Using the Empirical Bayes Method” showed a 37 percent reduction in crashes, and reductions were not significantly greater at intersections with larger volumes of pedestrians. This low-cost strategy needs only a moderate reduction in crashes for justification, an easily achievable threshold given the results of this study.

A pilot test of the pedestrian scramble is evaluated in a study, “A Pilot Study on Pedestrian Scramble Operations in Calgary,” by Acharjee et al., (2). By analyzing the intersections and using regression models to examine the number of conflicts and violations, the researchers found that the system decreased the number of conflicts significantly. They also showed that, of the violations recorded, most were within the flashing “don’t walk” phase, after many of the pedestrians had been able to safely cross.

Schrock and Bundy (169) sought an understanding of the effects of pedestrian countdown timers (CDTs) on driver behavior. They published their research in a report entitled “Pedestrian Countdown Timers: Do Drivers Use Them to Increase Safety or to Increase Risk-Taking.” In response to concerns that the signals may increase risky behavior by drivers, the researchers studied four intersections in Lawrence, Kansas, and recorded speed data and driver behavior observations. The results showed that drivers tend to use information from the pedestrian CDTs

to make more safe decisions as they approach intersections, an additional benefit of this pedestrian safety treatment.

To evaluate motorist yielding to pedestrians at unsignalized locations, Turner et al. (188) collected data from 42 sites across the US for publication in their paper, “Motorist Yielding to Pedestrians at Unsignalized Intersections: Findings from a National Study on Improving Pedestrian Safety.” In their study, they examined various engineering treatments from site to site. Using their motorist yielding data, the researchers were able to determine the most effective methods for increasing yielding among drivers. The most effective treatment, a red signal or beacon, showed yielding rates that exceeded 94 percent for every study site. After the study was completed, the team developed an implementation matrix to be used by local agencies to determine appropriate countermeasures and crossing treatments.

Eccles et al. (34) studied countdown signals at five locations in Montgomery County, Maryland, over the course of their study, “Evaluation of Pedestrian Countdown Signals in Montgomery County, Maryland.” The researchers observed the number of pedestrians waiting to cross, the number of those remaining in the intersection after the countdown, and any motorist-pedestrian conflicts. The signals were not shown to have a negative effect on pedestrian behavior, and no effect on vehicle speeds when approaching the intersection. The results also showed that most pedestrians are aware of and understand the countdown indicators displayed by the signals.

In the publication “Pedestrian Delay Estimation at Signalized Intersections in Developing Cities”, Qingfeng, Zhaoan et al. (153) conducted a two-part field study to evaluate the suitability of a signal phase cycle model for signalized intersections in developing cities, where pedestrian signal non-compliance causes congestion and other access problems. Part I involved only one crosswalk, and the signal cycle was divided into 13 subphases. Part II involved 13 crosswalks, but the signal cycles were only divided into green phases and non-green phases. They found that pedestrian arrival rates were not uniform throughout cycles. Pedestrians arriving during green phases might also receive delays; pedestrian signal non-compliance was so severe that delays were greatly reduced, but non-complying pedestrians might still receive delays; and for pedestrians walking different directions, though the relationships between average delay and arrival subphase were different, the overall average delays were almost the same. On the basis of the field study results, the authors made assumptions about the relationship between average pedestrian delay and arrival subphase, and developed a new model to estimate pedestrian delays at signalized intersections. They validated model using the field data. Validation results indicate that in the field study site the new model provides much more accurate estimation than existing models.

Geometric Design

In the paper “Synthesis on the Safety of Right Turn on Red in the United States and Canada,” Lord (114) sought to synthesize existing research on right turn on red (RTOR) policies in the US and Canada. To perform the study, crash statistics were analyzed and surveys were performed with transportation professionals and other experts on this issue. The author concludes that RTOR is not actually dangerous to either motorists or pedestrians at signalized intersections (in most cases).

Jagannathan & Bared (91) attempted to fill the gaps in research related to continuous flow intersections (CFI) with this study, entitled “Design and Performance Analysis of Pedestrian Crossing Facilities for Continuous Flow Intersections.” It is essential, the study reported, to include the needs and safety of the pedestrian when discussing CFI benefits. The authors used several models to evaluate CFI geometries and determine the types of crossings that optimize both vehicular travel performance and pedestrian crossing safety.

Johnson (93) conducted this case study of curb extensions in the City of Albany, OR, and their impact on motorist yielding behavior. He observed the number of vehicles that passed a crosswalk before a pedestrian was able to cross, as well as the number of those that yielded. It was determined that the curb extensions do, in fact, seem to increase yielding by motorists, in addition to decreasing the crossing distance for pedestrians. His research and conclusions are summarized in the document, “Pedestrian Safety Impacts of Curb Extensions: A Case Study.”

Midblock Crossing

The study, entitled “Characteristics Related to Midblock Pedestrian-Vehicle Crashes and Potential Treatments,” by Sandt & Zegeer (162) identified crash variable categories that were significantly higher among midblock crashes, as opposed to those at intersections. Several variables were distributed similarly among midblock and intersection crashes, such as lighting. Certain categories—such as two-lane roads, younger male pedestrian involvement, and rural crash locations—were more regularly associated with midblock crashes when compared with those crashes at intersections. The study also made recommendations for future research efforts in determining appropriate countermeasure treatments for midblock crossings.

This evaluation by Bowman & Vecellio (14), entitled “*Investigation of the Impact of Medians on Road Users*,” of the effects and impacts of medians on all road users gives attention to the role of medians in midblock crossings. The accident data were used to develop nonlinear predictive models for estimating the effect of cross-section type on vehicular and pedestrian accidents. It was found that raised median pedestrian accident rates are significantly lower than rates on undivided arterials. Additionally, the damage severity of motor vehicle accidents is lower for areas with raised medians than undivided areas in both central business district and suburban locations.

Boyce and Van Derlofske (15) of the Lighting Research Center (LRC) at Rensselaer Polytechnic Institute determined the effect of an in-pavement flashing warning light system installed on a crosswalk between a residential area and a recreational area on pedestrian safety, relative to striping. Striping alone reduced the number of automobiles that passed over the crosswalk while pedestrians were in it but did not reduce the speed of automobiles approaching the crosswalk or reduce the number of vehicles that went through while pedestrians were waiting to use the crosswalk. In-pavement flashing warning lights did reduce the speed of automobiles approaching the crosswalk and the number of vehicles that went through the crosswalk while pedestrians were waiting. Striping alone made the crosswalk more noticeable to drivers who were not familiar with the site. Adding in-pavement flashing warning lights made the crosswalk even more noticeable to such drivers. Boyce and Van Derlofske’s research is summarized in the paper,

“Pedestrian Crosswalk Safety: Evaluating In-Pavement Flashing Warning Lights.”

In “An Evaluation of Crosswalk Warning Systems: Effects on Pedestrian and Vehicle Behavior,” Hakkert, Gitelman, et al. (71) examined pedestrian and vehicle behavior at an uncontrolled pedestrian crossing equipped with a system for detecting pedestrians near the crosswalk zone and for warning drivers regarding the presence of pedestrians by means of embedded flashing pavement lights adjacent to the marked crossing. Devices were installed at four urban locations. Based on the study results, crosswalk site conditions for implementation are recommended.

Huang’s (81) paper “An Evaluation of Flashing Crosswalks in Gainesville and Lakeland” describes an evaluation of a flashing crosswalk system installed at two locations in Florida. The evaluation was conducted by the University of North Carolina Highway Safety Research Center (HSRC) during 1999. It provides site descriptions, data collection procedures, results, a summary and conclusions, and recommendations for future programs.

Rousseau, Tucker, and Do (159) conducted a before and after field study in Rockville, Maryland to assess whether in-roadway warning lights increase safe crossing situations for pedestrians at uncontrolled locations. This research was presented in the document, “The Effects on Safety of In-Roadway Warning Lights at Crosswalks: Novelty or Longevity?” Based on observations of the crosswalk, the authors suggest that: 1) improved performance may result if systems are installed with both passive and active actuation, and 2) it may be beneficial to place the detection bollards further apart than the width of the crosswalk.

The HAWK (high-intensity activated crosswalk) beacon device is evaluated in a study by Fitzpatrick and Park (57) entitled “Safety Effectiveness of the HAWK Pedestrian Treatment.” The HAWK uses two red lenses and a single yellow lens to alert motorists to a crossing pedestrian when activated. In the before and after study to evaluate the treatment, researchers found a 28 percent reduction in all crashes, and a 58 percent overall reduction in pedestrian crashes, after the treatment was installed.

Van Houten et al. (205) examined the reasons why pedestrians will not wait for the “Walk” signal at a midblock crosswalk before choosing to cross in their paper “Effects of Various Minimum Green Times on Percentage of Pedestrians Waiting for Midblock “Walk” Signal.” Instead, they look for gaps in traffic and cross according to their own judgment. The crosswalks studied in Miami-Dade County, Florida, showed that the minimum wait time was anywhere between 30 and 120 seconds before the pedestrians would stop waiting. As the wait time increased, fewer pedestrians complied with the signals. The findings can be used to design new types of signals and set signal patterns.

In other research to evaluate in-pavement flashing light systems, published as “An Evaluation of the Effectiveness of an In-Pavement Flashing Light System,” Nambisan et al. (134) used a before and after study to test the treatment’s effect on driver yielding rates. Applying the analysis to a low-volume roadway, researchers found that the installation of these systems significantly increased motorist yielding behavior. Additionally, the findings showed that vehicle speeds slowed when pedestrians were both crossing the street and waiting on the curb. In conclusion, the authors note that the in-pavement flashing lights are effective treatments for pedestrian and

motorist safety at low-volume locations.

Shurbutt et al. (176), presenting research in the paper “An Analysis of the Effects of Stutter Flash LED Beacons to Increase Yielding to Pedestrians Using Multilane Crosswalks,” selected three sites to test the effectiveness of rapid flash LED beacons on motorist yielding at multilane locations. Furthermore, the study analyzed systems with two and four beacons. A significant increase in yielding rates was shown, as well as an increase in yielding distance. The researchers also tested different types of beacons: overhead yellow, side-mounted yellow, and LED rapid flash beacons. It was shown that the rapid flash beacons caused the most dramatic change in driver yielding behavior.

Ellis et al. (35) examined the effects of placing in-roadway yield to pedestrian signs at varying distances from a crosswalk in the paper “In-Roadway ‘Yield to Pedestrian’ Signs: Placement Distance and Motorist Yielding.” The results showed that all placements of the treatment increased yielding rates, and that installing the treatment at the crosswalk was as or more effective than placing it 20 or 40 ft. in advance of the crosswalk. The authors concluded that the “data suggest that the in-roadway sign is likely effective because the in-roadway placement is particularly salient to drivers.”

Transit and Multimodal

The *Guidebook for Mitigating Fixed-Route Bus-And-Pedestrian Collisions* by Pecheux et al. (144) is intended to help transit agencies of all sizes understand pedestrian-bus crashes and determine countermeasures and strategies for reducing these crashes. A discussion of the most common types of collisions is followed by mitigation strategies and more than 80 applications. Also included are case studies that provide an in-depth look at some of these applications, as well as a discussion of important safety considerations for pedestrians around buses.

Lighting and Nighttime Issues

“The Informational Report on Lighting Design for Midblock Crosswalks” by Gibbons et al. (66) focused on evaluating lighting technologies and design strategies that enhance visibility of pedestrians in midblock crosswalks. Researchers determined that a vertical luminance of 20 lux in the crosswalk would provide the required level of visibility for drivers to detect pedestrians in most conditions. The paper also touches on the issue of lighting for crosswalks that located in close proximity to intersections.

Gibbons and Hankey (65) investigated the lighting levels required for crosswalk illumination in the publication “Influence of Vertical Illuminance on Pedestrian Visibility in Crosswalks.” Two major questions were examined: 1) the required vertical illuminance level for adequate pedestrian visibility, and 2) the selection of an object that could act as a surrogate for the pedestrian. The study found that a lighting design level of 20 vertical lux is likely adequate for proper pedestrian visibility. The surrogates used were an extruded octagon, a cylinder, and a cylinder with a ball on top. The experiment found that all surrogates performed equally well and that the surrogate can be chosen on the basis of the ease of calculation. It is recommended that a cylinder be used as a pedestrian surrogate.

In the “Informational Report on Lighting Design for Midblock Crosswalks,” Gibbons, Edwards, et al. (66) provide information on lighting parameters and design criteria that should be considered when installing fixed roadway lighting for midblock crosswalks. Static and dynamic experiments of driver performance were conducted with regard to the detection of pedestrians and surrogates in midblock crosswalks.

Sullivan and Flannagan (181) studied the influence of light level in three pedestrian crash scenarios associated with three adaptive headlighting solutions—curve lighting, motorway lighting, and cornering light. These results, presented in the paper “Determining the Potential Safety Benefit of Improved Lighting in Three Pedestrian Crash Scenarios,” were coupled to corresponding prevalence data for each scenario to derive measures of annual lifesaving potential. While all three scenarios suggested a potential for safety improvement, scenarios related to high speed roadway environments showed the greatest potential.

Wilken, Ananthanarayanan, et al. (210) were team members on a FHWA scanning tour which gathered information from European transportation ministries and lighting professionals on research and technologies in highway and roadway lighting systems. From observations, the panel developed recommendations for the U.S. lighting community in such areas as visibility design technique, pavement reflection factors; and lighting techniques for roundabouts, crosswalks, and pedestrian areas. This information is summarized in the report entitled European Road Lighting Technologies.

In “Educational Interventions Successfully Reduce Pedestrians’ Overestimates of Their Own Nighttime Visibility,” Tyrrell et al. (190) studied pedestrians’ estimates of their own nighttime visibility compared with actual visibility under various conditions. The participants were divided into groups that were given different levels of educational messages prior to the study, ranging from no additional education to a focused graphic/intensive lecture on the subject of visibility. It was shown that, overall, pedestrians tend to overestimate their own visibility in nighttime situations, but that educational messages can be effective in communicating the importance of visibility.

Kwan and Mapstone (100) provide a study on visibility aids that can be used to prevent injuries to pedestrians and cyclists due to crashes in the document entitled “Interventions for Increasing Pedestrian and Cyclist Visibility for the Prevention of Death and Injuries.” The results show that using fluorescent materials—such as yellow, red and orange—can increase visibility during daytime hours, while lamps, flashing lights, and retroreflective materials were effective at night. The authors also include a literature review summary on other research in this area.

Speed Management, Traffic Calming, and Roadway Design

Huang and Cynecki (82) evaluated effects of selected traffic calming treatments on pedestrian and motorist behavior at intersection and mid-block locations. The key findings, summarized under the title “The Effects of Traffic Calming Measures on Pedestrian and Motorist Behavior,” include: 1) Overall vehicle speeds were often lower at treatment sites than at control sites; 2) The combination of a raised crosswalk with an overhead flasher increased motorists’ yielding to

pedestrians; 3) Treatments usually did not have a significant effect on average pedestrian waiting time; and 4) Refuge islands often served to channelize pedestrians into marked crosswalks.

In “Relationship of Lane Width to Safety for Urban and Suburban Arterials,” Potts et al. (149) sought to study how lane width affects safety for road users in urban and suburban arterials. The study found that there was no clear evidence that lanes narrower than 12 ft increased crash frequencies, but did show that higher crash frequencies among narrower lanes in three particular situations. While the findings could be used to make the case for narrowing road lanes, it should be cautioned against using them in the three circumstances mentioned.

Pedestrians with Disabilities

The guides *Designing Sidewalks and Trails for Access Parts 1: Review of Existing Guidelines and Practices* by Axelson et al. (7) and *Part 2: Best Practices Design Guide* by Kirschbaum et al. (97) provide an in-depth look at the state of the practice for applying the American with Disabilities Act (ADA) and similar requirements to pedestrian facilities. Part I of the report focuses on ADA guidelines and requirements, while Part 2 highlights best practices and design examples that can be incorporated for ADA compliance.

Harkey, Carter, et al. (74) provide an introduction to currently available accessible pedestrian signals in the guide, “Accessible Pedestrian Signals: A Guide to Best Practices.” It provides guidance and understanding of traffic signals and modern intersection design for orientation and mobility specialists who must interact with the travel environment and work with traffic engineers. An appendix on research summarizes studies that have examined problems of blind pedestrians.

In “Accessible Pedestrian Signals: Effect of Device Features,” Bentzen et al. (11) compare the effect of push button-integrated accessible pedestrian signals on the crossing ability of blind pedestrians. It was found that a rapid-tick walk signal promoted the fastest onset of crossing and is therefore the preferred signal. Empirical evidence from participants with less knowledge of the devices as well as subjective data led to the recommendation that APS devices include a push button locator tone, a rounded push button with an activation tone or message, a tactile arrow incorporated into the push button, responsiveness to ambient sound, and a push button information message and beaconing in response to an extended button press.

Wall, Long, et al (208) described two experiments conducted with blind and sighted adults that explored street crossing behavior under conditions of free flowing traffic, with a focus on modern roundabout intersections. This study was presented in the document “Blind and Sighted Pedestrians’ Judgments of Gaps in Traffic at Roundabouts.” The first experiment was conducted at three roundabouts varying in size and traffic volume. Totally blind and sighted adults judged whether gaps in traffic were long enough to permit crossing to a median island before the next vehicle arrived. Gap distributions and measures of judgment quality are reported. Blind participants were less likely to make correct judgments than sighted participants, took longer to detect crossable gaps, and were more likely to miss crossable gaps altogether. In the second experiment, the response of drivers to blind pedestrians with and without mobility devices, such as long canes or dog guides, was evaluated. The experiment was conducted at a single-lane

roundabout, a midblock crossing, and a two-way-stop-controlled intersection. Site-specific characteristics appeared to have a greater impact on drivers' yielding than did a mobility device. The authors discuss applications of this research, including the development of methods for assessing pedestrian safety and driver behavior, and identifying intersections needful of modification in order to be accessible to blind pedestrians.

Wall et al. (2007) explored accessible pedestrian signals and the possibility of using APS to provide directional beaconing for pedestrians crossing a street in the paper "Audible Pedestrian Signals as Directional Beacons." It was found that providing an APS auditory signal only from the far end of a 16 m crossing reduced the amount of veering more than providing the signal from both ends of the crossing. Alternating the signal between the two ends of the crossing for a 7 second WALK phase provided good beaconing information as long as only one of two parallel crosswalks at an intersection were signaled at a time. The most effective beaconing situation was to include a push button locator tone at the far end that would activate when the WALK phase signal was complete.

Enforcement

In "Effects of a Driver Enforcement Program on Yielding to Pedestrians," a driver-yielding enforcement program that included decoy pedestrians, feedback flyers, written and verbal warnings, and saturation enforcement for a 2-week period was evaluated by Van Houten and Malenfant (2006) in the city of Miami Beach using a multiple baseline design. During baseline, data were collected at crosswalks along two major corridors. Treatment was introduced first at selected crosswalks without traffic signals along one corridor. A week later, enforcement was shifted to crosswalks along the second corridor. Results indicated that the percentage of drivers yielding to pedestrians increased following the introduction of the enforcement program in each corridor and that these increases were sustained for a period of a year with minimal additional enforcement. The effects also generalized somewhat to untreated crosswalks in both corridors, as well as to crosswalks with traffic signals.

Education

In order to evaluate an interactive multimedia (IMM) program used to teach young children about pedestrian safety, Glang et al. (1997) used a computer-delivered assessment and a real-life street simulation to measure the program's effectiveness. It was found that the IMM program was effective in teaching children about dangerous traffic elements and translating that knowledge into real environments. Their research is outlined in the publication "Using Interactive Multimedia to Teach Pedestrian Safety: An Exploratory Study."

Berry & Romo (1992) evaluated a pedestrian safety program for children entitled "Cyrus the Centipede" in the paper "Should 'Cyrus the Centipede' Take a Hike: Effects of Exposure to a Pedestrian Safety Program on Children's Safety Knowledge and Self-Reported Behaviors." Using a pre- and post-test on experimental and control groups of third graders, the researchers sought to determine the show's impact on the subjects' pedestrian safety knowledge and self-reported behaviors. Overall, it was determined that while the program was not very effective, the impact was strongly influenced by the individual teacher who delivered the program. This was

thought to be primarily due to the highly unstructured nature of the curriculum.

In “Teaching Pedestrian Skills to Individuals with Developmental Disabilities,” Batu et al. (10) explored methods for delivering pedestrian safety skills and education to individuals possessing developmental disabilities. After teaching three different skills for crossing the street to five such individuals, researchers used a multiple probe design to evaluate the effects of most to least prompting. It was shown that most to least prompting was an effective method of teaching pedestrian safety skills.

Mitman & Ragland (126) explore the knowledge of right-of-way laws as they relate to marked and unmarked crosswalks in their paper “Crosswalk Confusion: More Evidence Why Pedestrian and Driver Knowledge of the Vehicle Code Should Not Be Assumed.” Using intercept surveys and focus groups in the San Francisco Bay area, the researchers show that a substantial level of confusion exists about pedestrian right-of-way laws. These misunderstandings are exacerbated by intersections with unmarked crosswalks. The findings have implications for the engineering of pedestrian facilities, as well as enforcement countermeasures.

Harre and Wrapson (76) evaluate a safety campaign that was designed to decrease pedestrian crossings against red lights and encourage left-turning drivers to yield to pedestrians. Their evaluation was published under the title, “The Evaluation of a Central-City Pedestrian Safety Campaign.” Using educational media messages and rewards for safe behavior, five intersections were evaluated for effectiveness. The number of pedestrians crossing against red lights was cut by nearly 50 percent, but there were no improvements in driver yielding behavior.

Other

“An Analysis of Factors Contributing to ‘Walking Along Roadway’ Crashes: Research Study and Guidelines for Sidewalks and Walkways” by McMahon et al. (121) summarizes the results of a study that examined the safety impacts of having sidewalks and walkways along roadways. The document also provides guidelines and recommendations for providing such facilities.

In this long-term study termed an “Evaluation of the Miami-Dade Pedestrian Safety Demonstration Project,” Zegeer et al. (219) identified a comprehensive countermeasure program and implemented it to reduce deaths and injuries among pedestrians in a large urban environment. Using pedestrian crash data from 1996 to 2001, four zones in Miami-Dade County, FL, were identified as having abnormally high pedestrian-crash experiences. Based on location crash characteristics, as well as pedestrian (age, ethnicity) factors, 16 different types of education, enforcement, and engineering treatments were selected and targeted to reduce pedestrian crashes.

Turner et al. (187) provides an overview of the multidisciplinary program implemented in St. Petersburg, Florida, to increase motorists yielding to pedestrians in crosswalks, reduce pedestrian-motor vehicle conflicts in crosswalks, and to increase pedestrians’ feelings of comfort and safety while crossing the street. The report, entitled “Making Crosswalks Safer for Pedestrians: Application of a Multidisciplinary Approach to Improve Pedestrian Safety at Crosswalks in St. Petersburg, Florida,” documented the steps involved in assessing pedestrian

safety in the community, prioritizing and selecting countermeasures to improve pedestrian safety, implementing engineering, education, and enforcement interventions, and evaluating the effectiveness of the program. The results provide insight into the challenges of implementing a multidisciplinary program over a large urbanized city and give some recommendations on how the challenges can be overcome.

In “California’s Safe Routes to School Program,” Boarnet, Day, et al. (13) evaluated the impacts of 10 traffic improvement projects funded through the California Safe Routes to School program. The authors measured changes in perceived safety and safety-related behaviors associated with children’s trips to school. Changes in the number of children walking and bicycling following these improvements were also measured. The results showed that five of the 10 traffic improvement projects demonstrated a near-term, observable, measurable impact. Sidewalk gap closures and replacement of four-way stop signs with traffic signals appeared to have the highest potential for success.

Sayer and Buonarosa (165) examined work zone safety and daytime pedestrian conspicuity as influenced by garment design, garment material, pedestrian motions, and driver characteristics in the report “The Roles of Garment Design and Scene Complexity in the Daytime Conspicuity of High-Visibility Safety Apparel.” After studying driver reactions along a 31-km route, researchers determined no discernible difference in detection distances when pedestrians were wearing fluorescent yellow-green as opposed to fluorescent red-orange. As the complexity of the scene decreased, however, pedestrians were detected at greater distances. The researchers made recommendations on the safety of work zones and increasing motorist detection of workers along roadways.

Huang et al. (84) analyze automobile-pedestrian crash scenarios using data from the Swedish Traffic Accident Data Acquisition (STRADA), a database that pulls crash data from police and hospital records in a publication entitled “Evaluation of Remote Pedestrian Sensor System Based on the Analysis of Car-Pedestrian Accident Scenarios.” Using common crash scenarios, researchers were able to use various crash factors in developing a mathematical model to evaluate a system of detecting pedestrians using remote sensors. The remote detection system was shown to be effective in detecting pedestrians in the two major categories of automobile-pedestrian crashes (cars entering and leaving intersections colliding with pedestrians crossing the road), as determined from STRADA analysis.

Rosenbloom et al. (157) used unobtrusive observations of children crossing at a crosswalk with and without an accompanying adult to determine whether unsafe behaviors were influenced by the presence of an adult. The researchers, presenting their research as “Children’s Crossing Behavior With an Accompanying Adult,” noted four unsafe behaviors: not stopping at the curb, not looking before crossing, attempting to cross when a car is near, and running across the road. The most common unsafe behavior was not looking before crossing. Researchers also determined that the children accompanied by an adult actually committed more unsafe behaviors than the children who crossed without adults. Additionally, recommendations were made for child pedestrian programs and interventions.

In “Traffic Signal Phasing at Intersections to Improve Safety for Alcohol-Affected Pedestrians,”

Lenne et al. (108) investigate opportunities for the application of modified traffic signal operations to reduce crash risk for alcohol-affected pedestrians during high-risk periods. Using the so-called “Dwell-on-Red” treatment, which displays a red traffic signal in all directions while no vehicular traffic is detected, would cause vehicles to approach intersections at lower speeds. Using before and after speed data, the treatment was associated with lower vehicle speeds and substantial reductions in vehicles traveling at speeds threatening severe pedestrian injury. The study also makes recommendations for the applicability of this treatment in similar situations.

Lovette (115) explores the problem of blind zones behind automobiles as they relate to pedestrian safety, and gives an overview of the many countermeasures available to prevent crashes caused by these blind zones in his paper “Back-Up Detection Devices: What Do We All Need To Know? Dangerous Blind Zones.” The research touches on automated technologies, those equipped with sensors and cameras, as well as education programs and similar countermeasures. The study concludes by noting that while many technologies are effective in preventing these crashes, there is no substitute for driver alertness and child/adult education.

San Francisco Pedsafe II, a pedestrian safety project funded by the Federal Highway Administration, is evaluated and presented in the paper “San Francisco Pedsafe Project II Project Outcomes and Lessons Learned” by Hua et al. (80). This comprehensive planning and engineering project sought to develop a plan for a high-crash pedestrian safety zone and recommend low-moderate cost safety improvements. The authors evaluated 13 countermeasures over a three year period, and determined that six were generally successful, including flashing beacons, in-street pedestrian signs, and video detection. Lessons learned from this experience and recommendations for future research are also presented.

In a research report entitled “Pedestrian-Cyclist Conflict Minimisation on Shared Paths and Footpaths” prepared for Austroads, Mellifont et al (123) examined methods to reduce conflicts between pedestrians and cyclists on shared use facilities. They also developed best practice engineering, traffic management and urban design measures and education and awareness strategies to minimize conflict and to improve both perceived and actual safety on shared paths and footpaths. Through a literature review and consultation with key stakeholders through surveys and workshops, the team identified key issues associated with pedestrian/cyclist interactions and conflicts, and reviewed current practice in Australia and overseas.

Product Delivery and Technology Transfer

National Guides

The *AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities, 1st Edition* by AASHTO (1) presents effective measures for accommodating pedestrians on public rights-of-way. The guide recognizes the profound effect that land use planning and site design have on pedestrian mobility and addresses these topics as well.

In “Pedestrian Road Safety Audit Guidelines and Prompt Lists,” Nabors, Gibbs, et al. (132) developed pedestrian road safety audit (RSA) guidelines and prompt lists for FHWA to provide guidance on how to conduct an RSA with a better understanding of the needs of pedestrians of

all abilities. The Knowledge Base discusses basic concepts, and The Field Manual presents guidelines and prompt lists. The prompt lists are designed to aid communities in comprehensively and systematically identifying pedestrian safety concerns.

Harkey and Zegeer (72) developed PEDSAFE, an expert system used to provide practitioners with information to improve the safety and mobility of those who walk in the report “PEDSAFE: The Pedestrian Safety Guide and Countermeasure Selection System.” Online tools provide the user with a list of possible engineering, education, or enforcement treatments to improve pedestrian safety and/or mobility based on user input about a specific location.

In the “Toolbox of Countermeasures and Their Potential Effectiveness for Pedestrian Crashes,” the Federal Highway Administration (46) evaluates the crash reduction effectiveness of different pedestrian safety countermeasures in three major categories: Signalization (e.g., countdown signals, exclusive pedestrian phasing), Geometric (e.g., roundabouts, refuge islands), and Signs/Markings/Operational (e.g., lighting, enforcement). These estimates, otherwise known as crash reduction factors, describe the ability of a particular treatment to reduce crashes involving pedestrians. Using these CRFs, engineers and other officials will not only know the anticipated crash reduction for a particular treatment, but will be able to select the appropriate countermeasure for a particular problem or circumstance.

Zegeer, Stutts, and Huang (216) developed NCHRP Report 500 “Guidance for Implementation of the AASHTO Strategic Highway Safety Plan. Volume 10: A Guide for Reducing Collisions Involving Pedestrians” to provide strategies that can be employed to reduce the number of collisions involving pedestrians. This goal can be achieved through the widespread application of low-cost, proven countermeasures that reduce the number of crashes on the nation's highways.

Antonucci et al. (4) present this collection of strategies that can be implemented to solve pedestrian safety problems at signalized intersections. The findings, published under the title “A Guide for Addressing Crashes at Signalized Intersections,” reflect the current best practices in addressing these types of crashes, and will provide practitioners with the knowledge necessary for selecting and implementing treatments to properly address their local needs.

A Resident's Guide for Creating Safe and Walkable Communities by Sandt et al. (164) is a guide to help advocates, planners, health professionals, parents, and other community members promote pedestrian safety and walkability. Using current research, resources, and real life examples, the guide presents pedestrian safety knowledge to community members and outlines steps that can be taken to engage local officials on the issues. The guide includes information on identifying problems, taking action to address pedestrian concerns, finding solutions to improve pedestrian safety, and resources to get additional information.

Nabors et al. (133) have developed *The Pedestrian Safety Guide for Transit Agencies* intended to provide transit agency staff with an easy-to-use resource for improving pedestrian safety. The guide provides a comprehensive look at pedestrian safety issues that are influenced by transit operation. Some subjects highlighted in the guide include accessibility for those with disabilities, transit station design, and crosswalk placement. The guide also covers examples of countermeasures that have been successful in addressing pedestrian safety problems around

transit stops and lines. Program recommendations, such as education or enforcement campaigns, are included as well.

“How to Develop a Pedestrian Safety Action Plan” by Zegeer & Sandt (218) was developed to assist local officials with understanding pedestrian safety and what is needed to strategically address local safety issues. It is also intended to assist agencies in further enhancing their existing pedestrian safety programs and activities, including identifying safety problems, analyzing information, and selecting optimal solutions. The guide also contains information on how to involve stakeholders, potential sources of funding for implementing projects and how to evaluate projects. The guide is primarily a reference for improving pedestrian safety through street redesign and the use of engineering countermeasures, as well as other safety-related treatments and programs that involve the whole community. This guide can be used by engineers, planners, traffic safety and enforcement professionals, public health and injury prevention professionals, and decision-makers who have the responsibility of improving pedestrian safety at the state or local level.

The Manual on Uniform Traffic Control Devices for Streets and Highways by the National Committee on Uniform Traffic Control Devices (139) defines the standards used by road managers nationwide to install and maintain traffic control devices on all streets and highways. The MUTCD is published by the Federal Highway Administration. The MUTCD audience includes the insurance industry, law enforcement agencies, academic institutions, private industry, and construction and engineering professionals.

The Traffic Control Devices Handbook (TCDH) was prepared by the Institute of Transportation Engineers (ITE) (87) to augment the MUTCD as adopted nationally by the Federal Highway Administration. While the MUTCD outlines the design and application of traffic control devices on public roadways in the United States, criteria and data to make decisions on the use of a device and its application are not always fully covered in the MUTCD. This Handbook bridges the gap between the MUTCD provisions and those decisions to be made in the field on device usage and application.

The Design and Safety of Pedestrian Facilities: A Recommended Practice of the Institute of Traffic Engineers, another publication by ITE (86), is intended to provide guidance on the design of various pedestrian facilities. The guidelines are presented in detail for program managers, engineers, and agencies, and are combined with suggestions for proper installation and location where installation would be most effective.

This handbook by Staplin et al. (178) entitled *The Highway Design Handbook for Older Drivers and Pedestrians* provides recommendations that upon implementation may remedy deficient designs that disproportionately penalize older road users due to changes in functional ability experienced with normal aging. These may be most urgently needed where a crash problem with older drivers or pedestrians has already been demonstrated; however, the greater benefit arguably lies in designing safer new roads and identifying and modifying problems with existing roads before statistics reveal a crash problem. The engineering enhancements described in this document should benefit all road users, not just older persons.

State/Local Guides

Alta Planning & Design (3) developed a technical reference that provides the staff of the California Department of Transportation (Caltrans) with a synthesis of information on non-motorized transportation. This document is termed *Pedestrian and Bicycle Facilities in California: A Technical Reference and Technology Transfer Synthesis for Caltrans Planners and Engineers*. It is intended that this technology transfer will assist Caltrans in accommodating pedestrians and bicyclists on the state highway system throughout California, serving as a resource on policies, laws, programs, the Caltrans planning and design process, guidelines, and best practices.

The City of Stockton, CA (25) created guidelines in order to address safety concerns, improve pedestrian safety, and enhance pedestrian circulation on neighborhood streets. This document, entitled “Pedestrian Safety and Crosswalk Installation Guidelines,” describes best practices on engineering elements, such as pedestrian crossing treatments and intersection design to be incorporated into the City’s Neighborhood Traffic Management Program (NTMP) and Street Design Standards. These best practices are presented via a comprehensive pedestrian safety strategy of engineering, enforcement, and education programs.

The Louisville Metro Complete Streets Manual, drafted by the City of Louisville (24) is a comprehensive design and planning document that is focused on providing accommodation for all road users in all new and reconstructed roadways using a context sensitive approach.

The Sacramento Transportation and Air Quality Collaborative (161) prepared a guide, entitled *Best Practices for Complete Streets*, to provide suggested street standards for use when designing new streets and developments and when planning for future transit corridors. Suggestions are provided for traffic calming features that can be built into street designs. Although its focus is on urban and suburban streets, the guidelines may be helpful in determining rights-of-way that should be preserved for successful transition to urban standards.

Training Courses and Workshops

The Pedestrian and Bicycle Information Center (PBIC) offers courses and workshops on pedestrian safety for a variety of audiences with funding from the Federal Highway Administration and the National Highway Traffic Safety Administration. One two-day designing for pedestrian safety course is intended for engineers and other technical professionals and gives an overview of common pedestrian problems and potential countermeasures. For a broader audience of planners, law enforcement officials, engineers, and decision makers, the two-day planning for pedestrian safety course offers a more general approach to the issue of pedestrian safety. A three day option is also available, which blends components of the two main courses. Finally, the Creating Livable Communities course addresses the needs of citizens, advocates, public health professionals, and others who want to make pedestrian safety a priority in their communities. All of the course descriptions, instructor information, and scheduling information can be found at <http://www.walkinginfo.org/training/pbic/index.cfm>.

In “Developing and Implementing a Pedestrian Safety Action Plan. Progress Report: September

2004 – December 2007,” Sandt, Gelinne, & Zegeer (163) present a progress report on the pedestrian safety training courses based on the guide *How to Develop a Pedestrian Safety Action Plan*. Courses based on that guide have been taught across the country to local engineers, planners, law enforcement officials, and other decision makers to educate them on pedestrian safety needs and strategies for increasing safety. A background is given on course development, and the Authors present information from course participants and evaluation forms. The courses received overwhelmingly positive reviews, and recommendations are made for increasing the number and availability of courses.

Turner et al. (189) developed a curriculum on pedestrian and bicycle transportation for a graduate level course to be taught to planners and engineers in universities across the US. Their course materials are published as *FHWA University Course on Bicycle and Pedestrian Transportation*. The 24 lessons included in the curriculum cover a broad range of topics, from an introduction to bicycle and pedestrian issues to the planning and designing of facilities and the development of successful bicycle and pedestrian programs. The lessons are intended to provide students with a knowledge of the role of bicyclists and pedestrians within a transportation system and an understanding of policy, planning, and engineering practices as they relate to bicycling and walking.

The National Highway Institute (NHI) offers a Pedestrian Facility Design Course, intended to provide information and application opportunities for those involved in the design of pedestrian facilities. The course focuses on both corridor issues and intersection design issues, leading participants through a series of lectures, discussions, and video demonstrations. The course is intended for engineers, planners, program specialists, architects, and other decision makers.
<http://www.nhi.fhwa.dot.gov/>

The Association of Pedestrian and Bicycle Professionals (APBP) offers a course on Designing Pedestrian Facilities for Accessibility. Based on the Public Rights-of-Way Accessibility Guidelines (PROWAG) and Americans with Disabilities Act guidelines, the course covers all topics related to accessibility and planning or designing for all pedestrian populations. Topics include legal policies, sidewalk design, crossings, intersections, curb ramps, construction, maintenance, pedestrian signals, and temporary traffic control.
http://www.apbp.org/?Access_Course

Webinars

The Pedestrian and Bicycle Information Center (PBIC) offers bi-monthly webinars on various topics concerning pedestrian and bicycle safety and encouraging safe walking and bicycling. The webinars are intended for a diverse audience, from planners and engineers to advocates and public health professionals. Past webinar topics include “Fundamentals for Connecting Transit and Pedestrian and Bicycle Facilities.” Upcoming webinars focus on advocacy strategies for communities who want to make pedestrian and bicycle safety a local priority. Past webinar presentations are archived at the PBIC Web site:

<http://www.walkinginfo.org/training/pbic/webinars.cfm>.

The Institute of Transportation Engineers (ITE) offers a wide selection of webinars on various topics related to pedestrian safety. These webinars, intended for transportation professionals interested in staying current with their knowledge of pedestrian safety issues, are typically offered as a set of modules covering a particular topic. In addition to courses covering best practices and current research, the ITE webinar series also offers refresher courses for Professional Traffic Operations Engineers (PTOE) and other professionals. More information can be found at <http://www.ite.org/education/webinars.asp>.

The Association of Pedestrian and Bicycle Professionals (APBP) offers a monthly webinar in their professional development webinar series. These webinars are intended for a variety of professionals, covering technical (MUTCD: Bicycle and Pedestrian Signs, Markings and Experiments), political (Building Political Will for Strong Bike/Walk Programs: Effective Use of the "Three-Legged Stool" model in Columbia, Mo.) and health-related topics (Connecting with Public Health Professionals on Bike/Ped Issues). More information can be found at <http://www.apbp.org/?page=Webinars>.

The Federal Highway Administration Safety Office hosts quarterly webconferences for its pedestrian safety focus states (states with pedestrian fatalities above 150 or a fatality rate above 2.5) and cities (cities with the highest number of pedestrian fatalities). The webinars (which are now open to the people outside of the focus state and cities as well) help the participants share information; help resolve problems participants are facing; assist participants in working toward common goals; and provide information on new tools, research, countermeasures, and technologies available to help solve the pedestrian safety problem.

Conferences

The National Complete Streets Coalition (2006) conducted a Peer Workshop at the 2006 RailVolution Conference. The results are presented in html format, and summarize a workshop roundtable discussion on incorporating transit into complete streets policies and procedures. Experts from around the country each gave a mini-presentation on their work and issues relating to developing complete streets standards. It contains links to complete streets design guidelines developed by several cities.

The Pro Walk/Pro Bike Conference is a biennial event hosted by the National Center for Bicycling and Walking (NCBW), aimed at bicycle and pedestrian program specialists, advocates,

and government leaders who want to make bicycling and walking a priority. Also present at the conference are engineers, planners, agency staff, and advocates. The next conference will be held in Chattanooga, Tennessee, in the Fall of 2010.

The Walk 21 Conference is an international gathering of advocates, researchers, and specialists in the field of pedestrian safety and mobility. The conference sessions allow these professionals from around the globe an opportunity to share information, present research findings, and learn valuable information on the latest in best practices for pedestrian safety and walkability. More information can be found at <http://www.walk21.com/>.

The Transportation Research Board (TRB) Annual Meeting is considered the premiere transportation conference for researchers in the US. Held each year in Washington, D.C., the conference draws significant numbers of researchers and practitioners from around the country. Within the TRB, the Pedestrian Committee uses this opportunity to meet and discuss business items, such as prioritizing research needs and developing research needs statements.

Newsletters

The “Pedestrian Forum Newsletter”, published by the Federal Highway Administration (42) is a quarterly newsletter that presents an overview of FHWA’s Office of Safety activities related to its goal of improving pedestrian safety. The newsletter highlights research and tools developed by FHWA, NHTSA, and other groups involving the 4 E’s: Engineering, Enforcement, Education, and Emergency Services. The newsletter also gives updates on revisions to existing guides and announcements of upcoming guide, toolbox, and software deployment.

The PBIC Messenger is the quarterly newsletter distributed by the Pedestrian and Bicycle Information Center. Included in the newsletter are important updates on current research, tools, and best practices in pedestrian and bicycle safety, as well as a guide to upcoming events, trainings, and webinars. More information can be found at <http://www.walkinginfo.org/newsroom/newsletter/signup.cfm>

The Bike/Ped Professional is the newsletter of the Association of Pedestrian and Bicycle Professionals (APBP). The newsletter updates APBP members on current activities around the country, including important projects and research. There are also a number of resources aimed specifically at professional development in multiple fields. More information can be found at <http://www.apbp.org/>.

The “Centerlines Newsletter,” a free publication by the National Center for Bicycling and Walking (138), is an online text publication that is published on a bi-weekly basis. Its primary goal is to disseminate news and new strategies for creating walking- and bicycle-friendly communities to interested individuals. With a subscription base of almost 4000 persons, including advocates, bicycle and pedestrian professionals, and others, Centerlines is a useful resource for keeping up with developments in the ped/bike community.

Software

Harkey, Tsai, et al. (73) developed the “Pedestrian and Bicycle Crash Analysis Tool (PBCAT) (Version 2.11) [Software],” a crash typing software product intended to assist state and local pedestrian/bicycle coordinators, planners and engineers with improving walking and bicycling safety through the development and analysis of a database containing details associated with crashes between motor vehicles and pedestrians or bicyclists.

Web sites

The Safe Routes to School Guide, a resource of the US Department of Transportation (204), was developed as a comprehensive guide to be used by anyone interested in Safe Routes to School (SRTS). Specifically, schools and communities who would like to start a program will find background information, an overview of programs, and case studies that highlight engineering, enforcement, encouragement, education, and evaluation programs. The guide also contains case studies that provide success stories from existing programs.

“The Pedestrian Safety Campaign” consists of a set of outreach materials that can be customized by States and communities for their own pedestrian safety activities. As a Federal Highway Administration (51) resource intended for practitioners and advocates in need of materials to enhance their safety campaigns, the Web site offers downloadable materials such as public service announcements (PSAs), posters, press releases, and brochures.

The National Center for Safe Routes to School is a national clearinghouse that was set up by the US DOT to provide tools and resources for communities that are interested in increasing bicycling, walking, and safety in their neighborhoods. The Center provides knowledge and technical information to enhance Safe Routes to School programs around the country. More information can be found at <http://www.saferoutesinfo.org/>

The Pedestrian and Bicycle Information Center is the national clearinghouse for pedestrian and bicycle research, resources, and tools in the US. Established and funded by the US DOT, the PBIC manages two Web sites (www.walkinginfo.org, www.bicyclinginfo.org) devoted to collecting and disseminating important information related to walking and bicycling. Additionally, the Center hosts an image library (www.pedbikeimages.org), and offers other services such as training and technical assistance.

The Association of Pedestrian and Bicycle Professionals (APBP) is a professional development organization intended to serve individuals who work in the areas of safety, promotion, education, enforcement, health, and planning, as those fields relate to bicycling and walking. APBP offers many services, including a comprehensive collection of tools and resources and professional development seminars and trainings related to bicycling and walking. More information can be found at <http://www.apbp.org/>.

The Federal Highway Administration (FHWA) includes two offices relating to pedestrian and bicycle issues, one relating to the promotion of pedestrian and bicycle transportation and the other relating to issues surrounding pedestrian and bicycle safety. The FHWA Bicycle and Pedestrian Program (2009a) guides and oversees the implementation of pedestrian and bicycle legislation and ensures that states are in compliance with the legislation. Information about federal funding, funding sources, legislation, and accessible design can be found at <http://www.fhwa.dot.gov/environment/bikeped/index.htm>. The FHWA Office of Safety’s Pedestrian and Bicycle Program (2009b) develops a variety of materials, programs, and projects for use in preventing and reducing pedestrian and bicycle fatalities. More information can be found at http://safety.fhwa.dot.gov/ped_bike/.

Selected International Research and Reports

Muhlrad (130) presents a history and overview of pedestrian safety policies in Western Europe in his report entitled “A Short History of Pedestrian Safety Policies in Western Europe.” Focus is given to the gradually changing image of the pedestrian in the eyes of Western European communities, from an obstacle to a means of transportation.

Jensen (92) explores the history of walking and cycling among children in Denmark, and shows that the safety of children on the road has been improved by seat belt use and local measures. The study, termed “How to Obtain a Healthy Journey to School,” goes on to show the role that safe routes to school projects have played in establishing safety in jurisdictions through signalization and speed reduction measures. Additionally, Jensen shows that almost half of Denmark’s children live less than 1.5 km from their schools, which also influences mode choice and walking levels.

In “Safety and Accessibility Effects of Code Modifications and Traffic Calming of an Arterial Road,” Leden, Wikstrom, et al (107) analyzed the combined effect on driver behavior of changes to a roadway and changes to traffic laws in Sweden. In 1999 and 2000, pedestrian walkways, traffic islands, chicanes, a roundabout, and a two-directional cycle track were added along a major road in a busy community center. The purpose of the reconstruction was to improve safety for pedestrians and bicyclists, primarily for children, the elderly and the disabled, and to reduce the barrier effect of a busy thoroughfare. In May 2000, traffic laws governing the conduct of drivers at marked crosswalks in Sweden became stricter to improve safety and mobility for pedestrians. Traffic behavior was studied at the intersection where the roundabout was constructed. Yield behavior towards pedestrians and child bicyclists changed significantly even though the code change only related to pedestrians. Measures of speed, behavioral studies, questionnaires, face-to-face interviews, and crash data analysis suggest that safety has increased not only along the major roadway but also along adjacent roads.

Under a commission by the Land Transport Safety Authority, Macbeth, Boulter, and Ryan (118) reviewed research on New Zealand and international existing walking and/or cycling strategies, surveyed transportation professionals in local and regional councils, and described best practice from the perspectives of those involved. Their research was presented as “New Zealand Walking and Cycling Strategies – Best Practice.” Examples of best-practice content from existing strategies are used liberally in the research report to help illustrate the research findings.