

# Program Progress Performance Report

To US DOT/OST-R, University Transportation Centers

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# 1. Accomplishments

## What are the major goals and objectives of the program?

Through a strategically focused program that is synergistic with U.S. DOT priorities and MAP-21 goals, the Midwest Transportation Center (MTC) addresses regional issues related to its theme of **Data Driven Performance Measures for Enhanced Infrastructure Condition, Safety, and Project Delivery**, focusing on the overall goal of **State of Good Repair**. Under this theme, the MTC's objectives are to

- Serve as a focal point within the region and nationally for research that develops data performance measures for infrastructure condition, safety, and project delivery.
- Ensure efficient use of funds by building on existing programs, avoiding duplication, leveraging existing resources, and developing creative cooperative activities with industry.
- Develop products that are useful and relevant to stakeholders including national, state, regional, and local transportation agencies as well as industry and other researchers.
- Provide leadership in the next generation of technology transfer, beginning with the research itself—involving the user, innovative outreach, and new communications technology.
- Develop the next generation of transportation professionals and provide opportunities for current professionals.
- Provide leadership opportunities for students and young professionals.
- Recruit and retain a diverse workforce.

## What was accomplished under these goals?

The MTC accomplishes these goals by focusing on the following five activities:

- A. Research (goals 1, 2, 3)
- B. Outreach/technology transfer (goals 3, 4)
- C. Education (goals 6, 7)
- D. Workforce development (goals 5, 6)
- E. Center management (all goals)

The following sections summarize MTC accomplishments under each of these activities during the reporting period. Highlights include the following:

- MTC & IHRB combine funds for innovative research projects (page 6)
- 2016 Innovations Conference (page 7)
- Iowa Evening reception at 2016 TRB Annual Meeting (page 7)
- Transportation Safety Webinar Series (page 7)
- Research Implementation Meeting (page 8)
- MTC Outstanding Student of the Year 2015 (page 8)

### A. Research

The MTC's lead organization Iowa State University (ISU) is working with partners Wichita State University and Creighton University to help them develop transportation-focused

research programs; partner organizations University of Missouri–Columbia (UMC) and the University of Missouri–St. Louis (UMSL) are working with partner Harris-Stowe State University.

The total number of projects funded under this grant to date is 86, with 47 being led by ISU and 39 being led by partner or other institutions. During this reporting period, 10 new projects were initiated. All MTC-funded research projects, completed and in-progress, are listed at [intrans.iastate.edu/mtc/index.cfm/research/](http://intrans.iastate.edu/mtc/index.cfm/research/).

### Completed Research

During this reporting period, 7 final reports and 5 technology transfer documents were submitted for research projects funded under this UTC grant, bringing the total to 12 final reports to date (“Products” on page 16).

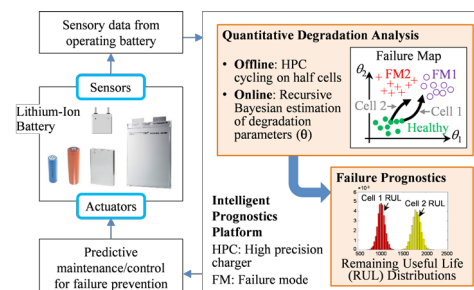
### Current Projects

Following are highlights of a few projects representing the work of all the partner institutions during this reporting period:

#### On-Board Prediction of Remaining Useful Life of Lithium-Ion Battery

PI: Dr. Chao Hu, ISU

Lithium-ion (Li-ion) battery technology has been playing a critical role in the wide-scale adoption of electric vehicles (EVs) and hybrid electric vehicles (HEVs). Real-time health diagnostics/prognostics and predictive maintenance/control of Li-ion batteries are essential for the reliable and safe operation of EVs/HEVs. Existing techniques in the battery management system (BMS) estimate the battery's state of charge and state of health, but neither can identify the degradation mechanism(s) the battery has experienced nor predict its impending failure. Hence, the information provided by these techniques are not sufficient for maintenance personnel and control electronics to make informed decisions on what and when to fix or replace. Alternatively, this research project intends to create an intelligent prognostics platform for the Li-ion battery, which will enable on-board estimation of degradation mechanisms and prediction of remaining useful life by leveraging a differential voltage analysis. The platform is expected to equip existing BMS with the capability to identify what degradation mechanism(s) are likely to cause an impending failure and highlight the event to trigger maintenance service and/or electronic control operation.

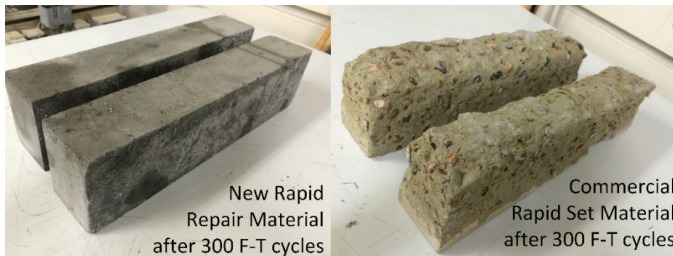


Predictive maintenance/control of Li-ion battery

## Develop an Eco-Friendly, Cost-Effective BiogROUT for Concrete Crack Repair

PI: Dr. Kejin Wang, ISU

The United States has an aging transportation infrastructure that requires constant maintenance and repair. Rapid repair of the deteriorated roads is essential so as to avoid the inconvenience of commuters and disruption of daily business. To meet service requirements and extend the pavement service life, the repaired pavements must also be strong and durable. To meet such demands, use of rapid-setting, high-performance mortar as a repair material is a very attractive option. In this research, fly ash, silica fume and limestone fines, the by-products of power plants, silicon production, and aggregate quarries, are being used to develop green, rapid-set, high-flow, high-performance mortar for pavement repair. The mortar being developed is self-consolidating and achieves one day compressive strengths of greater than 6000 psi. To ensure the suitability of the mortar for rapid patch repair applications, the development of compressive and rupture strength and elastic modulus were measured.



Differences between new rapid repair material and commercial rapid set material

## Data Driven Urban Traffic Prediction for Winter Performance Measurements

PIs: Dr. Zhengyuan Zhu, ISU

Because of the difficulty in defining expected performance based on varying winter weather conditions and traffic patterns, evaluating the performance of a city's winter highway maintenance program is a challenging task. However, the prediction of normal traffic speed change under severe weather in an urban setting with uncertainty is critical for measuring performance. So, to obtain these predictions, the research team proposed using a spatial Bayesian dynamic traffic model on urban road networks. Traffic data from both INRIX and Wavetronix were used to build the model. This work was built on the research team's previous and current work on point-level modeling and prediction of traffic speed drops during weather for performance evaluation in rural areas. A multivariate spatial-temporal model is being developed to accommodate the more complex road network structure in urban environments and to incorporate traffic data from both INRIX and Wavetronix sources. A future line of possible research includes integrating weather forecasting data into the model to provide more accurate and potentially real-time prediction under given weather conditions.

## Cost-Effective Field Test Methods for LRFD Resistance Factors of Drilled Shafts

PI: Dr. Jeramy Ashlock, ISU

In recent years, the Iowa Department of Transportation (Iowa DOT), as well as several other state DOT's, have made increasing use of drilled shaft foundations on bridge projects. Due to soil variability and the lack of redundancy, the Iowa DOT typically requires that a bi-directional Osterberg cell (O-cell) load test be performed on a demonstration shaft at each new bridge project. The load test results are then used to verify the predicted capacity and often to adjust the values of geotechnical shaft resistances used in designing the shafts for the entire bridge. However, O-cell tests are very costly (around \$100k per test) and can provide inconclusive results when only the upper or lower portion of the shaft (or neither) actually reach failure. As a result, extrapolation is commonly necessary to estimate the expected load-displacement behavior of the bridge foundations under actual top-down loading conditions. To develop Load and Resistance Factor Design (LRFD) calibration factors for drilled shafts without relying on extrapolation, this research project is investigating the use of top-down load tests on reduced-scale drilled shafts and developing scaling relations (if necessary) to predict the load-displacement curves of the full-scale shafts. Test results from the reduced-scale shafts will be compared to those from a full-scale O-cell test performed at an Iowa DOT bridge project site. The proposed research will contribute to the MTC's theme of Data Driven Performance Measures for Enhanced Infrastructure Condition, Safety, and Project Delivery. Specifically, the project will contribute load-test data for the Database for Drilled SHAft Foundation Testing, while aiming to enhance the safety of the infrastructure system through economical and reliable design methods for drilled shaft foundations. The final products of this research will include draft design guides and tech transfer materials for immediate use by engineers.

## Distributed Traffic Control for Reduced Fuel Consumption and Travel Time in Transportation Networks

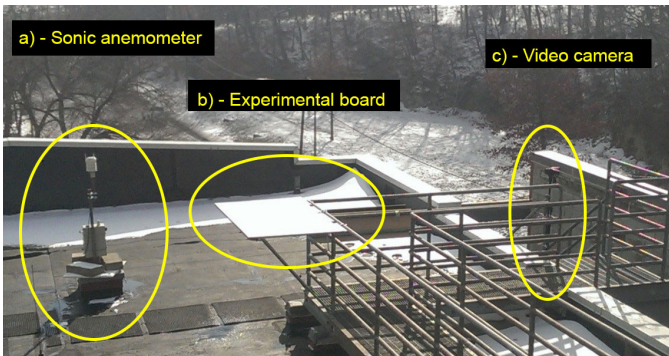
PI: Dr. Ran Dai, ISU

Current technology used in traffic control is unfortunately limited to a centralized approach that doesn't appropriately consider the efficiency of fuel consumption and is subject to the scale of transportation networks. This research project suggests the use of a distributed framework to reduce the balanced fuel consumption and travel time through hybrid control on speed limit and ramp metering rates. It proposes to integrate the roadway infrastructures equipped with sensing, communication, and parallel computation functionalities into a new traffic control paradigm. Going beyond the existing distributed architectures, where precise dynamic flow models and fuel consumptions have not been considered, work in the proposed research will generate traffic control strategies to realize real-time, macroscopic-level traffic regulation with high precision.

## Improving Traffic Safety Through Better Snow Fences: Image-Based Methods to Measure Trapped Snow Volume and the Snow Relocation Coefficient

PIs: George Constantinescu, Marian Muste, and Chris Rehmann, UI and ISU

This joint research project, which included researchers from both ISU and the University of Iowa, is looking at blowing and drifting snow as a major concern for safety, transportation efficiency, and road maintenance and repair. One common way to mitigate snow drifts on roadways is to install structural or living snow fences, but the design of snow fences relies on empirical relations—in particular, for estimating the snow relocation coefficient (SRC)—that do not necessarily apply to the Midwest. The main goal of the project is to develop an image-based method to evaluate the transport processes in the snow budget and measure the SRC directly in the field under various conditions. This experimental approach will also allow the temporal evolution of the volume of snow retained by a fence to be measured so that the efficiency of a design solution can be confirmed over a whole winter season. A set of non-intrusive measurement techniques will be assembled to document snow drifting over roads protected by snow fences. Snow drifting and transport will be quantified with high resolution using a combination of GPS technology and an image-based method called large-scale particle image velocity (LSPIV). During the first six months, the research team built an experimental arrangement suitable for lab scale measurements, installed and tested instrumentation, and performed preliminary measurements. This site is located on the roof of IHR-Hydroscience and Engineering at the University of Iowa. Additional field experiments will be conducted at targeted sites and under various meteorological conditions.



Experimental site at the University of Iowa containing a) sonic anemometer, b) experimental board, and c) video camera

## Women in Non-Traditional Railroad Field Positions

PI: Dr. Ray Mundy, UMSL

Through its Center for Transportation Studies (CTS), the MTC's partner organization UMSL is researching the lack of female representation in certain railroad field positions (such as train and track crews). At a time when railroads can be expected to be replacing a large portion of these workers due to retirements within the next decade, there is a lack of female

participation in applying for and occupying these excellent paying jobs. The CTS, in cooperation with the major Class One railroads of North America, has been surveying female and male employees in these positions to better understand their backgrounds, work environment, duties, and attitudes. Data from this survey will be matched with current railroad marketing and recruitment efforts to see if improvements can be made in reaching a more receptive female audience while supporting them with information that could assist them in considering a career in railroading.

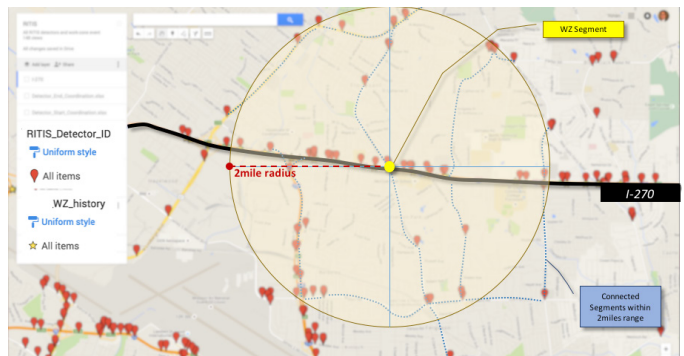


Women railroad workers

## Data-Driven Traffic Impact Assessment for Work Zones

PI: Dr. Praveen Edara, UMC

This research project is using historical data of traffic impacts resulting from work zones to develop an assessment tool for predicting future work zone impacts. This project will complement the research being conducted in a companion Smart Work Zone pooled fund project developing a prototype system using historical traffic and travel time data in work zones. Specifically, the spatial effects of work zones on adjacent roadways in a regional network will be assessed. Probe-based data of travel times are available for the St. Louis roadway network via the Regional Integrated Transportation Information System. With a two mile circular boundary established for each work zone location, all probe-based travel time segments within this circular boundary (i.e., influence area) are extracted for assessing the spatial effects of work zones.



An example of the two mile boundary around a work zone on I-270 in St. Louis, Missouri

## Implementation Evaluation of Rustic Road Geosynthetic Reinforced Soil Integrated Bridge System

PI: Dr. John Bowder, UMC

The objective of this research is to evaluate the early service life performance of a specific bridge—Rustic Road GTRS-IBS—in order to advance implementation of Geosynthetic Reinforced Soil-Integrated Bridge System (GRS-IBS) technology. Researchers originally placed instrumentation and monitoring equipment in the abutments during bridge construction. Since construction, the researchers have monitored the performance of the bridge by coordinating a survey of monument points on the bridge and abutments, using an inclinometer to measure a horizontal displacement profile within both abutments and collecting data from the electronic instrumentation. Current results indicate that Rustic Road GRS-IBS is performing well, with only small displacements noted from survey observations and inclinometer data. Visual observations of the bridge also indicate satisfactory performance. Instrumentation devices indicate the wall backfill is draining as expected.



View of Rustic Road GTRS-IBS north abutment with reflective survey markers

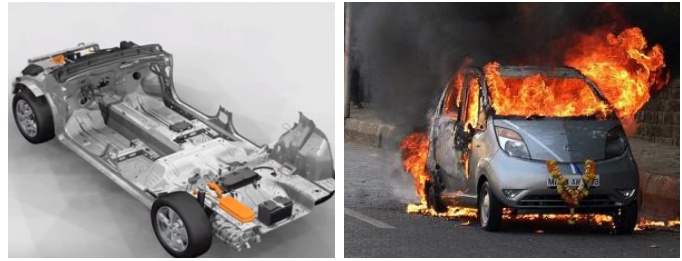
## Management of Safety-Critical Battery Failures for Electrical Vehicles

PI: Pingfeng Wang, Wichita State University

Researchers are conducting theoretical and experimental investigations of safety-critical battery failure modes and developing a Battery Management System (BMS) to diagnose, mitigate, and manage these failures for electrical vehicles.

Technical approaches of this research include (1) developing a new diagnosis approach to predict safety-critical failures of a battery system (e.g., lithium plating and thermal runaway) for electric vehicles (EVs) and hybrid electric vehicles (HEVs), (2) conduct laboratory experiment for failure diagnosis validation, and (3) develop an on-board diagnostics battery management system for early awareness of these potential impending safety critical failures.

By developing original, self-cognizant dynamic system approaches, this research creates a new standard for battery health management to address safety-critical battery failures. Compared with existing BMSs widely used in industry today, which mainly monitors battery health degradations, the proposed research enables an in-depth investigation of severe battery failures that could potentially lead to catastrophic accidents of EVs/HEVs. The development of such a BMS addresses one of the most critical barriers for a safe application of EVs/HEVs, thereby likely to positively impact the entire electrical vehicle industry.



Electric vehicle battery system failure: a) battery system in electric vehicle b) vehicle on fire

## Other Research-Related Activities

### MTC and the National Center for Rural Road Safety Co-Sponsor

The National Center for Rural Road Safety and the MTC are supporting the Roadside Safety Basic for Local Agencies in Lincoln, Nebraska, on May 26, 2016. This course provides the basic overview of roadside safety. The roadside safety problem in the United States is defined and countermeasures to keep vehicles on the road are discussed. The provision of a recovery area is also described, including discussions of clear zones and objects within it. The basics of safety design for drainage features and sign support will be covered. The course workshop will conclude with a short discussion of barrier basics.

### MTC Program Offers Research Funding

Since we are nearing the end of the current grant and fewer funds are available, MTC developed a solicitation that requests solicitations from each of the core areas represented by MTC and encourages faculty to collaborate with a particular emphasis on providing leadership opportunities for new faculty.

As in the past, the proposals will be reviewed by external reviewers to make final decisions on awards. Our due date for proposals is the end of April 2016.

### MTC and Iowa Highway Research Board Combine Funds for Innovative Research Projects

The MTC Program and the Iowa Highway Research Board will combine funding to develop, administer, manage, and operate the 2016 Innovative Projects Program. A primary goal for the Iowa Highway Research Board is to encourage innovation and longer-range technological advances in the field of transportation. To support such innovation and advances, the Board continues to encourage individuals or groups to submit to the Board proposals requesting seed funding for projects that are innovative or explore longer-range advances in aspects of highway transportation.

These projects may be “high-risk, high-reward” in nature, or they may be basic research that can lead to new fundamental insights that, in due course, will result in substantive advances in design, construction, instrumentation and monitoring, modeling, or management of highway-related projects. The proposing individual or group must demonstrate in their problem statement that their idea is truly innovative or addresses an important fundamental issue, and has the

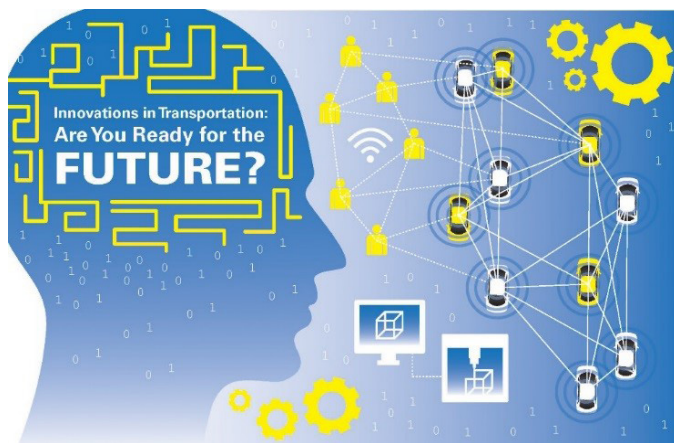
potential to bring about substantial benefits to transportation in Iowa. These projects are not necessarily expected to lead to results of immediate use in highway engineering but produce results holding promise for further useful development. Proposals will be solicited by an annual competitive call for proposals.

## B. Outreach/Technology Transfer

### 2016 Innovations Conference, Are You Ready for the Future?, August 16, 2016, Ames, Iowa

In the coming years, new and emerging technologies will dramatically change the face of transportation. For this reason, this one day event is being offered for anyone—local, state, and federal agency personnel, university researchers, industry, consultants, private business people—who wants to develop an understanding of what they can do today to prepare for tomorrow.

Offered in collaboration with the Iowa DOT, the MTC is looking ahead to identify and prepare for transportation-related challenges. Keynote speaker “futurist” Jack Uldrich will discuss how transportation personnel can survive and thrive in an era of unparalleled change.



Innovations in Transportation Conference banner

### InTrans, Iowa DOT Host Reception at TRB Meeting, January 12, 2016, Washington, D.C.

Transportation professionals from the United States and beyond enjoyed some Iowa hospitality during the Iowa Evening reception at the 2016 Transportation Research Board Annual Meeting. ISU’s Institute for Transportation (InTrans) and the Iowa DOT are the lead sponsors of this yearly event. The Iowans hosted individuals from the federal government, state DOTs, universities, other nations, and the private sector. Many graduate students also attended.

“The Iowa Evening is a great opportunity for us to network with our colleagues and talk about the outstanding transportation projects and programs we have in our state.”

—Shauna Hallmark, InTrans Director



Director of the Iowa DOT, Paul Trombino III (right)

### Road Safety & Simulation International Conference, October 6–8, 2015, Orlando, Florida

The University of Central Florida (UCF) and the University of Tennessee, Knoxville (UTK) hosted the 2015 Road Safety & Simulation International Conference, with the MTC serving as a co-sponsor.

The Road Safety and Simulation (RSS) series continually showcases advancements in traffic simulation and driving simulator technologies, introducing new initiatives and concepts that have emerged since the first RSS conference in Rome, Italy, in 2007. Under the sponsorship of the Southeastern Transportation Center, three world-class research centers support the conference: the Center for Advanced Transportation Systems Simulation, the Institute for Simulation and Training at UCF, and the Center for Transportation Research at UTK. These centers conduct sponsored research in driving simulators, traffic simulation, traffic safety, commercial vehicle operations, Intelligent Transportation Systems deployment, congestion pricing, human factors, and comprehensive transportation safety including surface modes, rail, and bicycle and pedestrian issues. There were approximately 200 attendees.

### Transportation Research Webinars: Moving Research into Practice - UTC Regions 5 and 7 Collaborate

Building on the success of other implementation activities, the MTC and partner UTC—the Roadway Safety Institute at the University of Minnesota—developed and co-hosted a webinar series, Transportation Research Webinars: Moving Research into Practice.

This webinar series showcases innovative research and features both researchers leading the work and practitioners implementing results in the field. Four webinars have been presented or are planned for spring 2016.

Featured projects were funded by the Iowa Highway Research Board, the Iowa DOT, the Minnesota DOT, the Minnesota Local Road Research Board, the Minnesota Department of Public Safety, and the National Highway Traffic Safety Administration.

The webinar schedule for this reporting period:

**February 16, 2016** (More information on page 8)  
 Evaluation of Safety Edge Benefits in Iowa  
 Shauna Hallmark, InTrans, Iowa State University  
 Bill Rosener, Asphalt Paving Association of Iowa

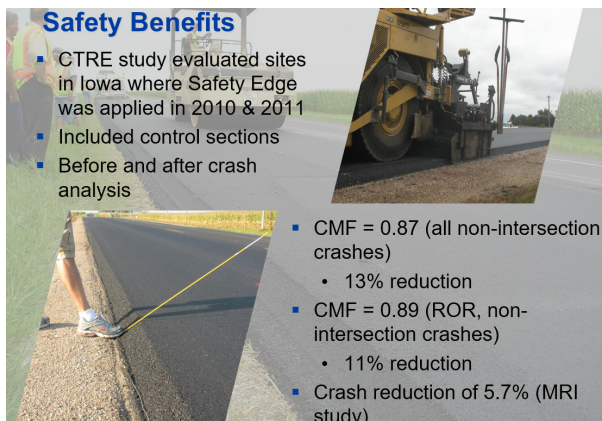
March 22, 2016

Evaluation of Safety and Mobility of Two-Lane Roundabouts

John Hourdos, Minnesota Traffic Observatory, University of Minnesota

### Details for the February 16, 2016, Transportation Safety Webinar

Director of the Institute for Transportation at ISU, Shauna Hallmark, and Bill Rosener, President of Asphalt Paving Association of Iowa, discussed the safety benefits of the safety edge, a study by researchers at the MTC. During the course of this research, the safety edge was reviewed for its impact on Iowa construction projects and its effectiveness in reducing crashes. The webinar presentation provided an overview of the project and discussed the results. The presenters reviewed the use of this technology in Iowa and outlined the benefits it has had on transportation safety throughout the state. The presentation was made interactive, which included pre-scribed polling questions and additional questions taken online at the time of the webinar. Attendees participated from 16 different states, and attendees included universities, counties, state DOTs, Federal Highway Administration, U.S. DOT, and consultants. The webinar attracted 105 participants in 16 states.



**Safety Benefits**

- CTRE study evaluated sites in Iowa where Safety Edge was applied in 2010 & 2011
- Included control sections
- Before and after crash analysis

- CMF = 0.87 (all non-intersection crashes)
  - 13% reduction
- CMF = 0.89 (ROR, non-intersection crashes)
  - 11% reduction
- Crash reduction of 5.7% (MRI study)

PowerPoint slide of safety edge project data

### County Engineers' Research Focus Group Meeting

Each year the Iowa DOT and the Local Technical Assistance Program (LTAP) co-sponsor an annual County Engineers Research Focus Group (CERFG) meeting in Ames, Iowa. At this year's event, on February 17, 2016, research updates were discussed and attendees had the opportunity to share ideas, tools, and techniques that others may not know about that have improved operations and saved county engineers' districts money. The attendees also participate in a brainstorming session to identify needed research projects that will be presented to the Iowa Highway Research Board (IHRB) for funding consideration.

We receive instant input/feedback to help district IHRB representatives better understand the county engineers' needs to target future funding opportunities. Attendees are county engineers and from the Federal Highway Administration, Iowa DOT, and InTrans.

### MTC and Iowa DOT Host Research Implementation Meeting

On November 5, 2015, the MTC and the Iowa Highway Research Board offered a one day Research Implementation Meeting to discuss three research projects, which were completed a few years earlier, so that attendees could discuss the implementation processes. Invitees included Technical Advisory Committee members on these three research projects, the research team, county engineers, assistant county engineers, and Iowa DOT personnel. The participants met as one large group in the morning and then broke out into three separate rooms; the principal investigators of these research projects made presentations, with discussions following. After meeting in these small groups, participants convened back as one large group to discuss implementation ideas and state what research implementation ideas did and did not work well for counties. Suggestions were provided for improving the research implementation processes.

The three research projects included:

- Add 283/TR-568-Modified Sheet Pile Abutments for Low-Volume Road Bridges
- Add 380/TR-621-Geosynthetic Reinforced Soil for Low-Volume Bridge Abutments
- Add 402/TR-632-Low Cost Rural Road Surface Alternatives and Add 479/TR-664-Low Cost Rural Surface Alternatives: Demonstration Project

### C. Education

#### MTC Outstanding Student of the Year 2015

Mackenzie Shelton is an undergraduate student from Harris-Stowe State University's Anheuser-Busch School of Business (HSSU), which is located in St. Louis, Missouri, and is a Historically Black College and University (HBCU). Mackenzie was chosen as this year's winner because she exemplifies integrity and commitment along with the team leadership abilities necessary for a successful student researcher. As a student member of the MTC research team at HSSU, Mackenzie along with two other students and four faculty members helped to launch a grant initiative entitled "Economic Sustainability of Inner City Streets: A Collaborative Transportation and Safety Model." This project focused on the creation of a safety model that applied social and economic variables within that community. The model will contribute and have a positive impact on improving the social and economic conditions of the citizens living in the St. Louis Inner City and Metropolitan Region as a whole.



Mackenzie Shelton



## **Study Abroad in Rome**

Transportation engineering is an increasingly global profession. To provide students with an international educational experience and enhance their global perspective regarding transportation, the MTC will lead the development of a study abroad opportunity in Rome, Italy, in May 2016.

The two-week course will help students prepare for careers in engineering firms and academia as well as in government and the non-profit arena. Through intensive classes, students will gain an understanding of the impacts of different engineering, historical, cultural, social, economic, ethical, environmental, and political conditions on the design and construction of various infrastructure projects outside the United States. Some scheduled site visits include: Colosseum, Colosseum underground, Roman Forum, Aqueducts and Appian Way, Roman walls, Spanish Steps, Pantheon, Vatican Museum, St. Peter's Basilica, and various traffic management facilities.

A new course, CE 395x: Global Perspectives in Transportation, was developed through the civil engineering department at ISU and was approved through the civil engineering and ISU curriculum committees. The course meets the engineering topics elective electives and international perspectives electives for civil engineering.

## **Undergraduate Research Networking Event (ISU)**

ISU student organizations affiliated with underrepresented minority groups hosted an Undergraduate Research Networking Event on November 11, 2015. Students attending were specifically interested in seeking out research opportunities, and through the registration process it was indicated that a significant number of the participants were interested in civil engineering/transportation-related topics. MTC Director Dr. Shauna Hallmark and MTC Educational Coordinator Dr. Peter Savolainen attended on behalf of the MTC and were able to make connections with many of the 146 student participants.

## **Principles of Transportation Engineering (CE 355)**

During the fall 2015 semester, MTC Educational Coordinator Peter Savolainen taught the first offering of ISU's redeveloped introductory transportation engineering course in the civil engineering curriculum. The course—CE 355: Principles of Transportation Engineering—was converted to a “flipped course” during the spring and summer of 2015 through a collaborative effort among the ISU transportation engineering faculty. As a part of this initiative, approximately five hours of traditional lecture content was converted to an online, video-lecture format. This allowed for traditional outside-of-classroom activities, such as homework and group projects, to be brought into the classroom. The video lecture content is also being used in other transportation courses at ISU and is freely available on YouTube for use by others. The effectiveness of the flipped classroom approach tested in this course was also evaluated, in a manuscript titled “A Flipped Classroom Approach to Teaching Transportation Engineering,” by ISU affiliates Dr. Aliye Karabulut-Ilgu and Dr. Peter Savolainen and graduate student Suhan Yao, which has been

accepted for presentation at the 2016 American Society for Engineering Education Annual Meeting. The second offering of the flipped course format is currently being implemented by ISU engineering professor Dr. Jing Dong.

## **MTC Undergraduate Research Program**

The MTC has continued the second year of its Undergraduate Research Program at ISU. As a part of this program, research seed funding is allocated to faculty who engage undergraduate students in research projects under the thematic focus of the MTC. Faculty provide matching funds, and this project is oriented toward facilitating broader opportunities for undergraduate research and encouraging students to consider graduate school opportunities.

Faculty Member and Project: Behrouz Shafei; Risk-Based Damage Assessment and Emergency Management of Highway Infrastructure Components under Extreme Events

Faculty Member and Project: An Chen and Daji Qiao; Smart Installation and Health Monitoring Systems for Large Anchor Bolts of Support Structure for Highway Signs, Luminaires and Traffic Signals (SLTS)

Faculty Member and Project: Sri Sritharan; Nondestructive Evaluation of Bonding Between Ultra-High Performance Concrete (UHPC) Overlays and Concrete Slabs

Faculty Member and Project: Alice Alipour; Improving the Aerodynamic Characteristics of Structural Supports of Signs, Luminaires, and Traffic Signals (SLTS)

## **Fall Transportation Graduate Student Research Seminar (ISU)**

The fall semester saw the successful completion of ISU's new, weekly Transportation Graduate Student Research Seminar. This series, which is led by ISU's Dr. Peter Savolainen, was developed by the transportation division of the Department of Civil, Construction, and Environmental Engineering (CCEE). Graduate students in transportation, including MTC Transportation Scholars, presented their research results, allowing them to develop their presentation skills and receive feedback from other students and faculty on their research. Each transportation student must participate in this seminar at least once during their degree program. Nine student presentations were made during the current reporting period with an average of 40 attendees.

## **Seminar in Transportation (TRANS 691) (ISU, UMC, UMSL)**

Led by MTC Director Shauna Hallmark, the “Tom Maze Transportation Seminar” presents weekly during the spring semester and features nationally and internationally recognized speakers who present on timely transportation-related topics and interact with the students. The seminar is broadcast online in real-time to students at MTC partner institutions; the broadcast location rotates among ISU, UMC, and UMSL.

Presentations are recorded and made available via the MTC website. During this reporting period nine presentations were made, and each presentation had an average of 53 attendees.

### **MTC Transportation Scholars**

The MTC continues to sponsor and manage the Transportation Scholars program at ISU, UMC, and UMSL. The program requires students to demonstrate excellence in coursework, research, leadership, and community outreach. MTC Transportation Scholars are required to

- Maintain a 3.0 grade point average.
- Participate in a research project or research group.
- Participate in the fall semester Transportation Graduate Student Research Seminar and Spring Semester Tom Maze Seminar Series (CE 691).
- Participate in a transportation student organization.
- Present research results at a conference or through a journal article.
- Mentor other students or participate in K–12 workforce development activities.
- Participate in the Leadership Institute, a set of online self-directed courses for public agency managers.

### **Transportation Engineers Association of Missouri (TEAM) Annual Conference**

Twelve Transportation Scholars from UMC attended the Transportation Engineers Association of Missouri (TEAM) annual conference on March 9–11, 2016, in St. Louis, Missouri. They all presented research posters, and the two winning posters were from transportation scholars Alaa Elsis (first place) and James Dawson (second place).



Alaa Elsis taking first place at the TEAM Annual Conference

### **WTS Sharon D. Banks Memorial Scholarship**

Rochelle Starrett, an undergraduate student at ISU, was selected as the winner of the WTS Sharon D. Banks Memorial Scholarship. Starrett plans to attend graduate school in civil engineering with a focus on sustainable transportation. She also plans to earn a PhD and become a professor. She has worked as an undergraduate research assistant through the MTC.

### **L.L. Waters Scholarship**

Iftin Thompson, a master's student at ISU, received the L.L. Waters Scholarship from the American Society for Transportation and Logistics. The L.L. Waters Scholarship Program was established to encourage advanced graduate study in the field of transportation and logistics for the purpose of preparing persons of high potential for professional careers in the field.

### **Student Paper Competition: SHRP2 Safety Data Bonanza**

Raha Hamzeie, a master's student at ISU, was one of six winners of the SHRP2 Safety Data Bonanza, a student paper competition that was held as a part of the 2016 Transportation Research Board Annual Meeting. Her research involved an analysis of SHRP2 naturalistic driving study data, with a focus on understanding the characteristics of those drivers who tend to be at fault in multi-vehicle crashes and near-crash events.

### **Students Presents as Part of Eisenhower Transportation Fellowship Program**

ISU's master's students Ellen Nightingale and Patricia Thompson presented in showcase sessions for the Dwight David Eisenhower Transportation Fellowship Program at the 2016 Transportation Research Board Annual Meeting. Nightingale presented a poster on an Iowa DOT project, "In-Service Performance Evaluation of Median Cable Barriers in Iowa," while Patricia presented a lectern session titled "Michigan Urban Trunkline Segments Safety Performance Function Development."

### **Trinect Fellowship Award**

Each year Trinect recruits 10 Iowa State University graduate students (Fellows) associated with the College of Engineering to work collaboratively with a selected elementary school teacher and ISU pre-service teacher to leverage the Fellow's expertise in science and mathematics. For fall 2016 through spring 2017, InTrans graduate student Ellen Nightingale has been selected to participate in this exciting program. Together, they will develop innovative and engaging STEM activities for elementary school students. The Fellows spend one full day every week throughout the public school year in an elementary classroom in Des Moines, Iowa, performing the duties of a "resident engineer" as they interact with their partner teachers and students. Nightingale will receive a \$25,000 stipend and paid benefits for her efforts.

### **Undergraduate Research Day at the Capitol (UMC)**

Student Sam Runge presented MTC research on the Geosynthetic Reinforced Soil-Integrated Bridge System (GRS-IBS) as part of the University of Missouri's Undergraduate Research Day at the Capitol in Jefferson City, Missouri, on March 15, 2016. Runge also discussed how participating in the research project has complemented his civil engineering education and exposed him to interesting aspects of transportation engineering.



Undergraduate Research Day at the Capitol

## Transportation Student Association (ISU)

MTC Transportation Scholars can meet several requirements of the program through membership in the Transportation Student Association (TSA), ISU's student chapter of the Institute for Transportation Engineers (ITE). The TSA provides a multidisciplinary (engineering, design, and business) forum for promoting student involvement in transportation research. TSA currently has 44 members and one faculty advisor: MTC affiliate and assistant CCEE professor Jing Dong. During the current reporting period, the TSA members had several major accomplishments:

- **2016 TRB Best Paper Award**

TSA students won the Best Paper in the Safety Area Competition at the 2016 Transportation Research Board Annual Meeting for "Examining the Safety Impacts of Narrow Lane Widths on Urban/Suburban Arterials." The authors were Timothy Barrette, Georges Bou-Saab, Amrita Goswamy, Raha Hamzeie, Emira Rista, Brendan Russo, Bo Wang, and Peter Savolainen.

- **Des Moines 8th Annual District Science Fair**

The Des Moines Public School District, the largest, most diverse district in Iowa, hosted their 8th Annual District Science Fair at the Science Center of Iowa on the evening of Thursday, February 11, 2016. TSA members Georges Bou-Saab and Ellen Nightingale represented ISU and TSA by participating as judges evaluating student projects.

- **Iowa Concrete Industry Night**

Iowa Concrete Paving Association and Iowa Ready Mixed Concrete Association collaborated with TSA for a night with industry. A total of 80 individuals attended the Iowa Concrete Industry Night on March 23, 2016, including students from the civil engineering department, TSA members, professors, and professionals.

- **Engineering Middle School Day**

TSA participated in a middle school engineering outreach event organized by the Engineering Student Council. TSA was one of many engineering student organizations that provided demonstrations and hands-on activities for middle school students to learn about different engineering-specific concepts. TSA chose to illustrate tension and compression forces needed in a bridge system by creating human bridges. Students were able to feel the forces in their arms and on their shoulders. ISU students also shared facts about bridges locally and around the world.



TSA members at Middle School Engineering Day

"Your students are doing an incredible job of conducting activities on campus . . . and their research is phenomenal!"

—Michael S. Hofener, 2016 MOVITE President

## D. Workforce Development

### Midwest Transportation Workforce Center (MTWC)

The MTC is a member of the University of Wisconsin–Madison led MTWC, one of five regional surface transportation workforce centers funded by the U.S. DOT and FHWA, which serves Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Ohio, and Wisconsin.

The Midwestern Transportation Workforce Summit was hosted by the MTWC in Madison, Wisconsin, from December 7–8, 2015. The theme of the summit was "Addressing the Future Now!" The summit was attended by private and public sector stakeholders in transportation, education, economic development, and other areas, with a goal to work together to improve transportation workforce development in the Midwest and across the United States.

The summit included sessions focusing on eight workforce initiatives that had been identified at an earlier stakeholder meeting, which included: Best Practices in Building a Pipeline into the Industry; Flexible CDL Training; Job Vacancy Survey; Outreach for Inclusion; Summer Job League; Technical Transportation Clearinghouse; Transportation Career App; and Transportation Day. The summit also featured a session on joining the Community of Practice group, which allows for interaction among stakeholders after the summit.

Additionally, the summit hosted a showcase of workforce development initiatives. MTC's booth showcased its K–12 initiatives, which included its series of summer workshops: one for high school students focusing on leadership and an introduction to transportation engineering and ones for high school and elementary school educators introducing them to transportation and engineering concepts and ways they could incorporate those into their classrooms. Additionally, the *GO!* website was showcased and available for participants to view.

### Leadership Summit

Former PhD student Nicole Oneyear attended the Western ITE Student Leadership Summit in January 2016 at California State Polytechnic University–Pomona. The summit is a student-run event—for students by students—that focuses on gaining leadership skills while networking and building relationships with students from other universities. Oneyear attended the event to learn more about this summit and the planning involved, because ISU, with the help of MTC and the Midwestern ITE, will be hosting the first Midwestern Student Summit in September 2016.

### GO! Online Magazine

*GO!* online magazine has become the MTC's premier tool for informing young people about careers in transportation. Through a variety of articles, activities, and resources, *GO!* provides information about a variety of transportation-related careers and academic programs. Financially supported by the MTC, the *GO!* initiative partners with the MTC consortium universities, ISU's Department of World Languages and Cultures, the Iowa DOT, OCTA Youth Programs (in Orange County, California), and representatives from [Online-MasterPrograms.org](http://Online-MasterPrograms.org), [AffordableCollegeFoundation.org](http://AffordableCollegeFoundation.org),

Collegeaffordabilityguide.org., OnlineColleges.net, and ChickTech, a national nonprofit whose mission is to retain women in the technology workforce. *GO!* also partners with the accelerated bridge construction-themed UTC at Florida International University, which provides one ABC-related article every quarter.

During this reporting period,

- Four or more new articles were published each month and promoted through Facebook and Twitter and via a monthly *GO!* e-newsletter, which is sent to over 1,300 teachers and transportation professionals across the country.
- The *GO!* Facebook page had 277 followers; the Twitter page had tweeted 1,172 times and had 340 followers.
- The Transportation Research Board e-newsletter regularly linked to *GO!*
- The *GO!* website was successfully redeveloped in February 2016, which included a new theme and plenty of new material for both teachers and students
- The comic strip, “Dot’s Adventures with Transportation,” was published each month



A panel from *Dot’s Adventures with Transportation*

### Young Engineers and Scientists (YES)

The MTC and ISU’s Center for Biorenewable Chemicals (CBIRC) are collaborating again on this summer’s session of the YES program. In this partnership with Iowa high schools, the YES program offers a research internship to accepted applicants. For six weeks, participating students have the opportunity to work on their research project for up to 40 hours per week under the supervision of a faculty mentor and/ or graduate student. At the end of the session, each student prepares a poster outlining his or her research for presentation at the YES reception. Four high school students have been selected and placed with InTrans for summer 2016, and a 2015 YES program participant, Jacob Hess, has continued

### **GO! content (during reporting period)**

October	
Articles	Creating active communities: The Complete Streets movement Creating active communities: The Open Streets movement Creating active communities: The Vision Zero initiative
ABC-UTC article	ABC: Bridge in a “pocket!”
Interview	Clearing the street: DSMove is an Open Streets movement in Des Moines, Iowa w/Jennifer Sayers
Dot comic strip	The Commute
November	
Articles	Women engineers of the 20th century: Meet Olive Dennis Women engineers of the 20th century: Meet Lois Cooper Women engineers of the 20th century: Meet Bonnie Dunbar
Interview	Women engineers today: Meet Shauna Hallmark w/Shaua Hallmark
Dot comic strip	Movies in Motion
December	
Articles	3D printing: How can it benefit you? 3D printing: What can it hurt? 3D printing: Building future infrastructure
Interview	3D printers in the classroom w/Joe Huebbe
Dot comic strip	Animals Abroad
January	
Articles	So, what’s the deal with Uber? Uber: What about taxi cabs? Uber drives into the future Iowa DOT campaigns to end traffic fatalities
ABC-UTC article	The importance of ABC today: A commentary
Interview	Impacts of “Teaching in the Fastlane” w/Daniel Loy
Dot comic strip	Open Streets
February	
Articles	Let’s go: One day in New York City Let’s go: One day in Rome Let’s go: One day in Istanbul What being a millennial means when it comes to safety
Interview	Rome through the eyes of a traveler w/Kelsy Postlethwait
Dot comic strip	Women Engineers of the 20th Century
March	
Articles	Four wheels: A history Two wheels: A history Taking flight: A history Los Angeles Freeway (written by artist Loren Kantor of California) No matter the weather, Iowa DOT Traffic Management Center is a “Highway Helper” The college student perspective: ISU The Wind Rises review: A story of love and war in Japan
Dot comic strip	3D Printers

to work with InTrans as an hourly student since completing the program. His experience was highlighted in the Ames Tribune newspaper as well as on the Ames Community School District website.

### Research Experience for Teachers (RET)

For the third year, the MTC at ISU is participating in RET, a program offered by ISU's CBiRC and funded by the National Science Foundation. The program provides an opportunity for public school teachers to work on active research projects while building their knowledge-base and science/engineering skills, which they can then use in their own classrooms. During summer 2016, MTC Director Dr. Shauna Hallmark and Dr. Omar Smadi will host three Iowa high school teachers at InTrans for six weeks. Craig Mohr, a chemistry/physics teacher at Southeast Polk High School, and Laura Condon, an algebra/statistics teacher at Esterville Lincoln High School, will work with Dr. Hallmark. Joseph Carey, a calculus/statistics teacher from Ankeny High School, will be working with Dr. Smadi.

### GO! Further: Workshop for High School Students

#### EXPANDING

The MTC will be offering three separate weeklong GO! Further workshop sessions at ISU during summer 2016. One of these sessions will provide a leadership and learning experience for 15 high school students who are involved in the Young Engineers and Scientists (YES) Program, in a similar fashion to the summer 2015 workshop session. The facilitator will assist the students in learning about the world of engineering and also provide them with hands-on activities to develop leadership skills and how to effectively work in teams. The additional two sessions will be initiated through a partnership with the Office of Pre-Collegiate Programs for Talented and Gifted. These workshop experiences will accommodate a total of 30 students, 15 per session. To ensure a diverse group of participants are selected to participate, the MTC will also collaborate with the Science Bound program, which partners with schools to increase the number of ethnically diverse Iowa students who pursue STEM careers. Materials about GO! Further will be sent to Science Bound leaders to distribute in high schools throughout central Iowa. Efforts in recruiting students for the summer 2016 programs will also be made in collaboration with ISU's Program for Women in Science and Engineering, in an effort to appeal to young women across Iowa.

### Teaching in the Fast Lane: Summer Workshop for Elementary School Teachers

Out of a pool of applicants from across Iowa, an estimated 25 elementary teachers will be invited to participate in this MTC-sponsored workshop from July 11–15, 2016. The week-long event introduces teachers to the field of engineering, engineering concepts, and engineering professions, with the goal of equipping them to enrich their own classrooms and raise awareness and enthusiasm about engineering among young students. The program includes presentations from ISU and Iowa DOT engineers and educators, hands-on activities (including some from the American Association of State

Highway and Transportation Officials Roadways in Developing Elementary Students kit), and field trips. After significant positive feedback during the summer 2015 workshop, this course will be held a second time.

### 2016 Toothpick Bridge Challenge

After attending the "Teaching in the Fast Lane" program in summer 2015, Heather Anderson, a teacher from Walnut Hills Elementary School in Waukee, Iowa, brought her knowledge back to the classroom. She held her own Toothpick Bridge Challenge with second and fourth graders. Some of their "bridge company" names were: Crossing Road Inc., Bridge Bosses, Build a Bridge, Bridgengineers, and Awesome City Bridges. There were 14 teams in total, and after completing their bridges they took it a step further by load-testing each design.



Toothpick bridges made by elementary students

"Thanks for sharing this lesson with me. I did have to alter it slightly to fit this age group, but we learned by researching, brainstorming, imagining, planning, designing/re-designing, building, collaborating, and problem solving."  
—Heather Anderson, Walnut Hills Elementary teacher, Waukee, Iowa

### Transportation Institute: Summer Workshop for High School Educators

#### EXPANDING

In summer 2016, this event, sponsored by the MTC and the Iowa DOT, high school instructors from across Iowa will explore a broad range of educational activities, relating to transportation, that are suitable for integration into high school physics curricula and afterschool STEM programs. Workshop facilitator and high school teacher from Johnston High School in Johnston, Iowa, Brad Jacobson will guide participants in relevant content and pedagogy to help participants gain a better understanding of transportation concepts associated with physics, supplemented with presentations from staff and faculty from the Iowa DOT and ISU.

Participating teachers will take pre- and post-content knowledge tests about the goals, history, and challenges of science, engineering, and technology. During the summer 2015 workshop, educators scored significantly higher on the post-program test compared to pre-program scores, and we anticipate even greater impact following the 2016 course. In response to the suggestion of facilitators and participants' feedback during the 2015 program, the 2016 program will span three weeks.

## Ready, Set, Build! Bridge-Building Challenge

### NEW THIS YEAR

The Ready, Set, Build! Bridge-Building Challenge took place at the Science Center of Iowa (SCI) on November 7, 2015. Groups, ranging from two to four students to even families, had three hours to build a bridge out of provided materials (e.g., Popsicle sticks, wooden dowels, masking tape, glue, string, and poster board). Awards were given for bridge efficiency, most innovative bridge, and teamwork. Participants were divided into four categories: 1st–3rd grades, 4th–6th grades, 7th–8th grades, and family. There were a total of 76 participants the day of the event and over 50 people came to observe the teams and participate in other event activities.

Participants had the opportunity to interact with engineering professionals from the Iowa DOT and InTrans and learn more about bridges and other transportation-related topics. ISU engineering graduate students also volunteered for the day to assist the young designers/builders with questions.

Through hands-on learning booths at the main entrance, the Iowa DOT and InTrans also provided over 1,200 SCI attendees with learning opportunities about transportation and bridges.

Overwhelmed with positive feedback from all participants and volunteers, the MTC, Iowa DOT, and SCI will again partner to expand the 2016 Bridge-Building Challenge into two separate events: November 11 will focus on classroom groups while the November 12 event will work with afterschool programs and family groups.



Students and families made and learned about bridges at the 2015 Bridge-Building Challenge

### Elementary School Traffic Study (UMC)

Dr. Praveen Edara at UMC and a group of undergraduate and graduate students worked with Dr. Heather McCullar of Benton Elementary School (BES) in Columbia, Missouri, to introduce 3rd graders to traffic engineering. The team first met with BES students and shared the role traffic engineers play in ensuring safe transportation in Columbia. The students were then introduced to a traffic project where they used cameras to record traffic and measured speeds of vehicles on streets near their school. Dr. McCullar then assisted students as they reviewed the videos and speeds to determine safety concerns. The students were then asked to propose solutions to those concerns. The team was invited back to BES to review student poster presentations and provide feedback. Students proposed good solutions to address speeding around the school, such as adding speed bumps and crossing guards.

### ASCE Engineering Day for Kids (UMC)

The UM student chapter of the American Society of Civil Engineers (ASCE), with support from the MTC, held its fall Engineering Day for Kids on Saturday November 7, 2015. There were over 60 3rd–5th grade participants. ASCE student members assisted the students as they learned about what civil engineers actually do. They built bridges and structures out of toothpicks and gumdrops, set-up and ran cars on a simulated highway, built retaining walls with sand and paper, and measured and calculated material properties.



Elementary students conducting experiments during ASCE Engineering Day for Kids

### Visit from Grand Rapids Public School District

During the Midwest Transportation Workforce Summit in Madison, Wisconsin, MTC Director Dr. Shauna Hallmark met with the Director of Innovative Strategies with the Grand Rapids Public School District and invited a group of students to visit the ISU campus and tour the InTrans facilities (e.g., Traffic Operations Laboratory, MiniCym, etc.). Grand Rapids Public Schools has the unique arrangement of having 12 “theme schools,” each with a customized curriculum and unique academic offerings centered on a certain theme (e.g., environmental science, arts/music, dual-immersion, college prep, etc.). On February 4, 2016, 7 students with a strong interest in research and engineering fields, along with two chaperones, visited InTrans. InTrans faculty and graduate students also spent time with the students, talking about their current research.

“Our visit was fantastic and had a tremendous impact on our students. A few of our students have started to view the various engineering fields (beyond what they already knew) in transportation as potential careers options.”

—Gideon Sanders, Director of Innovative Strategies, Innovation Central High School, Grand Rapids, Michigan

## E. Center Management

### Quarterly Partner Meetings

MTC leadership at ISU and its partner institutions have teleconference team meetings on the first Tuesday of every quarter. The goal is to identify commonalities among institutions, leverage funding for similar activities, and identify opportunities to collaborate. These conversations have been productive.

### Plan for Showcasing MTC Products

During this reporting period the MTC website was significantly modified/updated to reflect current research progress, educational/workforce development activities, and outreach initiatives. Some examples of new, highlighted content include the following:

### Homepage

- Introduction to MTC advisory council

### Publications

- K-12 “briefs”
- Dot’s Adventures in Transportation (online comic strip, a feature of *GO!* e-magazine)
- Latest issues of MTC e-news
- Readings in Modern Railroad Management (offsite link)

### Education

- Workshops for public school students and teachers
- Study Abroad in Istanbul (2015) and (upcoming) Study Abroad in Rome
- Accomplishments of Transportation Scholars (e.g., Student of the Year, Best Paper award)
- Accomplishments of Transportation Student Association
- New Transportation Graduate Student Research Seminar

### Outreach

- New Research Implementation Initiative (w/schedule of upcoming webinars)
- Legislative brief
- Workforce Development Workshop
- Upcoming (August 2016) Innovations in Transportation Conference

### How were results disseminated?

In general, information about the MTC and its activities, particularly for the purposes of enhancing public understanding, increasing interest in transportation careers, and advancing technology transfer, was disseminated via the following channels:

- *GO!* online magazine for teens
- MTC e-newsletter
- Website
- Research reports
- Most of the activities described under Outreach/Technology Transfer (beginning on page 7) and Workforce Development (beginning on page 11)

Detailed, itemized information about many of the above activities is provided in the annual performance metrics report to OST-R, U.S. DOT.

### What activities are planned for the next reporting period?

The following activities are planned for the next reporting period:

### Center Management

- Continue to hold regular teleconferences with team members
- Develop a plan for better showcasing MTC products/activities

### Research

- Continue to monitor progress of the research program
- Implement Year 4 research program
- Create joint panel with Iowa DOT and IHRB to develop research solicitation, solicit research, and select high-impact project for funding for joint research between the MTC and IHRB

### Education

- Hold the summer 2016 study abroad program in Rome, Italy
- Assess the undergraduate research program
- Track Transportation Scholar participation in required and recommended activities
- Make site visits for 2017 study abroad

### Workforce Development/Diversity

- Hold a K–12 bridge contest in conjunction with the Iowa Science Center (November 2016)
- Continue producing content for *GO!* magazine
- Plan summer 2016 workforce development activities and solicit participants: Research Experience for Teachers (RET), Young Engineers & Scientists (YES), Transportation Institute, *GO!* Further, Teaching in the Fast Lane, etc.
- Develop fall student research series

### Outreach

- Develop brochures to highlight the impact of three research projects
- Plan Innovations Conference (August 2016)
- Host two additional implementation workshops with UM; develop line-up for fall

## 2. Products

In addition to products and activities discussed in Section 1, the MTC has generated and/or funded the following products:

### Presentations (in chronological order)

- Keren–“Roadway Infrastructure in Various 3D Visualization Modes,” International Conference on Road Safety & Simulation, October 6–8, 2015
- Boeckmann–“Design of Maintainable Drains for Earth Retaining Structures,” Deep Foundations Institute 40th Annual Conference, October 12–14, 2015
- L. Su/G. Hu/L. Wang/Dong/Zhou–“Robust Optimization for Network Design Problems with Equilibrium Flows,” INFORMS 2015, November 1–4, 2015
- Brown–“Implementation of Asset Management in Grandview,” Missouri Fall APWA Conference, November 9, 2015
- Mundy–“Women in Transportation Operational Roles,” University of Wisconsin–Madison, December 2015
- Williams–“Development of Renewable Polymers for Use in Asphalt Pavements,” Transportation Research Board Annual Meeting, January 2016
- Alipour–“Performance Assessment of Corroded Highway Bridge Piers Under Cyclic Loading,” Transportation Research Board Annual Meeting, January 2016
- Hallmark–“Prediction of Lane Encroachment on Rural Two-Lane Curves Using SHRP 2 Naturalistic Driving Study Data,” Transportation Research Board Annual Meeting, January 2016
- Zhu–“Highway Speed Decreases during Winter Weather Events in Iowa,” 2016 International Conference & Workshop on Winter Maintenance and Surface Transportation Weather, February 2016 (online conference), April 2016 (in-person workshop)
- Zakery/Eisel–“An Economic Sustainability of Inner City Streets: A Collaborative Transportation and Safety Model,” Washington Business Research Forum, March 4–5, 2016
- Chang–“Evacuation Traffic Control in Autonomous and Connected Vehicle Environment,” RES/CON New Orleans 2016 joint conference with National Evacuation Conference (NEC), March 7–9, 2016
- Chang–“A Study for Congestion Mitigation for Hurricane Evacuation with Connected Vehicle Environment,” RES/CON New Orleans 2016 joint conference with National Evacuation Conference (NEC), March 7–9, 2016
- Boeckmann–“Implementation Evaluation of Rustic Road Geosynthetic Reinforced Soil Integrated Bridge System,” Transportation Engineers Association of Missouri (TEAM) Annual Conference, March 9–11, 2016
- Boeckmann–“Implementation Evaluation of Rustic Road Geosynthetic Reinforced Soil Integrated Bridge System,” Undergraduate Research Day at the Capitol, March 15, 2016

### Articles and Papers

- Cantor–“Owner Operators versus Company Drivers Safety Performance Analysis,” Transportation Journal, October 2015
- White–“Conference on Autonomous and Robotic Construction of Infrastructure,” Conference Proceedings, October 2015
- Mundy–“Airport Drop-Off Charges in Great Britain—Are they Coming to America?,” European Airport Review Journal, November 2015
- N. Yodo/P. Wang–“Resilience Quantification and Analysis of Complex Supply Chain Systems Using Bayesian Network,” AIAA Science and Technology (SciTech), 2016
- N. Yodo/ P. Wang–“Engineering Resilience Quantification and Design Implications: A Literature Survey,” ASME International Design Engineering Technical Conference and Computer Information Engineering (IDETC/CIE), 2016
- G. Bai/P. Wang–“Prognostics Using An Adaptive Self-Cognizant Dynamic System Approach,” Accepted, IEEE Trans. on Reliability, 2016
- G. Bai/P. Wang–“An Internal State Variable Mapping Approach for Li-Plating Diagnosis,” Accepted, Power Sources, 2016
- N. Yodo/ P. Wang–“Engineering Resilience Allocation for Early State Design of Complex Engineered Systems,” Accepted, Journal of Mechanical Design, 2016

## 3. Participants and Collaborating Organizations

The MTC utilizes many colleges, departments, and centers at ISU as internal partners: Civil, Construction, and Environmental Engineering; National Concrete Pavement Technology Center; Center for Transportation Research and Education; Bridge Engineering Center; National Center for Wood Transportation Structures; Center for Earthworks Engineering Research; Engineering Research Institute; Aerospace Engineering; Center for Weather Impacts on Mobility and Safety; Electrical and Computer Engineering; Business and Finance; Statistics; Industrial and Manufacturing Systems Engineering; Chemical and Biological Engineering; Center for Biorenewable Chemicals; Food Science and Human Nutrition; Supply Chain and Information Systems; Landscape Design; Agricultural and Biosystems Engineering; and the Virtual Reality Application Center.

Other collaborative efforts with external entities (other than collaborations among MTC partner universities) are summarized in the following table:



## Summary of Collaborative Activities

External Partners/ Collaborators	Partner Type	State/Country	Financial Support	In-Kind Contributor	Research Collabo- rator	Facilities	Personnel Exchange	Materials	Data
ABC-UTC at Florida International University	University	Florida	X		X		X		
Aegis Strategies, LLC	Industry	Missouri			X				
Ann L. Schneider & Associates, LLC	Industry	Missouri			X				
Argo Genesis,	Industry	USA	X						
Arizona State University	University	Arizona			X				
Asphalt Paving Association of Iowa	Industry	Iowa			X				
Buildex, Inc.	Industry	Kansas						X	
Caterpillar	Industry	USA	X						
City of Belton	Government	Missouri			X				
City of Chesterfield	Government	Missouri			X				
City of Columbia	Government	Missouri	X		X				
City of Grandview	Government	Missouri			X				
City of Jefferson	Government	Missouri			X				
Collins Engineering	Industry	Missouri			X				
Consulting Engineers Association	Industry	Missouri			X			X	
Costello & Associates, Inc.	Industry	Missouri			X				
Creative Visions Human Development Institute	University	Iowa			X				
Embry-Riddle Aeronautical University	University	Florida			X				
Federal Highway Administration	Government	USA			X				
Fibercon International	Industry	Pennsylvania						X	
HDR Consultants	Industry	Missouri			X				
HR Green	Industry	Iowa			X				
Illinois Department of Transportation	Government	Illinois			X				
Illinois State Highway Patrol	Government	Illinois			X				X
Indiana University	University	Indiana			X				
Integra Technologies, LLC	Industry	Kansas			X				
International Association of Transportation Regulators	Non Profit	Canada			X				
Iowa Department of Transportation	Government	Iowa	X					X	X
Iowa Counties (Various)	Government	Iowa			X				
Iowa Highway Research Board	Government	Iowa	X		X				

External Partners/ Collaborators	Partner Type	State/Country	Financial Support	In-Kind Contributor	Research Collabo- rator	Facilities	Personnel Exchange	Materials	Data
Kalamazoo County	Government	Michigan			X				
Kansas Department of Transportation	Government	Kansas			X				X
Kansas State University	University	Kansas			X				
Kansas State Highway Patrol	Government	Kansas							X
Lambert Airport	Industry	Missouri		X			X		X
Liberal High School	School	Missouri					X		
Medtronic, Inc.	Industry	Kansas			X				
Metropolitan Taxi Comission	Industry	Missouri	X	X					
Mid-American Air Museum Foundation	Non Profit	Kansas				X			
Midwest Transportation Workforce Center (UTC)	University	Wisconsin			X				
Missouri Counties (Various)	Government	Missouri			X				
Missouri Department of Transportation	Government	Missouri	X						X
Missouri State Highway Patrol	Government	Missouri			X				X
NASA Ames Research Center	Government	California			X				
National Advanced Driving Simulator	University	Iowa			X				
National Center for Rural Road Safety	University	Montana	X		X				
National Ilan University	University	Taiwan			X				
Nebraska Department of Transportation	Government	Nebraska							X
Nebraska State Patrol	Government	Nebraska							X
Norwich University	University	Vermont			X				
Orange County Transit Authority	Government	California							X
Purdue University	University	Indiana			X				
Road Industry Safety Consensus	Committee	Iowa			X				
Science Center of Iowa	Non Profit	Iowa			X				
Shrive Hattery	Industry	Iowa			X				
Smart Work Zone Deployment Initiative	Pooled Fund	Various States	X		X				
St. Louis Board of Alderman	Government	Missouri					X		
St. Louis Street Department	Government	Missouri			X				
Syracuse University	University	New York			X				

External Partners/ Collaborators	Partner Type	State/Country	Financial Support	In-Kind Contributor	Research Collabo- rator	Facilities	Personnel Exchange	Materials	Data
Terminal Railway Association of St. Louis	Industry	Missouri	X	X					
The Airport Ground Transportation Association	Industry	Missouri			X				
The Taxi, Limousine, and Paratransit Association	Industry	Missouri			X				
Transdev On Demand, Inc	Industry	Missouri			X				
U.S. Army Corps of Engineers	Government	USA			X				
Union Pacific Railroad	Industry	Missouri			X				
University of Missouri Extension	University	Missouri			X				
University of Iowa	University	Iowa			X				
University of Kansas	University	Kansas			X				
University of Maryland	University	Maryland			X				
University of Wisconsin	University	Wisconsin			X				

## 4. Impacts

### **What is the impact on the development of the principal discipline(s) of the program?**

The results of MTC-sponsored research conducted by faculty in transportation-related disciplines at all partner institutions fundamentally affect the understanding, teaching, and ultimately the state of the practice related to enhancing infrastructure condition, safety, and project delivery. As a consequence, the state of transportation infrastructure and operations is enhanced.

### **What is the impact on other disciplines?**

As stated in Section 3, Collaborating Organizations, the MTC regularly partners with faculty in other disciplines and related organizations, such as Electrical and Computer Engineering; Business and Finance; Statistics; Industrial and Manufacturing Systems Engineering; Chemical and Biological Engineering; Center for Biorenewable Chemicals; Food Science and Human Nutrition; Supply Chain and Information Systems; Landscape Design; Agricultural and Biosystems Engineering; and the Virtual Reality Application Center.

These partnering activities in research and beyond serve to broaden the understanding of these disciplines to include transportation-related issues, enhancing a multidisciplinary approach to transportation-related problem solving.

### **What is the impact on transportation workforce development?**

Although long-term impacts of the MTC's workforce development activities is difficult to quantify, a direct result of these activities is that hundreds of public school students are now being exposed to information about transportation-related careers and encouraged to pursue studies in disciplines that will help them succeed. In addition, university students pursuing transportation-related programs of study are being reinforced and challenged to higher achievements in such pursuits. For example, students participating in the 2016 Study Abroad in Rome will broaden their understanding of transportation infrastructure construction and operations to an extent that wouldn't have been possible without MTC sponsorship.

Some of the specific numbers include the following:

- Over 1,000 K-12 teachers were passively reached through *GO!*
- 283 K-12 students actively participated in targeted activities
- The MTC is working with the regional transportation workforce center to coordinate workforce development activities
- 52 students are participating in the MTC Transportation Scholars Program
- About 40 students participated in spring semester seminar activities
- 9 students are planning to attend the Study Abroad in Rome, Italy
- MTC supports various activities for transportation student organizations

### **What is the impact on physical, institutional, and information resources at the partner institutions?**

See the lists in Section 2, Products.

### **What is the impact on technology transfer?**

Through direct MTC sponsorship and management of workshops and conferences, more than 880 people received face-to-face training during the reporting period. See the complete discussion of Outreach/Technology Transfer in Section 1, Accomplishments (page 7), and the lists in Section 2, Products. In particular, with MTC support, the Innovations Conference, which is scheduled for August 2016, will focus on how new and emerging technologies that will dramatically change the face of transportation (page 7).

More than 200 practitioners were provided insight into transferring research to practice through the Transportation Research Webinars: Moving Research into Practice.

### **What is the impact on society beyond science and technology?**

MTC research has led to information that agencies utilize to improve traffic safety, reduce impact of construction, and reduce costs for agencies. Currently we are working on developing information that will allow us to quantify these impacts.

## 5. Changes/Problems

Nothing to report.

## 6. Special Reporting Requirements

Nothing to report.