



CENTER FOR TRANSPORTATION STUDIES



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ABSTRACTS



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What's Behind the Increase in Motorcycle Fatalities?

Enoch You
Student Intern

Leslie Seymour, MD, MPH
651-201-5489
leslie.seymour@state.mn.us

Jon Roesler, MS
651-201-5487
jon.roesler@state.mn.us

Mark Kinde, MPH
651-201-5447
mark.kinde@state.mn.us

Minnesota Department of Health
Center for Health Promotion
85 E 7th Place, P.O. Box 64882
Saint Paul, MN 55164-0882

Objective

In order to develop effective prevention strategies, it is important to understand why motorcycle fatalities have increased.

Background

Nationally, from 1997 to 2008 there was a steady increase in motorcycle fatalities with the 2008 total of 5,290 being the highest ever recorded.¹ This trend was accompanied by an actual reduction in the number of motorcycle crashes. This would suggest an increase in severity of the crashes.

Minnesota's experience is similar to that of the U.S.; from a low of 23 deaths in 1997, the number of fatalities trended upwards, peaking at 71 deaths in 2008, with a subsequent decline. From 1980 through 1999 the fatal crash rate has exceeded 3 deaths per 100 crashes in only 3 years. Since 2000 the fatal crash rate has been 3.0 or higher in every year, with four years having rates of 4.0 or greater. Again, this would suggest an increase in the severity of the crashes.

Methodology

Using CODES data, which links hospital and death certificate data with crash records, we examine the severity of injury in motorcycle crashes and identify any associated factors, such as type of motorcycle, engine size, age of driver and whether or not the driver participated in motorcycle driver's education class.

Using logistic regression, we look at and describe the factors contributing to motorcycle crash mortality in Minnesota. Based on the presented data, we suggest potential prevention strategies.

¹ Hedlund, James. Motorcyclist Traffic Fatalities: 2009 Preliminary Data. Spotlight on Highway Safety Prepared for Governors Highway Safety Association

Behavioral Substrates of Traffic Safety Stop and Work Zone Crashes: A Human Factors Analysis

Thomas J. Smith
School of Kinesiology, University of Minnesota
625 Hampshire Drive
Mendota Heights, MN 55120
Phone: 651-688-7444
Fax: 612-626-7700
smith293@umn.edu

Michael G. Wade
School of Kinesiology, University of Minnesota
220 Cooke Hall, 1900 University Ave. SE
Minneapolis, MN 55455
Phone: 612-626-2094
Fax: 612-626-7700
mwade@umn.edu

Introduction and Objective

Motor vehicle crashes in work zones, or with patrol or assist vehicles engaged in traffic safety stops, are distinctive and significant for at least two reasons. First, the targets/victims of such crashes typically are providing a public service, either for purposes of law enforcement or roadway assistance, or as workers contracted to a state or a municipality for purposes of roadway maintenance, upkeep and/or construction. Second, these employees typically cannot effectively insulate themselves from such crashes. That is, they usually are on foot, in close proximity to moving traffic, yet because of their job responsibilities they cannot pay close attention to the continuously and dynamically changing status of nearby traffic.

There is no consensus agreement among the traffic community as to why work zone and traffic stop crashes occur. Both environmental and enforcement design factors, and/or behavioral factors, typically are invoked. For example, a recent analysis by Ashton (2011) calls attention to a series of environmental and enforcement design factors that may contribute to traffic safety stop (TSS) crashes, including roadway design, existence and width of shoulders and lanes, exceptions to design standards, enforcement platforms, collision reporting and pullout investigation sites, median barriers, officer visibility, and vehicle conspicuity. A commonly invoked behavioral culprit is driver distraction, perhaps accompanied by excessive speed. Invoking driver distraction as a causative factor may have broad appeal, yet conceivably many different factors can contribute to distraction, ranging from different modes of physiological or psychological impairment, to a broad array of design issues. In other words, attributing work zone and TSS crashes to driver distraction lacks explanatory specificity and rigor.

This presentation will explore the basis of work zone and TSS crashes from a behavioral human factors perspective. A first assumption is that most if not all such crashes involve an interaction between some sort of design factor prevailing at the scene (some examples are cited above), and driver performance and behavior (it should be noted that human factors science is fundamentally concerned with performance-design interaction). A second assumption is that there are a number of well-documented sources of behavioral variability that conceivably can contribute, individually or in concert, to such crashes. A third assumption is that many of these behavioral factors may be common to both types of crashes.

The objective of this analysis is not to provide a definitive explanatory account of these crashes, but rather to introduce a more explicit interpretation of what may represent the underlying behavioral substrates of their occurrence, based on available crash causation evidence coupled with relevant human factors research findings. The ultimate objective is to introduce a more systematic behavioral framework for the traffic community to consider in analyzing, modeling and mitigating work zone and TSS crashes.

Background

The record in Minnesota over the past decade underscores the disturbing nature of TSS and work zone crashes. According to a report by Furst (2011) on TSS crashes in Minnesota: (1) between November 1, 2010 and January 19, 2011, 22 Minnesota State Trooper vehicles were involved in TSS crashes, with five troopers injured; (2) for the comparable 2009-2010 period, there were 10 trooper traffic stop crashes, with four trooper injuries; (3) from 2005 through 2009, there were at least 100 trooper TSS crashes, with 31 troopers injured, and 9,173 motorist

citations issued for 'move over' work zone violations.; and (4) in the year 2000, a trooper was killed as a result of a TSS crash. Nationally, according to Ashton (2011), 44.1 percent of a total of 681 accidental law enforcement officer fatalities between 1993 and 2002 were caused by TSS crashes.

As for work zone crashes, the Minnesota statistics are even more alarming: According to a report by Humphrey and Walsh (2011): (1) two work zone workers were killed on October 13, 2011, in a work zone crash alongside I-35W in Burnsville; and (2) there were 1,915 work zone crashes in 2010, with 11 workers and motorists killed; and (3) there were 1,788 work zone crashes in 2009. Nationwide, in 2004, work zone crashes killed 1,028 people and injured another 50,000 (NCHRP, 2004). This NCHRP report also notes that work zone construction workers are killed at a rate nearly three times higher than construction workers in other areas, and eight times higher than general industry workers.

Behavioral Substrates of Traffic Safety Stop and Work Zone Crashes

Building upon the assumption (above) that the crashes addressed here usually feature some type of design-performance interaction, this section introduces a series of behavioral factors that conceivably could play a role on the driver performance side of the interaction, by contributing to driver distraction as a general consequence. Two categories of such factors are considered, namely those that traffic community observers/specialists have identified as playing a possible/likely role in these crashes, and those that have not received comparable attention. For each factor, the analysis will underscore their possible contribution to both work zone and TSS crashes. However, despite this dissection approach, it should be emphasized that multiple behavioral and design factors likely contribute to most if not all such crashes.

Behavioral Factors Identified by Traffic Community Observers/Specialists

These factors include: (1) disregard of 'move over' law; (2) speed; (3) substance abuse; (4) loss of control due to adverse weather, especially on slippery roadways; and (5) oversteering.

Disregard of 'Move Over' Law. The 'move over' law was adopted in Minnesota in 2005 to protect TSS workers, and amended in 2008 to also protect work zone workers (Humphrey & Walsh, 2011). That over nine thousand citations for move over violations were issued in Minnesota between 2005 and 2009 (Furst, 2011) suggests that widespread disregard, or ignorance, of this law persists in the state.

Speed. According to the NCHRP (2004), 60 percent of work zone crashes occur on non-interstate highways with speed limits of 55 mph or higher. Ashton (2011) refers repeatedly to high speed highways as a major risk factor for TSS crashes. However, the Minnesota State patrol concludes that excessive speed was not a factor in the two October, 2011, Burnsville work zone fatalities cited above (Humphrey, 2011).

Substance Abuse. The NCHRP (2004) estimates that alcohol is involved in 40 percent of work zone crashes. In his recent, comprehensive review of TSS crashes, Ashton (2011) does not reference statistics pertaining to substance abuse generally, or alcohol particularly, as risk factors in TSS crashes. However, the Minnesota State patrol concludes that alcohol was not a factor in the two October, 2011, Burnsville work zone fatalities cited above (Humphrey, 2011).

Adverse Weather Effects. Ashton (2011) and Furst (2011) both note that inclement weather can represent a risk factor for TSS crashes. The latter report cites the conclusion of a Minnesota State Patrol trooper that such accidents are more common in winter because drivers are going too fast on snow and ice. A Federal Highway Administration report (2003) on work zone safety notes that stopping distances increase by 33 percent on wet roadways, and by over three hundred percent on icy roadways. Statistics provided to the author by the Minnesota State Patrol on TSS crashes in Minnesota for the months January through September, 2011 (Roeske, personal communication) show that 20 of the 22 total crashes during this period occurred in January, February and March, an extremely disproportionate distribution that strongly implicates snowy,/slippery/icy roadways as a major risk factor for such crashes.

Oversteering. In their provisional analysis of the Burnsville work zone crash cited above, the Minnesota State Patrol speculates that the motorist apparently steered away from a construction wall on his left, but overcompensated and swerved before losing control of the vehicle and spinning into the ditch where the victims were working (Humphrey & Walsh, 2011). It is also reported that the motorist involved was operating a new vehicle with more sensitive steering than his previously owned vehicle.

Other Behavioral Factors That May Contribute to Traffic Safety Stop and Work Zone Crashes

A series of additional behavioral factors are introduced here that plausibly can play a role in these crashes, but that heretofore have not been carefully considered by the traffic community. These include increased reaction time, attention-arousal interaction, inattention blindness, and steering bias linked to visual fixation.

Increased Reaction Time. It has been known for over a century that the more stimulus choices confronting a subject, the longer it takes for the subject to react to a particular choice. In the early 1950's, Hick and Hyman formalized this relationship by showing that the magnitude of the choice reaction time was linearly related to the logarithm of the number of choices (Schmidt, 1988). Hick's law, as it is now called, is one of the most robust predictive relationships in behavioral psychology.

What role does Hick's law play in TSS and work zone crashes? In contrast with routine traffic flow conditions, a motorist approaching a TSS or work zone confronts additional sources of visual stimulation, such as flashing lights, vehicles and workers on the roadway shoulder, warning signs, traffic routing and control warning paraphernalia, barriers, and so forth. Hick's law predicts that under these additional choice conditions, motorist reaction time to a particular stimulus source will increase. The argument offered here is that this increase, coupled with other factors, may compromise the ability of the motorist to safely react to a TSS vehicle or a work zone worker.

Attention-Arousal Interaction. A drop in the ability of subjects to maintain focused attention under conditions of high arousal represents another relationship in behavioral psychology with reasonable predictive validity (IBID). In contrast with routine traffic flow conditions, traffic safety stops or work zones, by their very nature, will tend to encourage higher levels of arousal on the part of approaching motorists, accompanied by a reduced ability to sustain focused attention on critical features in the visual field, such as a work zone worker or a law enforcement or traffic assist vehicle stopped on the roadway shoulder.

Inattention Blindness. One of the more notorious studies in experimental psychology was conducted by Simons and Chabris in 1999. This research involved a series of experiments in which observers watched a video of two teams of basketball players---one team clad in white shirts, the other in black shirts---each passing a basketball among themselves. The observers were instructed to count the number of passes made by either the white team or the black team. Partway through this task, either a woman with an umbrella or a person in a gorilla costume unexpectedly walked through the center of the action, remaining clearly visible for about five seconds before exiting the display. The observers were then asked if they had seen the unexpected object. Thirty-five percent of the observers failed to notice the woman with the umbrella, even though her presence was obvious to anyone not engaged in the counting task. Perhaps more startling, given its more unusual nature, even more people failed to notice the gorilla (56%). In both cases the unexpected figure moved through the same spatial locations that were being occupied by the attended basketball players.

This phenomenon is termed inattention blindness (Most et al., 2000). A prevailing behavioral interpretation is that detection of an unexpected object depends on the distance of that object from the spatial focus of attention. The argument for the role that this behavioral factor might play in work zone crashes advanced here is that the spatial focus of attention on the part of an approaching motorist may center on barriers or warning features, resulting in inattention blindness for a work zone worker more spatially removed from the attentional focal zone.

The possible role that inattention blindness might play in TSS crashes is less apparent. It is noteworthy, however, that the experimental paradigm for the empirical analysis of this phenomenon by Most et al. (2000),

cited above, required observers to focus on flashing lights. A hypothetical possibility is that the flashing beacons of the law enforcement or motorist assist vehicle during a TSS may reduce the focus of attention by an approaching motorist on the vehicle or employee involved in the stop. Ashton (2011) cites officer visibility and vehicle conspicuity as design factors that may play a role in TSS crashes, especially under reduced visibility conditions. The premise in both cases is that improving the detectability of the vehicle and the employee engaged in a TSS may broaden or diversify the spatial focus of attention on the part of an approaching motorist beyond the flashing lights themselves, thereby possibly mitigating the risk of a TSS crash.

Steering Bias Linked to Visual Fixation. The idea that the direction of your gaze may bias the direction of your steering during vehicle operation has received attention on the part of the human factors community over a number of decades. A report by Chatziastros and Bülthoff (2000) encapsulates the essence of this research. As these investigators point out, prior research has produced equivocal results. Namely, under conditions when a driver's gaze is fixated on another vehicle, previous observations show that: (1) there is a tendency to *steer towards* the vehicle in simulated driving environments; (2) *no such effect* can be observed in real traffic; and (3) the driver seeks to *increase the lateral distance* from the other vehicle, a behavior related to risk avoidance.

In an attempt to resolve these inconsistencies, these two investigators conducted a simulated driving study with more stringent control of experimental conditions, and with the driving task featuring unpredictable encounters with both moving and stationary other vehicles. Key findings are: (1) for both moving and stationary other vehicles, subjects exhibited risk avoidance behavior by steering to increase their lateral distance from encountered vehicles; (2) however, the maximum deviation occurred not before or close to the meeting point, but approximately two seconds after the passage; and (3) for encounters with stationary vehicles on the roadway shoulder, drivers steered *towards* the other vehicle. Based on these findings, the authors conclude that changes in the gaze pattern may be intimately linked to observed steering response, a behavior that they term the 'steering where you look' hypothesis.

Arguably, these findings are applicable to an understanding of the basis of TSS and work zone crashes. During traffic safety stops, and in work zones, stationary vehicles as well as employees typically are positioned off the edge of the roadway. In some instances, visual fixation by oncoming motorists on these features may be accompanied by steering bias towards the features, increasing the risk of either TSS or work zone crashes.

Conclusions

A basic tenet of human factors science is that the preponderance of variability observed in human behavior and performance is attributable to the influence of design factors in the performance environment, a phenomenon termed context specificity in performance (Smith, 1994). Our experience with TSS and work zone crashes tends to conform to this idea. That is, each particular TSS incident or work zone project embodies somewhat different design features and conditions. Based on the context specificity idea, the prediction is that the crashes that occasionally occur during these activities will be associated with somewhat different environmental design and behavioral factors, that may interact in a myriad of possible combinations. This is exactly what is observed. That is, the foregoing analysis has cited eight environmental design factors and five behavioral factors that have been invoked by other observers to explain TSS and work zone crashes, and has introduced four other behavioral factors that, arguably, also should be considered. It can safely be predicted that this enumeration by no means exhausts potential possibilities. The first conclusion, therefore, is that elaborating a unified explanatory framework for understanding TSS and work zone crashes represents an unrealistic expectation. The second conclusion is that efforts to date in delineating the nature and extent of contributory factors likely can benefit from a broader perspective, guided in part by principles and practices of human factors science. This presentation proposes to address this challenge, including the introduction of a checklist strategy and methodology for supporting a more systematic, data-driven approach on the part of law enforcement officials and accident investigators in their investigations of how and why TSS and work zone crashes occur. The ultimate goal of this approach is to devise traffic management and safety intervention strategies that are likely to mitigate the risk of such crashes.

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Using Event-Based Data to Assess Vehicle Pedestrian Crash Risk in the Absence of Clearance Interval at Signalized Intersections

Indrajit Chatterjee
612-625-4147
chat0123@umn.edu

Gary A. Davis
612-625-2598
drttrips@umn.edu

University of Minnesota
500 Pillsbury Drive SE
Minneapolis, MN 55455

All-red clearance interval plays a pivotal role in preventing potential vehicle pedestrian conflicts at signalized intersections. A recent study suggested that retiming of clearance interval resulted in a 37% relative reduction in pedestrian and bicycle crashes. Since these modifications generally led to increases in the clearance intervals, results from the study have implications regarding the mechanism by which at least some vehicle-pedestrian collisions occur. To validate such findings, a simulation based method using high-resolution event-based data obtained from loop detectors at three signalized intersections was used to first estimate crash probabilities and then a counterfactual approach to calculate the probability of the absence of the all-red phase as a necessary condition for the occurrence of the crash provided an alternate estimate of crash reduction factor for the all-red phase. Our study suggested that intervention of clearance interval was able to prevent 100% of potential crashes, which would have occurred otherwise even with driver's emergency braking effort. Such deviation in findings from the previous report could be attributed to the fundamental difference between the nature of the vehicle pedestrian conflicts at the two studies.

Investigating Lower-Cost, Shorter-Term Ways to Reduce the Frequency and Duration of Flood-Related Closures: MnDOT's Minnesota River Flood Mitigation Study

Mark Benson, PE, LEED GA
SEH, Inc.
3535 Vadnais Center Drive
St. Paul, MN 55110
651-490-2194
mbenson@sehinc.com

Background

SEH and W.F. Baird & Associates Ltd. (Baird) were retained by The Minnesota Department of Transportation (MnDOT) to develop a two-dimensional hydrodynamic model of the Minnesota River. This was part of a study investigating lower-cost, shorter-term ways to improve local and regional mobility during seasonal flooding in the Minnesota River Valley that can force closures of Trunk Highway 101 between the Cities of Chanhassen and Shakopee and Trunk Highway 41 in the City of Chaska. In particular, these river crossings have closed due to flooding six times between spring 1993 and spring 2011 with closure times varying from several days to several weeks. When Highways 101 and 41 are closed, the value of the additional time and miles traveled (using the Metropolitan Council's 2030 Regional Model to calculate the daily cost of closures) is \$670,000 per day in the year 2009 and is forecasted to be \$1,675,000 per day in the year 2030. While a long-term replacement solution has been identified for the Highway 41 river crossing, it will be decades before that crossing is replaced given current funding levels.

The overall study approach was built around the following major tasks: stakeholder and public involvement, traffic forecasting and analysis, historical flooding analysis, river modeling using computer aided hydrological analysis, design alternatives and analysis, impact assessment, and cost estimate preparation. The objectives of the modeling study were to: a) assess water surface elevation in the existing conditions and provide the necessary information for highway design; b) assess the impact of different design alternatives for highway improvements on the frequency of flooding and road closures; and c) develop and deliver to MNDOT, a calibrated, 2D model of the Minnesota River in the Finite Element Surface Water Modeling System (FESWMS) modeling environment.

Changes to the existing structures have the potential to cause a corresponding change in flood regime, typically through a combination of changes in conveyance, water levels, and velocity. The final report identifies a feasible design option at each river crossing that minimizes the risk of flooding without causing an increase in the 100-year floodplain elevation. The alternative bridge and highway crossings for Highway 41 and Highway 101 were predicted to reduce flooding of the transportation corridor by increasing conveyance for the more frequent flood events (e.g. the 10 and 50-year events) through the use of elevated land bridges and road grades. The feasibility level analyses conducted as part of the study serve as a screening tool to identify workable alternatives that warrant further consideration and development to support engineering level design. The study's findings are currently being used to pursue flood mitigation funding.

Presentation

The presentation will review historical flooding data, alternatives considered, river modeling results and the preferred alternative for both river crossing locations.

Assessment of Culverts Designed to Meet Stream Simulation Requirements

Bradley J. Hansen
Phone: 612-625-9220
Fax: 612-624-3005
hanse038@umn.edu

John Nieber
Phone: 612-625-6724
Fax: 612-624-3005
nieber@umn.edu

University of Minnesota
1390 Eckles Ave.
Saint Paul, MN 55025

Sara Johnson
Phone: 612-624-5972
Fax: 612-624-4398
john3999@umn.edu

Jeff Marr
Phone: 612-624-4363
Fax: 612-624-4427
jmarr@umn.edu

St. Anthony Falls Laboratory
2 Third Avenue SE
Minneapolis, MN 55414

In Minnesota there is not a standard culvert design used at road crossings to improve aquatic organism or fish passage. The design process for fish passage in Minnesota is currently based on the knowledge and experience of local county, state and DNR personnel. The design methodology attempts to maintain the natural stream dimensions, pattern and profile through the culvert crossing. If designed properly aquatic organisms and fish that can make it upstream to the culvert should be able to pass through the culvert. This research was conducted to better understand the hydraulic conditions related to the practice of recessing culverts and other fish passage design elements over a range of landscapes in Minnesota. The design elements analyzed included, bankfull width, slope, channel materials, side barrels and recessed culverts. Nineteen culvert sites were survey around the state. The main criterion used to evaluate performance of the culverts was the presence or absence of adequate sediment in the recessed culvert barrel. Six of the fourteen sites with recessed barrels had no sediment accumulation. A likely reason that these culverts lack sediment was increased velocities due to improper sizing relative to bankfull channel width and the accumulation of sediment in the side barrels. Wider “C” type channels also correlated with performance issues related to culvert design.

Cleaning Stormwater with the SAFL Baffle

Kurtis D. McIntire
605-254-5601
mcint130@umn.edu

Omid Mohseni
952-832-2665
omohseni@umn.edu

John S. Gulliver
612-625-4080
gulli003@umn.edu

St. Anthony Falls Laboratory
2 Third Avenue SE
Minneapolis, MN 55414
Phone: 612-624-4398

The SAFL Baffle is a low cost device invented at St. Anthony Falls Laboratory to boost the performance of sump manholes as stormwater treatment BMPs. Previous research showed that the SAFL Baffle improves the ability of standard sump manholes to capture sediments and hold onto them during intense storm events. However, the objective of this study was to know how the SAFL Baffle will perform when:

1. Clogged with debris like trash and vegetation
2. Installed in a sump manhole with an outlet pipe 90 degrees to the inlet pipe
3. Installed in a sump manhole with water entering through an inlet grate and inlet pipe

The results of the study show that a SAFL Baffle with 5" hole diameters should be installed in shallow sump manholes receiving debris loads. When working with 90 degree outlet manhole sumps, the SAFL Baffle should be installed at an angle of 90-120 degrees with respect to the direction of the flow in the inlet pipe. Finally, SAFL Baffles should be installed in sump manholes where the drainage basin of the sump inlet pipe is more than three times larger than the drainage basin of the inlet grate.

Economic Impact of Wisconsin's Commercial Ports, Helping to Keep the State's Economy Afloat

Liat Lichtman-Bonneville
608-267-3614
liat.bonneville@dot.wi.gov

Dennis Leong
608-266-9910
dennis.leong@dot.wi.gov

Robert Russell
608-266-2961
robert1.russell@dot.wi.gov

Wisconsin Department of Transportation
Madison, WI
Fax: 608-267-0294

The Wisconsin Department of Transportation and the Wisconsin Commercial Port's Association collaborated to produce an informational publication on the role and economic importance of ports and harbors in the state's economy. Wisconsin's location, bordered on three sides by commercially navigable waterways, perfectly situates it to benefit from water transportation. Wisconsin's ports serve as centers of shipbuilding, commercial fishing, ferrying services, and the efficient transport of bulk goods.

This publication focused on the direct, indirect, and induced economic impacts of the port terminal operators, vessel supply, shipbuilders and repair facilities, commercial fishing operations, and other marine-related businesses and provided estimated impacts in terms of employment, wages and salaries, and output. Through data collection, interviews with individual port managers and businesses and economic modeling, this publication illustrates the economic importance of Wisconsin's port facilities to guide future port infrastructure improvements and help potential shippers understand the unique capabilities and advantages of water transportation.

Data and modeling sources include; U. S. Army Corps of Engineers-Navigation Data Center, Global Insight's Transearch database, IMPLAN input-output economic model, and the U.S. Coast Guard. This publication will serve as a resource guide for the commercial ports and public and private fund advocacy for Wisconsin's port facilities' operations and expansion.

Minnesota's Trade Center Hierarchy

William J. Craig
Center for Urban & Regional Affairs
University of Minnesota
301 19th Avenue South, #330
Minneapolis MN 55455
Phone: 612-625-3321
Fax: 612-626-0273
wcraig@umn.edu

Bruce W. Schwartau
University of Minnesota Extension
Extension Regional Center, Rochester
863 30th Ave SE
Rochester, MN 55904-4915
Phone: 507-536-6308
Fax: 507-280-2872
bwschwar@umn.edu

Cities across Greater Minnesota provide the jobs, education, goods and services, homes, meeting places, and identity for nearly half the state's population. They are the hubs of activity, connected by roads to each other, to the Twin Cities, and to the national economy. Trade Center size and vitality are important considerations in planning for highway maintenance and upgrades. City vitality changes over time, so it needs to be monitored regularly. Past efforts to measure economic activity have been based on complicated analysis of business data from Dun and Bradstreet. Authors of that methodology suggested using a simpler approach based on sales tax information.

This presentation takes that approach, using sales tax data from the Minnesota Department of Revenue. We compare past approaches to determining Trade Center levels with the sales tax approach and find very similar results. We then use current sales tax data to rank and classify cities today. Change is occurring. Mankato has moved up the urban hierarchy and is now a primary regional center on par with St. Cloud, Rochester, and Duluth; together these four cities account for 28% of taxable retail and service sales in Greater Minnesota. Cities under 5000 and Iron Range cities tend to be losing ground. Cities in lake regions of the state are growing as they take advantage of seasonal sales. This report will highlight both the methodology and the results of our work.

On the Road to Complete Streets in Minnesota

Scott Bradley
MnDOT Office of Environmental Stewardship
395 John Ireland Blvd, MS 686
Saint Paul, MN 55155
651-366-3302
scott.bradley@state.mn.us

Bruce Holdhusen
MnDOT Research Services
395 John Ireland Blvd, MS 330
Saint Paul, MN 55155
651-366-3760
bruce.holdhusen@state.mn.us

Paul Stine
MnDOT State Aid Division
395 John Ireland Blvd, MS 500
Saint Paul, MN 55155
651-366-3830
paul.stine@state.mn.us

This presentation provides an overview of current Complete Streets research and implementation efforts by MnDOT and the Local Road Research Board, demonstrating that research is an important element in creating purposeful change. Transportation professionals on the front lines of planning, public involvement and design are eager for Complete Streets results they can use. This overview will help keep stakeholders informed and engaged in ongoing discussions, and set the stage for researchers to present results of individual projects at next year's CTS transportation research conference. Goals, scope and progress will be highlighted for several complete streets research projects recently initiated by MnDOT and the Local Road Research Board. An update will be included on revisions to State Aid Standards and MnDOT design standards. Recently-completed national research related to complete streets is ready for exploration at state and local levels, and ideas for proposed Minnesota implementation of that research will be discussed.

A Major Utility Project With a Complete Street Finish – East 75th and East 76th Street Reconstruction, Richfield, Minnesota

Jack Broz
HR Green
Court International Building
2550 University Avenue W, Suite 400N
Saint Paul, Minnesota 55114-2015
Phone: 651-659-7711
Fax: 651-644-9446
jbroz@hrgreen.com

Kristen Asher
City of Richfield
1901 East 66th Street
Richfield, MN 55423
Phone: 612-861-9795
Fax: 612-861-9181
kasher@cityofrichfield.org

Objective

The Metropolitan Council's Environmental Services (MCES) Division needed to construct a 36- to 42-inch diameter regional sanitary interceptor sewer across the community of Richfield to accommodate new development in the region. The sewer generally parallels Highways I-494 / MN-5 from Xerxes Avenue on the west end of Richfield, to Cedar Avenue on Richfield's eastern boundary, a distance of about four miles. The new sewer crosses Interstate 35W and the Canadian Pacific Railroad. Much of its alignment is within the rights-of-way of East 75th and East 76th Streets in Richfield, necessitating total reconstruction of these roadways. This alignment was chosen in part because those streets were already in need of reconstruction. The planned street reconstruction provided an opportunity to examine the mobility needs of the stakeholders that use this transportation corridor. At the same time, the Three Rivers Park District was interested in implementing its plan to connect a regional trail across Richfield. The project was constructed in three phases, beginning in 2008 and concluding in October 2011.

Methodology/Approach

The project employed a unique multiagency collaboration which included MCES, the City of Richfield, and Three Rivers Park District, with HR Green, Inc. as a project consultant. The project team successfully coordinated all three aspects of the project (sewer replacement, regional trail construction, and roadway redesign) using a Context Sensitive Solutions (CSS) approach which engaged stakeholders in the design of 75th and 76th Streets.

The 75th / 76th Street corridor was originally constructed after World War II as a four-lane facility. With newer, high-speed highways now located nearby, these deteriorating streets no longer carry sufficient traffic volumes to justify four lanes. Thus, the opportunity existed to replace the street with a narrower paved cross-section. Besides reducing street replacement costs by nearly a million dollars for MCES, this approach would open more space for landscaping and features to accommodate other modes of transportation, such as bicyclists and pedestrians. In addition, the narrowed pavement width allowed for wider boulevards with trees and adequate space for snow storage.

The final design for the roadway included a complete street section which reflected the needs of all stakeholder groups, was the most cost-effective and constructible route for the MCES interceptor, and served the City of Richfield's long-term vision of enhancing community livability. Additionally, the multi-use trail portions of the project addressed the long-term plan of Three Rivers Park District.

Findings/Results

The project team successfully applied an innovative CSS approach which engaged the public in the design process. The result was Richfield's first "Complete Street" system, which encourages walking, bicycling and mass transit use. In this case, the Complete Street option was also less costly than the replace in-kind approach, resulting in reduction of street replacement costs by nearly a million dollars for MCES. The results are highly satisfying to the residents of Richfield, and proved more economical for MCES in this case. Three Rivers Park

District was also able to implement a regional trail connection through the project area. As a results of this complete street project, Richfield is a more livable, less automobile-centric community that encourages walking, bicycling and mass transit use. This represents a true “win-win” scenario for MCES, the City of Richfield, and Three Rivers Park District.

Potential Applications

The Edina-Richfield Interceptor Improvements project is an exemplary story of multiple agencies cooperating to solve widely varying problems. The project satisfied diverse constituencies and saved money in the process. The project also exemplifies the application of design flexibility by engineers in service of the public interest and in response to stakeholder input. As an example, the standard trail, gutter and bike lane dimensions were altered slightly to accommodate more diverse uses of the right-of-way, while fulfilling the functional intent of those standards.

Policy Implications

Moving forward MCES will follow a similar process for future projects. This change in approach illustrates the profoundly positive impact of this multiagency project. CSS yields very high constituent satisfaction, because the precise needs of all stakeholder groups are reflected in the final design. One example from this project was the recognition that cyclists are not a monolithic group; there are different types of cyclists with different needs. The project included an off-street trail to accommodate pedestrians and novice cyclists, and an on-street bike lane to accommodate advanced and commuter cyclists.

Routes to Rails: Pedestrian Realm Planning in the Central Corridor

Hayley Bonsteel
University of Minnesota
bons0018@umn.edu

Carol Swenson
District Councils Collaborative of Saint Paul and Minneapolis
1080 University Avenue W
Saint Paul, MN 55107
651-249-6877/651-528-8165
carol@dcc-stpaul-mpls.org

Please note: This research was made possible through the University of Minnesota, Center for Urban and Regional Affairs, Neighborhood Partnerships for Community Research Program.

Objective

The Central Corridor Light Rail Transit line (Green Line) will serve the region's urban core — St. Paul and Minneapolis — and will have no park-and-ride facilities. According to the Draft Environmental Impact Statement in neighborhoods that are already developed, the vast majority of riders are expected to either walk, bike, or take a bus to the station. The quality of the pedestrian realm, the continuity of the pedestrian network, and the pedestrian's sense of personal safety and security are critical to encouraging people to walk to stations. Yet, windshield surveys of the pedestrian realm in the corridor, studies of existing pedestrian conditions and networks, and planning discussions with current residents all reveal that the pedestrian realm on many neighborhoods streets is unfriendly, people do not feel safe walking after dark, and pedestrian networks to LRT stations are incomplete in several neighborhoods.

This study was conducted as part of larger community initiative to ensure a quality pedestrian environment in the Central Corridor. The objective of the study was: to enable Minneapolis and St. Paul neighborhoods along the Central Corridor Light Rail Transit line (Green Line) to make well-informed and coordinated decisions about prioritizing and advocating for pedestrian realm improvements that will encourage constituents who live and work within a half mile of a light rail station to walk to light rail stations and/or remove physical barriers for persons with disabilities who rely on transit through well-informed decision making.

Note: For the purposes of this study, a pedestrian is any person afoot or any person in a wheelchair, either manually or mechanically propelled, or other low-powered, mechanically propelled vehicle designed specifically for use by a physically disabled person.

Method /Approach

The methodological assumption was that at different times over recent years, cities, counties, and neighborhoods in the Central Corridor have undertaken many studies to determine where and what types of pedestrian realm improvements are needed, to calculate the cost of improvements, and to identify how they might fund project implementation. Not wanting to duplicate work already completed, yet knowing that these plans have been done on a piecemeal basis for specific geographic areas, this study would gather and compare existing plans and compile them into a comprehensive overview of planning and funding for implementation of projects that would improve the pedestrian realm corridor-wide. Geographic Information Systems (GIS) maps and software would be used to identify where there are reinforcing strategies at different geographic scales and where there are gaps. A set of criteria and a scoring system would be developed to assess the degree of detail in the plans and how they addressed safety and implementation. Results for neighborhood level plans would be mapped and discussed in the final report.

Findings

- Neighborhood-initiated plans for the pedestrian realm were minimal and less specific than anticipated, and many of the plans were completed prior to any certainty that the Central Corridor Light Rail Transit line would be built.

- Plans for neighborhoods facing chronic disinvestment and safety issues focused on strategies to address these issues and had few, if any, strategies to improve the pedestrian realm.
- Recent city-sponsored corridor and station area plans do address the pedestrian realm in greater detail, but do not address the status of sidewalk conditions, identify unsafe intersections or areas, or fully consider sidewalks on streets that are parallel to the light rail line.
- Only a few plans included implementation strategies, projects and timelines.
- Although safety is a major concern that is often raised in Central Corridor community meetings, neighborhood plans have surprisingly little information about specific problem areas or intersections and strategies to address this issue.
- Public access to data about the locations of different types of crimes and the locations and frequency of pedestrian and bicycle accidents is challenging, which makes it difficult to identify priority areas for improvements.
- Despite all the work being done around Complete Streets and Healthy Living, neighborhood level planning organizations appear to lack tools to engage their constituents in substantive planning processes, especially when it comes to engagement of underrepresented groups.
- Preparing a GIS map of the Central Corridor was challenging because there is not an easily identifiable source for data for both Minneapolis and St. Paul segments of the corridor. This proved to be an obstacle to the research approach employed.
- The difficulties the primary researcher confronted in gathering GIS-based data and information are similar to the challenges neighborhood organizations face when undertaking a planning process for their respective community.

Potential Application

For Central Corridor neighborhood and community organizations to engage their constituents in pedestrian realm planning and priority setting for improvements, and to work collaboratively to ensure equitable pedestrian access to all light rail stations in the corridor, findings from this study can be used in the following ways:

- 1) Demonstrate to public sector transportation planners, especially those working in light rail transit corridors, the necessity for working with community leaders to develop a common set of GIS-based data that is accessible and supports a robust analysis of pedestrian realm considerations, such as crime, safety, maintenance, and general environmental conditions, e.g. tree canopy.
- 2) Demonstrate the need for neighborhood-friendly pedestrian realm planning handbooks and tools for documenting pedestrian realm conditions and establishing priorities for improvement projects.
- 3) Convene an inter-jurisdictional Central Corridor pedestrian realm working group to assess opportunities and short- and long-term priorities for improvements, develop coordinated strategies for implementation, and establish channels for on-going communication with and engagement of community groups in sustaining a healthy and friendly pedestrian realm.

Policy Implications

- The pedestrian realm is an integral component of the transportation system, especially in areas served by bus and rail transit. In fact, ridership projections are based on the assumption that riders will walk significant distances to use transit. This suggests that pedestrian realm improvements should be included in light rail transit projects, and that of community members and planners should have pedestrian-scale information and the resources needed to conduct a robust analysis, the pedestrian realm and needed improvements.
- Given the disproportionate transit dependency of low-income populations and communities of color, any Environmental Justice (EJ) analysis as part of an Environmental Impact Assessment should consider the condition of the pedestrian realm and improvement needed to ensure comprehensive transit equity. If improvements are needed and assessed to property owners, an analysis should be completed to discern if EJ populations suffer a disproportionate financial burden.
- Complete Street policies address many pedestrian realm issues. If a jurisdiction has not yet adopted these policies, consideration should be given to taking action to do so.

Visual Tools for Communication and Decision-Making: “Real Minnesota Examples”

Leif Garnass, P.E., PTOE
Senior Engineer
lgarnass@srfconsulting.com

Sean Jergens, ASLA
Senior Landscape Architect
sjergens@srfconsulting.com

SRF Consulting Group, Inc.
One Carlson Parkway North, Suite 150
Minneapolis, MN 55447
763-475-0010

Objective

The benefits of complex projects and designs are often difficult to convey to project stakeholders and the general public without the use of visual aids. Various tools are available to create visual aids that can be used to achieve this goal. This presentation looks at several examples of visual tools for communication and decision-making with some real Minnesota examples.

Methodology/Approach

Research to date details the importance of being able to create visual aids that assist in communication and decision-making, as well as detailed visualization procedures. Three dimensional modeling software used in combination with photographs and other graphic media are used together to create visual aids across a range of media. In addition, traffic simulation models are used to animate traffic operations to convey the complex operations of a design.

Findings/Results

Visual aids prepared with a specific audience in mind are effective in conveying the benefits of complex projects and designs to project stakeholders and the general public aiding in the decision-making process.

Potential Applications

Visual tools for communication and decision-making can be used at project management meetings, City council meetings, County board meetings, and/or public open houses. Visual aids, especially those that model a proposed design in three dimensions or that combine graphics with site photographs, are able to communicate the proverbial 1,000 words into a single image. We have found that they are a great tool to illustrate the aesthetic effects of a proposed design in a historic landscape, show a design specifically from a driver's or pedestrian's point of view, and as a tool to display complex traffic patterns as a simple animation.

The Role of Transportation in Quality of Life

Ingrid E. Schneider
ingridss@umn.edu

Tian Guo
guoxx278@umn.edu

University of Minnesota
1530 Cleveland Ave N
Saint Paul, MN 55108
Phone: 612-624-2250
Fax: 612-625-5212

Karla Rains
MnDOT
395 John Ireland Blvd
Saint Paul, MN 55155
651-296-3000
karla.rains@state.mn.us

Quality of life and related constructs dominate the stated benefits of various industries and organizations, including transportation. Despite more than 50 years of exploration, quality of life has multiple definitions and dimensions but specific transportation-related indicators remain scant. As such, an opportunity exists for both academic and transportation professionals to better understand the relationship between quality of life and transportation. Therefore, the purpose of this study was to assess and evaluate transportation-related quality of life indicators and their role in quality of life. Three inter-related approaches were undertaken: 1) a literature review, 2) focus groups, and 3) a questionnaire. Results from this study illustrate consumer generated transportation-related quality of life factors and an approach to their measurement and utility. First, a 2010 literature review assessed the state of quality of life research within and beyond transportation issues. Then, focus groups identified quality of life indicators and further differentiated how transportation elements contribute to or detract from quality of life. Finally, a 2011 questionnaire identified the indicators quantitatively among a representative sample of residents, allowing for assessment of how transportation related to quality of life overall as well as how various elements of transportation contributed to transportation satisfaction. Results indicated a commonly held list of quality of life attributes which included transportation. Seven transportation-related themes emerged from the focus groups (in alphabetical order): access, design, environment, maintenance, mobility, safety and transparency. Questionnaires were implemented among a sample of 7500 residents that represented the state's population. The questionnaire included measures of: quality of life (WHOQOL, 2000), importance of transportation dimensions of access, design, environment, maintenance, mobility, safety and transparency as well as resident satisfaction with these dimensions, and demographics. Results from 44% of the sample indicate transportation is an important quality of life area, Minnesotan's are satisfied with MnDOT services and this satisfaction is fairly consistent across regions, but satisfaction with transportation varies by age and income. Implications and opportunities for transportation planners and managers are provided.

Estimating Non-Motorized Urban Trail Traffic Using Negative Binomial Regression Models

Xize Wang
612-805-6403
wang2384@umn.edu

Steve Hankey
612-624-8047
shankey1028@gmail.com

Greg Lindsey
612-625-3375
linds301@umn.edu

Kris Hoff
612-568-3567
kristopherjhoff@gmail.com

Humphrey School of Public Affairs
University of Minnesota
130 Humphrey Center
301 19th Ave S
Minneapolis MN 55455

Data and models of non-motorized traffic on multiuse urban trails are needed to improve planning and management of urban transportation systems. Negative binomial regression models are useful when dependent variables are counts. This paper presents eight negative binomial models for estimating urban trail traffic using 1,898 daily mixed-mode traffic counts from six locations in Minneapolis, MN. Our models include up to 10 independent variables that represent socio-demographic, built environment, weather, and temporal characteristics. A general model can be used to estimate traffic at locations where traffic has not been monitored. A six-location model with dummy variables for each monitoring site rather than neighborhood specific variables can be used to estimate traffic at existing locations when counts from monitors are not available. Six trail-specific models are appropriate for estimating variation in traffic in response to variations in weather and day of week. Validation results indicate negative binomial models outperform models estimated by ordinary least squares regression. These new models estimate traffic within approximately 16.5% error, on average, which is reasonable for planning and management purposes.

ITS Data Needs: How Much Do We Really Need to Know?

Frank Douma
Research Fellow and Associate Director
612-626-9946
douma002@umn.edu

Tom Garry
Research Assistant
651-353-8214
garr0133@umn.edu

State and Local Policy Program
Humphrey School of Public Affairs
University of Minnesota
280 Humphrey School
301 19th Ave S.
Minneapolis, MN 55455

Intelligent Transportation Systems (ITS) need vehicle location, speed and route data to function. While this data often includes little or no information about the users of the transportation system, many ITS applications require some degree of data about the user, including information about their specific location, travel patterns, and/or identity. The need to collect and share this user data has led to some opposition over whether the benefits of some ITS applications outweigh the loss, or perceived loss, of privacy to the transportation user. The development and deployment of some ITS technologies have been delayed, prohibited or even removed after deployment due to such privacy concerns.

This research project will analyze the goals of ITS stakeholders (e.g., developers, operators, planners, advertisers, and transportation users) with respect to ITS technology and privacy, and identify where these goals come into conflict and what the law currently does to mediate these conflicts. The research will identify the types of data and the methods for obtaining it that create such conflicts, and in turn provide recommendations for both policy makers and industry practitioners to better manage these conflicts by suggesting alternative data collection methods and means of protecting the identity of transportation users. It will develop these recommendations in light of existing privacy laws and principles and the possible future direction of such laws and principles given the changes in technology.

In doing this work, the project will assess both (i) the privacy principles and laws relevant for ITS data collection and use, and (ii) the needs and perspectives of various ITS stakeholders. To do this, the researchers will have discussions with experts in ITS, telecommunications technology, transportation and privacy law to in order to identify stakeholder positions, and then view these positions through a common prism. This will result in a cohesive assessment of the data needed for ITS, the privacy implications of collecting such data, and recommendations for achieving similar ITS objectives through alternative data collection methods and means of shielding the identity of the user.

Length-Based Vehicle Classification

Scott Petersen, P.E.
SRF Consulting Group, Inc.
One Carlson Parkway, Suite 150
Minneapolis, MN 55447
Phone: 763-475-0010
Fax: 763-475-2429
spetersen@srfconsulting.com

Gene Hicks
MnDOT
395 John Ireland Blvd, MS 450
Saint Paul, MN 55155
651-366-3856
gene.hicks@state.mn.us

Currently in the United States, most vehicles are classified by their axle configuration. However, collecting axle-based data is relatively expensive and the equipment is prone to reliability issues. Classifying vehicles by length offers a lower-cost alternative and can be accomplished with existing infrastructure. The Minnesota Department of Transportation is leading a pooled fund study to research the capabilities and limitations of length-based vehicle classification schemes [TPF-5(192)].

Typical methods for collecting axle-based data are automatic piezoelectric sensor stations, weigh-in-motion stations, and manual methods. Conversely, common length-based methods are widespread and less costly, including loop detectors and several types of non-loop sensors, including sidefire and in-road sensors. The most frequently deployed data collection methods utilize loop detectors, and most dual-loop installations have the capability of reporting length-based vehicle classification.

The core field testing of this project consists of comparing physical vehicle lengths to the “magnetic lengths” that the loop and some non-loop detectors report. In addition, some laboratory testing is being conducted to explore loop detector equipment characteristics.

The project will also examine how vehicle length distributions vary from one region of the country to another, and by the functional class of the roadway. The end result will be the development of length-based classification schemes and an analysis of how they relate to axle-based classifications. This project will also establish accuracy and calibration standards for vehicle length-based measurements. Project results will be available at the 23rd Annual Transportation Research Conference.

Best Practices: Corridor Management/Maintenance of Paved Trails

Michael Marti, P.E.
Principal
mmarti@srfconsulting.com

Stewart Crosby, ASLA
Senior Landscape Architect
scrosby@srfconsulting.com

SRF Consulting Group, Inc.
One Carlson Parkway
Minneapolis, MN 55447
Phone: 763-475-0010

Maintaining the ever-growing miles of recreation trails within Local Agency jurisdiction is proving to be difficult due to the increased demands on trail use and funding limitations. The timely maintenance of paved trail surfaces and the surroundings along the corridor is critical to maintaining a good trail system.

Since there was no resource available to help local agencies manage and maintain their paved trail system, the Minnesota Local Road Research Board recently funded the development of a workshop on corridor management for paved trails. The workshop was developed through a task force that aggregated knowledge of local experts and extrapolated roadway pavement management strategies.

The workshop focuses primarily on the management and maintenance of the trail pavement, but also includes other elements such as vegetation, drainage, signing/striping, lighting, amenities, etc. As part of the development of the workshop, a maintenance schedule and checklist for a typical paved trail was created. This workshop steps the audience through the use of the schedule and checklist and educates them on various pavement issues and treatments. The presentation at the CTS conference will be a condensed version of the actual workshop, which is 2-3 hours long.

Transportation Agency Tool to Analyze Benefits of Living Snow Fences

David J. Smith
University of Minnesota
1994 Buford Ave
Saint Paul, MN 55108
612-839-7734
smit1260@umn.edu

Dean Current
University of Minnesota
1530 Cleveland Ave N
Saint Paul, MN 55108
612-624-4299
curre002@umn.edu

Daniel Gullickson
MnDOT
395 John Ireland Blvd, MS 620
Saint Paul, MN 55155
651-366-3610
daniel.gullickson@state.mn.us

Gary Wyatt
University of Minnesota Extension
1961 Premier Dr, Ste 110
Mankato, MN 56001
507-389-6748
wyatt@umn.edu

Diomedes Zamora
University of Minnesota Extension
1530 Cleveland Ave N
Saint Paul, MN 55108
612-626-9272
zamor015@umn.edu

A benefit and cost analysis tool was developed for the Minnesota Department of Transportation's (MnDOT) living snow fence (LSF) program. This transportation agency tool calculates global and site-specific economic, transportation and environmental benefits and the opportunity costs to landowners. This aids in prioritizing snow problem areas and developing landowner payment programs. Results from the application of the tool on U.S. interstate and U.S. and Minnesota (MN) highway snow problem areas in MN suggests an expansion of the program in the study agency and to other states with snow precipitation is justified. LSF are plantings of trees and/or shrubs set back from the right of way along the upwind roadside to minimize drifting and blowing snow problems on the roadway.

Blowing and drifting snow are costly realities for transportation agencies in regions with significant snow precipitation. Drifts that are large and heavy enough to be unmovable by standard plows require specialized equipment to keep roadways passable. Blowing snow can require extra trips by standard plows, increased plow time, and increased usage of sand and salt. Analysis of automatic vehicle location (AVL) system data and field surveys are used to estimate these cost savings from LSFs.

Snow fences can decrease travel time and reduce the severity and number of snow related accidents. The number and type of vehicles affected during these events is estimated from average daily traffic flows. A study in Wyoming shows that snow fences along interstate 80 have reduced accidents during blowing snow conditions by seventy percent (Tabler 1982). An analysis of accidents in Minnesota from 1995 to 2005 found over nine thousand snow related accidents in snow problem areas including sixty four fatal and one hundred and thirty one incapacitating accidents (URS Corporation 2008).

In addition LSF also provide environmental services such as wildlife conservation, hunting opportunities, and carbon storage and sequestration. The MnDOT LSF program includes collaboration with Soil and Water and Conservation Districts (SWDC), the USDA Farm Service Agency and the Natural Resources Conservation Service (NRCS). Coordinating the LSF program with the Conservation Reserve Program (CRP) and the Environmental Quality Incentives Problem (EQIP) provides additional resources that can reduce the transportation agency's share of the landowner payments by sharing in the cost of establishment and annual landowner payments. This lowers financial barriers to development and expansion of a program with substantial economic net benefits.

Salt Brine Blending to Optimize Deicing and Anti-Icing Performance and Cost Effectiveness

Stephen J. Druschel, Ph.D., P.E.
507-389-2115
stephen.druschel@mnsu.edu

Sarah Green
507-389-6383
sarah.green@mnsu.edu

Alex Raymond
507-389-6383
alex.raymond@mnsu.edu

Minnesota State University, Mankato
205 Trafton Science Center E
Mankato, MN 56001
Fax: 507-389-5002

Background

Many different deicer options are currently available, with a range of cost and performance factors.

Objective

The primary objective of this research project was to develop ice melt data to support a cost and performance evaluation tool for use by maintenance supervisors during winter maintenance operations. This spreadsheet-based tool will address the varying ice melt capacity of up to 50 different deicer compounds or blends of compounds for a temperature range of -30 to +30°F, and will be able to incorporate a changing price structure of available materials. Should maintenance supervisors require a more detailed evaluation, the cost and performance evaluation tool will be able to incorporate cost factors for storage, equipment corrosion, handling difficulty, and potential environmental impact.

Method

Ice melt capacity was determined in over 1200 tests using a modified SHRP methodology at temperatures ranging from +30°F to -30°F. Ice melt capacity is the amount of ice melted (brine created) per the amount of deicer applied. The units of ice melt capacity depend upon whether the deicer is applied as a solid (units of mL brine created / g of deicer applied) or liquid (units of mL brine created / mL of deicer brine applied).

Results

In the temperature range of 5 to 30 °F, most individual deicers do not show substantial improvement over rock salt for ice melt capacity, and many of the evaluated deicers show ice melt capacity much reduced compared to rock salt. Rock salt provided ice melt capacities from a low of 1 mL ice brine created from 1 g deicer added at 8 °F to a high of 8 mL ice brine created from 1 g deicer added at 30 °F. Some marginal gains may be seen for specific compounds, but these gains are neither significant enough nor of sufficient wide temperature span to make much difference. Many of the deicers considered produce dramatically lower ice melt capacities; it appears that the advantage of these “lower power” deicers may lie in attributes other than ice melting, such as low chloride content, adhesion to roadway surface, or low corrosion tendency.

Stockpile treatments likewise demonstrate no significant improvement in ice melt capacity with increasing application rate. Ice melt capacities are fairly constant for a given temperature across the range of applications from 3 to 30 gallons per ton, suggesting no benefit to ice melting from increasing application of stockpile treatments. As with individual deicers, it appears that the advantage of stockpile treatments may be in providing color for post-application visibility and adhesion to road surface to limit wind erosion of the applied deicer combination. Brine blends, in contrast, do show modest but significant improvement from secondary components at higher proportions, with ice melt capacities up to 4 mL ice brine created from 1 mL deicer brine added. Across a range of 0 to 30% additive, gains in ice melt capacity of up to 2 mL ice brine created from 1 mL deicer brine added were observed. As with individual compounds, the ice melt capacities of brine blends are highly related to the application temperature.

Estimating Value of Travel Time and Value of Reliability Using I-394 Dynamic Toll Data

Sean (Xiaozheng) He
612-625-0249
hexxx069@umn.edu

Henry X. Liu
612-625-6347
henryliu@umn.edu

University of Minnesota
500 Pillsbury Dr SE
Civil Engineering Building
Minneapolis, MN 55455

Xinyu (Jason) Cao
University of Minnesota
Humphrey Institute of Public Affairs
301 19th Avenue S
Minneapolis, MN 55455
612-625-5671
cao@umn.edu

This study applied a new methodology to dynamic toll data for evaluating drivers' value of travel time and value of reliability. Previous studies were generally based on drivers' behavior data from stated preference and revealed preference surveys that are costly to collect, from loop detector data that are hard to account for drivers' route choice, or from GPS data that require additional devices installed. This study proposed a new approach to estimate drivers' value of travel time and its reliability based on dynamic toll information collected from I-394, Minnesota. Compared with other types of data sources, it is reliable and easy to collect the drivers' route choice data without additional equipment installed. After analyzing traffic pattern changes, we estimated VOT and VOR distributions for each weekday, based on the toll records of the MnPASS system. We found that MnPASS users valued travel time reliability more than travel time savings. We also observed that the estimated VOT and VOR were higher on Friday than other weekdays.

I-394 MnPASS Express Lanes Performance Evaluation

Kenneth R. Buckeye
MnDOT
395 John Ireland Blvd
Saint Paul, MN 55155
Phone: 651-366-3737
Fax: 651-366-4155
kenneth.buckeye@state.mn.us

In 2005 the Minnesota Department of Transportation (MnDOT) implemented the state's first optional toll lane project, called the I-394 MnPASS Express Lanes. Located in the western half of the Minneapolis-St. Paul metropolitan area, the MnPASS Express Lanes project converted underperforming high occupancy vehicle (HOV) lanes on Interstate 394 into high occupancy toll (HOT) lanes allowing solo drivers the opportunity to pay an electronic fee to bypass congestion.

After more than five years of operational experience, MnDOT has conducted an evaluation to determine if MnPASS Express Lanes have met performance expectations and goals. Three areas of performance were evaluated: Lane performance, tolling operations, and customer satisfaction.

Primary benefits that toll paying MnPASS users receive include time saving, travel time reliability and enhanced safety. This analysis indicates that the lanes are performing efficiently, continuing to ensure free flow speeds for all users, and enhancing vehicle and person throughput in the corridor. In addition, the lanes generate sufficient revenue to cover operational costs. A recent survey indicates that MnPASS Express Lanes are providing value to users for their money in terms of time savings and reliability and overall, provide a high level of customer satisfaction.

Best Practices and Lessons Learned from Atlanta's I-85 Express Lanes Public Outreach and Education Program

Steve Peterson, AICP
Senior Transportation Planner
SRF Consulting Group, Inc.
One Carlson Parkway North, Suite 150
Minneapolis, MN 55447
763-475-0010
speterson@srfconsulting.com

Malika Reed Wilkins, Ph.D.
Director, Marketing and Communications
Georgia State Road and Tollway Authority
47 Trinity Ave, 4th Floor
Atlanta, GA 30334
404-893-6103
mwilkins@georgiatolls.com

Objectives

Similar to Minnesota, Georgia is seeking more innovative solutions to address its transportation issues. On October 1, 2011, Georgia's first High Occupancy Toll (HOT) lanes, the I-85 Express Lanes, opened along a 16-mile stretch of the I-85 corridor in northeast Atlanta. The project is a state partnership initiative led by Georgia Department of Transportation (GDOT), State Road and Tollway Authority (SRTA), and the Georgia Regional Transportation Authority (GRTA). Planning and implementation of the project's extensive public outreach and education program began three years before the HOT lane opened. Drawing on their experience with the MnPASS Express Lanes, SRF Consulting Group led a consultant team involved with these outreach efforts. The first objective of the outreach efforts was to build project support among key stakeholders for the conversion of the High Occupancy Vehicle (HOV) lanes to HOT lanes. A second objective was to identify potential customers and encourage them to sign up for a Peach Pass account.

Methodology

Market research was a key cornerstone of the public outreach and education efforts. Though much was known about the target market going into the project (e.g., media interests, hobbies, travel habits), there was little known about their attitudes toward tolling and in particular HOT lanes. Primary market research was conducted and included activities such as interviews, focus groups, and carpool surveys. The market research informed all facets of the project including the logo, advertising campaign, and promotions. As the project progressed, extensive use of social media (YouTube, Facebook, and Twitter), technology (mobile applications), stakeholder outreach events, and a \$1 million media buy helped to build Peach Pass brand recognition and drive account registration.

Findings

Public outreach and education efforts were extremely successful in building brand recognition in the I-85 corridor and getting Peach Pass account sign ups. In fact, within one month of project opening, over 100,000 Peach Pass transponders were in the market and 10,000 vehicles were using the lane per day.

Potential Applications and Policy Implications

The proposed session will highlight the innovative public outreach and education strategies implemented over the past three years including social media, outreach to diverse, non-English speaking communities, partnering with the media, maximizing free media, and others. With only two HOT lane facilities in Minnesota, this case study will provide session attendees with best practices and lessons learned to be applied to future projects. Many of these strategies used in Atlanta can also be deployed as part of public outreach campaigns for any number of other non-HOT lane transportation projects.

2010 Twin Cities Travel Behavior Inventory

Jonathan Ehrlich
Metropolitan Council
390 Robert St. N
Saint Paul MN 55101
651-602-1408
jonathan.ehrlich@metc.state.mn.us

In 2010 and 2011 the Metropolitan Council conducted several major surveys as part of its decennial Travel Behavior Inventory. At the 2011 CTS conference, initial findings from the 2010 Transit On-Board survey were presented. By spring of 2012, results will be available from the following survey areas:

Home Interview Survey: Between December 2010 and November 2011 over 12,000 households in the 19-county region filled out single-day diaries recording their personal travel. Information was collected on the household level (household structure, vehicle availability, income), person level (age, sex, employment/school status, educational attainment, possession of transit pass or MnPASS transponder), and trip level (location, activity, mode, price, and number of travelers). Challenges included weighting a survey conducted over full year in a dynamic economy and climate and ensuring sufficient participation across all socio-economic and geographic groupings. Survey participants were recruited and data was collected by phone, mail, and web in order to broaden the survey's reach. Particular focus was placed on ensuring that university students and bicyclists made up a sufficient portion of the overall sample.

GPS Home Interview Survey: Between May 2011 and November 2011, all members (age 12+) of over 250 households in the 19 county region carried a GPS receiver for seven days, and filled out a single day personal travel diary. The survey collected the same type of data as the home interview survey. It will be used to validate trip rates from the larger diary survey, and as a comparison point for future larger-scale GPS household data collection efforts.

Special Generator Surveys: In June 2011 and September 2011 special generator origin-destination surveys were collected at the Minneapolis-St. Paul international airport and the Mall of America. Surveys were web-based and administered via iPad tablets. This allowed dynamic revision of the sample plan during short-duration surveys (less than one week each).

MnPASS Survey- A follow-up survey was administered to household survey participants living in MnPASS corridors who do and do not own transponders and/or use MnPASS leading towards development of focused choice models.

External Survey- In October-December 2011, a license-plate mailback survey was conducted for travelers crossing 14 locations at the outside of the 19 county area.

Initial key findings will be available from each of the surveys: describing how transportation in the region has changed in the past decade and how new travel modes are being used. Full results will be used in the development of a new transportation forecast model for the region.

The Future of Forecasting at Metropolitan Council

Dennis Farmer
651-602-1552
dennis.farmer@metc.state.mn.us

Todd Graham
651-602-1322
todd.graham@metc.state.mn.us

Metropolitan Council
390 North Robert St
Saint Paul, MN 55101

Historically, the practice of socioeconomic forecasting at metropolitan planning organizations (MPOs) involved trends analysis, land capacity analysis and aspirational planning assumptions. Few agencies ventured into real estate market simulation and integrated transportation-land-use modeling. In preparation for a major forecast revision in 2012-2013, Metropolitan Council of the Twin Cities has replaced past practices and implemented an integrated portfolio of models. Components include:

- A Regional Economic Model for forecasting regional economic growth, employment and migration activity.
- A Regional Demographic Model for forecasting demographic characteristics of the region's population and households.
- A Land Use Forecast Model that will produce TAZ-level forecast scenarios based on bid-rent real estate market equilibration.
- The land use forecast model described above will be integrated with the Council's four-step Travel Demand Model.

This paper will present the design and specification of this multi-scale forecast modeling system, and will discuss workflow between the models. The authors hope that this information will be useful to other medium-sized planning agencies interested in combining models into systems that operate at multiple levels of spatial and temporal resolution.

The Metropolitan Council prepares population, households and employment forecasts -- and, in the future, land use forecasts -- for the Minneapolis-Saint Paul metro area. The Metropolitan Council uses these forecasts in authorizing (or constraining) local land use planning and in guiding and staging the deployment of regional systems and services.

Travel Demand and Reliable Forecasting for Transit

Mark Filipi
Metropolitan Council
Metropolitan Transportation Services
390 Robert St. North
Saint Paul, MN 55101
Phone: 651-602-1725
Fax: 651-602-1739
mark.filipi@metc.state.mn.us

In 2011, the Metropolitan Council developed a series of guidelines to ensure consistent transitway planning across the seven-county metropolitan region. Guideline 10 dealt with “Project Development, Leadership, and Oversight Guidelines”. More specifically, section 10.7 addressed transitway travel demand forecasting. Credible, reliable transit forecasts need to be a critical goal at every stage of the transitway planning process. They are necessary for sound evaluation of the need for and feasibility of a transitway in early planning, and then to justify funding in later phases.

Often, a difficulty in comparing one corridor to another has been the difference in metrics used between corridors. The guideline goes to some length to delineate how transit ridership for a corridor is to be determined.

The guidelines on transitway forecasting also provide some ideas for alternative methods for producing forecasts other than through the use of the region’s four-step travel demand model.

Suggested Design and Management Practices for Enhancing Public Engagement in Transportation Policy-Making

Kathryn S. Quick
612-625-2025
ksquick@umn.edu

Zhirong Jerry Zhao
612-625-7318
zrzhaio@umn.edu

University of Minnesota
130 Humphrey Center
301 19th Avenue South
Minneapolis, MN 55455

This paper is a report of a recently completed research project analyzing how the public can be effectively engaged in democratic decision-making and implementation of technically complex and sometimes politically sensitive transportation policies. The contribution of the research is a comprehensive analysis of strategies for enhancing public engagement specifically in transportation planning and policy via a review of the literature, identification of key design choices in organizing public engagement, a case study, and recommendations for further research. The research paper incorporates the following sections:

- Highlights from existing knowledge about the benefits, purposes, and challenges of public engagement.
- An assessment of the state of public engagement in transportation and an evaluation of participatory designs currently being used in the sector.
- A framework that we suggest transportation policy-makers utilize in deciding how to design public engagement processes.
- Description and analysis of two current participatory transportation planning cases in Grand Rapids, Michigan.
- Preliminary recommendations for how to engage the public in informed discussion of contemporary transportation systems sustainability issues in Minnesota.

Congestion Management and Safety Program: Overview and Technical Perspective

Mike Sobolewski
MnDOT Metro District Planning
1500 West County Road B2
Roseville, MN 55113
651-234-7795
mike.sobolewski@state.mn.us

The Congestion Management and Safety Program is a series of Lower-Cost/High-Benefit roadway improvements that seek to maximize mobility and reduce crash risk. This is accomplished by identifying and addressing key congestion and safety problem locations. Both MnDOT's *Metro District Highway Investment Plan* and the Metropolitan Council's *Transportation Policy Plan* specify highway funding for Lower-Cost/High-Benefit improvements over the next 20 years. CMSP Phase III is the set of actions performed to identify and recommend solutions that will most cost-effectively provide congestion and safety relief on the trunk highway system in the metropolitan area.

The steps of this effort can be broadly grouped in two categories: problem location identification and cost-effective project screening. Data collection relied on two primary sources of data including MnDOT's annual *Metropolitan Freeway System Congestion Report* and workshops with local stakeholders. While the Congestion Report provides excellent information for freeway congestion, information on problem locations on the expressway and arterial trunk highways is less readily available. Local stakeholders were essential in providing accurate and current input on existing problems on these facilities.

The screening of cost effective projects relied on readily-available data sources and engineering judgment of experts in highway design and traffic operations disciplines. Conceptual designs for Lower-Cost/High-Benefit solutions were developed for a subset of locations from the data collection proven to have the most significant traffic and safety issues. These solutions were competitively screened to identify the best combinations of problem magnitude, solution effectiveness, and cost. The final list of recommended improvements was provided to MnDOT for programming.

It is expected that this process of problem location identification, concept development, and improvement screening will be repeated in future programming cycles. Numerous lessons were learned in this effort that proved beneficial for this type of process. These include engagement of local stakeholders for input and outreach, use of GIS application for data inventory and reference, and reliance on technical experts for development of cost-effective concepts. Areas for improvement include standardization of data collection, additional validation of problem locations, and broader engagement of MnDOT functional area staff.

Congestion Management and Safety Program: Overview and Technical Perspective

Project Location Screening Process

Paul Morris
SRF Consulting Group, Inc.
One Carlson Pkwy N, Suite 150
Minneapolis, MN 55447
763-475-0010
pmorris@srfconsulting.com

The Congestion Management and Safety Program (CMSP) is a series of Lower-Cost/High-Benefit roadway improvements that seek to maximize mobility and reduce crash risk. This is accomplished by identifying and addressing key congestion and safety problem locations. A challenge in this process is identifying the most cost-effective concepts to be recommended for implementation. A number of methods to screen problem locations and Lower-Cost/High-Benefit solutions were developed to assist in this process as part of the CMSP study.

The first challenge was validating and prioritizing problem locations for concept development. Over 500 locations were identified in the data collection effort which referenced MnDOT's annual *Metropolitan Freeway System Congestion Report* and workshops with local stakeholders. Due to the large number of locations, screening inputs were necessarily readily-available and paired to problem locations through automated processes. GIS databases and a screening tool to distinguish the most severe problem locations were developed to assist in this effort.

The highest-ranking problem locations were carried forward for development of improvement concepts. Methods were established to quantify the operational and safety benefits of proposed solutions to facilitate cost-effectiveness rankings. The final prioritization screening used a three-way comparison to identify solutions with the best combinations of problem magnitude, solution effectiveness, and cost. This approach was shown to be beneficial through sensitivity of appropriate solution cost-effectiveness given the problem magnitude.

Establishing screening and prioritization methods for CMSP was a crucial element in achieving project success. The large number of problem locations and complexity of concept solutions demanded a straightforward approach to identify the most cost-effective roadway improvements. Elements of this process that proved to be highly beneficial include the use of GIS application for data inventory and the development of a screening tool to distinguish severe problem locations. In addition, lessons were learned that could improve this process in future studies.

Update on Minnesota's County Roadway Safety Plans

Howard Preston
CH2M HILL, Inc.
1295 Northland Drive
Mendota Heights, MN 55120
651-365-8514
hpreston@ch2m.com

This unique MnDOT project is now in its second year and Safety Plans have been completed for 47 counties (46 in Greater Minnesota plus Hennepin). Highlights of the project include developing a new risk assessment process to identify candidates for safety investment based on the presence of roadway characteristics that are over represented at the handful of locations with crashes and then the development of almost \$115,000,000 of safety projects, the application of a specific counter-measure at a specific location.

The process of analyzing crash and roadway data for the county roadway system has produced a database with over 13,000 miles of paved roadways, 12,000 horizontal curves and 6,000 intersections. The Update will provide an overview of the process, compelling crash facts (i.e., 88% of severe crashes occur on the 56% of the county system that is paved, 52% of all severe road departure crashes occur in horizontal curves and curves make up less than 10% of the system by mileage) and examples of the outcome of the risk assessment process. In addition, a summary will be provided of the types of suggested safety projects.

Reaction to this safety planning effort has been positive at all levels - the county engineers that have received their Plans have been successful at securing safety funds for their high priority projects, MnDOT staff have seen an improvement in the quality of the projects submitted for funding (a much higher fraction that are consistent with Minnesota's Strategic Safety Planning goals) and the Federal Highway Administration recently recognized MnDOT's efforts to address safety on local roadway systems by selecting this project for a National Roadway Safety Advocates award.

Performance of Drainage Ditches in Infiltrating Stormwater Runoff

Farzana Ahmed
Research Assistant
University of Minnesota
St. Anthony Falls Laboratory
2 Third Ave. SE
Minneapolis, MN 55414
612-624-4629
ahmed262@umn.edu

John S. Gulliver
Professor
University of Minnesota
Department of Civil Engineering
122 Civil Engineering, 500 Pillsbury Dr SE
Minneapolis, MN 55455
612-625-4080
gulli003@umn.edu

John L. Nieber
Professor
University of Minnesota
Department of Bioproducts and Biosystems Engineering
Room 203 BioAgEng, 1390 Eckles
Saint Paul, MN 55108
612-625-6724
nieber@umn.edu

How much water can swales infiltrate? How do we know? In an LRRB project, we have found that in swales and other stormwater BMPs, sufficient measurements of infiltration must be made to compensate for the large variation in infiltration rates. Then, the statistics of the measurements will tell us something valuable about the swale. From the analysis on five swales, it was found that the sides of the swales has higher infiltration rate than the center, allowing for most of the runoff to be infiltrated on the sides of the swale. This presentation will show the spatial variation of the infiltration rate of the five vegetative swales located in Twin cities metro area and will discuss a case study which is indicative of the amount of infiltration of the stormwater runoff that comes into these swales for design rainfall events. So far, our observation is that properly designed and maintained swales (drainage ditches) can be an effective stormwater BMP.

The Minnesota Filter: A Tool for Capturing Stormwater Dissolved Phosphorus

Andrew J. Erickson
St. Anthony Falls Laboratory
Department of Civil Engineering
University of Minnesota
2 Third Ave SE
Minneapolis, MN 55414
Phone: 612-624-4629
Fax: 612-624-4398
eric0706@umn.edu

Ross T. Bintner
City of Prior Lake
4646 Dakota Street SE
Prior Lake, MN 55372
Phone: 952-447-9831
Fax: 952-440-4245
rbintner@cityofpriorlake.com

John S. Gulliver
Department of Civil Engineering
University of Minnesota
122 Civil Engineering Building
500 Pillsbury Drive SE
Minneapolis, MN 55455
Phone: 612-625-4080
Fax: 612-626-7750
gulli003@umn.edu

Peter T. Weiss
Department of Civil Engineering
Valparaiso University
1900 Chapel Drive
Valparaiso, IN 46383
Phone: 219-464-5220
Fax: 219-464-5065
peter.weiss@valpo.edu

A recent study of nationwide municipal monitoring data reports that the fraction of total phosphorus that is dissolved (phosphates) is approximately 44% (median values) and detailed monitoring studies have shown that this fraction can range from 0 to 100% for some rainfall events. Very few stormwater treatment practices can consistently capture dissolved phosphorus over the life-cycle of a treatment practice, and therefore a large portion of the phosphorus load is entering our impaired water bodies. The “Minnesota Filter” is a new treatment system that can capture 80-90% of the dissolved phosphorus fraction and can be used in many applications including sand filters, wet detention basins, permeable weirs, ditch check blocks, and rain gardens, among others. This presentation will provide performance and design information from recent and on-going field studies of field installations of the Minnesota Filter.

Characterization of Concrete Sediments from Construction Operations for the Protection of Storm and Surface Waters

Stephen J. Druschel, Ph.D., P.E.
Minnesota State University, Mankato
205 Trafton Science Center E
Mankato, MN 56001
Phone: 507-389-2115
Fax: 507-389-5002
stephen.druschel@mnsu.edu

Leah C. Roue, Ph.D.
507-389-5925
leah.roue@mnsu.edu

Brian Wasserman, D.I.T.
507-389-1875
brian.wasserman@mnsu.edu

Minnesota State University, Mankato
354 Wiecking Center
Mankato, MN 56001
Fax: 507-389-1096

Objective

Sediments composed of cement or concrete particles are created as byproducts of concrete construction from such operations as demolition, grinding, and saw cutting of existing concrete, and placement and finishing of new concrete or mortar. These sediments have proven difficult to control in stormwater management best management practices designed for soil-derived sediments. Highway and bridge construction is particularly affected by the difficulty with concrete sediments due to the proximity of ditches, stormwater piping and surface water. This work attempted to identify and characterize cement and concrete-derived sediments so that soil-sediment based stormwater best management practices design could be adjusted to improve capture and management of the cement and concrete-derived sediments.

Method

This work identified and characterized cement and concrete-derived sediments from a wide range of construction operations:

- Bridge deck demolition
- Saw cutting, dowelling, and replacement of concrete pavement
- Profile grinding
- Saw cutting green concrete
- Bridge deck pour
- Bridge pier tremie pour (underwater concrete)
- Concrete truck wash out
- Foundation installation
- Mortar mixing and use in masonry
- Formwork and concrete placement for culvert wing walls
- Bridge parapet construction
- Super sack mortar station
- Stained concrete
- Stucco concrete
- Shotcrete
- Gunite

Site visits were conducted for most of the construction operations. Identification included assessing the source, relative magnitude, mobility and potential risk of sediments from each operation. Laboratory evaluation of grain size, gradation, particle shape, acidity and erodibility was done to characterize selected sediments. Adjustments to the soil-sediment based stormwater best management practices design were developed to improve capture and management of the cement and concrete-derived sediments.

Results

Large volumes of concrete sediments were observed created by demolition, saw cutting and pavement grinding, with smaller amounts of cementitious particles observed created by concrete and mortar placement operations. Demolition operations created larger particle sizes, widely distributed over a range of sizes. Saw cutting and pavement grinding created fine particles of a uniform size. Concrete and mortar placement had limited amounts of fine cementitious particles. Grain size distribution and shape were determined for selected sediment sources representative of greater mobility and/or volume associated with environmental risk. Erodibility was both a time-dependent variable and a grain size-associated factor.

Potential Application

Concrete sediment characterization is applicable to protection of storm and surface waters adjacent to all forms of construction incorporating, rehabilitating or reconstructing concrete.

Policy Implications

Concrete sediments can be controlled using existing stormwater best management practices (BMPs) if adjustments are made for sediment grain size, uniformity, angularity and activity.

A Wise Investment – Accommodating Future Uses on Today’s Streets

Luke Olson, PE
Transit Project Manager
HDR Engineering, Inc.
701 Xenia Avenue S, Suite 600
Minneapolis, MN 55416
763-591-5419
lucas.olson@hdrinc.com

Objective

As our City streets are being rehabilitated through streetscape or complete street improvement projects, are there things we can do now to make them more adaptable for high capacity transit future? This talk will focus on how we plan and design our streets today can reduce costs and improve safety of implementing a future streetcar and/or LRT.

Methodology

The presentation will be delivered by *Luke Olson* – One of HDR’s National leads in Urban Rail Transit design and their local transit lead. Based on his experience in dozens of cities across the country, Luke will touch on the common urban rail design issues and how forethought on current street improvement projects can save money on future transit investments. It’s not just money, though. Safety is also an important issue. Providing adequate “space” for a future urban rail, provisions for bike lanes/crossings and traffic configurations are important things to take into account even if the transit element may not be implemented until some time in the future. Luke will get into the details of these issues and provide recommended guidelines to make a street/corridor streetcar/LRT “ready.” Some of the topics include:

- Existing and new/replaced bridge structures (loading/track slab)
- Overhead obstructions (i.e. skyways, bridges, etc.)
- Street lighting (clearance to the overhead wire/maintenance access)
- Lane configuration and cross slopes (0% slope between rails desired – how does that work?)
- Underground utilities (relocate now or later?)
- Traffic signals (TSP and controller types)
- Bike facilities (Conflicts between rail flange and narrow tires)

The overall concept and theme of the presentation is to encourage big picture thinking on our streets and make sure we don’t deliver street improvement projects which preclude or make future transit implementation costly and unsafe.

Potential Applications & Policy Implications

Both Minneapolis and St. Paul are talking about streetcars as part of their future. Minneapolis has already accomplished a feasibility study and identified a potential long term streetcar network. St. Paul is not far behind looking to do a similar study in the near future. This will result in numerous City streets identified as a potential future streetcar route. With careful planning, there are several things that can be done now that will save money and improve safety in the future. Often at little or no cost! Establishing guidelines for streets that have been identified streetcar/LRT corridors is something that could be considered by Cities and/or the region.

Mixing Fast Trains on Freight Rail Corridors

Leif Thorson, PE
Senior Professional Associate
HDR Engineering, Inc.
701 Xenia Avenue S, Suite 600
Minneapolis, MN 55416
763-591-5468
leif.thorson@hdrinc.com

Dan Krom
Director of Passenger Rail Office
MnDOT
395 John Ireland Blvd
Saint Paul, MN 55155
651-366-3193
daniel.krom@state.mn.us

Judith Mitchell
Director of Passenger Rail Strategic Initiatives
Canadian Pacific Railway
501 Marquette Avenue
Minneapolis, MN 55402
612-347-8056

Objective

To provide an understanding of the issues, obstacles, and opportunities of planning and implementing Commuter and Intercity passenger train service upon privately owned and operated freight rail corridors.

Methodology

Presentation would be developed around a three part presentation with recommendations or suggestions as well as time for questions and answers.

Dan Krom – Director of MnDOT’s Passenger Rail Office would present on the DOT’s perspective focusing on why there is a need for intercity passenger rail service and why the existing rail system is the corridor which is usually considered. He will also discuss the need for speed, scheduled trains, station stops, and point to point transit times.

Judith Mitchell, PE – Canadian Pacific Railway’s director of passenger rail strategic initiatives would present and explain the need for a viable and flexible freight rail system past, present, and future. She will highlight the inherent constraints and problems that overlaying passenger service on freight lines has in the flexible and fluid operations of freight train service. Judith will discuss the concerns that CP has for public use of their privately held property, their big picture need to provide service to their customers, economic viability of CP within the U.S. freight rail system. She will also discuss the challenge of long range planning on what is essentially a service on demand business.

Leif Thorson, PE – HDR’s senior professional associate of rail services would present on some of the more common engineering solutions to the conundrum. These would include additional tracks, sidings, signaling, grade separations, crossovers, bridges, and focus on the bottlenecks.

Potential Applications & Policy Implications

How do we shape public policy around what is a public use on privately held property that also serves as a key component in the transportation network? How do we address unseen issues that may come up in future years? These could be opportunities such as better technologies, or challenges such as a significant increase in freight? For example, if gas went to \$5 per gallon, more freight would move by rail at the same time rail travel became more economical.

Transit Project Development in Uncertain Times

Reed Lee, PhD
Senior Transit Planner
HDR Engineering, Inc.
2010 NE Loop 410, Suite 400
San Antonio, TX 78209
210-841-2920
reed.lee@hdrinc.com

Objective

As transit agencies and local governments face uncertainty for federal funding of transportation projects, and more competition for those limited federal funds, innovative approaches to project development and funding are needed to meet agency and community goals. The Redlands Passenger Rail Project is presented as an example of developing a strategy to deliver new fixed guideway transit service more quickly through phased implementation and locally-based financing.

Methodology

The presentation will be delivered by Reed Lee – Senior Transit Planner for HDR Engineering, Inc. Reed was the project manager for an Alternatives Analysis (AA) of the Redlands Corridor in San Bernardino County, California. Being adaptive and innovative in project development and financing can lead to successful project development and implementation. In some cases, such as the Redlands Passenger Rail Project, a change in direction can lead to quicker implementation. The Redlands Passenger Rail Project was initiated as an Alternatives Analysis project by the San Bernardino Associated Governments with the intent of pursuing FTA New Starts or Small Starts funding, dependent on the final project costs. As alternatives were developed and evaluated, funding through either New Starts or Small Starts did not appear to be a successful strategy. By looking at available local funding and financing options, and funding through the metropolitan planning organization (Southern California Association of Governments) coupled with a phased approach to implementing the project, a strategy for delivering the project was developed. The initial phase of the project is in Preliminary Engineering. The first phase has fewer stations and a lower level of service than alternatives evaluated in the AA. It will be funded locally with the intent to give the corridor time to develop and establish a base of ridership to pursue FTA New Starts funds for the future phases. Some of the topics include:

- description of the study area
- summary of the project history
 - alternatives considered
 - coordinated land use and transit planning
- description of the Redlands Corridor Strategic Plan
 - phased implementation

The concept of the presentation is to illustrate how an adaptive approach to project development can result in achieving agency and community goals and objectives.

Potential Applications & Policy Implications

As transit agencies and local governments must deal with reduced funding, a greater range of financing options and approaches to project development need to be considered.

20-Years of the Twin Cities “A” Minor Arterial System: Looking Back and Positioning to Look Ahead

Mary Karlsson, P.E.
Metropolitan Council
390 Robert Street North
Saint Paul, MN 55101
651-602-1819
mary.karlsson@metc.state.mn.us

Steve Peterson, AICP
SRF Consulting Group, Inc.
One Carlson Parkway North, Suite 150
Minneapolis, MN 55447
763-475-0010
speterson@srfconsulting.com

The “A” Minor Arterial System is unique to the Twin Cities. It was created to supplement the region’s Principal Arterial (PA) system in response to findings in the 1988 Transportation Policy plan concluding the necessary resources were not available to greatly expand the region’s Principal Arterial system. With the passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991, the region directed a portion of the Surface Transportation Program (STP) Urban Area funds to be used to implement improvements to the “A” Minor system. To mark the 20-year anniversary of the “A” Minor Arterial System being in place and the change in policy for provision of freeway mobility, the region’s Transportation Policy Plan calls for an evaluation of the system. Through study, the region is working to evaluate if the nearly 2,000 mile “A” Minor system has been successful in supplementing mobility on the roughly 700-mile Principal Arterial system over the past 20 years. The study will also evaluate how this original, supplementing purpose fits with the new regional policies and identify needed changes, if any, to make the system, its purpose, and regional policies more consistent.

Metropolitan Council staff is managing the study effort. The planning sub-committee for the region’s Transportation Advisory Board (TAB) Technical Advisory Committee (TAC) helped shape the study’s scope of work and ongoing technical support for the study is being provided by a 14-person Technical Steering Committee consisting of representatives from the TAB’s TAC, MnDOT Metro District, the seven counties (Anoka, Carver, Dakota, Hennepin, Ramsey, Scott & Washington), and from five of the ten cities on the TAC (Maplewood, Minneapolis, Plymouth, Rosemount, and St. Paul). The study’s consultant team is led by SRF Consulting Group and includes Cambridge Systematics.

The presentation will summarize findings from the first phase of the study – reflection on the 20-years of “A” minor system planning, implementation, and funding – and discuss the challenges encountered while performing this part of the system-level evaluation.

US 10 and CSAH 83: A Right-Sized Solution

Jack Corkle
Anoka County Highway Department
1440 Bunker Lake Blvd
Andover, MN 55304
Phone: 763-862-4219
Fax: 763-862-4201
jack.corkle@co.anoka.mn.us

Brandi Popenhagen
WSB & Associates, Inc.
701 Xenia Avenue, Suite 300
Minneapolis, MN 55416
Phone: 763-287-7178
Fax: 763-541-1700
bpopenhagen@wsbeng.com

US 10 in the City of Ramsey has been studied as a corridor for over 10 years. Numerous studies and environmental documents have been completed for most of the corridor. One of the final areas yet to be studied was the intersection of CSAH 83 (Armstrong Blvd). Recognizing that this intersection is a main gateway to the city, the City of Ramsey and Anoka County, in conjunction with the Minnesota Department of Transportation (MnDOT) partnered in developing a preferred concept and complete an EA/EAW for the intersection.

Although this is a typical activity, the process for identifying the concept to move forward for additional design and environmental work was not. At the time this project was started, MnDOT was transitioning into its process of “right sizing” projects. The concept of “right sizing” is focused on being fiscally responsible, while addressing a majority (not necessarily all) of design needs.

Getting the key stakeholders such as MnDOT functional groups, the county and the city to agree to a concept can be time-consuming and can require several iterations and a number of modifications. Knowing that a new directive (right-sizing) will increase the time it takes to get something through the process, and understanding that new directives sometimes cause internal conflicts and require additional discussions, this project required a different approach.

The study team decided that a design charrette would be a useful tool in gathering the different agency stakeholders in a collaborative effort in determining a solution for the intersection improvements at US 10 and Armstrong Blvd. This presentation will cover the charrette process from planning, execution, and lessons learned. We will also uncover what right-sizing meant for the proposed intersection improvements at US 10 and CSAH 83.

MnDOT's Corridor Investment Management Strategy: A New Transportation Planning Approach

Brad Utecht
651-366-3773
brad.utecht@state.mn.us

Ryan Wilson
651-366-3537
ryan.wilson@state.mn.us

Brian McLafferty
651-366-3747
brian.mclafferty@state.mn.us

MnDOT
395 John Ireland Blvd
Saint Paul, MN 55155

MnDOT is in the process of updating its 20-year State Highway Investment Plan. This plan, which was last updated in 2009, details investment needs, sets spending priorities, and outlines strategies to meet system performance goals. Many emerging factors have influenced MnDOT's approach to this plan update, including an adopted 50-year Vision, new legislative requirements, uncertain revenue projections, and an expressed desire among stakeholders to better understand and more fully participate in investment decision making. These factors have prompted MnDOT to redesign its planning process to be more transparent and responsive to local input on issues relating to the economy and quality of life.

A key component of the redesigned process is the Corridor Investment Management Strategy (CIMS) which is a new, evolving planning and outreach method to improve transparency and collaboration in an era of fiscal constraint. CIMS will be an ongoing, collaborative process between MnDOT and local stakeholders that identifies where MnDOT and stakeholders may work together to address MnDOT's system performance issues as well as community and economic development opportunities. The presentation will describe the development of this process and detail early lessons learned from implementing this collaborative planning process.

Minneapolis Transportation Infrastructure Study

Heidi Hamilton, PE
Deputy Public Works Director
City of Minneapolis
350 S 5th St, Room 203
Minneapolis, MN 55415
heidi.hamilton@ci.minneapolis.mn.us

David Hutton, PE
Senior Associate
SRF Consulting Group, Inc.
One Carlson Parkway North, Suite 150
Minneapolis, MN 55447
763-475-0010
dhutton@srfconsulting.com

The Minneapolis Public Works leadership, working with SRF staff, analyzed key elements of its transportation infrastructure (e.g., pavement, bridges, traffic signals and street lights) to determine existing conditions, issues and trends, performance gaps, alternative scenarios, and possible funding options to address needs.

Objectives: More specifically the study objectives included:

- Providing background information on existing conditions and current performance levels and funding trends
- Identifying key issues and infrastructure maintenance and replacement gaps
- Reviewing comparable peer city infrastructure performance
- Establishing Minneapolis performance measures and indicator methodologies
- Preparing alternative infrastructure performance scenarios (based on different funding levels) and identifying the impacts of each
- Analyzing financial options
- Providing a comprehensive set of funding options that could be pursued to close identified performance and financial gaps.

Approach: The study approach included five discrete phases as presented below:

Stakeholder Input – A Steering Committee comprised of several technical staff from the Transportation Business Line was established to share information, discuss technical analyses, review findings, and gain stakeholder buy-in of study recommendations.

Investigation Process – For each of the four infrastructure categories knowledgeable service team members were surveyed to assess existing conditions. The assessments included assembling data, gathering information about current management strategies, establishing performance benchmarks, evaluating current levels of investment, considering regulatory mandates, identifying performance shortfalls, and investigating alternative maintenance and capital strategies and funding.

Market Research – The Steering Committee identified three peer cities (St. Paul, Denver, and Seattle). For each of these cities telephone interviews were held with senior staff to discuss system performance, to identify innovative system maintenance or operational methods, and to explore unique funding strategies. This information was summarized in a matrix format for comparative review.

Technical Analysis – Using the data previously assembled, the Steering Committee completed detailed analysis of each infrastructure category. This analysis examined operational practices/baselines, determined inventory and performance gaps, established performance measures, defined alternative performance scenarios (baseline, constrained, ideal), ran financial/level of service forecasts for each scenario and recommended the optimal resource allocation where possible.

Financial Options – The Steering Committee then reviewed current CIP/financing methods, identified forecasted funding shortfalls, considered new and innovative funding options and their applicability, and presented the

results to the City Council's Transportation/Public Works Committee with the intent of beginning a policy discussion about politically feasible funding strategies.

Results

The comprehensive analysis was compiled into a technical report for use by senior staff. A high level summary report was presented to the City Transportation and Public Works Committee to foster elected leaders' understanding of the critical infrastructure issues, needs, opportunities and funding options, so as to affect City budget and policy directions.

Applications & Policy Implications

Aging infrastructure, rising costs, and stagnant revenues are challenging city, county, and state officials. Public works directors, engineers, and elected leaders are struggling to find resources to maintain their transportation facilities at satisfactory levels. The need has never been greater for sound infrastructure planning tools including: performance measures, indicator methodologies, alternative scenario and gap analysis, and resource allocation mix. The Minneapolis Transportation Infrastructure Study provides excellent examples of proven methods, best practices and valuable lessons learned for use by various practitioners.

Is it Time for Minnesota Bicycle Helmet-Use Law? What Data Suggests

Ayo Adeniyi, MBBS, MPH
651-204-5439
ayo.adeniyi@state.mn.us

Leslie Seymour, MD, MPH
651-201-5489
leslie.seymour@state.mn.us

Jon Roesler, MS
651-201-5487
jon.roesler@state.mn.us

Anna Gaichas, MS
651-201-5478
anna.gaichas@state.mn.us

Mark Kinde, MPH
651-201-5447
mark.kinde@state.mn.us

Minnesota Department of Health
Center for Health Promotion
85 E 7th Place, P.O. Box 64882
Saint Paul, MN 55164
Fax: 651-201-5800

Objective

While Minnesota has no bicycle helmet use law, 21 states (including the District of Columbia) have enacted some form of bicycle helmet usage laws, mostly for riders younger than 16. Can Minnesotan child bicyclists afford to do without state bicycle helmet legislation?

Background

Of all victims of traffic-related crashes, bicyclists are the most prone to injuries, trauma of the head and brain (traumatic brain injury, TBI) in particular. While the incident count of bicycle-related morbidity and mortality may appear low - there were at least ten bicycle fatalities among the 421 traffic fatalities in Minnesota during 2009 - the burden of the injury is quite significant for victims, their families and the public healthcare system. Traumatic brain injuries are often life threatening, with life-long debilitating outcomes.

One of the cardinal purposes of public health surveillance system is the collection of population-wide data that could guide policies formulation and prevention strategies. Surveillance data have shown bicycle helmets to be effective in mitigating TBI, making the use of helmets the single most effective way to reduce head injuries and fatalities resulting from bicycle crashes.

While Minnesota has no bicycle helmet use law, 21 states (including the District of Columbia) have enacted some form of bicycle helmet usage laws, mostly for riders younger than 16. Can Minnesotan child bicyclists afford to do without state bicycle helmet legislation?

Methodology

Analysis would include presentation of injury trends, hospital fatality rate calculation and cost data summation using data from Minnesota Trauma Registry, hospital discharge records, supplemented by abstracted data.

CrashHelp: An Innovation to Improve Traffic Crash Emergency Medical Response

Thomas Horan, Ph. D.
Research Director
Center for Excellence in Rural Safety (CERS)
State and Local Policy Program
Humphrey School of Public Affairs
University of Minnesota
301 19th Ave. S., Room 280
Minneapolis, MN 55455
909-607-9302
tom.horan@cgu.edu

Benjamin Schooley, Ph. D.
Research Assistant Professor
School of Information Systems and Technology
909-607-9395
ben.schooley@cgu.edu

Frank Douma
Humphrey School of Public Affairs
University of Minnesota
612-626-9946
douma002@umn.edu

Objective

Of the “Four-E’s” of highway safety (education, engineering, enforcement, and EMS), the last functions as a safety net when the others fail. However, in the EMS system there are major gaps in information delivery between on-scene emergency medical providers and definitive care providers. This presentation will introduce CrashHelp, a mobile multimedia EMS application that closes this information gap. CrashHelp uses existing and emerging technologies, to more effectively collect, share, and visualize emergency medical information, improving the EMS systems.

Ideally, this material would be presented in a panel with Lee Munnich and David Thorpe to consolidate current research by the Center for Excellence in Rural Safety (CERS) at the University of Minnesota’s State and Local Policy Program. This will provide conference attendees from rural areas a variety of strategies to increase the safety of local roads.

Methodology

1. **Conceptual Model – 2004-2006:** Development of Time-Critical Information Services Model for EMS that emphasizes end-to-end performance.
2. **Case Study Research – 2005-2009:** Two case studies to validate the model and explore best practices: San Mateo County, Mayo Clinic Trauma System.
3. **Prototype Development and Beta Testing – 2009-Present:** Review of comparative cases, design and testing of prototype CrashHelp, and beta test in Boise, Idaho.

Results

Run from July 18 to October 31, 2011, the beta test in Boise, ID included 20 ambulances from two providers, six hospitals, and the Idaho EMS agency. Over 80 unique paramedic users generated on-scene or in-transit information via mobile devices and transmitted this directly to hospitals. Other results included improved information collection by on-scene EMS personnel, improved communication between pre-hospital transport and hospital organizations (ED / Trauma), improved care decision-making by hospital personnel (for some incidents), and improved resource utilization by hospital personnel.

Potential Applications

CrashHelp is expected to begin a pilot demonstration in Minnesota in 2012. This will provide another opportunity to examine its application in EMS systems.

Policy Implications

CrashHelp provides a real-time interface between on-scene medical providers and providers of definitive care. For regions adopting CrashHelp, the tool will potentially provide increased efficiencies in the delivery of definitive care, hospital billing, and EMS medical treatment.

Identifying Issues Related to Deployment of Automated Speed Enforcement

Lee Munnich
Senior Fellow and Director
State and Local Policy Program
612-625-7357
munni001@umn.edu

Frank Douma
Assistant Director
State and Local Policy Program
612-626-9946
douma002@umn.edu

Humphrey School of Public Affairs
University of Minnesota
301 19th Ave. S., Room 280
Minneapolis, MN 55455

Objective

Automated Speed Enforcement can be an effective strategy for reducing road fatalities, especially in rural areas where low traffic volumes and smaller populations make human-based enforcement mechanisms inefficient, if not impossible. However, political and legal obstacles have stood in the way of implementing this safety measure. Using Minnesota as a case study, this presentation will examine automatic speed enforcement's effectiveness, public support, and legal considerations.

Ideally, this material would be presented in a panel with Thomas Horan and David Thorpe to consolidate current research by the Center for Excellence in Rural Safety (CERS) at the University of Minnesota's State and Local Policy Program. This will provide conference attendees from rural areas a variety of strategies to increase the safety of local roads.

Methodology

1. Review existing empirical data regarding the effectiveness of automated speed enforcement where it is deployed in the United States.
2. Survey Minnesota residents documenting the degree of public support for deployment of automated speed enforcement, and in what situations.
3. Identify legal and political questions raised and Minnesota laws affected by deployment of automated speed enforcement.

Results

Research is ongoing.

Potential Applications

The presentation will focus on initial articulation of issues based upon findings from the above 3 efforts, and suggestions for addressing them.

Policy Implications

This effort focuses on Minnesota as a case study, identifying the key issues raised by the prospect of deploying automated speed enforcement in Minnesota, and seeking to provide valuable information on which technologies, approaches and requirements would be most likely to gain legislative support.

Occupant Restraint Usage in Minnesota

Hal Campbell
651-201-7078
hal.campbell@state.mn.us

Kathleen Haney
651-201-7064
kathleen.haney@state.mn.us

Department of Public Safety
Office of Traffic Safety
444 Cedar Street, Suite 150
Saint Paul, MN 55101

The Minnesota Department of Public Safety Office of Traffic Safety conducts annual observational surveys of seat belt usage in Minnesota. For 2010 and 2011 nighttime as well as daytime surveys were conducted and compared. An additional survey was undertaken to assess booster seat usage in response to recent legislation.

Our presentation would highlight the methodology and results of all three survey types. In addition to these direct observational surveys the presentation would highlight the results of an evaluation of Minnesota's Primary Enforcement law that will be conducted this winter.

Some areas of interest to be presented include:

- Although seat belt use among fatally injured persons is substantially lower during the nighttime hours, observed seat belt usage among the total population did not significantly differ from day to night
- Daytime belt use for front seat occupants was the same in the annual survey as it was reported in the booster seat survey
- Results from the yet to be conducted evaluation of Primary Enforcement

Development of a Portable Weigh-in-Motion (WIM) System for Rural Highways

Taek Kwon
University of Minnesota Duluth
253 Marshall Alworth Hall, 1023 University Dr
Duluth, MN 55812
218-726-8211
tkwon@d.umn.edu

Benjamin Timerson
MnDOT
395 John Ireland Blvd, MS 450
Saint Paul, MN 55155
651-366-3855
benjamin.timerson@state.mn.us

Recent increase in heavy truck volumes on local roads, caused by higher demands on agricultural commodities, raises great concerns on the life of existing local road infrastructure, elevating the needs for truck weighing and enforcements. Installing permanent Weigh-in-Motion (WIM) stations could solve the problem but is expensive (over \$250,000 per station) and rarely justifiable for local roads. In addition, mechanistic designs introduced in the 2002 Design Guide demand WIM data as one of the primary inputs to pavement design. Consequently, measuring and collecting vehicle weight data is increasingly becoming imperative in road maintenance and reconstruction. One solution to bringing the WIM technologies to local roads at a low cost is to use portable WIM systems that can be easily moved around to collect data from multiple locations. Unfortunately, portable WIM systems that can be deployable at the level of state highway traffic are presently not available on the market. MnDOT recognized this need for portable WIM systems and initiated a research project with the University of Minnesota Duluth to develop a weigh-pad based portable WIM system that can be easily deployed much like a tube counter. A prototype was completed in 2011 and successfully tested on the MnRoad test track and on Highway-53. The developed system is battery operated, low cost, and easily installable on both rigid and flexible pavements. This talk will provide present status and some details on the tests of the prototype.

Concrete Paving and Texturing for Sustainability

Bernard Izevbekhai
MnDOT
1400 Gervais Ave, Suite 645
Maplewood, MN 55109
651-366-5454
bernard.izevbekhai@state.mn.us

Contemporary concrete pavement technology is challenged to provide efficient material utilization, reduced chemical pollution, reduced noise pollution and as well as durability. In addressing these issues, efforts have been made to minimize surface run-off by the use of pervious concrete. Noise reduction initiatives have culminated in the development of quiet concrete pavements. The effective use of recycled aggregates and higher pozzolanic-substitution has been demonstrated in Interstate 94 test cells in the MnROAD research facility.

This paper discusses the processes used, the successes achieved as well as the continuing efforts. A cost-effectiveness analysis of each of these initiatives is summarized.

Overview of the Minnesota Department of Transportation Connected Vehicle Safety, Mobility, and User Fee Project

Cory Johnson
Connected Vehicle Program Engineer,
MnDOT Office of Traffic, Safety and Technology
1500 W. County Road B2, MS 725
Roseville, MN 55113
651-234-7062
coryj.johnson@state.mn.us

J. Kyle Garrett
Mixon/Hill, Inc

Christopher J. Hill
Mixon/Hill, Inc

The Minnesota Department of Transportation (MnDOT) has undertaken the multi-year Connected Vehicle Safety, Mobility, and User Fee (CVSMUF) Project to demonstrate the utility of Connected Vehicle applications for the agency and the traveling public in Minnesota. As the name implies, the program addresses multiple transportation operational needs. The safety applications provide in-vehicle signing to supplement the driver's view of the roadway and potential intersection conflicts; the mobility applications both collect and provide traffic data; and the user fee system demonstrates collection of mileage-based revenues while protecting the driver's privacy. As a Connected Vehicle program, information is shared between in-vehicle and infrastructural systems through wireless communications. Unlike the majority of Connected Vehicle demonstrations, the in-vehicle components are developed entirely from aftermarket devices, the communications include both commercially-available 3G cellular and local agency-installed Dedicated Short Range Communications (DSRC), and the infrastructure ranges from the roadside to the back office. The program has developed and is deploying a set of applications to 500 volunteer test participants in the Twin Cities area. Complete results of the program will become available in 2013.

Background

The Connected Vehicle initiatives (formerly called Vehicle Infrastructure Integration or VII) were developed from previous intelligent highway vehicle programs including the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, the Transportation Equity Act for the 21st Century (TEA-21) of 1997, and the Intelligent Vehicle Initiative (IVI) that was created through TEA-21. Connected Vehicle programs seek to improve traffic safety and mobility while enhancing commerce in the areas where it will be implemented.

MnDOT initiated the Connected Vehicle Safety, Mobility and User Fee project in 2008 as a means of assessing the value of Connected Vehicle technologies for Minnesota. The goals of the project are to:

- Evaluate the effectiveness of in-vehicle signing for improving safety using localized applications.
- Fill the gap between the existing Connected Vehicle Proof of Concept demonstration and future funding decisions.
- Determine if the in-vehicle signing approach being developed could be used to implement additional Connected Vehicle applications.
- Assess if the proposed Connected Vehicle application could be used to implement mileage-based user fees.
- Assess the viability of a non-network Connected Vehicle safety application, especially for rural deployments.
- Demonstrate the proposed Connected Vehicle approach for providing location-specific traveler information and collecting vehicle probe data.
- Assess the feasibility of using consumer devices for implementing Connected Vehicle applications.

The work was divided into two phases in order to provide an implementation decision point. Phase I consisted of tasks necessary to identify why the deployed system is needed, what the proposed system should do, when and where the system should be deployed and how the system should work. The results of the Phase I work became the basis for the decision to proceed to Phase II, which is focused on the design and implementation of the system, its demonstration deployments, and a complete evaluation.

The project work has been distributed among three teams: Technical Program Management, Evaluation, and Implementation. The teams have worked with each other extensively during Phases I and II to ensure that project goals are met in a timely and coordinated manner. Project management duties have been shared by all three teams to ensure each team is allowed input on the others' work plans.

Three application areas were identified by MnDOT in Phase I that best meet their safety, mobility and funding goals: an In-Vehicle Signing application addresses safety issues; an Enhanced Traveler Information application would improve driver mobility; and a Mileage Based User Fee (MBUF) application could counteract the problem of diminishing fuel tax revenue. All of these applications were required to be deployed on aftermarket devices within a common in-vehicle platform.

Phase I – System Concepts and Planning

The goal of Phase I of this project was to develop the system concepts and to plan for implementation in Phase II. The Phase I scope of work was divided into two components. The Technical Program Management Team formulated a system concept and scope of work for implementing a system in Phase II. The Evaluation Team prepared plans for assessing the effectiveness of the system in meeting the research goals. The two teams worked together with MnDOT to assure that the Evaluation Team understood the scope of the system and that the Technical Program Management Team incorporated provisions to support the evaluation.

A Practical Concept of Operations

Development of the system concepts started with a series of workshops and interviews to assess the needs and goals to be addressed by the project. As noted above, the project is addressing safety, mobility, and user fee applications, which suggested an equally broad set of stakeholders. Although the concept workshop attendees were limited to state agency staff, participants represented perspectives of drivers; traffic managers and planners; traffic data consumers and providers; transportation operations and maintenance; state, county, and municipal road engineers; the state Department of Revenue, which is responsible for collection of fuel taxes and subsequent distribution of funds; and the state Department of Public Safety, which collects registration and license tab fees and issues license tabs.

A survey of mileage-based fee programs and analyses of similar Connected Vehicle demonstrations and applicable technologies were conducted to provide a context for the description of solutions and operational scenarios. These studies identified numerous demonstrations of VMT-based fee programs, cooperative vehicle-infrastructure systems, and aftermarket devices with navigation and traffic information. The Minnesota program, however, appears to have been the first to consider combining these elements into a single demonstration program with public participation.

Concepts were focused on the demonstration and possible deployments within the state of Minnesota. The concepts and scenarios reflect a basis in and evolution from Minnesota-specific practices and did not attempt to address other states' operating models. Neither did the system concepts presume links to other Connected Vehicle architectures or systems

The specific applications envisioned for the system demonstration included:

- Mileage-based user fee
- In-vehicle signing for work zones, school speed zones, speed limit zones, curve speed warnings, and intersection conflict warnings
- Probe data collections and enhanced traveler information

The system concept consisted of a consumer aftermarket in-vehicle navigation device, interfaces to external traffic data providers, back office systems to accumulate MBUF and probe data, and wireless and network communication to link those systems. DSRC was specified only for local safety functions such as intersection conflict warnings.

These results were documented in a Concept of Operations (ConOps), a set of preliminary requirements to be applied directly to the Phase II implementation, and a Phase II Implementation Scope of Work. Implementation scenarios in the ConOps described what the Connected Vehicle applications should do, and the preliminary requirements set constraints on the design and operations of the overall system. The preliminary requirements addressed functional

requirements and system-wide constraints, but did not attempt to constrain the design alternatives for any particular components.

Setting Up an Objective Evaluation

It has been important to the program to provide quantitative assessments of system performance and user acceptance as well as the technical demonstration. Phase I also created a Preliminary Evaluation Plan as for the implementation, to be revised and applied in conjunction with the Phase II system deployment. The Evaluation Plan provides a basis for an analysis of the evaluation objectives, the design of the pilot demonstrations with the 500 user participants, data collection activities, and focus group interviews and procedures. Staging the development of the Evaluation Plan early in the project, prior to even the implementation decision, has helped assure that the demonstration fulfills its institutional and technical goals.

The Evaluation Plan identified seven objectives related to measuring the outcome of the deployment. These are

- Document the programmatic / implementation experience of the Pilot Study.
- Assess the technical performance of systems and sub-systems.
- Assess customer satisfaction with the in-vehicle system.
- Investigate the safety impacts of the system.
- Investigate mobility impacts associated with MBUF.
- Investigate the feasibility of generating probe-based travel times using the system.
- Assess future potential and overall feasibility.

Various techniques will be used to collect evaluation data in service of these objectives, including vehicle data, surveys, focus group meetings, interviews, and observations. Data will be collected during both “baseline” and “test” periods to assess how drivers’ behavior and opinions change with and without the functionality being evaluated. Considered together, the data collected will provide a picture of how drivers behave, how the test system affects their behavior, and how their perceptions about the system and the underlying policies change over time. Among the key areas of investigation are miles traveled and travel patterns, perceptions of fairness and accuracy, and opinions regarding privacy.

In preparing for recruitment, the Phase I Evaluation Plan considered how to be most representative in selecting a broad range of Minnesotans balanced against the practical requirement of efficiently administering a large test deployment with multiple goals. These goals include the needs to involve rural and urban drivers, to include high usage corridors and safety zones, and to create reasonable pricing zones to assess the effects of fees on driving behavior. The Pilot Study Project Team (MnDOT, the Technical Program Management (TPM) Team, and the Evaluation Team) chose to conduct the test within the greater Twin Cities Metro Area in order to include urban and highly congested regions while focusing on a specific Metro area county with a high rural population and many commuters. The population of Wright County is approximately 120,000 and the county covers approximately 660 square miles. Focusing the Pilot Study on Wright County provides a mix of urban and rural opinions with 47 percent of the county being defined as “urban” and 53 percent of the county being defined as “rural”. (1) It is important to note that although Wright County does include many rural residents, given that these individuals live in close proximity to the Metro Area, their viewpoints may indeed differ from those in more remote areas of the state. Although not part of the current scope of work, the Evaluation team may exercise the option to conduct a statewide telephone survey to reach viewpoints of this population

Phase II – Implementation

The ConOps and Evaluation Plan created in Phase I showed sufficient promise for the demonstration that MnDOT decided to proceed with the Phase II implementation. The Phase I work products—the ConOps, the preliminary requirements, and the implementation work plan—became the basis for the Phase II request for proposal. The proposals received by MnDOT described a range of implementation alternatives, particularly for the aftermarket consumer device(s) to be used for in-vehicle processing, the user interface, and for communications. The leading candidate solutions were built around personal navigation devices, mobile phones, or a combination of the two.

After selection of the Implementation contractor, implementation plans followed a standard systems engineering process to specify the requirements and design. The Phase I ConOps became the basis for a revised Phase II

document with greater detail around the types of devices to be used in the system design. The Phase II system requirements specification incorporated the Phase I preliminary requirements, new requirements derived the Evaluation Plan criteria, and detailed requirements driven by the proposed system architecture. The demonstration was given a public-facing name of the Minnesota Road Fee Test (MRFT).

The Implementation contractor evaluated multiple alternatives for each of the system’s architectural components. The system’s final in-vehicle design incorporates a 3G Samsung Captivate(TM) Android smartphone with CoPilot(R) or Google navigation software and custom in-vehicle signing and MBUF applications; a vehicle identification module that assures the device is being used in its assigned vehicle; and supplemental DSRC radio for the intersection safety application. Back-office applications, hosted in a Microsoft Windows Azure(TM) cloud services platform, include Web services for communications, the admin Web portal, and participant Web portal; the system database; and file storage.

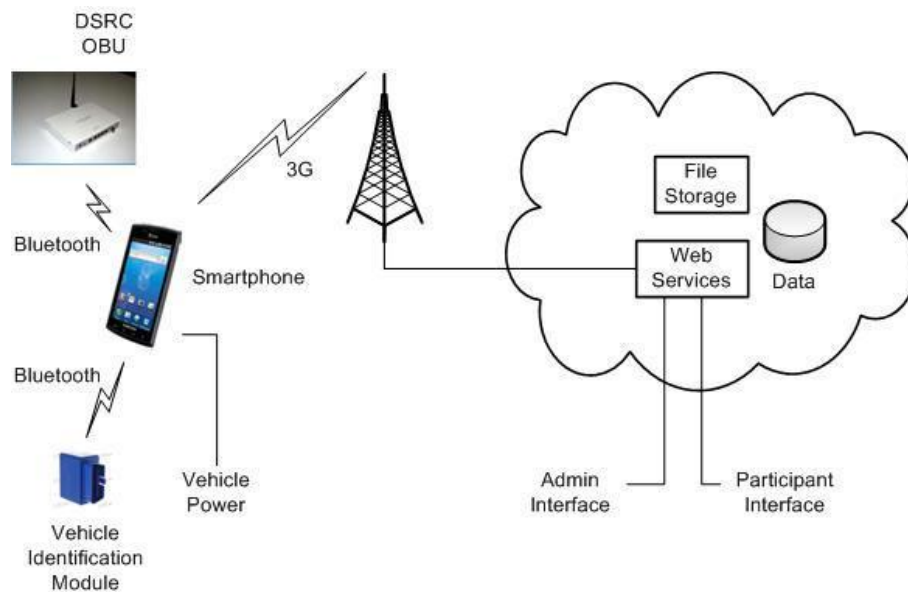


Figure 2. System Elements

MBUF Pricing Zones

The system provides the capability to define multiple MBUF pricing zones. The relevant system requirements describe several categories of zones distinguishing between national, state, metropolitan, and other large geo-zones. For the Phase II implementation, this feature will be used to distinguish between travel in the Twin Cities metro and travel in less urbanized areas. Other pricing factors—for example, time of day, travel on specific roadway segments—may also be applicable.

The issue was then to define a Twin Cities “metro zone” for the demonstration. The metro zone is not required or intended for test purposes to implement any particular operating strategy or objective like reducing congestion. It should, however, have some connection to geographic landmarks and operational realities. Several alternatives were identified:

- A broad interpretation of the metropolitan area would include all seven metro area counties. For test purposes, this would include Hennepin County (Minneapolis and suburbs), but exclude Wright County. It would not explicitly distinguish urban from rural zones.
- A precise distinction might use the Metropolitan Urban Services Area (MUSA) as defined by the Twin Cities Metropolitan Council. The MUSA describes the extent of the metro area for infrastructural planning purposes and generally matches a traveler’s expectation for being in the “metropolitan area.” The MUSA is not, however, easily described at a detailed level.
- From a driver’s perspective, the I-494/I-694 beltway provides a very clear, easy-to-describe metro zone boundary.

In-Vehicle Signing Strategy

The user needs and requirements also specified that the in-vehicle signage needs to accurately reflect the physical roadside signage. While it might be sufficient for evaluation purposes to create artificial zones around a school, for example, driver expectation could be confounded by inconsistent signage. The definition of zones was necessarily constrained by signage actually present in the field along those high-traffic roadways.

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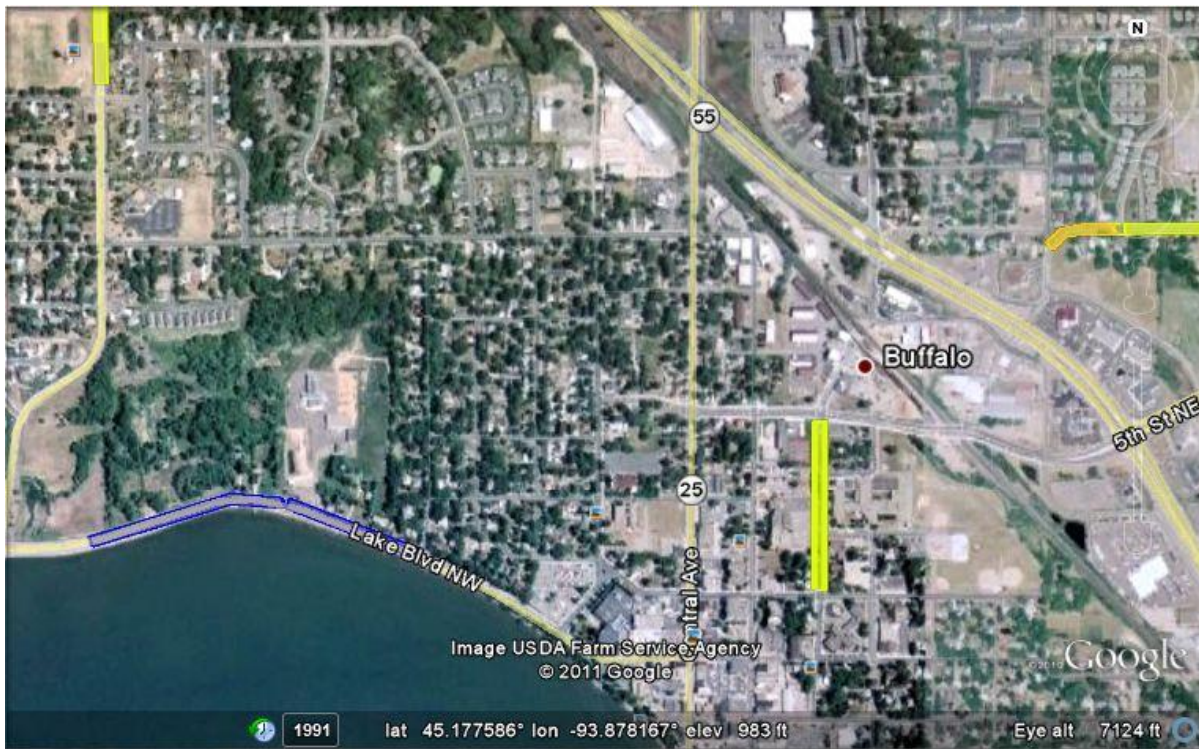


Figure 4. Typical Signage Zones
[yellow – schools; orange – curves; blue – speed limits]

Testing

Development and testing of the prototype system was completed in August 2011. As is typical of complex systems engineering and development projects, testing was performed at unit, integration, and complete system levels by the Implementation Team. Unit testing of system component hardware and software was performed throughout the development process. Integration testing of internal system interfaces was performed as individual components were completed and added to the functional core of the system.

System testing was performed by a team independent of the developers within the Implementation Team. Tests were performed both across the Wright and Hennepin County deployment areas and on the MnDOT MNROAD test facility. Issues encountered in system testing were documented and resolved prior to system release to MnDOT for acceptance testing.

Acceptance testing was performed over two weeks by MnDOT users with varying levels of technical and programmatic knowledge of the project. The test users performed the same sign-up, training, and installation activities as will be used with actual project participants. The test group used the system throughout the two testing weeks and was able to check the project web site for trip records, receive invoices for mileage fees, and pay invoices. The test period also allowed the project team to verify the accuracy of signage zone and mileage fee system functions.

Final system modifications to resolve functional and operational challenges were followed by regression testing that assured that all system requirements had been met.

Prototype Deployment

Five hundred drivers will participate in the six month long field deployment, and will be segmented into three cohorts (or “waves”) starting at different times of year to control for seasonal variation in driving behavior. In order to randomly recruit a representative sample of drivers to participate in the study while ensuring that drivers are likely to drive frequently through the limited number of “safety zones: and probe corridors that will be included in the study, the Evaluation Team took a multifaceted approach to recruiting. The Evaluation Team will recruit 400 drivers randomly sampled from Wright County to accomplish the primary goals of the project including gathering perception

data and documenting driver behavior in response to MBUF. An additional 100 drivers will be recruited from the Twin Cities metro area but will be selected using targeted screening criteria about when and where they drive. Specifically, these drivers will be selected based on the frequency with which they travel through safety zones and probe corridors of interest. At least 50 of these drivers will be from Hennepin County.

The first participant cohort will begin the test deployment in September 2011. This cohort will be composed of 150 drivers from Wright County.

Participant Experience

Participation in the program will evolve through six stages of interaction.

- In the first stage, the participant is recruited and receives enough information about the program to elicit his/her participation.
- The second stage enrolls the participant; provides and installs the in-vehicle components of the system; and captures the baseline data on the participant, his/her vehicle, and its mileage. The participant agrees to use the device whenever and wherever the vehicle is driven; to cooperate with the program administrators in system updates, surveys, interviews, and odometer readings; and is informed of the stipend and incentives for participation. The participant is also instructed in how to use the system's navigation features.
- In the third stage, the participant uses the system for navigation purposes and, from a program perspective, establishes a baseline of driving behaviors and mileage.
- The fourth stage has the participant return for a second odometer reading and a briefing on how the mileage-based road user fee and signage components will operate in the next phase. Participants in this stage are given funds from which they will pay out invoices for mileage driven in the vehicle.
- In the fifth and longest stage, participants use the device whenever driving their vehicles. Invoices for miles driven are billed and intended to be paid monthly. In-vehicle signage is active and warning drivers of excessive speed in the configured zones.
- The sixth stage concludes the participant's experience with a final odometer reading and removal of the in-vehicle equipment. Settlement is made for all miles driven in the fifth stage. Participants are interviewed about their experience, and may be asked to participate in more detailed follow-up surveys.

Access to participant data is strictly controlled and limited to individual participants and system administrators. Probe data is transmitted and stored separately from mileage fee records. Participants must explicitly associate trip data with their user accounts in order for there to be any correlation between records. Participants can access their records, view and pay invoices, schedule odometer readings, and get information on the test program through a Web portal.

Field deployment to the first of three waves of users is scheduled for September 2011 and will extend over six months of operation. Subsequent waves will also use the system for six months each, to be followed by an evaluation and decommissioning period. The final report is scheduled to be published in November 2012 on the project website at www.dot.state.mn.us/milesbaseduserfee.

Summary and Lessons Learned to Date

Although final results from this program are not yet available, the progress to date provides several key lessons for Connected Vehicle application development and deployment. First, broad institutional support and input is needed to develop a realistic concept of operations, especially where policies and statutes (for example, privacy and user fees) may affect the system. Some Connected Vehicle solutions can be built pragmatically with aftermarket components. Consumer electronic products, commercially available wireless networks, and cloud computing services are creating tremendous opportunities for rapid development and deployment. User interactions with the system—from the perspective of consumer/drivers, agency operators, and administrators—need to be factored into the system design from the beginning. Requirements need to reflect the intended operations, not just be focused on the technology itself. Measures of success need to be understood and incorporated into the system plan. The need to monitor and evaluate system performance may drive design features that would otherwise be excluded or overlooked.

References

(1) Source: City Data, Wright County, Minnesota, http://www.city-data.com/county/Wright_County-MN.html (Accessed October 21, 2010).

Minnesota Road Fee Test: Mileage Based User Fee Rate Structure Concept

Daryl Taavola, PE, PTOE
Vice President
URS Corporation
100 S. 5th St., Suite 1500
Minneapolis, MN 55402
612-373-6889
daryl_taavola@urscorp.com

Cory Johnson, PE
Traffic Research Director
MnDOT
1500 West County Road B2
Roseville, MN 55113
651-234-7062
coryj.johnson@state.mn.us

Dan Nelson, AICP
ITS Planner
URS Corporation
100 S. 5th St., Suite 1500
Minneapolis, MN 55402
612-373-6334
dan_nelson@urscorp.com

This technical paper describes one potential method of assigning mileage-based user fees to vehicles participating in the Minnesota Department of Transportation (MnDOT) sponsored Connected Vehicle demonstration called Minnesota Road Fee Test (MRFT). Under this proposed approach, Mileage-Based User Fees (MBUF) would be determined by first establishing a Base MBUF Rate depending on the type of vehicle and then adding an Incremental MBUF Rate that would vary by roadway classification, defined in terms of geographic location, roadway jurisdiction, and time of day for travel. MBUF are intended to provide jurisdictions responsible for building and maintaining roads and bridges with an alternative source of revenue to the gasoline tax currently assessed to gasoline distributors and passed on to motorists at gas stations based on the amount of gallons of fuel consumed. An alternate approach to assessing MBUF fees during the demonstration will be implemented based on input gathered from focus group meetings conducted in early 2011.

Evaluation of the Minnesota Road Fee Test: Preliminary Data

Jennifer Rephlo
SAIC
8301 Greensboro Drive, MS E-12-3
McLean, VA 22102
703-676-2407
jennifer.a.rephlo@saic.com

Cory Johnson
MnDOT
1500 County Road B2 W
Roseville, MN 55113
651-234-7062
coryj.johnson@state.mn.us

Sheryl Miller
SAIC
8301 Greensboro Drive, MS E-12-3
McLean, VA 22102
703-676-4501
sheryl.miller@saic.com

Chris Armstrong
SAIC
8301 Greensboro Drive, MS E-12-3
McLean, VA 22102
703-676-4436
christopher.m.armstrong@saic.com

Nicholas Kehoe
SAIC
8301 Greensboro Drive, MS E-12-3
McLean, VA 22102
703-676-6872
nicholas.p.kehoe@saic.com

The Minnesota Department of Transportation (MnDOT) is conducting a pilot project entitled the Connected Vehicles for Safety, Mobility, and User Fee (ISMUF) project. This project aims to demonstrate the capability of one aftermarket device to accomplish three primary goals:

1. Assess mileage-based user fees;
2. Convey safety alerts through in-vehicle signage; and
3. Provide a means for vehicles to serve as probes to generate corridor travel times. (This is a test of feasibility, however, and drivers in the test will not see these travel times.)

The pilot test, known as the Minnesota Road Fee Test, is unique in that it is using a commercial off the shelf device (a smartphone) as the means for assessing mileage-based user fees. Using an in-vehicle device for assessing fees enables drivers to see current rates in real-time and allows for a much more detailed fee structure than would be possible without technology (e.g., pricing by zone or by time of day). The Minnesota test is combining both congestion pricing and cordon pricing as drivers will be charged a higher fee for any miles driven in the Metro Area during peak hours. Using an in-vehicle device also allows for mileage based user fees to be integrated with other in-vehicle technologies. The Minnesota test is combining the fee assessment system with other safety and mobility technologies that are in support of the United States Department of Transportation's (USDOT's) research in vehicle connectivity with the wireless communications environment and Cooperative Intersection Collision Avoidance Systems (CICAS) Initiatives. In terms of mobility applications, drivers in the test will serve as probes to generate travel times. In terms of safety applications, drivers will be presented with safety alerts when traveling through select school zones, work zones, speed zones, and curves.

Science Applications International Corporation (SAIC) designed and is currently conducting the independent evaluation of the Minnesota Road Fee Test. SAIC is recruiting 500 Minnesota drivers from the greater Twin Cities Metro Area. The test kicked off in September 2011 and will conclude at the end of 2012. The 500 drivers are divided into three "waves" to control for seasonal variations in driving behavior. Each driver will participate in the test for approximately 6 months, the first 2 months of which are a Baseline Period, in which

only navigation features of the smart phone are present, and the remaining months of which are the Testing Period, in which mileage-based user fees (MBUF) & safety signage functions are present.

As of May 2012, the team will have preliminary findings to share. One complete “wave” of data will have been collected, representing approximately 150 drivers traveling for a period of 6 months with the device in their vehicle. Preliminary findings from trip data should reveal driver behavior in response to this alternate method of fee assessment. Changes to traveler behavior could include fewer miles traveled or fewer trips made, as well as shifts in when trips are made (to avoid higher fees during peak periods). The evaluation team will also have collected and begun analysis on a wealth of data from other sources including help desk inquiries and service reports, invoicing records, surveys, focus groups, and interviews.

Guidelines on Bus Rapid Transit Development in the Twin Cities: Overview and Best Practices

Cole Hiniker
651-602-1748
cole.hiniker@metc.state.mn.us

Mary Karlsson
651-602-1819
mary.karlsson@metc.state.mn.us

Metropolitan Council
390 Robert Street North
Saint Paul, MN 55101

By 2013, the Twin Cities region will be operating its first bus rapid transit (BRT) line, the Red Line (Cedar Ave), connecting Apple Valley and Eagan to the Mall of America and the Blue Line (Hiawatha) light rail transit (LRT) in Bloomington. However, questions remain among transportation professionals, elected officials, and most importantly, the public, about what BRT is in this region and how it relates to LRT and differs from existing bus service. Recent efforts have attempted to better define BRT for our region, based on experience within the region and best practices from around the country. These efforts include the Regional Transitway Guidelines, the Arterial Transitways Corridor Study, and the implementation of BRT on the Red Line and elements of BRT on the Orange Line (I-35W).

The region's Transportation Policy Plan (TPP) lists two types of BRT for development in the region, Highway BRT and Arterial BRT, but its descriptions of the modes are policy-level and not oriented toward the details of implementation and operation. And while the TPP recognizes one of the primary advantages of BRT over rail modes is its flexibility to tailor implementation to match a specific corridor's needs and challenges, this flexibility contributes to confusion about BRT. The flexibility of mixing service types, infrastructure scale, and implementation timing needs to be balanced by a level of regional consistency across BRT and other transitway corridors that maintains the integrity of the "BRT brand" and ensures the expectations of policy-makers and transit users are met.

The Regional Transitway Guidelines create a basis for decision-making in BRT implementation by establishing best practice for nine elements of transitway implementation:

- Service Operations
- Station Spacing and Siting
- Station and Support Facilities
- Runningways
- Vehicles
- Fare Collection Systems
- Technology and Customer Information
- Identity and Branding
- Project Development, Leadership, and Oversight

Within these areas, the Guidelines establish the region's shared expectations for the technical elements of Highway and Arterial BRT projects. These Guidelines will serve as the starting point for BRT implementation in the region and are written so they allow for flexibility in local decision-making while supporting regional consistency in transitway development. The presenters will provide an overview of the technical elements of BRT and how the mode fits within the region's existing network of bus and rail service. The focus of this presentation will be on Highway BRT, and a separate presentation within this same session will focus on the details of Arterial BRT. The presentation will include references to projects in development in the Twin Cities region and, when appropriate, references to projects from around the country.

Arterial Transitway Corridors Study: Results and Conclusions about Arterial Bus Rapid Transit

Charles Carlson, AICP
Metro Transit
560 6th Avenue North
Minneapolis, MN 55411
612-349-7639
charles.carlson@metc.state.mn.us

Katie Roth, AICP
SRF Consulting Group, Inc.
One Carlson Parkway, Suite 150
Minneapolis, MN 55447
763-475-0010
kroth@srfconsulting.com

Arterial bus rapid transit (BRT) is a cost effective means to deliver improved transit service quality in urban areas. Metro Transit, with SRF Consulting, completed a comprehensive study of eleven arterial transitway corridors to evaluate the potential of arterial BRT, or “Rapid Bus” improvements.

The project team developed concept plans for enhanced speed, reliability, and customer experience for each study corridor. The project team will share these plans as well as study results including cost estimates, ridership forecasts, and other corridor conclusions. The presentation will conclude with prioritized corridors for further development, next steps and key considerations toward implementing BRT/Rapid bus corridors for the Twin Cities region.

The eleven corridors evaluated in the *Arterial Transitway Corridors Study* include Snelling Avenue, East 7th Street, West 7th Street, Robert Street, Central Avenue, Nicollet Avenue, Hennepin Avenue, Lake Street, West Broadway, Chicago Avenue, and American Boulevard.

The Arterial Transitway Corridors Study began in early 2011 and will conclude in early 2012. At the CTS Research Conference in May 2011, agency staff introduced the study in a conference session. For 2012, the project team will share study results and conclusions developed since the 2011 CTS Research Conference.

Red Line/Cedar Avenue Bus Rapid Transit Development

Sam O'Connell, AICP
Sr. Transit Specialist
Dakota County
14955 Galaxie Avenue
Apple Valley, MN 55124
952-891-7105
sam.oconnell@co.dakota.mn.us

By fall of 2012, the Twin Cities region will have its first operational bus rapid transit (BRT) line, the Red Line (Cedar Ave), connecting Apple Valley and Eagan to the Mall of America and Blue Line (Hiawatha) light rail transit (LRT) in Bloomington. In addition to introducing new services and facilities, the new transitway will extend benefits to existing commuter and local transit services.

Cedar Avenue is a highway with regional transportation significance within the Twin Cities metropolitan area, with over 100,000 average daily trips on the northerly end of the roadway. To maintain mobility along the 6-mile arterial section of Cedar Avenue (County Highway 23), an approach was identified that incorporates highway improvements and new transit services along the corridor. Developing BRT services and facilities for the Red Line will reduce congestion and provide economic development opportunities by incorporating traffic control changes, improvements to signalized intersections, access management, and roadway upgrades.

Stations and service in the transitway are planned to be staged incrementally. Initial BRT transitway investments were made in 2009 as part of the Urban Partnership Agreement. Additional service, with the introduction of station-to-station service, additional stations and layover facilities are planned for fall of 2012. Weekday station-to-station service will every fifteen minutes and every thirty minutes for weekend service. With the area of service being highly suburbanized; the provision of park-and-ride facilities and their functions with the community have also played an important role in development in the transitway.

The specifics of transportation tools needed in planning, designing, constructing and zoning to implement bus rapid transit are all key elements to the success of the Cedar Avenue Transitway. Specific elements that make the Cedar Avenue Transitway a unique BRT system include: uniquely designed stations and vehicles; ITS components; wayfinding; streetscaping and landscaping developed to provide a focal point through the business area of the corridor with special attention for pedestrians and bikers; and features to allow general traffic and transit vehicles to operate safely and efficiently.

The Regional Transitway Guidelines project set forth guidance on the many different elements of transitway implementation to set a basis for decision-making in BRT implementation that is based on best practices and other important considerations. The Red Line/Cedar Avenue Transitway addressed many of the guideline components.

Transportation Impacts of Transitways: A Case Study of the Hiawatha Line

Jason Cao
612-625-5671
cao@umn.edu

Jessica Schoner
612-412-4273
schon082@umn.edu

Humphrey School of Public Affairs
University of Minnesota
301 19th Ave S, 295 Humphrey Center
Minneapolis, MN 55455

This research evaluates the impacts of light rail transit on residential location choice and travel behavior. Federal and state governments have made substantial investments on developing transitways and promoting transit-oriented development. Will these ambitious efforts bring about meaningful transportation benefits? This study addresses this question by developing a matched-pair case study. Using the 2011 data of 1308 residents in six neighborhoods in the Twin Cities, we will explore the differences in residential preferences and travel behavior across the six neighborhoods and the role that light rail transit plays in the differences. In particular, we will investigate how important access to light rail transit was in residential location choice, and we will isolate the impact of light rail transit on driving and transit taking while controlling for confounding factors. This research will offer important policy implications on transportation benefits of transitways.

Doing Business Around Transitways: Survey Research on Business Perceptions of Twin Cities Transit Projects

Yingling Fan
Humphrey School of Public Affairs
University of Minnesota
301 19th Ave S, 295E Humphrey Center
Minneapolis, MN 55455
612-626-2930
yingling@umn.edu

Andrew Guthrie
Humphrey School of Public Affairs
University of Minnesota
301 19th Ave S, 280 Humphrey Center
Minneapolis, MN 554544
612-624-2082
guth0064@umn.edu

Major transit projects can have profound impacts on nearby businesses. Transitways—such as light rail or bus rapid transit lines—are frequently touted as catalysts for the development of vibrant neighborhoods with healthy local businesses. In a broad sense, the planning literature generally supports such claims: numerous studies find commercial property value premiums associated with proximity to premium (usually rail) transit stations. Willingness to pay more for commercial space near transit stations is generally taken to indicate favorable business conditions near transit. Other research finds evidence of commercial uses proliferating around fixed-guideway transit stops. Existing research however, focuses on broad, overall market trends, and does not consider the experiences and perceptions of individual station-area businesses. In addition, businesses in station areas of planned transitways often express concerns over lost business during transit construction and potentially being priced out of the neighborhood if neighborhood revitalization indeed occurs.

To fill this gap in existing knowledge and gain a neighborhood-level perspective of transitways' business impacts, the authors conducted a detailed survey of 160 businesses along four existing and planned fixed-guideway transit projects in the Twin Cities region. The survey sought to identify “winners” and “losers” in the transit development process—businesses which see themselves as either directly benefiting or suffering from transitway development. Randomly sampled business owners and managers responded to the survey through either an in-person interview or an electronic questionnaire. The survey found a small plurality of respondents who saw the transit project in their neighborhood as benign with regard to their businesses, though only slightly fewer expected transit improvements to have a somewhat positive impact over the next five years. Respondents expecting negative impacts from transit development were fewer in number, but more likely to expect strong impacts. In addition, a strong majority expressed either concerns or uncertainty about short-term construction impacts of future transitways. While employees' current commutes were dominated by driving, significant percentages of respondents reported that at least some of their customers arrived using alternative modes. More respondents expected employees to use future improved transit than reported employees using current transit services, and a majority expected at least some of their customers to use future services. Policy implications discussed include policies aimed at supporting otherwise viable businesses through transitway construction, and at encouraging transit passengers to patronize station area businesses.

2040 Minnesota's Roadmap to the Future

Margaret Donahoe
Minnesota Transportation Alliance
525 Park St, Ste. 240
Saint Paul, MN 55103
651-659-0804
Margaret@transportationalliance.com

Objective

To develop a long-range, multi-modal, comprehensive plan for Minnesota's transportation system that shows the interconnectedness of the modes and that is easy for the public to understand and support.

Methodology

We centralized numerous studies and reports from MnDOT, the Metropolitan Council and other transportation agencies and organizations and then solicited input from Transportation Alliance members. We included needed investments on the local system in addition to investments needed on the state and interstate system.

Findings/Results

The result of our work is a report that outlines how transportation investments impact Minnesota's economy, presents a map of what the transportation system could like in 2040, provides suggestions for strategies to improve the project delivery process and details many funding and financing options at both the state and federal levels that would increase the ability of the state to make needed transportation investments.

Policy Implications

The report provides policymakers in Congress, the governor and the legislature with a strong case for how transportation investments can create jobs and improve the state's economy and quality of life. In addition to showing the improvements needed on the transportation system, the report provides specific policy recommendations for changes in project delivery and accountability that are designed to improve the cost-effectiveness of transportation investments. Given that policymakers need to deal with funding and financing for the transportation system, this report provides detailed information on many funding and financing options that should be considered as the state works to improve the safety and effectiveness of the transportation system.

Development of Guidelines for the Design of Turn Lanes

Howard Preston
CH2M HILL, Inc.
1295 Northland Drive
Mendota Heights, MN 55120
651-365-8514
hpreston@ch2m.com

Section 5-3.01.03 of MnDOT's Road Design Manual (RDM) states that the objective of a turn lane is to be long enough to account for both storage and deceleration. The RDM goes on to suggest that the typical length of a turn lane is 300 feet of full width plus additional length based on a 180 taper section (15:1 taper from 12 foot wide lane), plus any additional length needed to accommodate down grades. This guidance relative to the typical length of a MnDOT turn lane has been in place for at least 35 years and has resulted in a very high degree of consistency along MnDOT's system of trunk highways – most turn lanes around the State are 300 feet long plus the 180 taper. However, since the current guidelines were developed two things have occurred which has caused some designers to ask – do these guidelines still work? First, two parts of the TH system, rural expressways and some high priority rural 2-lanes, now have posted speed limits greater than 55 miles per hour with higher actual operating speeds, which suggests the need for a longer deceleration distances. And second, traffic volumes and the fraction of heavy commercial vehicles have increased all across the system, which suggests the need for longer full width storage distances.

As a result, MnDOT initiated a project to develop a new process for designing the lengths of turn lanes. The process was intended to require slightly more effort on the part of designers (compared to simply using 480 feet), but it was expected that the process would produce turn lane lengths that more accurately reflected actual conditions on the road. The process that was ultimately adopted by MnDOT includes five steps: 1) Obtaining Data (Speed, Volume & Grades), 2) Determining the Type of Facility (Expressway/Conventional Road, Rural/Urban, Signal/STOP Control), 3) Calculate Turn Lane Demand (Deceleration + Storage), 4) Calculate Turn Lane Design (Account for Geometric Conditions) and 5) Document the Turn Lane Length.

The project included applying the suggested process to a variety existing highways to see if the computed turn lane lengths make sense. The results indicate that the higher operating speeds and higher traffic volumes do in fact require longer lengths for both deceleration and storage. In some cases, high speed rural and high volume urban signalized intersections, the computed lengths are almost twice the previously suggested 480 feet. MnDOT is currently working to incorporate this new process into the RDM.

Smartphone-Based Decision Support for the Visually Impaired at Signalized Intersections

Chen-Fu Liao
Minnesota Traffic Observatory (MTO)
Department of Civil Engineering
University of Minnesota
500 Pillsbury Drive SE
Minneapolis, MN 55455
612-626-1697
cliao@umn.edu

The blind and visually impaired travelers rely heavily on walking and taking public transit for their transportation needs. A major challenge for this population is safe crossing of intersections. As a result of the American with Disabilities Act (ADA), Accessible Pedestrian Signal (APS) systems at signalized intersections have improved significantly since 2000. However, these systems still have shortcomings for both users and municipalities, and new approaches are needed to adequately serve pedestrians with low vision. As part of our ongoing effort to develop a prototype Mobile Accessible Pedestrian Signal (MAPS) application for the blind and visually impaired, we have interviewed ten blind and low-vision people to better understand what types of information they use at intersection crossings and to identify information types that could assist them. With these survey results, a MAPS prototype was developed that provides signal and intersection geometry information to smartphone users at signalized intersections. User interaction is via simple tactile input (single or double-tap) and Text-To-Speech (TTS) technology. The overall goal of our project is to provide accessible information to the visually impaired at signalized intersections through a smartphone. This presentation will summarize the results from phase one study and preliminary results from field experiments.

In the future, intersections equipped with Dedicated Short Range Communications (DSRC) technology will advance the capabilities of MAPS to next level of mobility and safety applications for people with vision impairment. MAPS can take advantage of the low-latency capability of DSRC to coordinate cooperative communication among pedestrians (waiting at the crossing), traffic signal controllers, and approaching vehicles, thereby providing dynamic decision-making support to all travelers, not just the visually impaired.

Safe Intersections

Thomas A. Sohrweide, PE, PTOE
Manager, Traffic Engineering Services
SEH Inc.
3535 Vadnais Center Drive
Saint Paul, MN 55110
651-490-2072
tsohrweide@sehinc.com

Objective

Develop low-cost, readily deployable, low maintenance systems using commercial off the shelf technology, that can be used by transportation agencies to reduce crashes and fatalities at low-volume, non-signalized rural intersections.

Methodology

To meet this objective, five systems as described below have been designed and are being tested. The design of the systems varies by type of control, communication, detection, warning, signing, and fault notification. The systems also vary as to being either time based or speed based.

Findings

At the time of this abstract, the systems have not been installed. By the dates of the conference, the systems will have been installed and 30 day acceptance tests completed. The overall evaluation of the effectiveness will be in process.

Potential Applications

These systems are intended for use with low volume (rural) traffic conditions. The system advantages will be increased safety through relatively low cost, easy to install and maintain.

Bridge Approach Panel Expansion Joints

Farhad Reza, Ph.D., P.E.
Associate Professor
Department of Mechanical & Civil Engineering
Minnesota State University, Mankato
Mankato, MN 56001
507-389-5081
farhad.reza@mnsu.edu

In Minnesota, a concrete approach panel is typically used to provide a transition from a roadway pavement to a bridge. Between the pavement and the approach slab is an expansion joint to accommodate the movements of the bridge, primarily due to temperature changes. This is particularly critical for semi-integral and integral abutment bridges which are the preferred choice of MnDOT for spans less than 300 ft. Minnesota currently uses an “E8” detail at the expansion joint which is susceptible to premature failure leading to costly maintenance efforts. The results of a project aimed at identifying longer-lasting solutions for the expansion joint will be presented. Specifically, the presentation will provide an overview of the practices of other agencies, a description of some of the new methods being tried in Minnesota, and the results from monitoring the expansion and contraction of three recently constructed bridges.

Minnesota's Mileage-Based User Fee Demonstration Project

Cory Johnson, PE
MBUF Project Manager
MnDOT
1500 W. County Road B-2
Roseville, MN 55113
651-234-7062
coryj.johnson@state.mn.us

Ken Buckeye, AICP
Value Pricing Program Director
MnDOT
395 John Ireland Blvd
Saint Paul, MN 55155
651-366-3737
kenneth.buckeye@state.mn.us

Lee Munnich
Director, State and Local Policy Program
Humphrey School of Public Affairs
301 19th Ave S, 161 Humphrey Center
Minneapolis, MN 55455
612-624-7746
lmunnich@umn.edu

John Doan, PE
Senior Advisor
Atkins
11482 Goodhue Street NE
Minneapolis, MN 55449
763-355-8746
john.doan@atkinsglobal.com

Overview

This abstract is being proposed as a single session that would address various aspect of research that is ongoing or recently completed on the topic of mileage-based user fee (MBUF). Three broad areas of research related to MBUF will be presented, including:

1. Preliminary findings from **MBUF technology demonstration** which includes 500 participants in Wright and Hennepin counties.
2. Findings from **market research** of key stakeholder and broader public sentiments related to MBUF. The market research instruments included stakeholder interviews, focus groups and an online survey.
3. Recommendations of the **MBUF Policy Task Force** which deliberated over a six-month period, from June through November 2011.

Research Objective

This research project is being undertaken as part of an MBUF demonstration that was written into law by the state legislature and governor in 2007. Like many transportation organizations across the globe, the Minnesota Department of Transportation (MnDOT) is conducting research on a mileage-based user fee that may one day allow motorists to be taxed for the miles they drive instead of the amount of gas they buy.

Description of Research Elements/Approach:

MnDOT has recruited 500 volunteers in Wright and Hennepin counties in Minnesota to use off-the-shelf technology such as a Smart Phone with GPS applications. The phone will be programmed for motorists to submit information that MnDOT will use to evaluate whether the device provides timely and reliable travel data. In addition, the technology will have the ability to be shut off by the user so as to protect privacy and/or security of data. Default conditions with the device turned off requires user to pay the highest rate for the travel period or roadway.

In order to get broader policy input, MnDOT created a policy task force to examine the implications of implementing a mileage-based user fee. The policy task force was appointed by the MnDOT commissioner to gather and compile questions, concerns, expectations and preferences about a mileage-based user fee. The group held monthly meetings from June through November 2011. Their findings and recommendations will be presented to the MnDOT Commissioner in December 2011.

The project consultant team led by the University of Minnesota's Humphrey School of Public Affairs conducted extensive, statewide market research in the form of key stakeholders focus groups and a large-randomly sampled online survey of the broader public.

The market research yielded findings from five stakeholder focus groups held in throughout Minnesota. The focus groups, dubbed as "listening sessions" occurred over a course of eight weeks from April to June, 2011, lasted approximately two hours each, and met in the communities of Bemidji, Duluth, Rochester, Saint Cloud and Willmar. Attendance at each focus group varied from 8 to 15 participants, with an average of about 12 participants per session. Instant polling technology was used at each session to stimulate conversation and ensure that comments were provided by majority and minority opinions. The MBUF topics covered included measuring familiarity with the concept, use of revenues, technology options, privacy and applicability to various user groups.

In addition, an online-opinion survey of 400 Minnesotans was conducted to explore questions and concerns that must be addressed before such a fee could be implemented. The issues include how mileage should be reported, how user fees should be charged, collected and enforced, or whether charging motorists per mile is a fair, equitable funding source for road construction and maintenance.

Findings

The test, which began in September 2011 has collect base-line data on the driving habits of the volunteers. Ultimately, the demonstration will determine whether the relatively simply device with installed applications can effectively communicate real-time information about construction zones, crashes, congestion and road hazards that could improve driver safety. The research will record miles and road use and automatically report that to a central processing center while strictly protecting the privacy of volunteers. Volunteers' names and home contact information, as well as the data that identifies their vehicle, financial account information, travel routes, days and times of trips, are classified as not public to ensure privacy and that research results are valid. Volunteers will be paid to participate for six months and will be surveyed periodically to understand issues and concerns around the demonstration.

The findings from the qualitative and quantitative market research were used to inform the policy discussions of the MN MBUF Task Force. The following key findings from the online survey and focus groups were presented to the task force.

Online Survey Findings

1. Almost half of respondents reported having heard of a fee based on miles drive, of those, three-fourths indicated some familiarity with the concept.
2. Respondents are more supportive of rates base on vehicle size and emission level than on level of congestion.
3. A majority agree that a system should be transparent and that oversight responsibilities and costs should be borne by the government. A majority disagree that a system should use "high technology" (i.e. GPS) to collect information. People want their privacy protected.
4. Respondents want a flexible system that accommodate collecting fees from future vehicles, such as all-electric and other alternatively fueled vehicles, but are less likely to favor "social policy" initiatives such as congestion pricing.

Focus Group Findings

1. Lacking knowledge of specific project characteristics, some individuals had trouble answering hypothetical questions about MBUF.
2. Strong sense that current fuel tax regime is inequitable, not all users pay their fair share.
3. Frame MBUF discussion on fact that some vehicles don't pay for using roads; identify equity issues that are larger than revenue shortfalls.
4. Widespread belief that current system is flawed and/or failing to raise necessary revenue. Curiosity over whether MBUF would replace or supplement current fuel tax system.

5. Concerns over costs of implementing and administering MBUF, especially given relative efficiency of current fuel tax system.
6. Regardless the funding mechanism, concerns that people will try to game or cheat the system.
7. Concern that if applied to commercial vehicles, the increased freight costs will be passed along to consumers in the form of increased prices for goods.
8. General understanding that smart phone technology already tracks consumer location; however, recognition that consumer choice makes this privacy risk more accessible. In addition, privacy concerns were more acute and less acceptable under a mandatory MBUF system.
9. Skepticism over whether general public or policymakers could ever support MBUF given its complexities. Concern that elected officials will lack the “political will” to implement a system as complex as MBUF.
10. Appreciation for familiarity with fuel tax system; “we may not love what we have, but we know what we have.”

The findings and recommendations of the MBUF Policy Task Force will be adopted in late November 2011, after the submission deadline for this abstract. By spring 2012, when the CTS Research Conference convenes, the MBUF Policy Task Force will have finalized its recommendations and presented them to the MnDOT Commissioner and other key stakeholders.

Impacts of Mileage-Based User Fee Scenarios on the Trucking Industry

Jeffrey Short
American Transportation Research Institute
2060 Franklin Way, Suite 201
Marietta, GA 30067
770-432-0628
jshort@trucking.org

ATRI is currently conducting research related to the costs and benefits of replacing the motor fuels tax with a mileage-based user fee (MBUF) system. The emphasis of this research is the potential impacts of such a change to the trucking industry.

Through a literature review, the research team has developed several possible MBUF scenarios, including a simple, flat-fee scenario and a highly complex, multi-tiered fee system. The impacts to highway user fee effectiveness, efficiency, equity and manageability that may result from a change in revenue collection systems are next analyzed along with the revenue impacts from a change to the MBUF. The research concludes with an analysis of the costs and benefits of the three MBUF scenarios to the trucking industry.

Smartphone-Based Travel Experience Sampling and Behavior Intervention

Yingling Fan
Humphrey School of Public Affairs
University of Minnesota
301 19th Avenue S
Minneapolis, MN 55455
612-626-2930
yingling@umn.edu

Chen-Fu Liao
Department of Civil Engineering
University of Minnesota
500 Pillsburg Drive SE
Minneapolis, MN 55455
612-626-1697
cliao@umn.edu

Qian Chen
Humphrey School of Public Affairs
University of Minnesota
301 19th Avenue S
Minneapolis, MN 55455
612-868-3995
chen2291@umn.edu

Frank Douma
Humphrey School of Public Affairs
University of Minnesota
301 19th Avenue S
Minneapolis, MN 55455
612-626-9946
douma002@umn.edu

This research develops a smartphone-based application for monitoring respondents' transportation routines, examining travel-related well-being impacts, and intervening against unhealthy travel behavior. We take advantage of the smartphone's portability to collect momentary, real-time travel behavior, physical activity, and psychological well-being data, thus quantifying the various beneficial health impacts of non-motorized travel (e.g., physical activity) and negative impacts of auto use (e.g., traffic stress and loss of time in traffic). To do so, we designed a pilot behavior intervention study including 24 participants to explore how the smartphone-based application could provide information to respondents about how their travel behavior may impact their health, to encourage them to reflect on their travel experiences, and to influence travel behavior decision-making. Finally, we documented how much locational and identifying information is needed for our research, and will provide recommendations for how this data is collected, analyzed and deleted to ensure participants' privacy. Overall, this research is about exploring the potential of advanced smartphone technology to understand and influence people's travel behavior. Results from this research helps to determine the feasibility of applying smartphone technology in travel data collection and behavior intervention among the general population.

The smartphone application is developed using the Android system. Unlike Apple's *IPhones* and Microsoft's *Palm series*, Android phones offer open development platform and a diverse set of built-in hardware sensors including orientation, GPS, accelerometer, light, magnetic field, and temperature sensors, which are better designed to detect human movements and physical activity intensity. Our Android-based application includes three local programs based on smartphones and one inter-participant comparison program based on a remote system server. The three smartphone-based local programs include a monitoring program, a context-triggered survey program, and an evaluation program as shown in Figure 1.

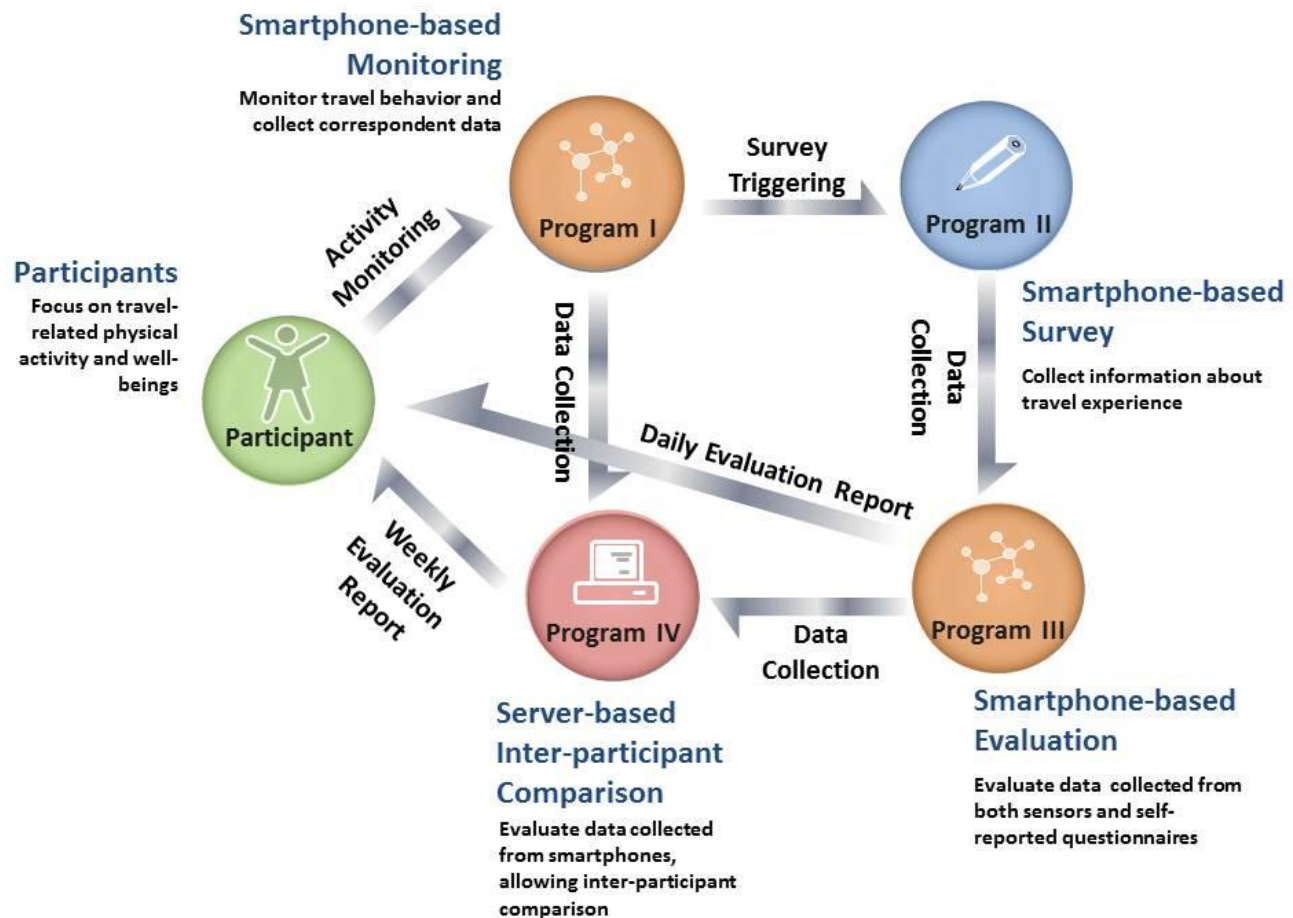


Figure 1 Framework of the Application Prototype

The monitoring program (Program I) detects movements by continuously monitoring and recording XY coordinates and moving speed of smartphone users. Based upon the recorded location and speed data, the monitoring program determines start and end time of each trip, as well as trip duration and distance. In addition, Program I utilizes the built-in accelerometer in smartphones to record acceleration outputs (unit: m/sec^2) along three orthogonal axes (x, y, and z), and base upon acceleration, determines physical activity intensity and further estimates physical activity-related energy expenditures (e.g., calories burned).

The context-triggered survey program (Program II) automatically triggers a short survey on the smartphone upon completion of each trip conducted by the participant. The program will display a series of trip questions on the phone screen, including questions about the purpose, companionship, mode, secondary activities, and psychological experience/well-being during the trip. Each survey action is anticipated to take 2-3 minutes.

The evaluation program (Program III) summarizes both monitoring and self-report survey data, and calculates daily and weekly physical activity amount and average well-being status that are related to travel for each participant. The calculations are conducted locally on each participant's smartphone, and calculation results are displayed on smartphone for each participant.

Finally, the system server-based inter-participant comparison program (Program IV) operates on a remove system server and collects monitoring and survey data from all the participants in the field study. The program conducts weekly inter-participant comparison to rank each participant in terms of their physical activity amount and well-being status. As a way to encourage inter-participant competition and promote healthy travel behavior changes, the rankings are sent to participants' smartphone for their information.

Pre-Treatment Evaluation and Assessment of Experimental Bicycle Facilities in Minneapolis, Minnesota

Christianne Roach
University of Minnesota
2323 Pierce Street NE, Apt. #2
Minneapolis, MN 55418
716-622-5885
roach098@umn.edu

Rebecca Hughes
University of Minnesota & City of Minneapolis
612-382-4246
rebecca.hughes007@gmail.com

In 2007, Minneapolis was awarded a grant from Bike Walk Twin Cities through a federal funding program administered by Transit for Livable Communities (TLC), the Non-motorized Transportation Pilot Program (NTP). The NTP is a source of federal funding created by Congress to demonstrate the extent to which bicycling and walking could carry a significant share of the transportation load, and represent a major portion of the transportation solution. The grant funds were awarded in an effort to improve conditions for bicycling and walking along approximately 33 miles of Minneapolis streets. This study evaluated the current / pre-treatment conditions prior to the installation of experimental techniques that include 10.5 foot travel lanes, 5 foot bicycle lanes, and 7 foot parking lanes on both sides of an existing street. These lanes are not typically allowed under current MnDOT regulations due to the lack of adequate existing public right-of-way. The purpose of this evaluation was to analyze existing, pre-treatment behaviors and lane deviations within the study site, including encroachment and safety related issues. The data collected during our study is intended to provide a baseline for comparisons to be used with future post-treatment evaluation necessary to complete the study. The evaluation was designed with two data collection approaches: field observation and video data collection. Our primary research questions were to investigate 1. the volume of traffic modes at the study site 2. how bicycles and vehicles currently travel within the roadway without the proposed lane markings; and 3. how bicycles and motorized modes of traffic interact with each other in terms of encroachment or lane deviation. Amongst our results, we found that a significant amount of bicycles currently use the roadway, and that the majority of them are already riding in what will be the new bicycle lanes. There is also evidence that the presence of striped bicycle lanes may influence bicycles that currently travel in parking lanes to instead travel in the new bicycle lanes, resulting in smoother traffic flow. In terms of safety, the new treatment may alleviate the percentage of encroachment because the lines will offer a visual aid to motorized modes of traffic. Potential public policy implications of this study are that MnDOT design regulations may change because existing public right-of-way is proven adequate and that public transportation safety programs may emphasize the potential problems of encroachment by motorists more.

This study results from a partnership between the University of Minnesota - Humphrey School of Public Affairs, Transit for Livable Communities, and the City of Minneapolis.

Estimating Use of Non-Motorized Infrastructure: Models of Bicycle and Pedestrian Traffic in Minneapolis, Minnesota

Steve Hankey
612-626-8910
hank0126@umn.edu

Greg Lindsey
612-625-0669
linds301@umn.edu

Xize Wang
612-805-6403
wang2384@umn.edu@umn.edu

Humphrey Institute of Public Affairs
301 19th Ave. S
Minneapolis, MN 55455
Fax: 612-625-3513

Background

Traffic counts and models for describing and estimating use of non-motorized facilities such as sidewalks, trails, and bike lanes generally are unavailable. Because officials lack both the data and tools needed to estimate use of facilities, their ability to make evidence-based choices among investment alternatives and to optimize management of transportation and recreational systems is limited.

Objective

Our research has two objectives: (1) Develop models that estimate non-motorized traffic on all streets and non-motorized facilities in Minneapolis, MN and (2) identify significant correlates of active travel.

Methods

This paper (1) summarizes counts of cyclists and pedestrians during 2007-2009 at 240 locations in the city of Minneapolis, Minnesota, (2) develops scaling factors for estimating 12-hour (6:30am-6:30pm) “daily” counts from hourly counts, (3) presents separate models for estimating daily bicycle and pedestrian volumes using both ordinary least squares and negative binomial regressions, (4) estimates daily bicycle and pedestrian traffic for every street segment in Minneapolis ($n = 12,481$), and (5) validates the models by comparing estimated and actual daily bicycle and pedestrian volumes for 119 locations where counts were taken in 2010.

Results

Across all facility types and locations between 2007 and 2009, mean pedestrian traffic (69/hour) exceeded mean bicycle traffic (42/hour) by 64 percent. Significant correlates of non-motorized traffic vary by mode and model and include weather (temperature, precipitation), neighborhood socio-demographics (household income and education), built environment characteristics (population density, land use mix), and street and bicycle facility type. When controlling for these factors, bicycle traffic was higher on streets with bicycle facilities than without. We found that 1-hour counts were highly correlated with 12-hour “daily” counts suggesting that counting campaigns may focus on short time scales without compromising quality of data.

Conclusions and Policy Implications

These new models can be used to aid policy-makers by estimating bicycle and pedestrian traffic for street segments where counts are unavailable and estimating changes in traffic associated with other changes in the built environment such as creation of bicycle lanes or redevelopment that changes land use. Our models can be extended in the future by incorporating additional counts at new locations and by incorporating new explanatory variables.

Sharing to Grow: A Case Study of Local Economic Activity Around NiceRide Minnesota Bike Share Stations

Jessica Schoner
612-412-4273
schon082@umn.edu

Xize Wang
612-805-6403
wang2384@umn.edu

Andrew Harrison
252-294-8527
harr1436@umn.edu

Greg Lindsey
612-625-0669
linds301@umn.edu

Humphrey School of Public Affairs
University of Minnesota
301 19th Ave S, 295 Humphrey Center
Minneapolis MN 55455

Bike sharing systems are being rolled out in several cities across the United States, and many more are considering implementing bike sharing. This study examines local economic activity associated with bike sharing programs through a mixed methods investigation of the NiceRide Minnesota bicycle sharing system. Bike sharing systems are largely absent from the literature on public transit, bicycling, and economic development; this research fills this gap by measuring the marginal effect of bike sharing stations on local businesses, land use, and NiceRide user trip-making and expenditure patterns. This research is important for planners and policymakers because the findings will enable local and regional governments to more comprehensively evaluate the potential benefits of a bike sharing system and estimate the magnitude of impact it may have on local businesses. The findings from this research may also help connect local businesses and bike sharing organizations by explaining the mutually beneficial relationship between station placement and commercial and retail activity.