Annual Report 2015
The Transportation Future...
Made in Minnesota

The future of transportation is being made in Minnesota

Many Minnesota products are well-known—and shipped—worldwide. From Post-it® notes to medical devices to Cheerios™, products originating in Minnesota are proof that our state's industries can innovate and thrive in changing times.
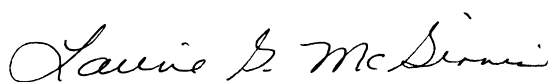
The University of Minnesota is also an exporter to the world. Our output? New knowledge and a skilled workforce—the underpinnings of innovation and prosperity.

U of M researchers generate the breakthrough ideas and real-world solutions needed to tackle transportation challenges. Faculty also educate and mentor the students who will put these ideas into place, whether in the public sector or private industry.

CTS supports these efforts in many ways. For example, we form connections among disciplines, funders, and stakeholders to ensure that research takes a broad look at the issues and addresses practical needs. We operate student programs such as summer camps to attract K-12 students to transportation-related degrees. And we make information available through events, websites, and other means.

This annual report shares highlights of these activities. As always, our success depends on the support of our partners, sponsors, and committee members. My deepest thanks to you all for your commitment.

Sincerely,

Laurie G. McGinnis

Laurie G. McGinnis, Director
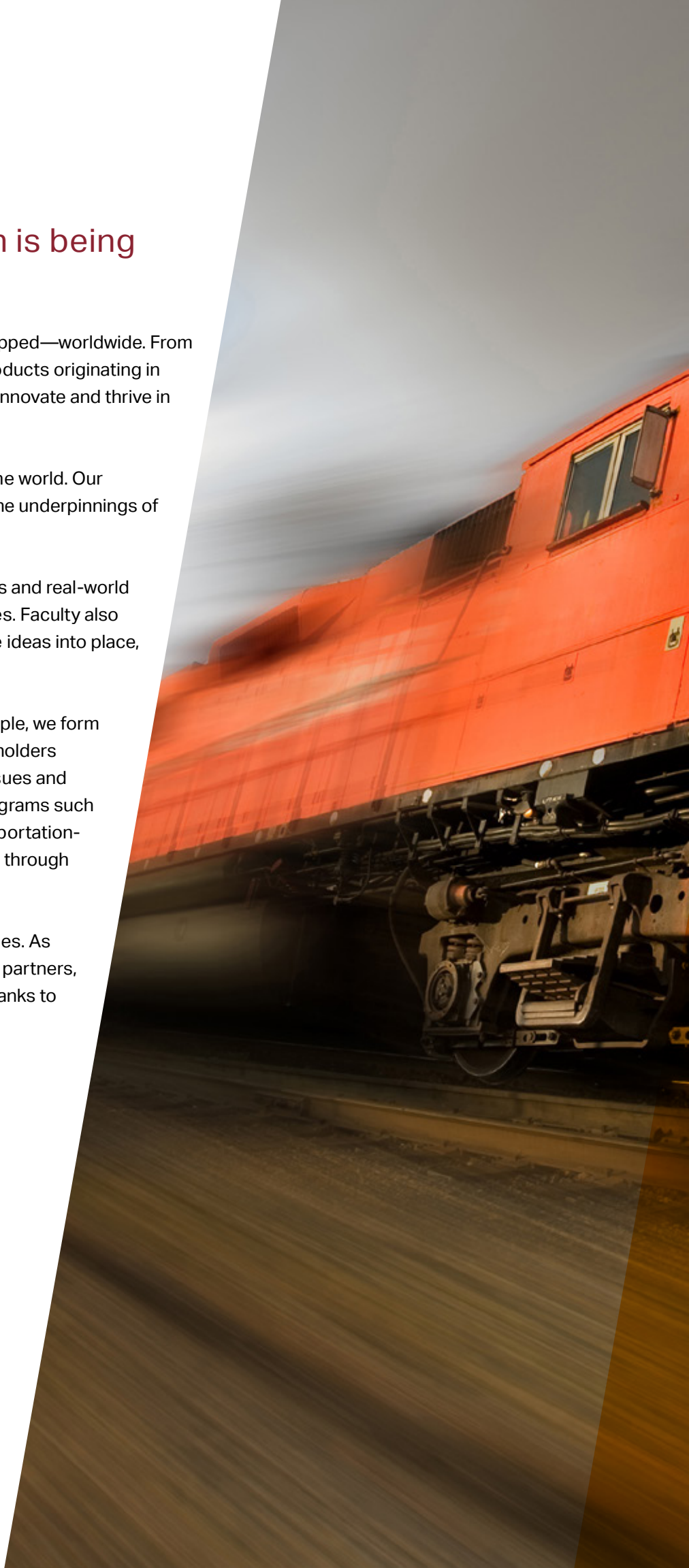
"**The University of Minnesota** is an exporter to the world."

Smartphone app improves work-zone safety for visually impaired pedestrians

Navigating sidewalks and intersections affected by road construction can be challenging for all pedestrians, but it's especially difficult for those who are blind or visually impaired.

To help these pedestrians find their way safely, University of Minnesota researchers developed a smartphone app that can detect upcoming work zones and provide routing instructions. The app uses Bluetooth beacons—which can be attached to signs, posts, or construction barriers in a work zone—that communicate with the GPS receiver on a user's smartphone.

When a beacon is detected, the phone vibrates and provides an audio message. The message includes the pedestrian's current location, the location of the work zone, and suggested routing instructions. The user can tap the smartphone to have the message repeated.

The app builds on a previously developed smartphone-based system that was designed to provide visually impaired pedestrians with geometric and signal timing information at signalized intersections.

The federal government strongly encourages states to provide either audible warnings or tactile maps at work zones where visually impaired pedestrians will likely be affected. "The smartphone application is a step in that direction," says Ken Johnson, a work zone, pavement marking, and traffic devices engineer at the Minnesota Department of Transportation (MnDOT). "It's a way to see if this type of wayfinding device would work."

Researchers are improving the app's accuracy and reliability for use in more locations—even in GPS-unfriendly environments—under a grant from the Roadway Safety Institute.

Researcher: Chen-Fu Liao, senior systems engineer, Minnesota Traffic Observatory
Sponsor: MnDOT

20.6 million Americans 18 and older report experiencing significant vision loss.

Model helps transit planners prioritize shelters and amenities

Many transit users think their wait for a bus or train is much longer than it actually is. Improved shelters and amenities such as real-time schedule displays are becoming a popular strategy to overcome this misperception and encourage more people to use transit.

To better understand what specific aspects of stations and stops make transit wait times seem shorter to users, U of M researchers studied 36 stops and stations throughout the Minneapolis–St. Paul metropolitan area. 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 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 model developed in the project includes many other variables such as household income, trip purpose, and the presence of benches and route maps.

"This study provides important insight that is directly applicable to the work we are doing to ensure that our customers have the best possible experience using transit service in the Twin Cities," says Marilyn Porter, director of engineering and facilities for Metro Transit.

Metro Transit is upgrading all of the region's bus signs over the next two years, installing 150 new shelters, and adding amenities to many existing shelters.

A 5-minute wait felt like only 3.2 minutes for riders who had access to shelters.

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New crash report interface improves usability and data quality

The data collected at the scene of a crash by law enforcement officers are important for more than just drivers and their insurance companies. The information is also used on a much larger scale by state agencies and researchers to analyze and evaluate crashes, trends, and potential countermeasures.

As part of an effort to improve this data quality in Minnesota, a team of U of M researchers redesigned the electronic crash report interface used by law enforcement officers. The team's goal was to create a new interface that improves the accuracy, data entry speed, reliability, and meaningfulness of crash report data. The project occurred in conjunction with a redesign of Minnesota's crash records database.

For the project, researchers from the U's HumanFIRST Laboratory completed a human factors analysis on the existing crash report interface to identify potential problem areas. Following the analysis, the team built two versions of a mock crash report interface—a "wizard" and a form—and conducted four rounds of usability testing with law enforcement officers for both versions. Because the results were split, the state chose to build full versions of both, which will allow officers to choose the version they prefer.

After making adjustments to the prototype, the team handed it off to the state vendor to build the new system. Team members also worked collaboratively with the vendor to complete additional usability testing. The new interface launches in early 2016.

"The results of the HumanFIRST prototypes are being combined with the vendor's prior experience for a best-of-breed approach," says Kathleen Haney, traffic records coordinator at the Minnesota Department of Public Safety (DPS). "This is a fantastic project, and the results will be relevant for years to come."

Researcher: Nichole Morris, principal researcher, HumanFIRST Laboratory
Sponsors: Traffic Records Coordinating Committee, Minnesota DPS; MnDOT

Officers from 73 law enforcement agencies across Minnesota participated in the redesign and usability testing process.

Cyclopath makes bike routing available statewide

Bicyclists across Minnesota can plan their rides using Cyclopath, an online bicycle map and trip planner developed at the University of Minnesota.

Originally launched in 2008 to serve the seven-county Twin Cities metro area, Cyclopath now includes the complete MnDOT road and state trail network. A simpler version of Cyclopath is also now available as an Android app.

Cyclopath generates personalized bicycle routes for its users. For instance, cyclists can look for routes that minimize distance or that favor bike trails or lanes. It also features a "Bike + Bus" multimodal option that lets cyclists integrate Metro Transit bus routes into their trips.

What makes the tool unique is that it allows users to edit the system's maps of roads and trails. Cyclists can add and connect new trails to the map, enter tags to identify characteristics, participate in discussions, and rate roads and trails for "bikeability."

The statewide expansion project was sponsored by MnDOT, which also provided the U of M team with access to data on state roads and trails. "MnDOT frequently receives requests from the public for long-distance route planning," says Jasna Hadzic, a bicycle and pedestrian planner at MnDOT. "In 2013, we updated the print version of the Minnesota Bicycle Map, but we still needed a tool that was more up-to-date and user friendly. Expanding Cyclopath helped us meet that need."

The daily number of users creating routes with Cyclopath jumped from 100 to about 250 after the statewide network expansion.

Researchers: Loren Terveen, professor, and Landon Bouma, lead software engineer, Department of Computer Science and Engineering
Sponsors: National Science Foundation, MnDOT, Metropolitan Council, other local partners

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Permitted left-turn model, spreadsheet help improve intersection safety

Many transportation agencies, including the Minnesota Department of Transportation, are interested in using flashing yellow arrow signals. 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.

To help engineers make more informed decisions about when to use flashing yellow arrows, U of M researchers led the development of a model that helps predict the probability of left-turn crash risk at a given intersection at different times of day. This model will help traffic engineers determine when the crash risk is sufficiently low to allow for the safe use of flashing yellow arrows.

The research team used 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 then generates 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. The tool is available online, and a tutorial is under development.

Work to enhance the tool is continuing under a grant from the Roadway Safety Institute.

In 2012, there were almost 3,300 crashes involving left-turning vehicles in Minnesota, including more than 1,100 fatal and injury crashes.

Researcher: Gary Davis, professor, Department of Civil, Environmental, and Geo- Engineering
Sponsors: MnDOT, Minnesota Local Road Research Board

Finance database provides foundation for decision making

U of M researchers 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 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.

Local property tax is the largest single source of transportation revenue in Minnesota (2010 data).

Researchers: Zhirong (Jerry) Zhao, associate professor, and Adeel Lari, director of innovative financing, Humphrey School of Public Affairs
Sponsor: Transportation Policy and Economic Competitiveness Program

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Portable weigh-in-motion system provides low-cost screening

Heavy freight vehicles are a concern for many local transportation agencies due to the damage they can cause to roads. Weigh-in-motion (WIM) systems can provide useful data about freight vehicles that use a given road, but current systems are expensive. They are also permanent, requiring costly and intrusive pavement cuts or boring to install.

A University of Minnesota Duluth researcher developed a portable WIM system prototype that can be installed with tape and anchors in less than 40 minutes and that costs significantly less than permanent WIM systems. The prototype's portability gives agencies the flexibility to gather data at multiple locations without the additional costs of purchasing a new system.

Researchers field-tested the portable WIM system in two phases and upgraded the system with significant software changes. This system proved accurate enough for screening low-volume roads to identify sites where overweight vehicles are likely to travel.

The system can also provide improved data about vehicle class and weight that would be valuable for planning and pavement design or to better understand the impacts of heavy freight vehicles on a particular road. MnDOT has two of these systems available for local agency use.

Trucks carry more than **63%** of goods moved in Minnesota (by volume, 2012).

Researcher: Taek Kwon, professor, Department of Electrical and Computer Engineering, University of Minnesota Duluth
Sponsor: MnDOT

Knowledge and Expertise

Protocols help reduce stormwater runoff from road construction sites

Transportation practitioners have new tools to help keep stormwater runoff from road construction out of our waters, thanks to research from the University of Minnesota.

During a rainfall, eroded sediment from a site can quickly reach nearby lakes or rivers. Because of this negative impact, the Minnesota Pollution Control Agency requires a stormwater pollution prevention plan to limit sediment discharge from sites.

Turbidity values, which measure the cloudiness of a fluid, are typically used to gauge the amount of eroded sediment in construction runoff. The usefulness of these measurements, however, depends in part on how well the data represent runoff at specific sites. Turbidity monitoring also can be expensive; costs include equipment and personnel to install and monitor the data-collection systems.

U of M researchers investigated turbidity relationships for the conditions found at Minnesota construction projects and developed protocols for the design and installation of cost-effective turbidity monitoring systems. The two systems they developed can be used to help transportation agencies cost-effectively monitor the turbidity of construction site runoff.

"There is a correlation of properly selected, sequentially timed, installed, and maintained best management practices [BMPs] and brown water discharge from construction activities," says Dwayne Stenlund, MnDOT erosion control engineering specialist. "Turbidity monitoring helps answer why BMPs are required by permit and contract."

Sediment from a road construction site can quickly reach nearby lakes or rivers—and degrade the quality of our waters.

Researchers: Bruce Wilson, professor, Department of Bioproducts and Biosystems Engineering; John Gulliver, professor, Department of Civil, Environmental, and Geo- Engineering
Sponsor: MnDOT

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New software will aid design of concrete pavements

Concrete is the material of choice for many roads. A team of experts created a new tool for designing concrete pavements that last longer and cost less—work that earned them the 2015 CTS Research Partnership Award.

Researchers in the Department of Civil, Environmental, and Geo-Engineering worked in partnership with MnDOT and the Concrete Pavement Association of Minnesota to develop the new design tool—named MnPAVE-Rigid.

Before this project, MnDOT designed concrete pavements using a program based on a modified version of a national design procedure from 1981. It was based on outdated data, didn't take several important factors into account, and produced very conservative designs.

The new design tool makes use of the latest design procedure from the American Association of State Highway and Transportation Officials and incorporates local climate and traffic data, along with calibration specific to Minnesota pavements. This produces a program that better models concrete pavements and ensures that road designs are suited to local conditions.

MnPAVE-Rigid, a standalone Windows executable program, was officially made the MnDOT concrete pavement design program in 2014, and it's now being used by MnDOT district personnel and MnDOT-contracted consultants. New designs are typically one to two inches thinner than the previous designs, which will significantly reduce construction costs.

"This software allows pavement designers to use sophisticated mechanistic-empirical design procedures in a simple format, while still providing robust results," says Luke Johanneck, MnDOT research project engineer.

Researchers: Professor Lev Khazanovich and research associate Derek Tompkins, Department of Civil, Environmental, and Geo- Engineering
Sponsor: MnDOT

The U of M, MnDOT, and the Concrete Pavement Association of Minnesota received the CTS Research Partnership Award for their creation of the new software.

MnDOT scholar-in-residence shares knowledge with practitioners

Greg Lindsey, a professor at the Humphrey School of Public Affairs, was appointed the first MnDOT scholar-in-residence in early 2015. In this role, Lindsey is working in the MnDOT Office of Transit's Bicycle and Pedestrian Section, where he is helping MnDOT develop a district-based plan for permanent and long-term bicycle and pedestrian traffic monitoring.

Lindsey's appointment expands on MnDOT's existing partnership with CTS and builds on his work for the Minnesota Bicycle and Pedestrian Counting Initiative, a collaborative effort between MnDOT and the U of M.

One of the goals of Lindsey's work is to develop tools that practitioners can use to prioritize infrastructure investments. Findings from one recent study—specifically designed to engage local agencies—have already been incorporated into a draft manual. The new MnDOT document is being used in statewide training workshops.

New online training offered to local maintenance personnel

The Minnesota Local Technical Assistance Program (LTAP), a part of CTS, launched two new online courses designed for local agency staff. Fifty practitioners have already completed the new courses, which focus on sign maintenance and management and culvert installation and maintenance.

The courses are part of a continuing effort by Minnesota LTAP to offer affordable, consistent training to maintenance personnel at cities, counties, and townships across the state using the latest technology. They were developed with funding from the Minnesota Local Road Research Board and in partnership with MnDOT, city and county agencies, consultants, and industry experts.

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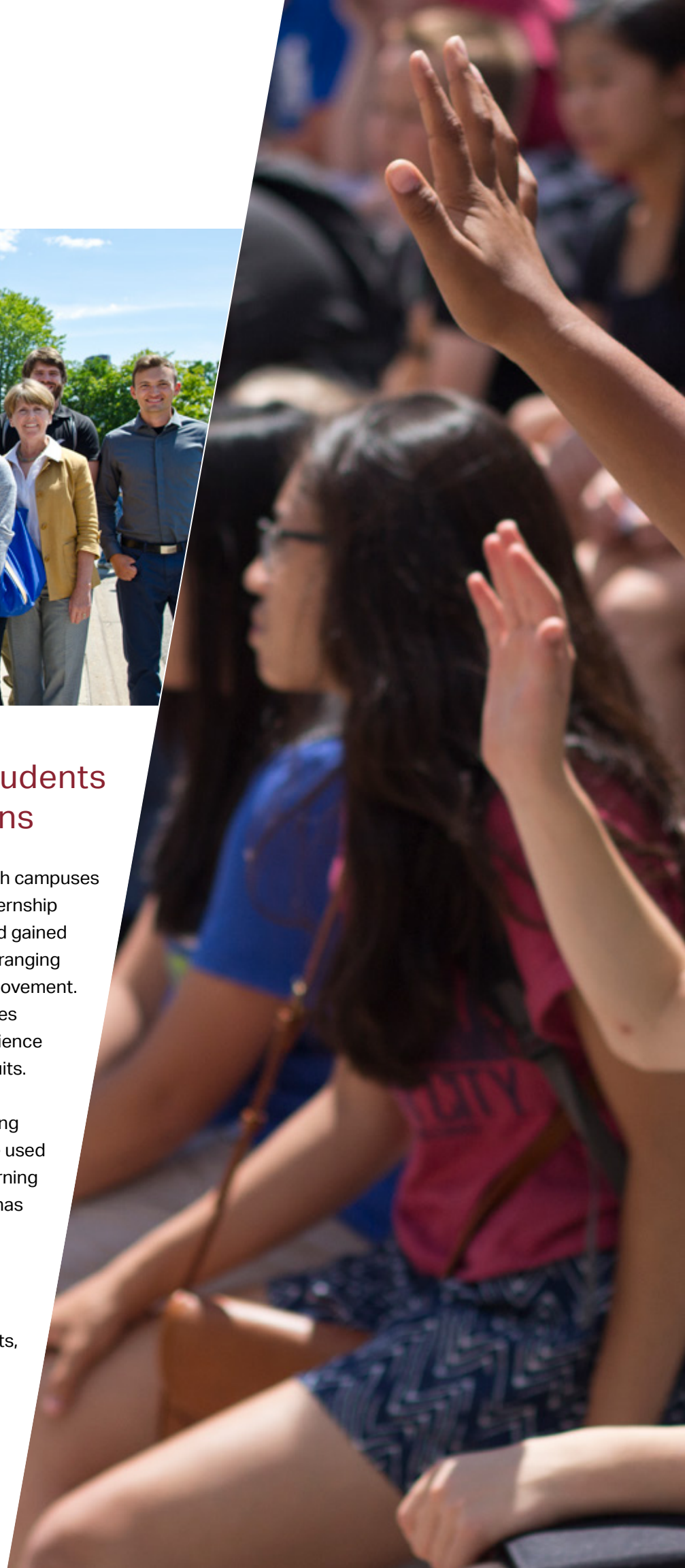
Internship program helps students build skills, make connections

Eight students from the U of M Twin Cities and Duluth campuses participated in the 2015 Summer Transportation Internship Program. Interns worked at MnDOT for 10 weeks and gained valuable transportation-related experience in areas ranging from designing roadways to measuring pavement movement. The program, offered jointly by CTS and MnDOT, gives students the opportunity to gain professional experience and skills that will complement their academic pursuits.

Luke Horsager spent much of his internship equipping MnDOT boats with new GPS and Bluetooth software used for river mapping and monitoring bridge scour. "Learning how to operate and troubleshoot the new software has been really valuable," he says.

Heidi Gray, a MnDOT Metro District designer, supervised one intern on two design projects. Gray says the program is valuable not only for the students, but also for the supervisors and MnDOT as a whole. "It's really good to get young people in here and teach them what MnDOT is all about," she says.

Summer camp engages the next generation of the transportation workforce

CTS introduced the next generation of the workforce to transportation topics and careers during a two-week summer program in July. Twenty-nine students entering seventh through ninth grade completed the program, where they got hands-on experience with topics ranging from distracted driving to aeronautics to traffic management.

The CTS-hosted National Summer Transportation Institute is part of a national program designed to attract and introduce the brightest young minds from diverse segments of society to education and career opportunities in transportation. It was sponsored by CTS with funding from the Federal Highway Administration administered by MnDOT.

Activities included hands-on group projects, tours of transportation-related labs at the U of M, and field trips to MnDOT, the St. Croix River Bridge, UPS, the Minneapolis–St. Paul International Airport, Metro Transit, the Minnesota Transportation Museum, and the St. Paul Port Authority.

"This was one of the best camps we have ever experienced," one parent said. "There was always a plan for college, and this program increased enthusiasm, preparedness, and maturity."

Education Awards

Matthew J. Huber Award (honoring students in engineering, science, and technology fields)
• Indrajit Chatterjee, doctoral candidate, civil engineering; Gary Davis, advisor

John S. Adams Award (honoring students in policy and planning fields)
• Andrew Guthrie, doctoral candidate, public affairs; Yingling Fan, advisor
• Spencer Peck, master's candidate, urban & regional planning; Frank Douma, advisor

Roadway Safety Institute Outstanding Student of the Year
• Stephen Zitzow, master's candidate, civil engineering; John Hourdos, advisor

Made in Minnesota

Blowing snow control website helps agencies keep roads drift-free

An online tool is now available to help transportation agencies design drift-free roads. The Minnesota Drift-Free Roads Design Module allows users to create two types of mitigation strategies: a proper road design and a snow fence design. Users are able to enter a site-specific blowing snow problem and examine solutions.

The tool was created by partnering staff at the Minnesota Department of Transportation and the Minnesota State Climatology Office, with technical support from the U of M College of Food, Agricultural and Natural Resource Sciences.

The design tool is one of the components of the Blowing Snow Control Tools website, created and maintained by U of M Extension and CTS. The site also includes a snow control cost/benefit tool developed previously by U of M researchers.

Accessibility metrics and teen driver research garner media attention

University research on accessibility to jobs and teen driver safety garnered extensive local and national media attention in FY15.

In October 2014, the Accessibility Observatory released the second report in its Access Across America series. The report examined the accessibility to jobs by transit in 46 of the largest metro areas in the United States. The report received coverage from more than 30 news outlets across the country, including the *Washington Post* and CityLab.

In February 2015, the University-developed Teen Driver Support System (TDSS) received widespread local media attention, including coverage by Minnesota Public Radio, the *Star Tribune*, and WCCO 4, FOX 9, and KSTP 5 television news. TDSS is a smartphone-based system that provides real-time feedback to teen drivers about risky behavior behind the wheel and texts violation information to parents.

169 media stories nationwide reference U of M transportation research, education, and engagement.

Showcase convenes researchers, practitioners to share safety solutions

The Roadway Safety Institute (RSI), the Region 5 University Transportation Center led by CTS, convened researchers and practitioners from across the region at a showcase event in May. The Roadway Safety Showcase: Safety Innovations for Today and Tomorrow highlighted the latest work by RSI researchers from the University of Minnesota, University of Illinois at Urbana-Champaign, University of Akron, and Auburn University.

Eighty-five attendees learned how RSI researchers are developing solutions for some of today's most pressing safety problems related to such areas as rail grade crossings, tribal nation roads, and bikes and pedestrians. The showcase also provided opportunities for information exchange, networking, and the development of potential collaborations.

Events bring international perspectives to Minnesota

Fall Luncheon: "Will Rising Trip Productivity Change Travel Choices?" Patricia Mokhtarian, Georgia Institute of Technology

Winter Luncheon: "Smart Cities and Smart Mobility," Jaume Barceló, Technical University of Catalonia

2015 Research Conference plenary sessions:
• "A Traffic Manifesto—Reducing Congestion For All," Ralf-Peter Schäfer, Traffic and Travel Information Product Unit, TomTom
• "The Panama Canal Expansion: Myths and Realities for the North American Economy," Jean-Paul Rodrigue, Department of Global Studies and Geography, Hofstra University

Made in Minnesota

CTS helps MCOTA improve statewide transportation coordination

CTS and University researchers assisted the Minnesota Council on Transportation Access (MCOTA) with several engagement, research, and communication activities. MCOTA—the statewide transportation coordination council established by the Minnesota Legislature—and its member agencies are charged with improving transportation access throughout the state, especially for older adults, veterans, and people with lower incomes or disabilities.

First, CTS convened stakeholders and facilitated the discussion that led to the development of a strategic action plan for MCOTA. In addition, CTS coordinated seven regional workshops around Minnesota to help MCOTA gather feedback on a proposal to establish regional coordination councils. These councils would assist in promoting greater collaboration among transportation service providers and human service agencies to provide improved access to transportation for these specific populations, helping MCOTA realize its vision: Minnesotans will have access to coordinated transportation services to meet their mobility needs.

Other products included a primer of funding sources, common standards for financial records, data collection and analysis of vehicle sharing, and an online map of human services transportation providers' areas of service.

Leaders honored for distinguished service

CTS presented the following awards at its Annual Meeting and Awards Luncheon on April 6.

Richard P. Braun Distinguished Service Award (outstanding leadership in research and innovation): **Timothy Henkel**, assistant commissioner and director of the Modal Planning and Program Management Division at the Minnesota Department of Transportation

Ray L. Lappegaard Distinguished Service Award (outstanding leadership, mentorship, and support for the profession): **Brian Lamb**, general manager, Metro Transit

William K. Smith Distinguished Service Award (leadership, mentorship, and education of future leaders in private-sector freight transportation): **Ronald Dvorak**, marketing director for Lake Superior Warehousing, the terminal operator for the Duluth Seaway Port Authority's Clure Public Marine Terminal

Distinguished Public Leadership Award (public leaders who have influenced innovative transportation policy directions): **Senator D. Scott Dibble**, chair of the Minnesota Senate Transportation and Public Safety Committee

Timothy Henkel

Brian Lamb

Ronald Dvorak

Senator D. Scott Dibble

Executive Committee

Chair Jay Cowles
Co-Chair, Itasca Project Transportation Committee

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Senator, Minnesota Senate

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Global Business Director, 3M

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Commissioner, Minnesota Department of Transportation

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Gerard McCullough, Associate Professor

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Alireza Khani, Assistant Professor
Lev Khazanovich, Associate Professor
Joseph Labuz, Professor and Department
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Jia-Liang Le, Assistant Professor
David Levinson, RP Braun/CTS Chair in
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Chen-Fu Liao, Senior Systems Engineer,
    Minnesota Traffic Observatory
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Julian Marshall, Associate Professor
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Derek Tompkins, Research Associate

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Greg Lindsey, Professor
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Will Northrop, Assistant Professor
Rajesh Rajamani, Professor

Plant Biology
David Biesboer, Professor

St. Anthony Falls Laboratory
Jeff Marr, Associate Director for Engineering
    and Facilities

Urban and Regional Affairs
Ed Goetz, Professor and Director, Center for
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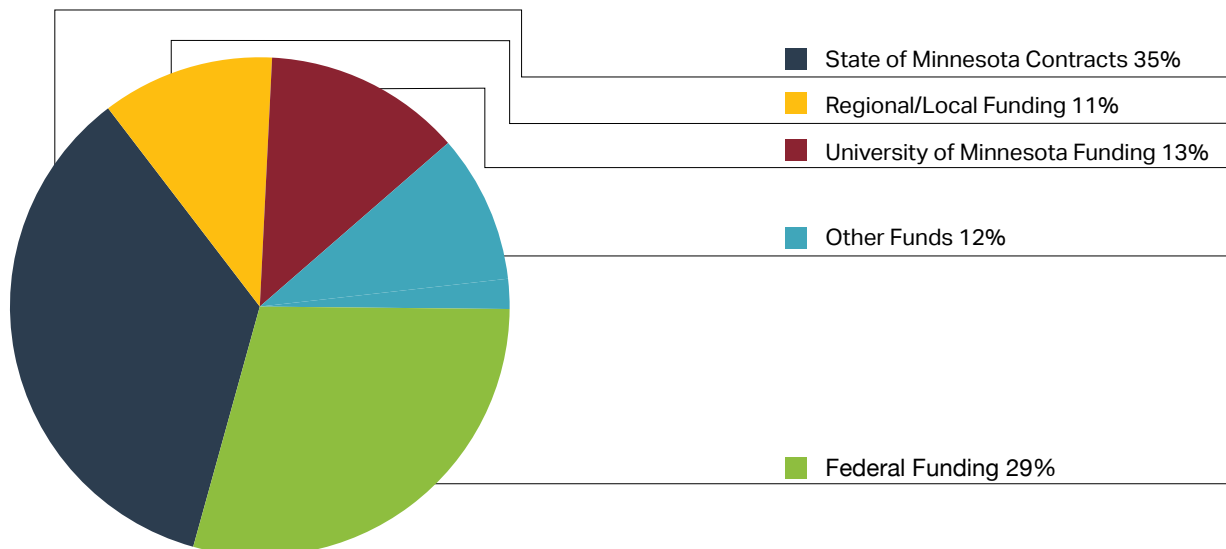Thomas M. Scott, Professor and Director
    Emeritus

Civil Engineering (Duluth)
Eil Kwon, Professor and Director, Northland
    Advanced Transportation Systems Research
    Laboratories

**Electrical and Computer Engineering
(Duluth)**
Taek Kwon, Professor

FY15 Revenues: $17,467,312

- State of Minnesota Contracts 35%
- Regional/Local Funding 11%
- University of Minnesota Funding 13%
- Other Funds 12%
- Federal Funding 29%

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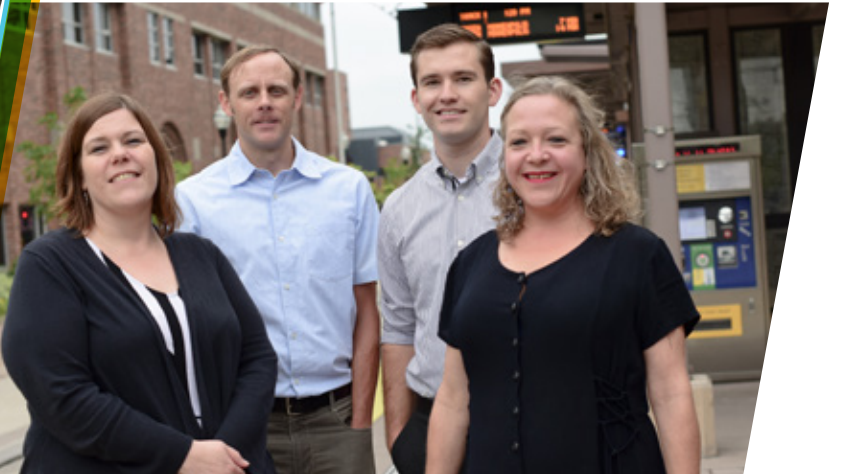
Top left: Dawn Spanhake, Laurie McGinnis, Gina Baas
Top right: seated—Angela Kronebusch, Arlene Mathison. Standing—Christine Anderson, Toni Prekker, Pam Snopl, Amy Friebe, Marilee Tuite, Michael McCarthy
Middle right: Penny Harris, Brian Hasty, Erik Haugan, Mary Snyder
Bottom right: Hannah Grune, Colleen O'Connor Toberman, Mindy Carlson, Jim Grothaus, Elizabeth Andrews, Brenda Thomas, Stephanie Malinoff, Kaydee Kirk, Kylie Bivins

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