In recent years, the transportation community has introduced significant changes to improve left-turn safety at signalized intersections—and for good reason. Nationally, intersection crashes represent one-fifth of all fatal crashes, and most of these are crashes involving left turns.

In response to this serious safety problem, the Federal Highway Administration has adopted a new national standard for permissive left turns: the flashing yellow arrow. This signal warns drivers that they should proceed with a left turn only after yielding to any oncoming traffic or pedestrians. Flashing yellow arrow signals can help prevent crashes, move more traffic through an intersection, and provide additional traffic management flexibility.

Transit shelters and amenities affect perceived wait times

Time seems to fly when you’re having fun, but not when you’re waiting for a bus at an unsheltered stop. In a new study, U of M researchers found that several factors can have a measurable impact on riders’ perceptions of wait times. A shelter can make the wait seem shorter, for example, whereas for women, unsafe conditions can make the wait seem longer.

The study, sponsored by the Transitway Impacts Research Program (TIRP), grew out of the interest of several TIRP partners to learn how riders’ perceptions of wait time is affected by transit shelters,

New permitted left-turn model helps improve intersection safety

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A common assumption among transportation planners is that commuters want to minimize their travel time—and that they’ll pay good money to do so. But what if the ability to multitask while traveling alters that choice? Commuters might pick transit over a car—even when the transit alternative takes longer—if it allows them to use their travel time more productively.

“Multitasking is a hallmark of modern life that has the potential to impact not just our transportation behavior but also our location behavior—for example, it may make people less inclined to reduce their commuting distance or even move further away,” says Patricia Mokhtarian, a civil and environmental engineering professor at the Georgia Institute of Technology. “The traditional cost-benefit calculations used by transportation planners to justify transportation improvements may also be impacted, because travel multitasking could make people less willing to pay to reduce their travel time.”

At the CTS Fall Luncheon in December, Mokhtarian discussed her latest research that sheds light on the impact of multitasking behaviors and attitudes on commuters’ mode choice.

Mokhtarian’s research team surveyed more than 2,000 commuters in northern California in 2011. The researchers then analyzed how participants’ attitudes toward multitasking and their perceptions of travel modes affected their mode choices. They found that travel multitasking does have a statistically significant, though modest, impact on mode choice.

“We found that the more likely someone is to use or want to use a laptop on a given mode, the greater the chance that they’ll choose that mode,” says Mokhtarian. “This propensity to multitask appears to account for a not-insignificant slice of rail and carpool mode share. For example, if there were no laptops or tablets, rail share in the study area would drop .08 percent, making ridership 11 percent lower.”

Based on these findings, Mokhtarian believes the ability to multitask on transit offers a marketing opportunity for transit operators. “Transit has a unique appeal to the pro-technology, organized, and pro-multitasking commuter who wants to work during their commute, so it makes sense to market to these commuters who have a higher probability of choosing transit.”

These research results also point to potential future impacts of self-driving cars for transportation planners. “The competitive advantage rail and transit currently enjoy thanks to multitasking may be short-lived as driverless cars become a reality,” Mokhtarian says. “Our models show that a 1 percent to 3 percent bump in drive-alone share is possible in our study area as driverless cars allow people to multitask while in their own vehicle.”

Ultimately, the new modeling tool developed by her team can be used to inform transportation decision making as new technologies and changing attitudes make multitasking easier and more desirable, and as driverless vehicles become increasingly prevalent, Mokhtarian says.

A video of Mokhtarian’s presentation is archived on the CTS website.
Autonomous vehicles: The legal and policy road ahead

Autonomous vehicles could spark transformative changes not just in mobility, but also in matters as diverse as urban form and retail shopping. At a conference held by the University of Minnesota, state and national leaders explored the various legal, ethical, technical, and policy dimensions of these vehicles.

The conference, held October 31, featured more than 25 leaders from academia, government, industry, and other interests.

From the U of M, RP Braun/CTS Chair David Levinson hypothesized some possible directions:

- Autonomous vehicles enable more car sharing. Instead of the sunk cost of car ownership, people pay the marginal cost per trip—and thus make fewer trips.
- Shared cars can be right-sized for any given trip, so fewer large cars are needed. Increased safety reassures people about driving smaller cars.
- Smaller cars travel closely together on narrower lanes, so capacity increases.
- As networks get faster, people choose to travel farther. Cities decentralize and more megacities and “placeless places” develop.
- At the same time, inner cities get denser, as less space is needed for parking and garages.
- With lower labor costs, transit becomes more cost-effective.
- Driverless trucks lower delivery costs. Combined with drones, robotics, and online shopping, retail shopping declines.

Frank Douma, associate director of the Humphrey School's State and Local Policy Program, noted that at least 90 percent of transportation fatalities are attributable (at least in part) to human error, according to national estimates; the driving population is aging, and current funding is not keeping up with the needs of the existing transportation system. “With the potential to address these points by creating a safer, more accessible, and more efficient system, decision makers need to pay attention to the development of these technologies and make adjustments to transportation policy that will encourage the most beneficial deployment scenarios,” said Douma, an event moderator.

Max Donath, director of the Roadway Safety Institute, cautioned that significant challenges with reliability and robustness must be addressed before full automation is possible, and suggested that limited commercial and military uses could precede wider adoption. Janet Creaser, a research fellow with the U's HumanFIRST Laboratory, added that in the short term, traffic incidents could actually increase as drivers learn how to interact with automated systems.

State Senator Scott Dibble, chair of the Transportation and Public Safety Committee, predicted that creating a legal framework for autonomous technology will be a fairly long political process. Persuading legislators that such systems are safe will be “a pretty high bar” to get over, he continued, and liability and insurance will be big barriers—and lengthy ones. Data privacy issues will also be a “huge subject of conversation,” he said. “We’ll take a close look at the experiences of other states ... and learn how those early experiments are working.”

The event was made possible through funding and support from the Humphrey School of Public Affairs, the Transportation Policy and Economic Competitiveness Program, CTS, and the Minnesota Journal of Law, Science & Technology.

Articles based on the conference will be published in the spring 2015 issue of the Minnesota Journal of Law, Science & Technology, a multidisciplinary journal edited by University of Minnesota faculty and law students.

Nissan has announced that it will introduce intersection autonomy by 2020.

Minnesota’s Transportation Conference
March 3–5, 2015
Bloomington, MN

Registration is now open for the 2015 conference, the largest transportation event in the state. Attendees will learn about the latest transportation innovations and network with fellow professionals. The event will kick off with an opening reception at 4 p.m. on March 3, followed by two full days of sessions. Learn more at mntransportationconference.org.
Driving vehicles that use electricity from renewable energy instead of gasoline could reduce the resulting deaths due to air pollution by 70 percent. This finding comes from a new life-cycle analysis of conventional and alternative vehicles and their air-pollution-related public health impacts published in December in the Proceedings of the National Academy of Sciences.

The study also shows that switching to vehicles powered by electricity made using natural gas yields large health benefits. Conversely, vehicles running on corn ethanol or vehicles powered by coal-based or “grid average” electricity are worse for health; switching from gasoline to those fuels could increase the number of resulting deaths due to air pollution by 80 percent or more.

“These findings demonstrate the importance of clean electricity, such as from natural gas or renewables, in substantially reducing the negative health impacts of transportation,” says Chris Tessum, co-author of the study and a researcher in the Department of Civil, Environmental, and Geo-Engineering (CEGE).

The U of M team estimated how concentrations of two important pollutants—particulate matter and ground-level ozone—change as a result of using various options for powering vehicles. Air pollution is the largest environmental health hazard in the U.S., in total killing more than 100,000 people per year. Air pollution increases rates of heart attack, stroke, and respiratory disease.

The authors looked at liquid biofuels, diesel, compressed natural gas, and electricity from a range of conventional and renewable sources. Their analysis included not only the pollution from vehicles, but also emissions generated during production of the fuels or electricity that power them. With ethanol, for example, air pollution is released from tractors on farms, from soils after fertilizers are applied, and from supplying the energy to ferment and distill corn into ethanol.

“Our work highlights the importance of looking at the full life cycle of energy production and use, not just at what comes out of tailpipes,” said bioproducts and biosystems engineering assistant professor Jason Hill, co-author of the study. “We greatly underestimate transportation’s impacts on air quality if we ignore the upstream emissions from producing fuels or electricity.”

The researchers also point out that whereas recent studies on life-cycle environmental impacts of transportation have focused mainly on greenhouse gas emissions, it is also important to consider air pollution and health. Their study provides a unique look at where life-cycle emissions occur, how they move in the environment, and where people breathe that pollution. Their results provide unprecedented detail on the air-quality-related health impacts of transportation fuel production and use.

“Air pollution has enormous health impacts, including increasing death rates across the U.S.,” said CEGE associate professor Julian Marshall, co-author on the study. “This study provides valuable new information on how some transportation options would improve or worsen those health impacts.”

This research was supported by the U of M’s Initiative for Renewable Energy and the Environment, the Office of Energy Efficiency & Renewable Energy of the U.S. Department of Energy, and the Agricultural and Food Research Initiative of the U.S. Department of Agriculture.

(Reprinted from a U of M press release.)
U of M researchers have created an online database that will serve as a foundation for understanding transportation finance issues in Minnesota.

The Minnesota Transportation Finance Database is composed of annual data from various transportation funding sources—at the state, county, and local level—as well as transportation expenditure allocations in Minnesota; some files date back to 1975. The site will be updated annually.

The database was created as part of the multiple-year Transportation Policy and Economic Competitiveness (TPEC) Program, which was funded in 2013 state legislation.

The database provides public access to enhance public engagement and informed decision making, and facilitates transportation research linking transportation investments to other data regarding transportation inputs, outputs, or outcomes.

“Our main focus is on transportation policy and economic development,” says Lee Munnich, TPEC director. “We believe an independent and robust source of transportation finance information will facilitate an informed discussion and decisions on how to build and maintain a world-class transportation infrastructure for a competitive Minnesota economy.”

The database is online at tpec.umn.edu/research/finance/MNTF.

**Finance database provides foundation for decision making**

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**CTS Winter Luncheon: Smart Cities and Smart Mobility**

The term “smart city” is pervasively invading our world, but what exactly does it mean? What makes a city smart? According to Jaume Barceló of the Technical University of Catalonia (UPC) in Barcelona, “smartness” is not simply synonymous with technology. Rather, it depends on the appropriate use of technology grounded in a sound methodological approach.

At the CTS Winter Luncheon, Barceló, professor emeritus in the Department of Statistics and Operations Research at UPC, will discuss the concept of the smart city from a systems point of view. Specifically, he’ll focus on one of the pillars of the smart city—smart mobility—and on his suggested methodology of transportation analytics. The luncheon will be held February 9 on the Minneapolis campus.

Barceló will offer an overview of data collection and analysis techniques (with an emphasis on data fusion) used to build models that shed light on how the urban system works. He will also discuss the main dynamic models that can help decision makers support the development of smart cities.

Barceló specializes in optimization and simulation techniques related to transportation planning, traffic management, traffic simulation, and dynamic fleet management. Since 2007, he has been the scientific director of transport and ICT projects at inLab FIB, a research laboratory at UPC.
amenities such as posted schedules, and characteristics of surrounding areas. “Waiting time is a convenient way to measure how burdened a waiter feels,” explains Andrew Guthrie, research fellow with the Humphrey School of Public Affairs.

The research team gathered data at 36 stops and stations throughout the Minneapolis–St. Paul metropolitan area, ranging from unprotected curbside stops to light-rail stations and transit centers, Guthrie says. Collection took place at various times of the day during all seasons and weather conditions.

Data collection teams—consisting of one recruiter and one videographer—surveyed more than 880 riders. The recruiter asked just-boarded passengers to estimate the time they had spent waiting at that stop; the videographer provided an objective measure of the actual waiting time.

The overall results: “Perceived and actual wait times are clearly related, but the relationship is variable,” Guthrie says. “The waiting environment can change perceptions.”

Nearly 85 percent of those surveyed waited 10 minutes or less. Even with waits under a minute, however, people tended to perceive at least a minute or two, and they tended to estimate in round numbers (5, 10, 15 minutes). “This creates an initial ‘penalty’ of overestimates,” he says.

Researchers also found several variables to have statistically significant impacts. The presence of a shelter—even a simple one—made waits seem shorter, especially for waits less than 10 minutes. “The biggest difference in perception was between any shelter and none at all,” he says. The presence of a NexTrip real-time information sign also shortened perceived waits.

Posted schedules produced a “really interesting pattern,” Guthrie says. For shorter waits, schedules caused people to overestimate wait time, but after about 10 minutes, people began to underestimate it. “It’s possible that for short waits, people compare the clock and the schedule and get impatient, but for longer waits, they are reassured to know the bus or train is coming,” Guthrie says. “This implies that posting schedules is more important for routes with less frequent service.”

Gender alone was not significant, but there was a stark difference for women in less safe environments. “Most sites in the study were rated as safe, but at those that were not, there’s potential to improve the experience for riders and potential riders,” he says.

“With several major initiatives currently under way to expand the number of shelters at bus stops and to improve the quality of transit schedule information across our entire network, the timing of this project could not be better,” says Marilyn Porter, director of engineering and facilities for Metro Transit. “This study provides important insight that is directly applicable to the work that we are doing to ensure that our customers have the best possible experience using transit service in the Twin Cities.”

The model developed in the project includes many other variables such as household income, trip purpose, and the presence of benches and route maps. “Users of the model will be able to choose criteria and predict the impacts of hypothetical feature mixes,” Guthrie says.

A final report is planned for publication in March. Humphrey School associate professor Yingling Fan was the study’s principal investigator; David Levinson, RP Braun/CTS Chair in the Department of Civil, Environmental, and Geo-Engineering, was co-investigator.

TIRP was launched by the Hennepin County–University of Minnesota partnership and has grown to include a mix of funding partners and program supporters.

A 5-MINUTE WAIT felt like only 3.2 MINUTES FOR RIDERS WHO HAD ACCESS TO SHELTERS.
Many transportation agencies, including the Minnesota Department of Transportation (MnDOT), are interested in using the new flashing yellow arrow signals to accommodate within-day changes: protected left turns (signaled by a green arrow) could be used when needed to lower crash risk, while permitted left turns (signaled by a flashing yellow arrow) could be used to reduce delay when crash risk is low.

“Of course, this requires being able to predict how the risk of left-turn crashes changes as intersection and traffic characteristics change within the course of a day,” says Gary Davis, a professor of civil, environmental, and geo-engineering at the University of Minnesota.

To help engineers make more informed decisions about when to use flashing yellow arrows, Davis is leading the development of a model that could help predict the probability of left-turn crash risk at a given intersection at different times of day. This model—which will ultimately be available as a set of spreadsheet tools—will help traffic engineers determine when the crash risk is sufficiently low to allow for the safe use of flashing yellow arrows. The project is sponsored by MnDOT and the Minnesota Local Road Research Board.

To develop the statistical model, the researchers needed to determine how the risk for left-turn crashes varies depending on time of day, traffic flow conditions, and intersection features (such as number of opposing lanes, number of left-turn lanes, and median size). The process included developing a database containing left-turn crash information, intersection features, and traffic volumes, as well as developing a set of 24-hour traffic pattern estimates to help fill gaps where hourly traffic volume counts were not available. The resulting statistical model uses this information to determine relative crash risk for every hour of the day at a given type of intersection.

Currently, Davis and his team are using the model to develop a spreadsheet tool that will allow traffic engineers to choose their type of intersection and enter the available turning movement count. The tool will then generate a specialized graph for that intersection showing the relative crash risk by time of day. Any time the crash risk is at or below the level identified as acceptable, engineers can consider using flashing yellow arrows.

“By simulating how crash risk changes as traffic conditions change, this model could help identify conditions when permitted left-turn treatments would be a good choice and what times of day a protected left turn might be a better option,” Davis says.

Moving forward, Davis is leading an additional project related to the use of flashing yellow arrows, funded by the Roadway Safety Institute. The project will first review video data of drivers making permitted left turns to characterize left-turn gap acceptance and turning trajectories. Then, Davis will incorporate the findings into the existing statistical model. To further improve the model’s accuracy, the study will compare the crashes described by the simulation model with reconstructed real-world left-turn crashes.

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