TechPlan

Planning and Policy for Intelligent Transportation Systems

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—James Oberstar

We gratefully acknowledge the vision and support of James Oberstar who has served in the U.S. Congress from Minnesota's Eighth District since 1974 and has become the body's leading expert on transportation policy. Currently, Representative Oberstar chairs the Committee on Transportation and Infrastructure.

Pictured *(left to right)*, Research Assistants David Coyle and Sarah Aue, Project Director Frank Douma, Chairman Oberstar, and Research Assistants Brad Utecht and Lyssa Leitner.

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Frank Douma

DEAR FRIENDS:

For many years, the State and Local Policy Program at the Humphrey Institute has helped coordinate research grants to investigate the intersection of technology, transportation, and public policy. Over time, new technologies have developed—when we started researching these issues in the early 2000s, Twitter was something birds did—and with new technologies come new questions and issues. Some of these questions are variations on age-old policy conflicts: How much privacy can an individual expect while using a public road? Others are completely new: Will online forums replace town hall meetings when deciding where to place transit or transportation infrastructure?

This report covers the most recent work done under the auspices of TechPlan, grants funded through the Intelligent Transportation Systems (ITS) Institute at the University of Minnesota. These grants allow researchers concerned with public policy an opportunity to study how technology affects important decisions about roads, transportation funding, emergency response, and a diverse array of other issues.

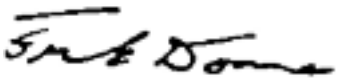
We hope this report will keep you up-to-date about what this research has produced thus far. The topics covered are wide-ranging—how collaborative agreements can be reached on technology-intensive transportation projects, the effect of technology on gathering public opinion about land use decisions, how social networks affect job-finding (and, therefore, commuting decisions), how school choice decisions impact travel and pollution, and whether online purchasing will replace shopping trips or simply stimulate more visits to the store.

What these projects have in common, other than a connection between transportation and technology, is the potential to address long-term issues and problems in transportation policy. While some address immediate transportation challenges, others take a longer view, envisioning options and solutions to issues that at the moment seem intractable.

The projects were chosen for funding through a competitive, peer-review process, with national transportation experts helping to review proposals and provide commentary on the work as it proceeds. This not only helps the ITS Institute fund projects that are innovative, but it also helps researchers to pursue projects with regional significance. I'd like to thank Max Donath and the ITS Institute staff for their ongoing support of faculty research in public policy.

This is not our final report on TechPlan research. Several of the projects detailed on these pages are ongoing, and some are just beginning. My own work into privacy regulation shows the area is evolving, with new developments likely to occur on any given day. Thank you for your continuing interest in the ways technology is changing public policy.

Sincerely,



Frank Douma
Assistant Director, State and Local Policy Program
and TechPlan Program Coordinator

Private road?

Technology and privacy sometimes collide on the open road

Technology can make roads safer than ever by monitoring for speeders, bringing emergency help to drivers through on-board communication systems, or making sure teen drivers aren't reckless on the road. However, that increased safety often comes at the expense of drivers' privacy. A stoplight takes a picture of your car as it rolls through a red light or on-board cellular phones are monitored by police investigating a crime, for example.

"People tend to be suspicious of technology that saves them from themselves," says Frank Douma, assistant program director of the Humphrey Institute's State and Local Policy Program. The amount of data collected by new technologies raises questions as to whether it is protected by a myriad of state and federal privacy laws and legal principles. As new technology raises more privacy issues and laws change, developers of intelligent transportation systems (ITS) are looking for ways to address them.

"The legal environment is fairly uneven," says Douma. "If you want to improve technology nationally, you need to consider the level of privacy protections." The variations in privacy laws have led to many cases nationally and in Minnesota in which new technologies were seen as intrusive by motorists.

"There is a complicated legal landscape to navigate for ITS developers and planners," says Douma. While homes often are classified as legally private, cars have not been granted the same status. About 25 years ago, the U.S. Supreme Court ruled that roadways are essentially public spaces in which individuals should not expect a right to privacy. This federal standard, however, is a minimum standard, and many states have added layers of privacy protections, usually prompted by cases that assert a violation of privacy due to either law-enforcement technologies, such as lights with cameras on them or new information-management systems that seem to open data to the world. For example, cameras and GPS monitors now make wide-scale tracking of motorists possible, whereas, in the past, tracking could only be done by a police officer in a squad car. "Technology is changing the law," says Douma.

THIRD-PARTY DATA COLLECTION

To accommodate changes in the legal terrain, many governmental units, such as local police and state transportation departments, are turning to private companies to collect and manage transportation-related data. The reason is simple: Private companies are not subject to open-records laws. When public agencies collect data, state and federal privacy laws regulate how that information can be shared with outside parties. Using third parties allows agencies to take advantage of technologies without incurring the same legal risks. On the other hand, one advantage of public collection is a greater ability to share data among government agencies. If private companies collect data, there are fewer restrictions to consider, permitting more flexible use of the data. However, private companies may want to use data for secondary uses, such as marketing.

"Third parties make it a lot easier to obtain information," says Douma. "While it's not a public record if you contract out the monitoring and collection of data, those records do not have the government protections against sharing that data either." The so-called third-party doctrine is a "double-edge sword" for those concerned with both technology and the law, says Douma.

Use of contractors to handle potentially sensitive information raises other questions, too. Is a company able to keep records private, even though it was collected using

"… the more personal the nature of the information that is collected, the greater the number of privacy considerations that exist." —Frank Douma

a public road? Can private companies refuse to turn information over to police conducting investigations? What about handing data over to other private entities, such as insurance companies? Can ITS-generated data, such as the global positioning systems in a roving spouse's car, be used in civil litigation, such as divorce? So far, Douma says, courts generally have acted to protect privacy only when it seems some harm has been done.

As part of this TechPlan research project, Douma reviewed changes in privacy law and created a toolbox for ITS developers to use in determining the privacy implications of new technologies. The toolbox asks developers to consider applications of the technology along three dimensions: anonymous vs. identifiable information; consent; and public vs. private actors.

In general, if a technology generates personally identifiable data, the likelihood of privacy concerns rises. Anonymous data—traffic counters used to control traffic flow, for example—will not raise privacy issues. However, many technologies require data that is identifiable in order to work. Automatic tolling requires information to connect a particular car to an account and therefore to an individual. Cameras that monitor for stoplight violations do so by recording a car's license plate or even by taking a picture of the driver. To avoid legal challenges, ITS developers have attempted to make data more anonymous by stripping it of parts of the information (a partial plate number, for example) or dumping data immediately after use. Finding ways to allow technologies to work with personal data without raising privacy issues is one of the major challenges facing ITS developers, Douma says.

A second method for dealing with privacy concerns is to have those using a technology give consent by specifically indicating they agree to give up personal data to use the technology—opting in, such as signing up for automatic tolling. "Some of this simply is making the effects of technology transparent," says Douma. "If you don't want the government to know where you are, do not use automatic tolling."

The final consideration for ITS developers is the question of who should collect and keep data and decide whether and how it can be shared. It's important to ensure that individuals who give up data to private companies understand how it might be used. ITS developers need to be aware of state and local laws that may restrict use of secondary information with private organizations as well as with law enforcement.

Douma advocates several best practice policies as organizations manage private data, including establishing a privacy policy that is clearly articulated and followed, insulating data and controlling access to it so it is not accidentally used incorrectly, and confirming that retention and sharing policies relating to data are strictly followed.

"The basic rule is, the more personal the nature of the information that is collected, the greater the number of privacy considerations that exist," says Douma. □

Humphrey Institute Principal Investigator

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Press 1 for "yes"

Technologies engage the public in new ways

Planners in Dakota County wanted to gather public opinions about how best to preserve the areas around the Vermillion River, a rare cold-water prairie river that runs across the southern edge of the county. During information-sharing sessions about the natural corridor, the planners decided to use a new but fairly simple technology—keypad voting. During half a dozen meetings, several hundred citizens registered their opinions with the push of a button. The system helped planners gather demographic information about those attending the meetings and allowed citizens to rate concepts about river development and tell planners their priorities for the river corridor. Planners say that the keypad voting resulted in better information than typically is gathered at these kinds of public meetings and provided a more democratic process where even the shyest person in the room was heard.

Planners acknowledged the need to tailor the technology to the purpose of the meeting or project and to make sure that the technology itself did not "steal the show" from the issues being discussed.

The only problem planners found was that they had to be careful to make sure participants did not think that their keypad votes bound the county to a particular course of action.

Keypad voting is one of many new presentation, visualization, and communication technologies that are changing how the public participates in decisions about land use, transportation, and other policy issues. Programs range from the familiar Google Earth mapping software to specialized programs, such as Big Box Evaluator, where citizens can imagine the effect of a large store on their neighborhood, or UrbanSim, which simulates how actors (individuals and businesses) would behave under different planning scenarios. Many of the new technologies are relatively simple—a comment form on a project website, for example—while others are complex, such as a visualization program that allows citizens to "fly through" a potential roadway. The new technologies are merging with traditional methods of gathering feedback on public plans, creating new opportunities and challenges for planners, engineers, and public officials, says Carissa Schively Slotterback, an assistant professor at the Humphrey Institute who recently used TechPlan funding to complete a study of how technology is viewed by officials conducting participation processes.

Schively Slotterback, whose research focuses on public participation in decision-making, conducted a two-pronged survey of planners, engineers, and others who participate in planning processes to determine how they decide whether, how, and when to use technology in participatory meetings. Schively Slotterback and research partner John Hourdos, director of the Minnesota Traffic Observatory, gathered insights from practitioners about typical processes and how technology might enhance those events through five focus groups and an in-depth follow-up survey.

"More and more communities are starting to look at technology to enhance what they are doing in their participation processes," Schively Slotterback says. "They are not replacing other participation techniques, but they are using technology to enhance them."

In the course of focus group conversations with 58 practitioners, Schively Slotterback and Hourdos found that participation processes take three distinct forms, each of which may benefit from different technologies—open houses where information is shared with the public, formal public hearings at which citizens respond to proposals and offer their views, and committee meetings involving a mix of elected and appointed public officials where technical details are discussed. The researchers supplemented the focus group results with a survey of 100 practitioners about their attitudes toward participation technologies. Both sets of respondents had high levels of contact with the public, with more than one-third of the respondents working with the public several times a week or more and another 50 percent having contact with the public from once a month to several times a month. Only four percent of those involved in the study had no regular contact with the public.

The focus groups identified several opportunities associated with technology use, including generating greater interest in participating in planning processes (the "wow" factor, as one survey respondent called it); increasing par-

ticipation (all those shy people recording their views with keypads), managing information and feedback about projects, and building trust with community members. Participants were particularly enthusiastic about greater use of websites, keypad voting, and photo-editing software that could be used to demonstrate options at public meetings.

Technology also presents challenges, however, that some practitioners consider significant. It can be costly—both in terms of investments in hardware and software and in the time and money it takes to train staff to use the technology. In addition to training, it often requires additional effort on the part of time-strapped staff because technology rarely replaces traditional practices but is added on to them. Moreover, some regions of the state have less access to technology, particularly high-speed Internet connections, and public meetings often are held in spaces, such as churches and town halls, where technical equipment must be brought to the site. Other concerns about technology include the fact that those who are traditionally marginalized in public processes have less access to technology, too, and that some technologies—particularly visualization technologies—are extremely difficult for some members of the public to understand. "There are people who have trouble reading a map," Schively Slotterback says, "and for some, a fly-through animation is very difficult to grasp."

"The greatest immediate opportunity is building on existing technologies," continues Schively Slotterback. "What can we do on the web? Many practitioners are putting more information on the web and making it more interactive so it is not just a one-way flow of information." For instance, the City of Minneapolis has put sections of its comprehensive plan on the Internet so that the public can read them and comment. Also in Minneapolis, a neighborhood-planning group created a wiki—a website that allows participants to create and edit material on the site—where local residents could add information to the plan.

In addition, the planners Schively Slotterback and Hourdos talked with acknowledged the need to tailor the technology to the purpose of the meeting or project and to make sure that the technology itself did not "steal the show" from the issues being discussed. "Decisions about the use of technology in participatory processes should be based on a clear sense of the contribution that the technology can make," Schively Slotterback says. Websites and

project FAQs online are great for communicating with the public, but, for gathering feedback, such methods as keypad voting or visual preference surveys work better. All online forums, however, require careful monitoring to ensure that discussions remain civil and balanced and are not dominated by a small group of participants.

More advanced technologies may be more commonly used as more planners and engineers are trained in their use and the public is better able to understand visualization systems. "Practitioners are really excited about visualization technologies, but are concerned about access to data, staff capacity, and cost," Schively Slotterback says. "All of these concerns will be mitigated slowly as technology evolves."

Because this is a changing area, Schively Slotterback says that additional research, particularly case studies of the implementation of various technologies in real-world settings, would provide greater insight into how technology affects the public conversation about transportation and planning. □

Humphrey Institute Principal Investigator

Carissa Schively Slotterback (cschively@umn.edu)

The wheels on the bus…

School choice decisions have surprising impact on environment, health

Many parents agonize over choosing a school for their children. Will the children thrive in an environment that is more structured or flexible? Is the school safe and nurturing? Are the teachers top-notch? Few parents, however, ask themselves what the environmental or health impacts of their school choice are.

Yet school decisions drive transportation choices—car? Bus? Walk? A recently completed TechPlan research project found that school choice can produce significant environmental impacts in the form of increased emissions from buses and cars. In addition, driving students to school reduces the opportunities for exercise and may increase risks for obesity.

"These kinds of transportation issues are not always considered by school boards or parents," says Julian Marshall, assistant professor of civil engineering at the University of Minnesota, who conducted the study with Humphrey Institute colleague Elizabeth Wilson and other collaborators. "We're not taking a position on school choice," Marshall emphasizes. "School boards and parents have many factors to consider in making those decisions. This paper is just observing that the goals of school choice conflict with health and environmental issues."

The most recent study, published in the journal *Environmental Science and Technology*, is one of several projects that grew out of an experience Wilson had as she biked to work one morning. She found herself riding behind five school buses, each taking students from the same St. Paul neighborhood to a different school. Choking on exhaust fumes, she realized that many of these students could have walked to a neighborhood school nearby. As an initial project, researchers compared the distance students traveled to that neighborhood school (one Wilson's daughter attended) and another St. Paul school that drew students from all over the city. The researchers found that the citywide school had six times fewer walkers and that students traveled 4.5 times as many miles to get to school, creating more than three times the pollutants produced by transporting students to neighborhood schools.

From there, Marshall, Wilson, and other researchers devised a survey of 1,200 parents in school districts in St. Paul and Roseville to find out where their children attended school, why they chose the school, and how the children were transported. The choice of a school outside of their immediate neighborhood (called magnet schools in Minnesota) resulted in fewer children walking or biking to school, with a significant increase in miles traveled each day by bus or car. The study confirmed other research that indicated that, at distances of more than one-half mile, rates of walking declined significantly. (Only a small percentage of students bike no matter where they go to school.)

This is part of a larger trend of students going to schools farther from home and a decrease in walking. In 1969, nearly half (41 percent) of all U.S. elementary students walked to school, compared with 13 percent in 2003. While school choice began as an effort to voluntarily desegregate schools, it's currently seen as a way for parents to improve educational opportunities for their children. The survey found that parents rated such attributes as teacher quality, curriculum, and class size as most important in picking a school. Some listed transportation and living close to school as important but these items were not among the top considerations for parents.

The Roseville–St. Paul study prompted Marshall's most recent work, which uses logit regression models to test school choice scenarios, their effect on how children commute to school, and, ultimately, the environmental impact of school choice policies. "Logit regression models predict the relative likelihood of an outcome," Marshall says. This study used the data gathered in the Roseville–St. Paul study, but focused only on St. Paul because of the prevalence of school choice in that district. Of the families surveyed, 65 percent of the children attended a magnet

school and only 35 percent attended their neighborhood school. Data related to school location, commute distance, grade of child, race, gender, and transportation methods used was analyzed along with comparative information, such as the distance to closest school and possible travel routes by car or bus, for various school choices based on St. Paul school district travel policies. Researchers then considered the likely emissions generated by school-related travel using U.S. Environmental Protection Agency data and produced estimates of pollution generated by several policy scenarios, including the current school choices, a random scenario, one where children could only go to their neighborhood school, one that allowed families school choice within a region of the city, and one that mandated walking by all children living within one mile of their current school.

In 1969, nearly half (41 percent) of all U.S. elementary students walked to school, compared with 13 percent in 2003.

The researchers were surprised to discover that the only option to significantly reduce emissions was the one in which all students attended their local school. By eliminating school choice, the average distance traveled to school would drop four to five fold, Marshall says. The model predicted more parents might drive children to school in this scenario, but the driving distances would be cut in half. Busing rates would drop by half as well and overall emissions related to school commuting would decline by three to eight times over the current system.

Marshall expected that the scenario in which parents could choose a school within a region closer to home might reduce travel and pollution, but the model said no. Even with more students attending schools closer to where they live, the overall travel distances are not changed much. The number of students being bused declines by seven percent but the number of families driving to school rises almost 50 percent. Emissions of nitric oxide drop by 13 percent but the other four pollutants measured (carbon monoxide, carbon dioxide, particulate matter, and volatile organic compounds) would rise.

Mandating that all students living within a mile of their school walk decreases driving and busing slightly, but this plan only would change the travel modes of a relatively few students, resulting in little change in emissions, the study found. "The emission reductions for increased walking are surprisingly modest," Marshall says. "In general, the biggest difference is achieved by going back to traditional neighborhood schools."

The TechPlan study takes no position on school choice as a public policy but highlights the often-overlooked environmental and health effects of school decisions. For instance, when faced with maintaining and updating an older building or building a newer school on available land farther from students' homes, many districts choose the new school. "Our investigation highlights the potential environmental, health, and economic benefits of locating schools relatively close to students' homes," Marshall says.

Researchers also noted the lack of tools for school districts to use in determining how school policies affect travel decisions and, ultimately, the environment. Marshall and colleagues are in the early stages of developing a tool to answer that need. The tool is available online now at **www.schooltransport.hhh.umn.edu**.

Humphrey Institute Principal Investigator
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Getting things done–jointly

Technology drives public collaborations, but relationships keep them on track

The advent of congestion pricing on Interstate 35W, one of the Twin Cities' most crowded roadways, couldn't have happened without the latest in transportation technologies, such as global positioning systems that keep buses on narrow shoulders and wireless technologies that allow drivers to automatically pay to use faster lanes. It also would not have occurred without several very timeless assets: trust, resourcefulness, and a willingness to work together.

The I-35W project illustrates which factors contribute to successful cross-sector collaborations to accomplish large public projects. The project and the Urban Partnership Agreement (UPA) that governed it fascinated Humphrey Institute researchers Melissa Stone, Barbara Crosby, John Bryson, and Emily Saunoi-Sandgren, whose study of the I-35W corridor provides insight into what people and processes are necessary to create successful cross-sector collaborations. Their research, which was part of the TechPlan program, has applications, not only in transportation and technology, but also in other settings, such as business and health care.

[Public] collaborations are political, and the context in which discussions occur greatly affects the chances of success.

"For these kinds of collaborations to work, people need to know how to operate in a shared environment," says Stone, a professor of public and nonprofit management and an expert in organizational behavior. Government officials asked to collaborate are "working to get something done jointly, but they exist in huge independent bureaucracies. They need to understand when and how to work with each piece of that dynamic," she says.

Several factors led to the success of the I-35W collaboration, including already existing relationships among key participants. The project began in 2006 when the U.S. Department of Transportation (USDOT) announced it would provide $1.1 billion in funding for joint urban transportation projects using integrated transit, congestion pricing technologies, and telecommuting strategies to reduce traffic congestion. The Twin Cities was one of five urban areas selected to participate in the program. Many of these partners previously had worked together on the development of another congestion pricing project called MnPASS, which operates on Interstate 394, a major route into downtown Minneapolis from its western suburbs.

"These previous relationships helped form trust beyond agency boundaries," says Stone. "It was a positive preexisting relationship." In addition to knowing and trusting each other, many of the participants "really believed in this way of working. They had credibility within their own organizations and they had the ability to protect, nurture, and sponsor this work." For many political appointees, collaboration can be "scary," she says, because it requires giving up a degree of control that officials possess within their own organizations.

While elected officials and political appointees—particularly former USDOT Secretary Mary Peters—sponsored and moved the collaboration forward, a key factor in its success was the role of non-agency advocates for technology use in transportation. These individuals and groups, including advocates from the University of Minnesota, sponsored forums and other events to discuss the practicalities of the technologies and how to make a partnership work. "They created a space for discussions to take place," says Saunoi-Sandgren, a research fellow at the Humphrey Institute. "If the U did not exist, could this networking have taken place or would it have been stymied?"

The researchers found that much more inclusive processes tend to encourage more effective collaborations during the planning phases. (Implementation seems to require more hierarchy.) Regular meetings and forums to address issues and allow views to be aired are time-consuming but important to ensure broad support for collaboration. In addition, says Saunoi-Sandgren, promoters of congestion pricing in Minnesota had been quietly but persistently talking about the benefits of the technology for many years and looking for opportunities to implement the idea.

Collaborations, according to Stone and Saunoi-Sandgren,

are political, and the context in which discussions occur greatly affects the chances of success. "You need to understand the 'Big P' politics—things like a governor's visibility or upcoming elections or conflicts between the legislature and executive branches," says Stone. "You also need to understand the 'Little P' politics—the relationships among organizations and individuals involved." Events outside of discussions also can benefit or harm efforts to collaborate. For instance, in August 2007, the I-35W bridge north of downtown Minneapolis collapsed. The policy discussions that resulted from the tragedy directed public attention away from congestion pricing and possibly may have allowed the project to go forward more easily.

While the politics of the project often could be complicated, the technology itself attracted people and the effectiveness of the technology is vital to the acceptance of future projects using congestion pricing and technology-assisted transit. "In terms of the future," says Saunoi-Sandgren, "a lot hinges on the success or failure of the technology. For example, the GPS steering on buses has to work safely. The technology was a driver of the collaboration."

The Twin Cities case study not only provides insight into how collaborations work, but it also suggests several new areas for research. In future studies, Stone and Saunoi-Sandgren hope to explore the role of neutral conveners in collaborations by examining other sites that weren't chosen by USDOT or else dropped out of the UPA program.

Stone says, "It has been totally fascinating to bring our organizational framework to a policy field and technologies that are outside of our comfort zone. It's given us a chance to step back and see more general lessons about how collaborations work."

LESSONS LEARNED

Researchers identified several lessons from the Minnesota Urban Partnership Agreement:

1) Successful collaborations are built on pre-existing relationships. Funders may want to evaluate the extent and quality of these relationships in making funding decisions.
2) Project sponsors and champions from different sectors do not need to agree totally on the "problem," but do need to agree enough to proceed.
3) A skillful project manager who can connect all parts of the project, innovate when necessary, and take calculated risks is vital to a collaboration's success.
4) Project planners should use inclusive processes and flat structures at the planning stage; implementation requires more hierarchical structures. In other words, a kind of organizational and collaborative "ambi-dexterity" is needed.
5) Respected, neutral organizations and conveners can help stakeholders reach agreement in the planning phase.
6) Regular meetings help build cross-level, cross-sector, and cross-boundary understandings and commitments.
7) Issues should be carefully framed to build agreement among sponsors and champions at all levels; for example, congestion pricing was sold as a way of expanding the capacity of the transportation system without having to build new roads.
8) Early support from key political leaders is beneficial.
9) Successful collaborations have both sponsors with formal authority to secure political support and other resources and champions who may lack formal authority but supply ideas, energy, and determination. These advocates can evaluate alternative solutions and lobby informally for the most promising solutions.
10) Because large collaborations are so complicated, a multi-faceted accountability system is necessary to keep track of data, processes, and outcomes. □

Humphrey Institute Principal Investigator

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Clicks and trips

Does the Internet reduce or increase shopping travel?

Technology is changing how we work, shop, interact with friends and colleagues, and communicate, but not always in the ways we anticipate. For example, conventional wisdom argues that telecommuting would lead to less driving. Not necessarily so, says Xinyu (Jason) Cao, an assistant professor of policy and planning at the Humphrey Institute, who studies technology and travel behavior and their effect on land use.

"Telecommuting reduces commuting trips," Cao notes, "but may increase the total number of non-work-related trips. The logic is that it increases free time so people are more likely to go places, such as drinking coffee at Starbucks or shopping in the middle of the day."

As part of the TechPlan grant, Cao, Frank Douma, and students Fay Cleaveland and Zhiyi Xu recently examined another technology that is expected to reduce travel: E-shopping via the Internet. They found that while the potential to reduce travel (and even parking demand) exists, shopping decisions are complicated and the interactions among Internet use, shopping, and travel defy any quick or clear conclusions—at least for now. By giving shoppers more information and enticing them with more images of products, e-shopping may increase travel as well as decrease it.

Understanding e-shopping and its influence on travel is important for planners. According to the U.S. Bureau of Transportation Statistics, a large proportion of all trips are for shopping and errands. "Shopping is a significant part of daily travel," says Cao. While Internet shopping still accounts for less than five percent of total purchases, according to the U.S. Commerce Department, it has increased significantly and is expected to grow in the future. "E-shopping can reduce the number of vehicles on the road, it can reduce emissions, it can even reduce parking demand, which has effects on land-use patterns," notes Cao. Its greatest impact likely is to be seen in the area of non-daily purchases, such as books, digital assets, and other entertainment.

SUBSTITUTE OR COMPLEMENT?

Like telecommuting, e-shopping's influence on travel demand is complicated, as studies in both the United States and Europe have shown. Sometimes e-shopping replaces travel to retail stores—a customer goes online, finds the item he or she wants, and buys it online. "This

kind of substitution can reduce travel demand," says Cao. In other cases, e-shopping seems to induce shopping-related travel. While online, a customer notices a product, then decides to make a special trip to the store to buy it—a complementary effect. E-shopping may simply modify travel plans as well. A customer searches online for a product and decides to swing by the store while out doing other errands.

In addition to the complicated ways in which e-shopping influences whether and where individuals buy products, research also has been inconclusive about the effects of shoppers' location and demographics on decisions to shop and buy online. Two theories dominate discussions, says Cao. One—the efficiency theory—argues that people who live in areas more distant from retail stores are more likely to shop online because it saves time. The other theory—the innovation-diffusion theory—counters that people who live in urban areas have greater access to

Internet technology, are more open to new ideas and technologies, and are, therefore, more likely to shop online.

In a recent research project, Cao's group tested both of these theories by surveying households in urban, suburban, and exurban neighborhoods of the Twin Cities. All of the households had access to the Internet. The survey asked respondents about their attitudes toward shopping, including price consciousness and how much they enjoyed shopping as a recreational activity. It also asked participants about specific buying habits and purchases of items not bought for daily use, including books, CDs, and DVDs. A series of detailed questions traced the role of the Internet in buying and travel decisions for recent purchases. In addition to the survey, respondents were asked to fill out activity diaries for two days to capture the number and types of trips they took.

"The results provide evidence for both a substitution and a complementary effect," says Cao. When asked about their most recent online purchase, 29 percent of the respondents said they would have made a special trip to the store if the item had not been available online, while 14 percent said they would have ordered the item through a catalog or other alternative to a retail store. Eighteen percent would not have made the purchase at all and 39 percent would have combined the purchase with another trip to the store. Moreover, nearly half of the respondents (49.3 percent) said they had made a special trip to the store because of something they saw online.

But other factors also seem to affect travel decisions and Internet purchases. Controlling for these factors in future studies may lead to more clarity about the relationship between e-shopping and travel. For instance, Cao's study found that more frequent shopping is associated with factors like having children in the home, being retired, and having a broadband Internet connection. And, those who were long-time users of the Internet were less likely to shop in a store. Frequent product information search tends to correlate with larger amounts of in-store shopping. The analysis also found that urban residents tended to shop more frequently, evidence supporting the innovation-diffusion theory.

Cao's study also examined the behaviors of those who reported that they enjoy shopping more and found they were (not surprisingly) more likely to shop in a store and less likely to buy online. These people might look for an item online or compare prices there, but they liked the experience of making purchases in a store. The behavior of this subgroup may lead to skewed results in some surveys about e-shopping, Cao says. "The result suggests that if we do not control for shopping attitudes, we tend to underestimate the complementary effect between online shopping and in-store shopping," he says.

While the potential to reduce travel exists, shopping decisions are complicated and the interactions among Internet use, shopping, and travel defy any quick or clear conclusions—at least for now.

While the research sheds light on e-shopping patterns and the direction of influence among the Internet, shopping, and travel, it also raises questions. More research is needed in such areas as what role household shopping responsibility plays in in-store and online shopping, how e-shopping affects trip generation and trip chaining (how individual errands are linked together), how technology effects the shopping process overall, and how e-shopping varies depending on the type of product consumers are buying.

Cao is continuing his analysis of the Twin Cities data by reviewing the information generated in activity diaries respondents completed as part of the survey. For his next step, he plans to use a structural equations model to compare various daily activities with technology use and travel behaviors. □

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Pivot point

New CrashHelp program gives ER doctors information as they need it

If you've watched the long-running television program *ER*, you have a sense of how accident victims are processed at a typical hospital. A brief radio message from an emergency vehicle driver indicates the patient is coming in. Then, the victim arrives; a harried paramedic quickly describes the victim's condition, and the doctor takes it from there with minimal understanding of the patient's condition or the nature of the crash.

Drama aside, in the treatment of traffic accident victims, the handoff between emergency workers and ER doctors is one of the "pivot points" that may determine whether a patient recovers or dies, says Thomas Horan, executive director of the Claremont Information and Technology Institute in California and a visiting scholar at the Humphrey Institute. "The ER usually gets just what comes in the door," says Horan, "so information gaps are likely."

Since 2004, Horan and research partner Benjamin Schooley have studied emergency medical response and the roles technology can play in improving traffic crash response times and outcomes. Collisions take a terrific toll in life and property, particularly in rural areas. More than 40,000 Americans die each year in traffic crashes, with more than 60 percent of those crashes taking place in rural areas where response times often are longer due to greater distances. Among men ages 16 to 21, crashes are the number-one cause of death. If you include other kinds of trauma, accidents are the number-one killer of people under age 44.

Working with emergency care providers in Minnesota and nationally, as well as doctors at the Mayo Clinic in Rochester, Horan and Schooley have analyzed the crash response process in-depth from the victim's point of view, looking for ways in which technology could improve the timeliness of communications. "We've been successful in understanding the end-to-end process of emergency response," Horan says. "What's the information flow? How can it be better? What are the crucial pivot points where there could be improvements?"

For instance, research conducted between 2007 and 2009 in Olmsted County, Minnesota, showed that patients had more severe injuries and longer hospital stays when the time between the initial 911 call and the arrival at the hospital was longer. The same research confirmed earlier studies showing that patients over age 60 were more likely to have long hospital stays after a crash. Using this data, plus information from focus groups and other interviews with emergency care providers, Horan and Schooley determined that improving the information flow to doctors before a patient arrived at the hospital would provide the greatest improvement in patient outcomes. Giving doctors more information earlier presented practical challenges, however. Police, fire, ambulance, and medical providers often used different communication systems, and paramedics could not be diverted from patient care for more than a few seconds to provide extra information. They simply did not have time to input data into a computer.

"It's a tough sweat to go from figuring out what might be a good idea to an actual prototype," says Horan, "but we have done that."

INTRODUCING CRASHHELP

With support from the TechPlan program, Horan and Schooley created CrashHelp, a system that combines photo, video, and audio clips taken with a mobile phone with a web-based geographic interface system to allow doctors to see pictures of the crash scene and the victim before the patient arrives at the hospital. Here's how it works: When emergency workers arrive at the scene, they use a mobile phone equipped with a Google Android ap-

plication to take video or pictures of either the scene or the victim or both. Android is a software operating system that can be equipped with special-purpose applications to run on cell phones. It is compatible with a wide variety of mobile phones as well as with Google Earth and other mapping software.

"The camera is on a mobile phone platform," says Horan. "It takes a couple of clicks to take the pictures or video." The emergency worker would then enter minimal information about the patient, such as name, age, and gender (Jane Doe, age 75, Female—that's it.) Once entered, the software captures the location of the incident (the GPS coordinates)—a crash at intersection of I-35 and State Route 10—and this, along with the identification information, the videos and images, and any audio clips that might be recorded, instantly are uploaded to a computer server. The server uses a program—colloquially called a "mashup"—that pulls together information from multiple sources and uses various programs from the Internet to produce a visual indicator.

Back at the hospital, the ER doctors sign into the CrashHelp website. There, they see a mark indicating the location of a crash on a map, at Interstate 35 and State Route 10. They click on the mark and can see the photos and videos. One side of the screen lists information about the patient, and a special icon on the map would further alert doctors that this victim is older than 60. The website also would report when 911 dispatchers first heard about the crash, how long it took for emergency personnel to arrive on the scene, and their likely arrival time at the hospital. In addition to this specific data, the pictures themselves would provide vital information: Was the victim thrown from the car? If the victim has a wound, is it on the head or the leg? Was the car damage so extensive that internal injuries are likely? "A picture is worth 1,000 words," says Horan. "The photos and videos provide a lot more information than can be passed on verbally when the patient arrives at the hospital."

While the primary expected benefit of the system is quicker and better treatment of crash victims, that is not its only possible benefit. Seeing the severity of the accident can help doctors decide whether they need to call in a complete trauma team or whether the injuries can be handled with the crew currently on duty. Providing basic information and a digital "snapshot" of the incident and patient status before the patient arrives means that ambulance crews and other emergency workers will spend less time at the hospital, keeping them available for other emergencies. Finally, having crash data in a consolidated website will provide useful training and analysis tools for all kinds of emergency care providers.

Since developing the prototype in 2009, Horan and Schooley have presented the CrashHelp concept to the Emergency Medical Services Safety Foundation and to a conference of emergency care providers in Utah. The response to CrashHelp has been positive, and Horan and Schooley hope to do a demonstration project using CrashHelp. The project likely would occur in southeastern Minnesota with continuing cooperation from the Mayo Clinic, Horan says.

"The advent of visual information systems and applications represents a promising new way to bring EMS data to healthcare providers." —Thomas Horan

"The advent of visual information systems and applications represents a promising new way to bring EMS data to healthcare providers," Horan says. "Further research can provide insights into how these systems can be aligned with stakeholder needs as well as with EMS system standards and protocols."

"We still have to pilot it and see how it will be used," says Horan, who notes that the technologies that power CrashHelp were not invented when he and Schooley first began their research. As technology improves, the opportunities to improve safety also will increase. □

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It's who you know....

...and maybe where you live that affects job searches and home location

Talk about social networking today and many people imagine sitting at a computer connecting with old friends from college. Facebook, LinkedIn, Twitter, and other computer applications make it easy to connect virtually. But old-fashioned connections—who lives on your block, for instance—can explain much about where people work, how they find jobs, and even where they meet to discuss business.

The effects of social networks on home and work locations—and therefore their influence on travel decisions—is at the root of research being done by David Levinson, professor of civil engineering, and Nebiyou Tilahun, recent Ph.D. in civil engineering from the University of Minnesota and now a post-doctoral research associate at the Urban Transportation Center at the University of Illinois. In a series of TechPlan-funded studies, Tilahun and Levinson examined the role of social location and information and communication technology (ICT) on home and work decisions. The studies explored the phenomenon of people who live near each other also working near each other, how job-search methods could lead to different commute outcomes and how these, in turn, may affect decisions to relocate residence. While the topics are somewhat independent of each other, they are linked by the common theme of exploring how "who you know" affects travel-related choices in ways that are significant for transportation planners.

NEIGHBORLY INFLUENCE

The relationship between work and home location has long been of interest to transportation researchers because of its effect on travel times. Levinson and Tilahun argue that connections with neighbors create another layer of influence on both job location and work finding that can help explain transportation patterns.

For the study on work–home location, Tilahun and Levinson used U.S. Census data and Minnesota employment information to link the home and work locations of about 4,000 residents in four areas in each of two Minneapolis suburbs: Edina and Brooklyn Park. The suburbs were chosen because they represent a broad cross-section of incomes from the area. Using a variety of mathematical models, including quadratic assignment procedures and logit regression analysis, Levinson and Tilahun found that several types of demographic characteristics were related with higher levels of sharing a home and work census block than others.

For instance, blocks with higher numbers of multi-person households showed stronger correlations between work and home co-location than those with more single-person households. Blocks with more homeowners, as opposed to renters, also were more likely to have more people whose job locations were close to each other. As average age increased within a block, so did the incidence of home and work co-location.

"With age and experience, individuals may be better able to exploit their networks from the neighborhood in getting employment," Levinson says.

The study also found that blocks in which more people listed their race as Asian, black, or "other" showed higher rates of having similar work and home locations.

SOCIAL NETWORKS, JOB FINDING, AND RELOCATION

For the second part of the study, Levinson and Tilahun looked at how people searched for work and the effect of technology and social networks on job-finding paths. With the advent of the Internet, job seekers now have access to information about more jobs, including those farther from home, which would theoretically increase the likelihood of either longer commutes or an eventual relocation.

Understanding social networks and their effects on individual choices could—at least, theoretically—improve understanding of travel decisions, aiding in transportation planning at the city and regional level.

To understand the effects of technology on job searching, job finding, and relocation decisions, the researchers surveyed 5,000 people from three areas of the Twin Cities. The areas were chosen to provide a mix of suburban and city dwellers, income levels, and races. In a lengthy questionnaire, respondents were asked about how they found their current job and what impact that had on their place of residence.

Personal contacts remained the biggest factor in job finding, with 40 percent of those who were not self-employed using contacts to find their current job. While the Internet is a growing job-finding strategy, this largely has come at the expense of answering newspaper ads and other types of formal searches rather than use of contacts. Moreover, use of the Internet appears to be a "less efficient method, at least compared to contacts," notes Tilahun. Of those that found their current job since 2005, almost 31 percent found it through an Internet search, though 74 percent of that group would use the Internet as their primary search tool. While only 18 percent of those who found their job since 2005 said they would use contacts as their primary search method, 43 percent found jobs through contacts.

Analysis of the data also revealed that the usefulness of the Internet as a job-search tool depended on level of education. For instance, while individuals with less than

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LET'S MEET!

With Facebook, instant messaging, and Blackberries, meeting in person seems so 20th Century. But people still crave face time, and travel for social and recreational purposes—often to meet with a friend, relative, or associate—still accounts for almost a quarter of all household travel. As part of their research on social networking and transportation, David Levinson and Nebiyou Tilahun examined how meetings varied based on demographic characteristics and how communication media were used to schedule meetings and maintain relationships.

Using data gathered from their earlier work on social networking, Levinson and Tilahun analyzed information on 744 meetings held by 222 people in one week. The analysis found some not surprising things—meetings with family members and close friends are more likely to be held at home rather than a neutral space, whereas meetings with more distant connections tend to occur outside of the home—and some things that might be considered surprising—men tend to have longer meetings than women.

About a third of the meetings were held in individuals' homes—with most of those held on the weekend. On the weekend, single women were most likely to hold meetings outside of their home while married men were the most likely to hold meetings at home. During the week, single men were the most likely to meet away from home while married men were still most likely to meet at home. At out-of-home meetings, close friends, family members, and co-workers were the most likely meeting partners.

From the data, Levinson and Tilahun developed models to predict the likelihood of a meeting requiring travel (in home or out of home) based on such characteristics as gender, meeting purpose, anticipated duration of the meeting, age, and time of the week, among other things.

Gender and the number of social contacts a respondent had directly affected the duration of meetings and indirectly affected the distance traveled to meet. Overall, the study illustrated the importance of social contacts and the location of those contacts in determining how much travel an individual undertakes.

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a bachelor's degree were more likely to find a job in the newspaper than online, those with a bachelor's had greater success using the Internet. For those with master's or professional degrees, recruiters were the best source of jobs. In addition, job seekers who already were employed were more likely to get a job through a contact than any other means. Interestingly, the researchers found that the size of an individual's social network as measured by the number of people they were in contact with twice a month or more and the number of contacts who lived within three miles of the individual's home had only limited effect on his or her job-finding path. Only two situations produced statistically significant insights: Those with small social circles were more likely to find jobs through formal searches and those with a high percentage of their social circle living near them (50 percent within three miles) were more likely to find jobs through contacts.

RELOCATION DECISIONS

Using the same survey data, Tilahun and Levinson then explored the relocation decisions of workers. While deciding where to live is a complicated calculation involving economic, social, and family issues, "being close to work" was cited by nearly 37 percent of respondents as one of the top three reasons for relocating. To determine the relationship among job finding, relocation decisions, and commuting patterns, Levinson and Tilahun used path analysis, a method of testing a set of hypothesized variables and their expected relationships against actual data. For the analysis, a number of assumptions were made about which individuals might relocate (younger households sooner than older ones, smaller households sooner than large ones, those who got a job through contacts rather than through the Internet, for example) and the effect of the relocation on commute time.

Not all of the assumptions held up against the data, but the analysis provided a picture of who relocates after a job search and where. Among the findings:

- Older individuals relocated faster than younger ones, an unexpected finding;
- Those renting relocated faster than those who own their home;
- Those planning to buy a house took longer to relocate, likely because of the time needed to find and purchase a home;
- Those who found their job through the Internet relocated quickest after finding a new job, another surprising finding. "This trend held up even after controlling for age and commute distance, so there may be unseen variables among those who use the Internet to find work that makes them especially footloose," says Levinson.
- The study also found that those with stronger social networks were likely to take more time to move and not as likely to move far from the original home.

While gathering data at the individual level is difficult and costly, understanding social networks and their effects on individual choices could—at least, theoretically—improve understanding of travel decisions, aiding in transportation planning at the city and regional level.

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TechPlan:
Going Forward

Going forward:

New TechPlan research

Rapid changes in transportation technologies create new opportunities for research as technologies are tested, modified, and adapted. Several TechPlan projects are in the beginning stages to address emerging issues in transportation and technology.

FINDING BETTER WAYS TO FUND ROADS

Since the 1930s, fuel taxes have been a major source of funding for roads—at least that is what many Americans think. While fuel taxes began as a reasonably fair and efficient way to ask users to pay for roads, transportation systems today essentially are an "unpriced commodity," according to Ferrol Robinson, a Humphrey Institute researcher who is part of a team of researchers examining whether the U.S. fuel tax should be retained or replaced. The average user of U.S. roads pays only about three cents per vehicle mile traveled. However, a driver on a congested highway imposes between 10 and 29 cents of costs per vehicle mile traveled.

As part of an ongoing study of road funding mechanisms and technology, the Humphrey Institute researchers have created a set of criteria by which to examine fuel taxes and alternative funding sources, says Lee Munnich, Jr., director of the State and Local Policy Program. The researchers—Robinson, Munnich, David Coyle, Zhirong Zhao, and Adeel Lari—are measuring various road-funding options against five tax-financing principles: efficiency, equity, revenue adequacy and sustainability, environmental sustainability, and feasibility. Their first project measured fuel taxes against these criteria.

The study found that while fuel taxes rate highly for feasibility—they are politically accepted and relatively easy to administer—they do not rate particularly well in terms of efficiency, revenue adequacy and sustainability, or equity. Fuel taxes do not reflect the actual cost of using the road system, resulting in overuse, and many drivers are unaware of how much they pay in fuel taxes, often over- or under-estimating the tax by a factor of five. Moreover, as cars have become more fuel efficient, taxes collected compared to miles driven are dropping. "In time, some cars won't be using gas at all," says Munnich, "so it's not clear how sustainable gas taxes will be as source of revenue."

The next phase of the study will rate taxing systems based on vehicle miles traveled (VMT)—the primary alternative to the fuel tax—against the five criteria. During the course of the 18-month project, researchers plan to analyze technologies that could be used for VMT-financing systems and public education and awareness programs to address issues related to road financing.

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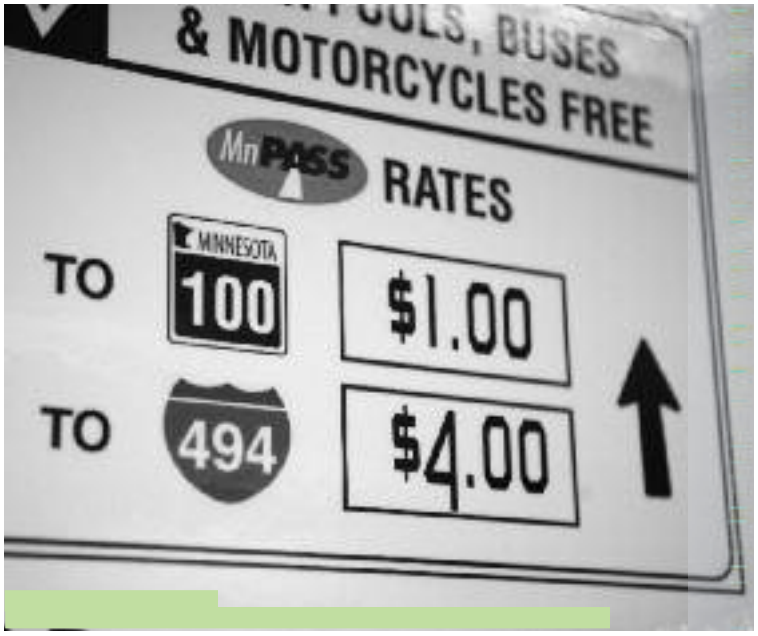

SOCIAL COSTS/BENEFITS OF CONGESTION PRICING

Minnesota's first application of congestion pricing—the MnPASS lane between downtown Minneapolis and its western suburbs along Interstate 394—has been in operation since 2005, attracting up to 3,000 cars per day to the special lanes. A new TechPlan research effort will examine the social benefits and costs of the congestion pricing project, giving policymakers a sense of the long-term implications of MnPASS. According to data from the Minnesota Department of Transportation, the MnPASS lane has improved traffic flow along I-394, but it has not produced significant improvements in mobility throughout the Twin Cities' transportation network. Moreover, it has not reached one of its goals: providing additional funds for transit and highway projects in the region. "We have made a lot of investments in the project," says Xinyu (Jason) Cao, principal investigator and assistant professor of regional policy and planning at the Humphrey Institute. These have raised concerns about the effectiveness of the project.

For this study, which will continue through 2011, Cao will use advanced analysis tools to compare the societal benefits and costs of the high-occupancy toll lane with the high-occupancy vehicle lane that previously existed along Interstate 394. Among the factors to be considered are the travel time savings, savings on fuel consumption, and benefits of reduced crashes.

"We anticipate that because the lane reduces the amount of stop-and-go traffic, the number of crashes will go down," says Cao. By giving drivers the option to pay to go faster, the MnPASS lane has improved overall speeds along the highway, says Cao. His study will look at travel times along different segments of the road for MnPASS users. By comparing the MnPASS lane to the previous configuration of the highway, the study will give policymakers greater insight into the overall costs and benefits of the project.

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BETTER PLANNING FOR BIKE AND PEDESTRIAN PATHS

Are bike and walking paths like the fictional field of dreams—if you build them, they will come? A TechPlan project designed to help planners understand how bike and pedestrian trails and other places designated for non-motorized traffic are used has begun gathering data in the Twin Cities. Led by Greg Lindsey, professor of environmental planning and associate dean of the Humphrey Institute, the research will use infrared sensors to gather information about when and how often bike trails are used in the Twin Cities.

"Our goal is to develop both descriptive information and models of non-motorized traffic on trails and other pedestrian areas," says Lindsey, who also is working with students in his Capstone Workshop on non-motorized traffic on the project. Infrared traffic counters—similar to the technology used to track animals on paths in the wild—have been installed on Minneapolis's Midtown Greenway bike path and will be installed on other trails as well. The counters have been located near city Department of Public Works bike counters in order to double check the results of the infrared counters and give the researchers more in-depth data about trail use. "One thing we are trying to do is to explain and optimize different methods of counting," says Lindsey. For instance, if two users go by a counter side-by-side, the infrared counter may only see one of them. "Infrared counters systematically

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undercount," Lindsey says, but that is correctable using a mathematical formula.

The counters will record traffic on the trail during different times of the day and different times of the year, and the data will be compared with information gathered from other cities. Comparing use of trails in Minneapolis to Indianapolis, for example, Lindsey found that there was greater seasonal use in Minneapolis—perhaps due to its colder climate. However, it is well known that the modal share for bicycle commuting is higher in the Twin Cities than in Indianapolis. Ultimately, Lindsey's research is aimed at figuring out how to better plan for non-motorized traffic. "Does painting a bike lane lead more people to use it?" he asks. "We're trying to understand the factors that lead people to use trails. The goal is to develop tools for planning so cities don't have to do customized work when planning for bike trails." □

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