New modeling for bike and ped traffic to improve planning, safety

Giving people more options to bike or walk to their destinations has been a high priority for transportation planners in recent years. But as the number of pedestrians and bicyclists using the transportation system increases, so does the potential for serious—or even deadly—crashes involving these high-risk road users.

“To best prevent bicycle and pedestrian crashes, transportation planners need a better idea of how many people are using nonmotorized transportation and what their exposure to risk is,” says Greg Lindsey, a professor in the University of Minnesota’s Humphrey School of Public Affairs.
More than 25 percent of a typical transit agency’s bus drivers do not have regular work assignments. These reserve drivers cover work resulting from both planned and unplanned work assignment changes such as training, vacations, driver illness, weather, equipment breakdowns, and unexpectedly high volumes of riders on some routes.

A dispatcher assigns planned open work to reserve drivers a day in advance, but unplanned work is assigned as it becomes available without knowledge of which pieces of work may become available later that day—giving rise to the challenging problem of online interval scheduling.

“This is a complex problem with a lot of different factors at play,” says Diwakar Gupta, a professor in the Industrial and Systems Engineering Department. “Assignment decisions must be made sequentially without information about all potential future job requests, and a driver’s earlier assignment may not be interrupted to accommodate a new job. Also, the scheduler may need to select a particular driver when multiple drivers can perform a job, but they do not all have the same amount of time remaining in their duty shift.”

Making assignment decisions is a balancing act that requires choosing between reserve operators or regular operators receiving overtime pay. For example, researchers examined sample data from Metro Transit and found that the average utilization of reserve drivers was between 50 and 60 percent; at the same time, the daily overtime usage during weekdays was well over 100 hours in three of the agency’s largest garages, adding tens of thousands of dollars in overtime costs daily. On the other hand, overtime drivers are fully productive during these assignments, while reserve operators may not be.

To help address this trade-off, U of M researchers designed an algorithm that increases the amount of work covered by same-day reserve drivers. “Because reserve drivers’ wages are already committed and overtime drivers are paid for each minute of extra work performed, increasing the amount of work assigned to reserve drivers can result in savings for transit agencies,” says Gupta.

After conducting in-person observations of transit dispatch operations and performing a robust review of existing literature on interval scheduling, researchers created and tested the new, improved algorithm for online interval scheduling in a transit setting.

“We designed our algorithm to strike a balance between accepting all jobs that can be assigned to reserve drivers and a strategic approach that accepts only jobs longer than a certain threshold in order to achieve the best possible performance in both average and worst-case scenarios,” says Gupta. “One way we did this was to strategically assign some of the work to overtime drivers in order to improve the overall utilization of reserve drivers.”

The National Science Foundation sponsored the research. Metro Transit provided data and allowed a student to shadow dispatchers in one of its garages to help the team learn how assignment decisions were made.

“Metro Transit is committed to delivering all scheduled service and to do so as efficiently as possible while working within the constraints of our work rules and labor agreement,” says Brian Funk, deputy chief operating officer for Metro Transit’s bus service. “Professor Gupta’s research in this area can help to inform staff of the trade-offs when making these challenging decisions.”

The result of this research is an easy-to-implement algorithm with fail-safes such as a dispatcher override feature for certain decisions. Not only does this new method of interval scheduling offer significant potential savings for transit agencies, it has many possible uses in other applications that require the on-demand processing of jobs.
Exhibit teaches kids to be seen and be safe with reflectivity

Roadway Safety Institute staff taught more than 450 kids about reflectivity, pedestrian visibility, and safety at Tech Fest on February 27. The event, hosted annually by The Works Museum in Bloomington, is designed to introduce kids to engineering and technology concepts through hands-on activities and demos.

At the Institute exhibit, kids and their families viewed the “No White at Night” video as an introduction to reflectivity and safety. Then, they experimented with flashlights, a black box, road signs, and other materials to learn about the principles of light and reflectivity.

Visitors also struck a pose in the reflectivity photo booth, where they could try on reflective costumes (including vests and headlamps) to help them understand what types of clothing they can wear to help them be seen and be safe.

The Institute’s exhibit piloted a concept that will be used in a permanent exhibit to be installed at The Works later this year.

Students explore transportation, education opportunities during campus visit

On March 8, CTS welcomed 60 eighth-grade students to the University of Minnesota campus, where they explored transportation topics and learned about STEM-related education at the U.

The visit was part of an Advancement Via Individual Determination (AVID) course the students are taking at Lake Middle School in Woodbury. The AVID organization is dedicated to closing the achievement gap by preparing all students, especially those traditionally underrepresented in higher education, for college and other postsecondary opportunities. The middle-school course is specifically designed to prepare students for taking courses in high school that will put them on a college-bound path.

As part of their visit, the eighth-graders heard from a panel of current U of M students about STEM-related programs and opportunities at the U. They also learned about pedestrian safety and reflectivity. In addition, researcher Chen-Fu Liao gave students an introduction to traffic engineering, including a hands-on experience managing traffic flow using the online game Gridlock Buster.
A unique research partnership between the University of Minnesota and the Minnesota Department of Transportation (MnDOT) has led to the creation of a new risk-analysis ranking system for the 52 septic systems located at safety rest areas, travel information centers, truck stations, and weigh scales at MnDOT facilities across Minnesota. This three-year partnership brought together the septic system expertise of the U of M with the wastewater expertise of the Water Services Unit of MnDOT’s Office of Maintenance Building Services Section.

“One key goal for this project was developing a risk-analysis ranking system that can be used to help decision makers allocate funding to sites on a need-basis in order to provide up-to-code systems that protect public health and the environment,” says Neile Reider, water services engineer with the MnDOT Office of Maintenance.

The project, led by Sara Heger of the U of M’s Onsite Sewage Treatment Program in the Water Resources Center, began with an extensive record search in which many documents were digitized and a database of information was created. Many of these records were previously paper-only copies and were not stored in a centralized location; records included septic permits, soil survey information, septic system drawings and specifications, well permits and logs, water usage, drinking water testing results, and past inspection reports.

The next step was the development of a draft protocol for septic system assessment. The draft protocol was then pilot-tested on five septic systems and further refined based on those experiences. The result was a full assessment protocol that includes a preliminary review of the site, a facility assessment, effluent sampling, septic tank inspections, evaluation of advanced treatment units, and an assessment of the soil treatment system. The research team then used this full assessment protocol to perform detailed, consistent evaluations of all 52 MnDOT-operated septic systems.

Throughout the investigation, data were collected on more than 100 characteristics of the septic systems—such as environmental conditions, soil treatment systems, and management methods—at each of these 52 sites. The information then was used to develop a risk ranking for all systems.

Overall, 45 of the 52 wastewater systems evaluated were in “average” to “above average” condition, with five facilities in “excellent” condition. The remaining seven are most in need of repairs or replacement, Heger says. In addition, the rating system flags all systems with public safety or health issues as “below average” until those items are rectified.

“Through the partnership, we were able to collaborate and create a useful tool that we could use for planning purposes,” says Reider. “Also, this is not a one-time analysis, but a tool we will use to continually reassess our systems.”

Heger adds that the project and process could be modified to evaluate facilities in other states or those owned by other entities.

Registration now open!

International Symposium on the Sharing Economy Public Forum

May 17, 2016, The Commons Hotel, Minneapolis

Registration is now open for the symposium’s Public Forum, which will explore the promise—and potential perils—of the sharing economy, with a focus on shared mobility. Practitioners, entrepreneurs, government representatives, and other leading thinkers will share their perspectives in presentations and panel discussions.

Registration and program information are available at sharingeconomy.umn.edu/events.
What physical goods can—or should—be shared, and what should be owned individually? As the answer to that question slowly changes, the direction of our transportation future is changing, too.

“For physical goods, one person’s use prevents someone else’s use, but many physical objects are not fully utilized by their owners,” says David Levinson, a professor in the Department of Civil, Environmental and Geo-Engineering (CEGE). “For example, cars typically remained unused for 22 or 23 hours of a day. Books and videos are often watched or read just once and then never used again. The basic idea of collaborative consumption is that things can be shared rather than individually owned to increase economic efficiency—that’s why we rent hotel rooms and cars while traveling instead of buying condos and vehicles.”

In a report sponsored by the Minnesota Department of Transportation (MnDOT) and the Minnesota Local Road Research Board, U of M experts examine three dimensions of sharing—cars, rides, and bikes—and their emerging implications for transport.

Car-sharing services such as Zipcar and Car2Go allow users to share a car just as they share a hotel room—by paying a third party and using it at separate times. Ride-sharing services such as Lyft or Uber function as modern taxi services that use mobile phone applications to allow passengers to request rides from independent drivers. Finally, bike-sharing services like Nice Ride Minnesota allow bicyclists to use a bicycle at the location they need it, often as an extender of transit service.

In the future, the report’s authors believe that with more widespread use of information technologies and the maturation of autonomous vehicles, ownership and possession will no longer be necessary prerequisites for on-demand mobility.

“While Mobility-as-a-Service is nascent today, it will eventually be a big change in how people travel,” says Levinson. “A vehicle from a giant pool of autonomous cars could be dispatched to a customer on-demand and in short order, deliver the customer to a destination, and then move on to the next customer. Even more efficiently, it might pick up or drop off some additional passengers on the way.”

Experts predict that the emergence of “cloud commuting” will have a number of implications:

• A smaller, more modern fleet that is used more efficiently and turns over faster
• Greater coverage in urban areas with higher demand
• Fewer trips for people who give up on vehicle ownership and opt to pay by trip
• Greater viability for the electrification of the vehicle fleet
• Demand for new street designs that emphasize pick-up and drop-off locations rather than on-street parking

“As a result of these changes, we expect to see less vehicle ownership and the increased use of Mobility-as-a-Service in cities, which will raise the value of cities and allow for the redevelopment of infrastructure now devoted to cars such as street space and garages,” says Levinson. “Overall, we expect future growth will be either central or exurban, and less in existing low-density suburbs that cannot effectively offer Mobility-as-a-Service nor fully exploit the wide-open spaces of the exurbs.”

The implications of a sharing economy are extremely provocative for MnDOT as well as other transportation agencies, says Ken Buckeye, program manager with MnDOT’s Office of Financial Management. “We must be prepared for this inevitability and consider the impacts to overall use of the system, how we collect user fees, and safety, among other things,” he says. “Importantly, transportation sharing is likely to encourage rational consumer behaviors that will have consequences for system performance.”

Levinson’s research is part of a multi-pronged study that analyzed the technological shifts altering surface transportation and the implications for Minnesota. Other contributors included CEGE assistant professor Adam Boies and Humphrey School of Public Affairs associate professors Jason Cao and Yingling Fan. Their high-level white papers are compiled in a final report: The Transportation Futures Project: Planning for Technology Change.
the United States. A frequent warning sign is excessive daytime sleepiness, which can manifest as drowsy driving.

“This study emphasizes that untreated obstructive sleep apnea is a pervasive threat to transportation safety,” says American Academy of Sleep Medicine President Dr. Nathaniel Watson. “It is critical for transportation companies to implement comprehensive sleep apnea screening and treatment programs to ensure that truck drivers stay awake at the wheel.”

As part of the study, researchers compared more than 1,600 truck drivers with OSA to an equal number of drivers screened as unlikely to have OSA. Drivers with the disease were given a mask with an air pump worn while sleeping to keep the airway open (an auto-adjusting positive airway pressure machine), and its use was electronically monitored. The rates of preventable serious truck crashes per 100,000 miles driven were compared across the study groups.

“To put our findings in context, if we look at 1,000 truck drivers each working for a year, the drivers with obstructive sleep apnea who refuse mandated treatment would have 70 preventable serious truck crashes, compared to 14 crashes experienced by both a control group and by drivers with sleep apnea who adhered to treatment,” says Stephen Burks, lead author of the study and professor of economics and management at UMM.

Burks organizes Morris’s Truckers & Turnover Project (T&T), assisted by Jon Anderson, professor of statistics, and Rebecca Haider, research coordinator. T&T researchers performed the statistical analysis of the study data, acquired from Schneider National—the first major motor carrier to institute an internal OSA program—and its sleep apnea services provider, Precision Pulmonary Diagnostics.

“I expect our sleep apnea findings will be carefully considered in the rulemaking process on sleep apnea standards for truck drivers and train operators just launched on March 8, 2016, by the U.S. Department of Transportation,” Anderson says.

According to Burks, the study’s findings stress the importance of adding OSA screening standards to the medical exam that commercial truck drivers take every two years.

T&T is a multi-year UMM research effort also involving faculty co-investigators at other institutions both in the United States and internationally. Funding for T&T was provided by Schneider National, the Roadway Safety Institute, and UMM. Additional funding for this research analysis was provided by the MacArthur Foundation, the Sloan Foundation, Harvard Catalyst/Harvard Clinical and Translational Science Center of Harvard University, and the National Surface Transportation Safety Center for Excellence.

**CTS Research Conference Call for Presentations**

*Curiosity. Discovery. Innovation.*

CTS has issued a call for presentations for its 27th Annual Transportation Research Conference. This year’s event will be held November 3, 2016, at The Commons Hotel in Minneapolis.

The conference convenes researchers and practitioners from Minnesota and the Upper Midwest to highlight new learning, emerging ideas, and the latest innovations in transportation.

New this year, potential presenters may submit a brief abstract for both lectern presentations and posters to be shared at the conference.

If you or your organization would like to share the results of your innovative research, implementation, or engagement activities in transportation-related fields, please submit an abstract by April 25, 2016.

For more information or to submit an abstract, please visit [cts.umn.edu/events/conference](http://cts.umn.edu/events/conference).
and researcher at the Roadway Safety Institute.

As part of a project sponsored by the Institute, Lindsey is working to develop new methods and tools to help transportation engineers estimate bicycle and pedestrian traffic volumes and assess these nonmotorized travelers’ exposure to risk.

So far, Lindsey and his team have collected bicycle and pedestrian counts in several Minnesota case communities, ranging in size from the large Twin Cities metropolitan area to much smaller cities such as Grand Marais and Bemidji. Because most studies of exposure and risk have occurred in larger urban areas, Lindsey expects the results from the smaller communities to be particularly useful.

With these counts complete, the researchers are developing models to adjust and extrapolate the data to measure the average annual daily number of bicyclists and pedestrians for specific road segments and networks. They are also creating models that estimate exposure to risk for nonmotorized traffic and then combining those models with traffic volume estimates to help predict and better understand potential for being involved in a crash or other hazardous situation. This information will help illustrate the need for countermeasures or different traffic controls at specific locations.

“Within our case study communities, these results will be used to inform decision making about strategies that can reduce the risk of crashes for bicyclists and pedestrians,” says Lindsey. “In addition, they will be useful for developing performance indicators and measuring progress toward them.”

Lindsey began work on the project in 2014. While the final study has not yet been published, early papers based on the research are already earning national recognition. In a paper presented at the Transportation Research Board’s 2016 Annual Meeting, researchers outlined a simplified model that can be used to easily generate spatial estimates of pedestrian and bicyclist traffic volumes in the field.

“Our results indicate that this simplified model can explain nearly as much of the observed variation in bicycle and pedestrian traffic as more complex, fully-specified models while offering the advantage of being easier to apply and interpret,” says Lindsey. “We were also able to confirm previous research that shows that factors influencing pedestrian traffic and bicycle traffic are different, and as a result these two modes must be modeled separately.”

Work on this project is ongoing, and a final report will be published later this year. The research is expected to have many benefits, including an improved understanding of bicycle and pedestrian traffic volumes and patterns; new tools, models, and guidance for monitoring traffic and assessing exposure to risk; and new insights on the relationship between exposure and risk, Lindsey says.
Study finds higher crash risk for truckers with untreated sleep apnea.

New modeling for bike and ped traffic helps improve planning and safety.

Algorithm helps transit agencies schedule reserve drivers.

How will sharing technologies shape our transportation future?