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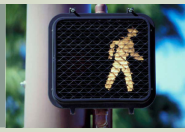

Report #6 in the Series:
Moving Communities Forward

Traffic Safety Methodologies

THE AMERICAN INSTITUTE
OF ARCHITECTS

CENTER FOR
TRANSPORTATION STUDIES
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Report #6 in the Series:
Moving Communities Forward

Final Report

Prepared by:

Gary Davis

Department of Civil Engineering
University of Minnesota

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200 Transportation and Safety Building
511 Washington Ave. SE
Minneapolis, MN 55455

Preface

Well-designed transportation projects demonstrate the potential to shape a community in ways that go far beyond the project's original purposes. Anecdotal evidence and advocacy exist on behalf of the benefits of well-designed transportation projects on communities, yet there is little organized quantifiable or qualitative data, nor is there a comprehensive guide for communities to maximize or integrate the diverse benefits that well-designed transportation projects can bring.

Recognizing this lack of data about the role of design in transportation, Congress authorized a study in Section 1925 of the 2005 Safe, Accountable, Flexible, Efficient, Transportation Equity Act: A Legacy for Users (SAFETEA-LU) to achieve two goals: (1) begin to measure how well-designed transportation projects can bring multiple enhancements to communities in terms of economic development, health and the environment, visual identity and design, public participation, and public safety; and (2) provide communities, designers, transportation officials, and policymakers a set of principles and practices to adapt to their unique situations and needs.

The *Moving Communities Forward* research team employed a case study-based approach, analyzing nearly 30 transportation projects that represent a broad spectrum of regions, demographics, and project types. The research team identified key principles and practices that designers and others can use—in the context of their unique situation and environment—to realize multiple enhancements to their communities.

Funding for the study was derived from a grant to the American Institute of Architects (AIA) from the Federal Highway Administration (FHWA), authorized by Congress in SAFETEA-LU. In 2006, the AIA selected the Center for Transportation Studies (CTS) at the University of Minnesota to conduct the pioneering research study.

To address the interdisciplinary issues raised by the study, CTS assembled a research team drawn from multiple fields. Research was allocated to five research projects; a sixth project synthesized the study's key findings into a single document highlighting major themes and recommendations:

1. Promoting Economic Development
2. Improving Health and the Environment
3. Designing Great Places
4. Fostering Civic Participation
5. Making Communities Safer
6. Study Synthesis

Results of this research are available in a series of reports on the *Moving Communities Forward* Web site: www.movingcommunitiesforward.org. The site also includes a summary report submitted by the FHWA to Congress in September 2007. The Web site is part of a coordinated outreach effort designed to share the research findings and recommended practices with transportation and design professionals, policymakers, and the public.

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Report Design
PAM DEL CANTO
GRETCHEN MAXWELL

CENTER FOR TRANSPORTATION STUDIES UNIVERSITY OF MINNESOTA

ROBERT JOHNS
Director, Center for Transportation Studies

LANCE M. NECKAR
Professor, Landscape Architecture, CTS Faculty Scholar/Fellow, University Institute on the Environment

Research Team

Economic
JOHN S. ADAMS (Principal Investigator)
Professor, Geography/CTS Faculty Scholar/Co-Director, University Metropolitan Consortium

BARBARA J. VANDRASEK, Research Associate, Geography/CTS Scholar

Health and the Environment
JOHN CARMODY (Principal Investigator)
Director, Center For Sustainable Building Research

VIRAJITA SINGH, Senior Research Fellow, Center For Sustainable Building Research

CHRIS PETIT, Research Assistant, Center for Sustainable Building Research

Visual Design
ANN FORSYTH (Principal Investigator)
Professor, Architecture/Director, Metropolitan Design Center/CTS Faculty Scholar

JUSTIN JACOBSON, Research Assistant
KATIE THERING, Research Fellow, Metropolitan Design Center

Public Participation
CARISSA SCHIVELY (Principal Investigator)
Assistant Professor, Urban And Regional Planning, Humphrey Institute Of Public Affairs/CTS Faculty Scholar

MEAGAN BEEKMAN, Research Assistant

CYNTHIA CARLSON, Research Assistant

JENN REED, Research Assistant

Public Safety
GARY A. DAVIS (Principal Investigator)
Professor, Civil Engineering/CTS Faculty Scholar

Staff
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ABOUT THE AMERICAN INSTITUTE OF ARCHITECTS

The American Institute of Architects (www.aia.org) is the voice of the architectural profession and the resource for its members in service to society. As AIA members, more than 80,000 licensed architects in over 300 state and local chapters express their commitment to excellence in design and livability in our nation's buildings and communities. Members adhere to a code of ethics and professional conduct that assures the client, the public, and colleagues of an AIA-member architect's dedication to the highest standards in professional practice.

ABOUT THE CENTER FOR TRANSPORTATION STUDIES

The Center for Transportation Studies' (www.cts.umn.edu) mission is to serve as a catalyst for transportation innovation through research, education, and outreach. CTS works with University of Minnesota faculty in over 25 disciplines to advance knowledge in a variety of transportation-related research areas. In 1997, CTS first became involved with transportation and urban design issues in its leadership of a major interdisciplinary effort, the Transportation and Regional Growth Study, which produced new understandings of the relationship between transportation and growth in the Twin Cities area. CTS has also worked closely with the Minnesota Department of Transportation and local governments in advancing Context Sensitive Design/Solutions practices through the development of training courses and web resources, which have helped Minnesota to be recognized by FHWA and AASHTO as a leading state in applying Context Sensitive Design/Solutions.

Contents

Overview:

Quantitative Safety Prediction in Context-Sensitive Design

The main objective of this section is to review how, and to what extent, safety issues are treated in context-sensitive design activities. The ideal to which we will refer is that safety issues should be an explicit and quantitative component of design decision making. This means that ideally, numerical predictions of the safety effects of different design alternatives should be part of how those alternatives are evaluated. Because a review of safety in all its aspects is beyond the scope of this project, we will focus on pedestrian safety and its relation to traffic-calming design elements.

Safety is cited as a dominant concern in roadway design but, as Hauer (1988) has pointed out, a federal commission charged with evaluating the safety impacts of proposed highway rehabilitation initiatives found the existing knowledge base inadequate to the task. This concern and the knowledge gap have led to a major effort on the part of the Federal Highway Administration, the Association of American State Highway and Transportation Officials, and the Transportation Research Board to produce the first edition of a *Highway Safety Manual* (HSM). This document, similar in spirit to the *Highway Capacity Manual*, is aimed at providing transportation engineers with tools for explicitly predicted the changes in crash frequency expected from different roadway design components.

Key Findings

Although quantitative safety prediction can be done for certain design elements, such as installation of a traffic signal at an intersection or removal of roadside obstacles, science-based prediction for the type and scope of design activities characterizing context-sensitive designs is much more difficult. This is especially true for predictions related to pedestrian safety, and produces a gap between the design ideal described above and design as it is practiced. It is recommended that measurement of safety effects be included as part of context-sensitive design projects, to expand the knowledge base on which a future prediction capability can be built.

Research Approach and Measures

The basic method employed by the HSM is to first generate an initial prediction of what the crash frequency would be in the absence of the design feature under consideration, and then apply an empirically-determined crash reduction factor (CRF) to the predicted crash frequency, to predict the change in crash frequency due to the design modification. The initial prediction could be based on historical crash experience of an existing roadway, or it could be computed using a regression-type model fit to data from similar roadways. The CRF should ideally have been computed from one or more well-designed before-after studies.

The HSM methods clearly rely heavily on historical crash experience. For those design features for which an adequate database exists or can be assembled, the HSM methods should, at least after iteration, lead to useable and empirically defensible evaluation tools. For example, several well-conducted studies have estimated crash modification effects, for vehicle crashes, of installing traffic signals at intersections, in part because crash frequencies at intersections tend to be high enough that reliable estimates can be made with reasonably-sized data sets. For crash types that tend to be infrequent or spatially diffuse, the HSM method encounters limits. These limits are perhaps most apparent when attempting to assess the costs and benefits of roadside improvements, because road-departure crashes tend to be locally infrequent. For example, on one-mile segments of two-lane rural highway, the frequency of road-departure crashes over say, three years, tends to equal zero for the majority of segments, tends to equal one for a few, and equal more than one for a very small number.

The most sophisticated tool for this task is the Roadside Safety Analysis Program (RSAP), developed by the Texas Transportation Institute for the Federal Highway Administration. In RSAP, the frequency and trajectories of road departures on a highway section are predicted using departure rates and distributions over trajectories taken from earlier studies. The expected frequency of collisions between vehicles and roadside obstacles on the section under design is then computed, and this expected frequency is used to assess the value of different changes in the section’s roadside. The data needed to apply the RSAP method consist primarily of traffic volumes and distribution of speeds on the road section under consideration, along with physical specifications of the section’s roadside. Crash data are not needed.

When we turn to vehicle/pedestrian crashes and their relation to traffic-calming actions, it would seem that, at least in principle, both the HSM statistical modeling approach and the RSAP simulation modeling approach ought to be applicable. A major limitation, however, is that both the HSM and RSAP approaches require measures of exposure in the form of measured or predicted traffic volumes. Vehicle traffic volume estimates for many roads are routinely made by state and local transportation agencies, and ad hoc traffic counts can be readily obtained using automatic, portable counters, so this requirement has not limited the application of these methods to vehicle crashes. At present though, few, and perhaps no, agencies routinely monitor pedestrian volumes. Although progress is being made in extracting pedestrian data from video images, a technology for automatic, portable pedestrian counters is still in the future.

In the absence of pedestrian exposure data, more limited analyses are possible. An RSAP-type simulation approach to ranking residential streets as to their potential traffic hazard to pedestrians has been described in Davis, Sanderson and Davuluri (2002). Here, a design vehicle/pedestrian encounter involving a child pedestrian running into the street without looking at traffic was specified, and the probability of such an encounter resulting in a collision was computed using speed and headway data collected on the streets. The streets could then be ranked according to these collision probabilities, and the probabilities of collisions leading to serious or fatal injuries. In essence, then, this approach estimated the probability of a collision, given that the design pedestrian entered the street, but did not estimate the frequency with which such street entries occurred.

An interesting alternative simulation approach was employed by the Road Accident Research Unit, at the University of Adelaide, to assess the effect of speed limit policies on fatal collisions between vehicles and pedestrians (McLean et al. 1994). In this study, fatal pedestrian collisions were investigated in detail and then reconstructed in order to estimate features such as the vehicle's initial speed and location prior to the collision. Simulation was then used to estimate how the vehicle's speed at collision would have changed had it been traveling at a different speed, and then how the probability of a fatal outcome would also have changed. This then allowed the research team to estimate the number of actual fatal collisions that would not have occurred, other things being equal, had vehicle speeds been governed by alternative speed limit policies. An extension of this approach is also described in Davis et al. (2002).

Cases

Bridgeport Way, University Place, WA

This project involved reconstruction of approximately 1.5 miles of Bridgeport Way, a four-lane arterial in western Pierce County, in the state of Washington. Photographs taken before the reconstruction indicate that Bridgeport Way consisted mainly of two lanes for traffic for each direction, separated in the middle by a two-way left-turn lane. Pedestrians unable or unwilling to travel to the rather widely separated intersections were thus required to cross five traffic lanes. After reconstruction the directional lanes were separated by a landscaped median, which pedestrians could use as a refuge, and several mid-block crossing points for pedestrians were provided. The pedestrian crossings initially contained in-pavement warning lights for drivers, but evidence of the warning lights' ineffectiveness led to their being replaced by pedestrian signals. Although the major pedestrian-oriented design elements—separated medians and designated pedestrian crossings—are not traditionally considered traffic-calming measures, improved pedestrian safety was identified as one of the reasons for the reconstruction.

As indicated above, applying both the HSM and RSAP evaluation methods would require measures of pedestrian exposure, in this case, at a minimum, crossing frequencies both mid-block and at intersections. Since discussion and design of the project began several years before actual construction, there was ample opportunity to collect such data before construction. Applying the HSM method requires a statistical model for projecting the pedestrian crash frequency under a do-nothing option. Developing this model would require pedestrian exposure and crash data, along with vehicle volume and other information, for a reference group of similar roadways. Since pedestrian exposures are not routinely collected, this would most likely require data collection visits to each of the reference group sites. Since pre-existing estimates of crash reduction factors for the Bridgeport Way design modifications are not available, Bridgeport Way could have provided an opportunity to compute such estimates. If instead an RSAP type of simulation approach were used, pedestrian exposure data would be needed only for Bridgeport Way, but the simulation model would require specifying the mechanism(s) describing vehicle/pedestrian collisions. These could be identified through detailed investigation and reconstruction of actual collisions during the “before” data collection process. If investigations/reconstructions of pedestrian collisions occurring earlier were available, these would be helpful.

Arguably, of the three cases considered here, this one is the closest to being amenable to a prediction of its pedestrian safety impacts. However, limitations in the existing data sources and knowledge base would probably preclude an off-the-shelf application of either an HSM or an RSAP type of approach. Considerable ad hoc data collection and model development would be required. If properly conducted, however, this exercise could provide an important addition to the state of knowledge.

Virginia Route 50

This case involved reconstruction of approximately 24 miles of primarily two-lane state highway. An initial Virginia DOT plan called for expanding the highway to four lanes and by-passing two of the towns through which the highway currently runs. A volunteer citizens group countered with a proposal to keep the highway at two-lanes, but to use traffic-calming measures to reduce vehicle speeds and address safety concerns while maintaining a desired rural character and tourist-friendly environment. After obtaining federal support, a decision was made to follow the citizens group’s recommendations.

A high frequency of vehicle/pedestrian collisions does not seem to have been a major concern in this case. (The primary safety concern appears to have involved vehicle collisions; it was also feared that redesigning the highway for higher speeds and traffic volumes would make the area less friendly to pedestrians and bicyclists and so harm the area’s tourism economy.) Predicting the effects on pedestrian collision frequency of the traffic-calming measures would be more difficult than for Bridgeport Way, due to the larger scope of this project and to the more diverse nature of pedestrian use. It follows then that off-the-shelf applications of existing safety assessment tools are probably precluded. An initial assessment would have to address, at a minimum (1) effects on pedestrians currently in the villages along the route, (2) pedestrians (and bicyclists) on the route’s connecting stretches, and (3) changes in pedestrian (and bicyclist) volume in response to the redesign. As with Bridgeport Way, a not-inconsiderable amount of ad hoc data collection and model development would be required. Issues (1) and (2) are within the scope of crash prediction methods, but addressing issue (3) would require demand modeling as well.

West Palm Beach, FL

The case involved a major redesign of a downtown area, accomplished in several projects, carried out over approximately 10 years. Because of the scope and uniqueness of this effort, especially its focus on radically altering the automobile/pedestrian mix in the downtown area, quantitative predictions of its effect on pedestrian crashes is beyond the capability of existing tools. As with the other two cases, appropriately designed studies of components of the West Palm effort, such as application of traffic-calming to a particular neighborhood, with adequate ad hoc data collection and model development, could add substantially to the current state of knowledge. But as with the other two cases, the opportunities are more amenable to research and knowledge building for the next generation of design tools.

Practices: Design Toolkit

For the long term, because genuine experimental research is rarely possible in road safety, advances in our ability to accurately predict the safety effects of design alternatives will have to come from observational studies of the effects of actual projects. That is, each project should be treated as a research opportunity. Although it is not yet possible to provide a recipe for how such research should be carried out, it is safe to say that having someone skilled in observational research involved in the design process should increase the likelihood of usable findings. In the shorter term, for projects where reliable quantitative safety prediction is not yet feasible, one alternative would be to include safety audits as part of the design process. In a safety audit, a team of reviewers, selected for expertise in important safety aspects, reviews a project's plans, highlights possible safety issues, and may make suggestions concerning mitigation. Interestingly, it can be argued that some of the participation activities characteristic of context-sensitive design inject a safety audit-like dynamic into the design process. In the absence of a formal safety audit, by explicitly including as participants experts who would normally be part of a safety audit team, it may be possible to realize at least some of the benefits of a more formal audit.

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