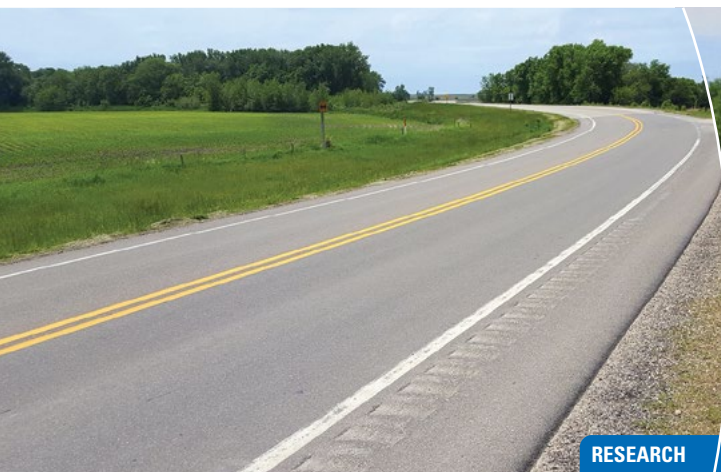


# UTC GRANT

## SUMMARY REPORT

SEPTEMBER 30, 2013 – SEPTEMBER 30, 2019



RESEARCH

OUTREACH/TECHNOLOGY TRANSFER

EDUCATION

WORKFORCE DEVELOPMENT



MIDWEST  
TRANSPORTATION  
CENTER



GRANT NUMBER  
DTRT13-G-UTC37

To US DOT/OST-R, University Transportation Centers

**Grant Number** DTRT13-G-UTC37

**Project Title** University Transportation Center-  
Region 7, Iowa State University



Submitting official signature: Shauna Hallmark

**Front Cover Photos**

*Research (top left)*

*Shoulder rumble strips on a two-lane roadway in rural Iowa, from a 2017 MTC-sponsored research project led by CTRE Safety Engineer, Peter Savolainen*

*Outreach/Technology Transfer (top right)*

*Ultra-high performance concrete (UHPC) implementation on a primary bridge in Iowa in June of 2018, as part of a combined effort amongst multiple local and national parties*

*Education (bottom left)*

*Tom Maze Transportation Seminar from March of 2018, with the Iowa DOT Chief of Motor Vehicle Enforcement, David Lorenzen, presenting*

*Workforce Development (bottom right)*

*Field trip to a bridge repair site during 2016 Teaching in the Fast Lane: Summer Workshop for Elementary School Teachers*

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# TABLE OF CONTENTS

1. Accomplishments.....	4
A. Research.....	5
B. Outreach/Technology Transfer.....	13
C. Education.....	17
D. Workforce Development.....	23
2. Participants and Collaborating Organizations.....	30
3. Products.....	31
4. Impacts.....	31



Photo by Christopher Gannon

## DIRECTOR'S MESSAGE

Over the past six years, the Institute for Transportation has successfully managed the Midwest Transportation Center (MTC) by addressing 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.”

Our success has relied on collaboration. In fact, over the grant period, the MTC has collaborated with 23 colleges, departments, and centers at Iowa State University and 81 external partners from various sectors of government, university, and industry. These connections have resulted in 83 completed projects, including 4 innovative research projects focusing on advances in the design, construction, instrumentation and monitoring, modeling, and management of highway-related projects.

The work performed by our researchers—nationally known scientists and engineers at the top of their fields—is paramount and will continue to impact the transportation community for years to come.

As the MTC’s lead institution, InTrans ranks seventh among the top university-based transportation research organizations in the United States, with more than \$14.2 million in annual expenditures from a variety of funding sources and with 26 full-time researchers and 20 affiliated faculty.

All of this couldn’t have been accomplished without the support of our partner universities—University of Missouri-Columbia, University of Missouri-St. Louis, Wichita State University, Creighton University, and Harris-Stowe State University—whose joint educational and research efforts are included in this summary report.

From seminars at the Transportation Innovations Conference to studying abroad in Italy and Great Britain to hosting safety summits and K–12 workshops, I hope the following stories show how much impact the MTC has had on Region 7. ●

# • ACCOMPLISHMENTS •

Through a strategically focused program that was synergistic with U.S. DOT priorities and MAP-21 goals, the Midwest Transportation Center (MTC) has addressed 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**.

## WHAT WERE THE MAJOR GOALS AND OBJECTIVES OF THE PROGRAM?

Under this theme, the MTC has had the following objectives:

- 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 stage—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.

## HOW WERE THESE GOALS ACCOMPLISHED?

The MTC has accomplished 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 over the six-year grant period. Highlights include the following:

- Big data/REACTOR Lab projects (page 6)
- MTC & IHRB combine funds for innovative research projects (page 10)
- Transportation Innovations Conference (page 13)
- Mid-Continent Transportation Research Symposium (page 16)
- Study Abroad program (page 17)
- Summer educational workshops (page 23)
- *GO!*—MTC's premier K-12 magazine (page 26) ●



*Halil Ceylan (right), director of the Program for Sustainable Pavement Engineering and Research, speaks to an attendee at the 2015 Mid-Continent Transportation Research Symposium*

## EDUCATIONAL PARTNERS ADD VALUE TO MTC GRANT



*Completed rustic road Geosynthetic Reinforced Soil-Integrated Bridge System from a past research project highlighted below*

While Iowa State University was the lead institution spearheading the research of the Midwest Transportation Center, the volume and quality of the work would not have been possible without the partner institutions and organizations that joined the grant.

Iowa State University has partnered with the following educational institutions through this grant:

- Creighton University
- Harris-Stowe State University
- University of Missouri–Columbia
- University of Missouri–St. Louis
- Wichita State University

Wichita State University and Creighton University in particular have partnered with Iowa State University to help develop transportation-focused research programs at their respective institutions.

Of the more than 80 completed MTC projects, more than 40 projects were led by the five partner universities.

### HIGHLIGHTED RESEARCH

#### **Advancing Implementation of Geosynthetic Reinforced Soil-Integrated Bridge Systems**

*PIs: Andrew Boeckmann and John Bowers, University of Missouri–Columbia*

Documented recent implementations focusing on technical performance and practical lessons from agency experiences in Geosynthetic Reinforced Soil-Integrated Bridge System contracting and construction

#### **Pavement Performance: New Approaches Using Predictive Analytics/An Assessment of the Models to Predict Pavement Performance**

*PI: Ravi Nath, Creighton University*

Developed models that provide an assessment of pavement condition based on an array of indicators that include pavement distress, pavement type, traffic load, structural data, and pavement repair history

#### **Economic Sustainability of Inner City Streets: A Collaborative Sustainable Asset Management Transportation System Model**

*PI: Fatemeh Zakery, Harris-Stowe State University*

Developed a sustainable asset management transportation system model for a target area in St. Louis, Missouri

#### **Strategic Design for Delivery with Linked Transportation Assets: Trucks and Drones**

*PIs: James F. Campbell and Donald C. Sweeney II, University of Missouri–St. Louis*

Provided a strategic analysis for the design of hybrid truck-drone delivery systems using continuous approximation modeling techniques to derive general insights

#### **Data-Driven Health Management of Electrical Vehicle Battery Systems**

*PI: Pingfeng Wang, Wichita State University*

Conducted theoretical and experimental investigations into the development of a self-cognizant dynamic system with the potential to predict and prevent failures of critical battery systems used in the increasingly popular electric and hybrid electric vehicles ●

## REACTOR LAB PROJECTS SPOTLIGHT USE OF BIG DATA



*Anuj Sharma, standing, meets with transportation researchers in the REACTOR Lab*

*Photo by Christopher Gannon*

Advances in technology mean that access to transportation data has never been easier.

The challenge is no longer storing the vast amounts of information available through sensors, cameras, and apps. The issue is understanding what it all means and how it can be harnessed to improve safety and mobility on roadways.

Research at InTrans' Real-Time Analytics of Transportation Data (REACTOR) Lab, formed five years ago, has focused on interpreting those data to provide that important context to support departments of transportation and to better assist motorists on their commutes.

MTC projects led by REACTOR Lab researchers have demonstrated the value of their interpretations and assessments. Those projects include:

- Vision-Based Traffic Conflict Detection of Signalized Intersections
- Performance-Based Operations Assessment of Adaptive Control Implementation in Des Moines, Iowa
- Using Operational Data to Assess Mobility and Crash Experience During Winter Conditions

Several other MTC-funded projects have also been conducted as transportation data have become more accessible.

**“More computational power means analyzing more data. With more data, we can make better predictions,”** said Anuj Sharma, REACTOR Lab codirector and principal investigator on two of the MTC projects listed above.

More specifically, the projects through the MTC indicate there are already valuable applications using big data streams, such as probe data and closed circuit television images, and there is yet more potential for the future.

### **BENEFITS FROM SELECT RESEARCH PROJECTS**

#### **Vision-Based Traffic Conflict Detection of Signalized Intersections**

*Principal Investigator: Anuj Sharma*

The project's proposed vision system can be used to better understand baseline driving behaviors (i.e., driver performance and trip characteristics), identify risk factors that contribute to hazardous situations, and improve the ability to develop safety countermeasures for road design.

This vision system can provide appreciable levels of performance for successfully automating the detection of objects in a naturalistic driving setting. In addition, the detector can be used to gather information about vehicle surroundings that is currently not available in the naturalistic driving study data or through the second Strategic Highway Research Program (SHRP2) roadway information database.

*REACTOR Lab projects continued on page 7*

REACTOR Lab projects continued from page 6

### Performance-Based Operations Assessment of Adaptive Control Implementation in Des Moines, Iowa

Principal Investigator: Anuj Sharma

Using the methods defined in this study, agencies can more frequently monitor corridor performance, more easily identify problematic segments, and more quickly identify system management solutions. This can help transportation agencies select the corridors that are in need of traffic signal retiming and can also help identify corridors suited for adaptive signal control implementation.

### Using Operational Data to Assess Mobility and Crash Experience during Winter Conditions

Principal Investigator: Zach Hans

This project promotes the use of extensive, rich data sets to investigate weather-related impacts on mobility and safety and evaluate opportunities for improving winter maintenance operations. In this research, new capabilities were introduced; existing capabilities were expanded; and limitations, challenges, and potential areas for additional investigation were identified.

Ultimately, this work can help the DOTs further mitigate the impacts of winter weather. The DOTs may use the resources developed in this study to supplement existing efforts to monitor traffic, weather, and surface conditions and direct their corresponding activities.

The work conducted at the REACTOR Lab has recently earned recognition from Google, which produced a video on their efforts. Highlights can be seen here: <https://www.news.iastate.edu/news/2019/01/22/intransai-ml>. ●

## HIGH FRICTION SURFACE TREATMENT STUDY TAKES TESTS ONTO IOWA ROADWAYS



Example of high friction surface treatment application

High friction surface treatment for high crash locations typifies the projects completed as part of the Midwest Transportation Center's grant and its theme of data-driven performance measures for safety.

The project incorporated several of the MTC goals as well, including ensuring an efficient use of funds by leveraging the grant to secure additional dollars from the Iowa DOT. Working with the Iowa DOT also helped meet the goal of developing relevant products for transportation agencies.

The Iowa DOT allocated \$1,000,000—in addition to an investment of \$34,999 from the MTC—to install high friction surface treatments (HFST) as a crash mitigation strategy on nine selected two-lane primary and paved secondary horizontal curves throughout the state. The results from the test sites offered a framework to determine which curves are the best candidates for the treatment versus other mitigation strategies.

**Horizontal curves were selected because they are overrepresented in Iowa's roadway system and are high-frequency, high-severity crash locations.**

This research project was divided into two phases with the following main objectives:

- Develop preliminary HFST candidate site selection criteria and apply these criteria to identify appropriate, high speed, primary and secondary paved horizontal curves for HFST application.
- Establish a baseline condition for all treatment sites and monitor HFST performance and basic driver behavior for a three-year period following treatment. Crash data from before and after were also collected.

HFST study continued on page 8

*HFST study continued from page 7*

The placement began in August 2017 and was completed in September 2017. Data have been collected since, including friction testing on all locations using a British pendulum tester.

The study provided the Iowa DOT with a procedure for selecting horizontal curves with high-frequency, high-severity crash records for HFSTs. The team has recommended standard practices for successful HFST implementation and included performance evaluation based on friction measurements and crash records after the treatments were placed.

Specifically, the team found that HFSTs provide improved texture and skid resistance in comparison to other pavement surfaces but might need multiple applications to guarantee sufficient visibility.

Further, the report clarifies that there is a need for an improved selection process that depends on the friction measurements and friction demand for the candidate locations, in addition to the crash records. The project winnowed a potential 6,287 test sites down to the final nine using a scientific process that earned recognition for its methods.

Prior to this, no formal criteria had been established for HFST application.

While other crash mitigation strategies exist, this project began to determine where the innovative, if somewhat more costly, high friction surface treatments would be best utilized in the state of Iowa, which is critical because safety performance is a crucial component of highway network performance evaluation. ●

## MTC RESEARCH PROJECTS

SEPTEMBER 30, 2013 – SEPTEMBER 30, 2019

### 2019

Performance Characteristics of Modern Recycled Asphalt Mixes in Missouri, Including Ground Tire Rubber, Recycled Roofing Shingles, and Rejuvenators  
Management of Bridges Considering Aging Mechanisms and Extreme Events  
On-Board Prediction of Remaining Useful Life of Lithium-Ion Battery

### 2018

Guide to Life-Cycle Data and Information Sharing Workflow for Transportation Assets  
The Interrelationships between Speed Limits, Geometry, and Driver Behavior  
Use of Biocementation for Slope Stabilization of Levees  
Hybrid Concrete for Advancing Pavement Performance  
Using Operational Data to Assess Mobility and Crash Experience During Winter Conditions  
Integration of Structural Health Monitoring into Multilayer Statewide Bridge Maintenance and Management Practices  
Enhancing the Fundamental Knowledge and Use of Asphalt Emulsions Using Systematic Scientific and Engineering Approaches  
Initial Characterization of Geopolymer Based UHPC Material Properties  
Performance-Based Operations Assessment of Adaptive Control Implementation in Des Moines, Iowa  
Evaluation of the Mechanical and Environmental Performance of Biofuel Co-Product-Stabilized Unpaved Roads  
Asset Utilization Potential of Building a Trucking and Rail Intermodal Hub in the St. Louis Region  
Vision-Based Traffic Conflict Detection of Signalized Intersections  
Women as Assets in Railroad/Transportation Operational Roles  
Data-Driven Health Management of Electrical Vehicle Battery Systems  
Data-Driven Highway Infrastructure Resilience Assessment  
Risk and Failure Resilience Quantification of Interdependent Transportation Systems  
Effect of Coupling on A-Walls for Slope Stabilization  
Intelligent Highway Management System for the City of Wichita  
Driver Crash Causation Study by Gender—Missouri, Iowa, and Illinois Comparison  
Evaluation of Rural Intersection Treatments  
Visualization and Communication in Pavement Performance/Visual Analysis of Pavement Performance and Related Factors  
Estimating Energy Efficiency of Connected and Autonomous Vehicles in a Mixed Fleet  
Evaluations of Large-Truck Crash Severity in Missouri  
Missouri Highway Safety Manual Recalibration  
Paving the Way for Autonomous and Connected Vehicle Technologies in the Motor Carrier and Rail Industries  
Why TNCs Will Be Regulated Like Taxis—Historically Speaking  
Development of Rural Road Bridge Weigh-in-Motion System to Assess Weight and Configuration of Farm-to-Market Vehicles  
Strategic Decision Support for Airport Capacity Planning  
Installation Guidance for Centerline and Edgeline Rumble Strips in Narrow Pavements

*2018 MTC research projects continued on page 9*



# • RESEARCH •

2018 MTC research projects continued from page 8

Big Data-Driven Prediction of Long-Term Bridge Performance and Management Improvements

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

Pavement Performance: New Approaches Using Predictive Analytics/An Assessment of the Models to Predict Pavement Performance

Creation of a Sustainable Collaborative Transportation and Safety Model

Optimizing Fleet Composition and Size under Uncertainty in Urban Transit Systems

Understanding the Impacts of Work Zone Activities on Traffic Flow Characteristics

## 2017

Evaluation of Work Zone Split Traffic Symbol Sign

Development of Crash Modification Factors for Lane Departure Countermeasures

Estimating Crash Modification Factors for Lane Departure Countermeasures in Kansas

Strategic Design for Delivery with Linked Transportation Assets: Trucks and Drones

Traffic Impact Assessment Tool for Moving Work Zone Operations

Advancing Implementation of Geosynthetic Reinforced Soil-Integrated Bridge Systems

Bridge Maintenance Program for the City of Columbia, Missouri

Investigation of the Link Between Macroscopic Traffic Flow Characteristics and Individual Vehicle Fuel Consumption

Developing a Data-Driven Traffic Impact Assessment Tool for Work Zones

Driving Simulator Study of Merge Signs

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

Field Measurements on the Effect of Temporary Rumble Strips in Work Zone Flagging Operations

FE-ANN Based Modeling of 3D Simple Reinforced Concrete Girders for Objective Structural Health Evaluation

Data Driven Urban Traffic Prediction for Winter Performance Measurements

Design of Maintainable Drains for Earth Retaining Structures

## 2016

Development of a Transportation Real-Time Technology Readiness Framework

Investigation of Rural J-Turn Design Factors Using the ZouSim Driving Simulator

Implementation of Transportation Asset Management in Grandview, Missouri

Aggregate Freezing-Thawing Performance Using the Iowa Pore Index

Development of an Eco-Friendly, Cost-Effective Biogrout for Concrete Crack Repair

Historical Performance Evaluation of Iowa Pavement Treatments Using Data Analytics

System-Wide Safety Treatments and Design Guidance for J-Turns

Assessing Segment- and Corridor-Based Travel-Time Reliability on Urban Freeways

Monitoring Vibrations on the Jefferson City Truss Bridge

Economic Impact of Multi-Span, Prestressed Concrete Girder Bridges Designed as Simple Span versus Continuous Span

Crash Location Correction for Freeway Interchange Modeling

Development and Evaluation of Portable Device for Measuring Curling and Warping in Concrete Pavements

Improving Striping Operations through System Optimization – Phase 2

Toward Autonomous and Robotic Infrastructure Construction: A Workshop and Field Studies of Productivity, Quality, and Safety Impacts

Developing Green, Highly Flowable, Rapid Set, High-Performance Concrete for Pavement Patch Repair

Assessing Risk of D-Cracking in Concrete Aggregates

Pervious Concrete Physical Characteristics and Effectiveness in Stormwater Pollution Reduction

Machine-Vision-Based Roadway Health Monitoring and Assessment

## 2015

Terrestrial Laser Scanning-Based Bridge Structural Condition Assessment

The Feasibility of Charging Private Vehicles an Airport Drop-Off and Pick-Up Charge

The Substitution of Ground Transportation for Service to Smaller Communities Now Receiving Essential Air Service Subsidies

Economic Impact for the Region of Replacement of the Merchants Bridge

Owner-Operator versus Company-Driver Safety Performance Analysis

Designing and Applying a Decision-Support System for DOT Fleet Assignment and Operation

Modeling Airside Operations at Major Airports for Strategic Decision Support

Economic Sustainability of Inner City Streets: A Collaborative Sustainable Asset Management Transportation System Model

Proof of Concept: Biocement for Road Repair

## 2014

Mass Transit Sustainability in the St. Louis Region

Research, Education, and Development (RED): Examining Characteristics of Roadway Infrastructure in Various 3D Visualization Modes

How Firm Size Affects Safety Performance in the U.S. Motor Carrier Industry ●

## JOINT FUNDED PILOT PROJECTS SUPPORT NOVEL OR INNOVATIVE IDEAS AND FUNDAMENTAL ADVANCES

Thinking outside the box on how to fund innovative solutions to transportation needs was an innovation in itself.

The Midwest Transportation Center partnered with the Iowa Highway Research Board (IHRB) to seek “high-risk, high-reward” projects that could lead to substantive advances in the industry.

The IHRB is an advisory group to the Iowa Department of Transportation (DOT) and is responsible for assisting in the development and continuation of an effective research program for Iowa highway transportation. One of its goals is to encourage transportation innovation and long-range technological advances.

Four projects were funded through this collaboration. Three projects focused on advances in pavement infrastructure, and one looked at the future of transportation with the rise of connected and autonomous vehicles.

Those projects were the following:

- Hybrid Concrete for Advancing Pavement Performance
- Initial Characterization of Geopolymer Based UHPC Material Properties
- Enhancing the Fundamental Knowledge and Use of Asphalt Emulsions Using Systematic Scientific and Engineering Approaches
- Estimating Energy Efficiency of Connected and Autonomous Vehicles in a Mixed Fleet

Though these projects have not necessarily led to results that are of immediate use in highway transportation, they certainly hold promise for further useful development.

The principal investigators for each of the projects have presented their final reports to the IHRB, sharing benefits and answering questions about future research potential. Each researcher shared that their research holds promise for Iowa roadways and expressed an eagerness to delve further into their respective research topics.

They have further spread the word about their research and its potential impacts by presenting posters at the Innovations in Transportation Conference held at Iowa State University (ISU) from October 9–10, 2018. More about each of the innovative projects and their future potential follow.



### Hybrid Concrete for Advancing Pavement Performance

*Principal Investigator: Kejin Wang*

The hybrid concrete mixture, a casting cement asphalt mixture (CCAM), has potential benefits not seen in traditional counterparts, including opening to traffic sooner than a conventional cement concrete pavement and a longer service life, a higher resilient modulus, and better rutting performance than traditional asphalt mixtures. The CCAM mixture uses Iowa materials and shows promising signs of reducing rutting in wheel paths, among other benefits.

The research team has successfully developed a CCAM that is designed for use on Iowa roadways and other cooler climate environments, but further study is needed on its key properties, particularly freeze-thaw durability, before it can be applied to Iowa pavements.

*Joint funded pilot projects continued on page 11*

*Joint funded pilot projects continued from page 10*



### **Initial Characterization of Geopolymer Based UHPC Material Properties**

*Principal Investigator: Jay Shen*

The results of this study indicate that an ultra-high-performance geopolymer (UHPG) can be achieved through engineered formulations using locally available concrete materials. Further development of UHPG has the potential to be a more cost-effective and environmentally friendly option than ultra-high-performance concrete (UHPC).

Only a limited number of UHPG mixes were studied in this project, so further study of the geopolymer-based mixes is necessary to understand and improve their properties. Particularly, future studies should be done to increase the density and decrease the porosity of the UHPG mix developed at ISU, as well as assess its durability properties. To further reduce the cost of UHPG, future studies should look at ambient temperature curing for strength development.

### **Enhancing the Fundamental Knowledge and Use of Asphalt Emulsions Using Systematic Scientific and Engineering Approaches**

*Principal Investigator: Ashley Buss*

Asphalt emulsions are a low-temperature alternative to hot applied asphalts that can provide an opportunity for energy savings and that are considerably easier to handle and store.

This research will help disseminate knowledge on asphalt emulsions and help fuel a better understanding of emulsion components to improve standards and test methods for emulsions. The ability to formulate and manufacture emulsions by varying different parameters will help benchmark and evaluate current practices and drive further innovation in the field of pavement preservation and rehabilitation.

### **Estimating Energy Efficiency of Connected and Autonomous Vehicles in a Mixed Fleet**

*Principal Investigator: Jing Dong*

Two newly developed rule-based adaptive cruise control (ACC) models—one for gasoline and one for electric connected and autonomous vehicles (CAVs)—outperform previous models in terms of energy consumption that shows potential benefits in a mixed traffic stream.

Future research should design an energy-efficient strategy for lane changing, which should be implemented in tandem with models to simulate real-world driving behavior. Future projects should also investigate the impact of potential communication delays and sensor failures on the performance of CAVs.

Full details of each project are available here: <https://mtc.intrans.iastate.edu/research/completed/>. ●

## DOT COLLABORATIONS USE SHRP2 NDS DATA TO IMPROVE SAFETY IN STATES

Funding from the Midwest Transportation Center allowed the Institute for Transportation (InTrans) and its partners to leverage more funds and in-kind assistance from external agencies with which researchers have had new and standing relationships.

The MTC funds have particularly allowed multiple opportunities to partner with two of InTrans' closest collaborators: the Iowa and Minnesota departments of transportation.

Two of those projects used data from the second Strategic Highway Research Program (SHRP2) Naturalistic Driving Study (NDS) to improve safety in Iowa, Minnesota, and ultimately, the US.

- **Use of SHRP2 NDS Data to Evaluate Roadway Departure Characteristics:** a project that leveraged \$50,000 in funding from the MTC grant to secure another \$525,000 from the Iowa Department of Transportation (DOT) to study speed and distraction from the perspective of the driver and roadway geometry and countermeasures from the perspective of the roadway.
- **Evaluation of Work-Zone Safety Using SHRP2 Naturalistic Driving Study Data:** a project that used \$50,000 in funding from the MTC grant in an initial phase to provide proof of concept to the Minnesota DOT (MnDOT) to analyze and model the role of speed and distraction in work-zone crashes and near crashes. Future phases of the project funded by MnDOT will continue to build models based on further data to ultimately provide the DOT with appropriate countermeasures for the state.

InTrans with its Center for Transportation Research and Education (CTRE) has been a leader on combining SHRP2 NDS data with roadway information, developing a roadway information dataset (RID) that is being used by researchers across the nation.

InTrans Director Shauna Hallmark and CTRE Director Omar Smadi have spearheaded this research and were the principal investigator or co-principal investigator on the two MTC projects.

Both projects have relied on the data available to make models to predict driver behavior and thus recommend strategies to the respective DOTs to prevent crashes and make their roadways safer.

Findings from the studies include the following:

- In analyzing the mean deviation of speed and lateral position, the study found that various roadway attributes influenced driving behavior. For instance, the mean lateral deviation on tangents was found to be affected by paved shoulder width and rumble strip presence.



*RIDView perspective of a roadway site used in the study*

- The analysis found that on tangents with no paved shoulder, rumble strips decreased deviation more than if there were paved shoulders.
- When looking at curves it was found that deviation in lateral position decreases as radius and curve length increase. It was also found that it increased as lane and shoulder widths increased.
- Additional roadway features such as guardrail presence, number of chevrons, and raised pavement marker presence were all also found to affect speed and lateral position on tangents and curves.
- Initial findings evaluating the probability of a driver being involved in a roadway departure-related crash or near crash increased by 36% for every second they were texting.

Additional analyses are being conducted on the project to look at the impact of roadway features, the interaction of driver distraction and roadway features, and the risk of roadway-departure-related safety-critical events.

Work is expected to be completed on this project by December 2019. ●

## INNOVATIONS IN TRANSPORTATION CONFERENCES ATTRACT OVER 400 PARTICIPANTS



*Simon Anderson presents the keynote to the crowd at the 2018 Innovations in Transportation Conference*

In 2016 and then again in 2018, Iowa State University’s Institute for Transportation (InTrans) and the Iowa Department of Transportation hosted a conference on the Iowa State campus focusing on the future of the industry.

With the slogan “Are you Ready for the Future,” the first conference on April 16, 2016, welcomed nearly 200 local, state, and federal agency personnel, university researchers, industry professionals, consultants, and private business people—anyone who wanted to develop a better understanding of the new and emerging technologies expected to change the face of transportation.

The keynote speaker was “futurist” Jack Uldrich, who discussed how transportation personnel can survive and thrive in an era of unparalleled change (i.e., “transformational transportation trends”). A total of 12 speakers represented the Federal Highway Administration, U.S. Department of Energy, research universities, Ford Motor Company and other businesses, and state transportation agencies. Speakers addressed emerging technologies, such as electric cars, connected and autonomous vehicles, and real-time traffic information. Other presentations were about bringing new energy technologies to the marketplace, creating rural mobility options, and finding transportation resources through data mining. A highlight was a panel discussion by four state transportation agency officials.

In 2018, attendance increased to 250 participants as the conference also expanded to a two-day event on October 9 and 10.

Attention, anticipation, and action were a theme from the 2018 conference’s keynote speaker Simon Anderson, who stressed the “three As” as key to appropriately preparing for the future. Anderson and more than two dozen other speakers offered their assessments of what was coming down the road in transportation and how agencies could be better prepared.

“Fundamentally, how we drive is changing,” said Ben Pierce, of HDR, Inc., one of the speakers.

Pierce laid out a vision of the future where advances in technology will make connected and autonomous vehicles nearly ubiquitous on the transportation network within three decades.

Anderson reminded attendees, however, that whatever changes do come, there will be secondary and tertiary effects to keep in mind. He also noted that changes are likely to happen quickly, using the example of two photographs 10 years apart, where the earlier photo had one motorized vehicle on the street and the latter had only motor vehicles on the same street.

Beyond the safety improvements that will come with connected and autonomous vehicles, speaker Omar Maher, of Esri, highlighted how the rise of big data can be used by agencies to identify crash clusters to make necessary changes.

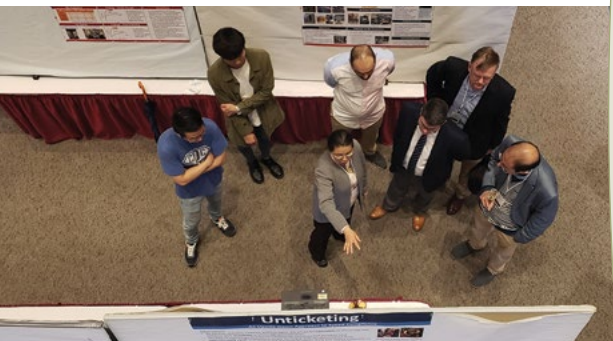
*Innovations conference continued on page 14*

# • OUTREACH/TECHNOLOGY TRANSFER •

*Innovations conference continued from page 13*

The conference also featured a reception and poster presentation. The posters showcased the work of InTrans staff, among others, and their innovative research. Attendees were able to hear from transportation agencies, the vehicle industry, and researchers and get insights into how all stakeholders can have a part in an innovative future of transportation.

The interaction among participants was particularly evident in the transportation leaders' panel discussion with Iowa DOT Director Mark Lowe, Federal Highway Administration Chief Innovation Officer Tony Furst, Michigan DOT Director Kirk Steudle, and Omar Maher of Esri. The speakers each came with different perspectives on leadership but with optimistic visions about the innovations that are just around the corner. ●



*PCC Engineer Kejin Wang discusses research during a poster presentation at the conference*



*The panel discussion closed out the two-day 2018 conference*

## **MORE OUTREACH/TECHNOLOGY TRANSFER EVENTS, PRESENTATIONS, AND MATERIALS PRODUCED**

### **Transportation Safety Webinar Series Helps Move Research to Implementation**

The Transportation Safety Webinar Series entitled "Moving Research into Implementation" was a joint effort between the MTC and UTC Region 5 partner, the Roadway Safety Institute at the University of Minnesota-Twin Cities. The webinar series showcased innovative research that has the potential for immediate implementation, with commentary from researchers as well as practitioners and implementers. Four free webcasts were produced in spring 2016 for an audience of 348 participants.

### **One-Page MTC Briefs, Summer Webinar Helps Research Implementation**

Over the entire grant period, the MTC has been focused on helping get new knowledge into the hands of transportation professionals. A research brief on a new bridge structural health monitoring system was posted on the MTC website and a webinar on the topic was held on July 19, 2017. The brief, titled "Bridge Structural Health Monitoring System Can Provide Immediate and Accessible Data," was the third in a series of MTC one-page documents that highlighted research results. The previous two briefs were "Safety Benefits of Safety Edge" and "Evaluation of Low-Cost Traffic Calming."

### **Development of New MTC Website Completed**

In late 2017, it was the goal of the MTC to redo their web space. Beginning in November 2018, the MTC has had a new and improved website, which includes up-to-date research, outreach information, and educational news. The MTC now benefits from a new, user-friendly, and state-of-the-art web environment that works on desktop, tablet, and smartphone platforms.

### **InTrans and Iowa DOT Host Iowa Evening Reception at TRB**

Transportation professionals from the United States and beyond enjoyed some Iowa hospitality during the Iowa Evening reception at the Transportation Research Board Annual Meeting. ISU's 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. InTrans has been doing this event since 2017.

### **MTC Welcomes AASHTO Spring Meeting to Iowa**

The MTC and the Iowa DOT helped welcome more than 400 transportation professionals from throughout the nation to Iowa for the AASHTO Spring Meeting, held in Des Moines from May 24 to 26, 2016. The Iowa DOT hosted the event and the MTC and InTrans jointly served as one of the meeting's sponsors. MTC director Shauna Hallmark and co-principal investigator Omar Smadi participated in the meeting.

### **Annual Missouri Traffic and Safety Conference**

This annual conference and seminar were managed by Charlie Nemmers of MTC/University of Missouri–Columbia (UMC) in partnership with the Missouri DOT and the Governor's Safety Office. In addition to the MTC/UMC partners in attendance, there was an MTC-affiliated presentation by Harris-Stowe State University.

*Outreach products continued on page 15*

# • OUTREACH/TECHNOLOGY TRANSFER •

*Outreach products continued from page 14*

## **InTrans 30th Anniversary Event**

The event, held on December 11, 2018, celebrated the 30th anniversary of InTrans, from its start with a single grant, and the 35th anniversary of its Local Technical Assistance Program, which formed from similarly humble beginnings. From this single grant, InTrans has now grown to \$20 million in expenditures. LTAP began by offering fewer than a dozen workshops each year to now being a large part of the 100-plus events that InTrans holds annually. InTrans Director Shauna Hallmark welcomed the more than 200 guests to the event and recognized the many partners there that have worked with InTrans over the years.

## **ISU Day at the Iowa Statehouse**

Each year, InTrans participates in the annual Iowa State University Day at the State Capitol in late February in Des Moines. In 2017, Iowa Governor Terry Branstad stopped to visit with InTrans/MTC transportation researcher Skylar Knickerbocker, who explained the work of the Real-time Analytics of Transportation (REACTOR) data laboratory at InTrans. In 2018, Shauna Hallmark, MTC/InTrans director, and Theresa Litteral, statewide multidisciplinary safety teams (MDST) facilitator, staffed a display explaining the Iowa Statewide Multidisciplinary Safety Team program and other high priority InTrans programs. In 2019, InTrans' Associate Director Neal Hawkins represented InTrans and shared with attendees how ISU engineers, in collaboration with the Iowa DOT, are developing practical solutions for Iowa roadways. He shared the Google-produced video (<https://www.news.iastate.edu/news/2019/01/22/intransai-ml>) that profiles InTrans' achievements in using big data and high-performance computing to support Iowa motorists' safety and travel efficiency.



*CP Tech Program Coordinator Sharon Prochnow reacts to receiving an award for her 31-year tenure with InTrans during the Years of Service recognition portion of the 30th Anniversary event*

## **County Engineers' Research Focus Group Meeting**

Each year the Iowa DOT and the Local Technical Assistance Program cosponsor an annual County Engineers Research Focus Group (CERFG) meeting in Ames, Iowa. Each year the group receives instant input/feedback to help district Iowa Highway Research Board (IHRB) representatives better understand the county engineers' needs to target future funding opportunities. There were 44 county and city engineers who participated in the 2017 meeting, 58 in 2018, and 25 in 2019.

## **2017–2019 Traffic and Safety Forums**

Each fall, InTrans hosts an annual Traffic and Safety Forum with assistance from the Iowa DOT. The forum brings together approximately 130 city and county engineers, Iowa DOT staff, consultants, vendors, and researchers from InTrans and other Iowa universities. Traffic and safety engineering professionals learn about new systems and innovations, share experiences, and address areas of concern.

## **Midwest Traffic Incident Management Safety Summit**

This annual event brings together key local, state, and national traffic safety professionals as well as responders from all disciplines focused on traffic and responder safety and the safe, quick clearance of traffic incidents. First responders and other transportation personnel, as well as traffic safety engineers and safety researchers/educators, were encouraged to attend this one-of-a-kind summit to learn about the Midwest's successful safety programs and resources, best practices for overcoming traffic safety challenges, and much more.

## **Ultra-High Performance Concrete (UHPC) for Bridge Applications Workshop**

InTrans and the Iowa DOT in partnership with engineers of Wapello and Buchanan counties in Iowa, the Iowa Highway Research Board, and Federal Highway Administration have been national leaders on the development and implementation of ultra-high performance concrete (UHPC) projects. One of their recent pioneering efforts has been to use UHPC as a bridge deck overlay. So, it was only a matter of time before their technique was implemented in the field on a primary bridge, which involved the international companies LafargeHolcim and Walo Bertschinger (WALO) that specialize in UHPC materials and construction automation, respectively. Before their site visit, a day-long workshop, supported by the MTC, highlighted various projects in Iowa and across the country that have used UHPC and offered insights about the material, the equipment, and the potential for more fully adopting UHPC in bridge projects. About 50 people attended. ●

# • OUTREACH/TECHNOLOGY TRANSFER •

## MID-CONTINENT TRANSPORTATION RESEARCH SYMPOSIUM BRINGS BEST PRACTICE TO THE MIDWEST



*Bo Wang, a mobility analytics manager at Ford Motor Company, delivers the keynote speech to kick off the 2019 Mid-Continent Transportation Research Symposium*



*2019 HoloLens tool demonstration on Advanced Geotechnical Methods in Exploration*

This biennial event, held opposite years at Iowa State University and the University of Wisconsin–Madison, focuses on bringing research implementation and practice-ready results to transportation professionals.

Each year, there are nearly 300 participants from the Midwest and beyond. In 2015, the symposium held from August 19 to 20 in Ames, Iowa, boasted a record number of 365 participants, with representation from local (county and city), state, and federal agencies, industry, and universities from 11 states and Canada. This was the 10th such event hosted by ISU since 1996. The 2015 theme was “Today’s Innovation, Tomorrow’s Best Practice.”

“Our goal was to provide a venue for participants to learn about advancements and applications in their fields as well as future directions for research,” said Shauna Hallmark, MTC Director. The Midwest Transportation Center served as a cosponsor.

Staff and faculty, as well as 78 students, from MTC partner universities also attended the symposium. The 2015 symposium program featured 24 concurrent sessions with nearly 80 presentations and a poster session/reception with 30 posters. New in 2015 was a special focus on implementation, with five sessions featuring discussions on moving research results into practice. These were joint webinars done with Region 5 (the University of Minnesota).

In 2016, the symposium was held from October 24 to 25 in Madison, Wisconsin, under the theme of “Where the Rubber Hits the Road: Moving Research to Implementation.” ISU had several faculty, staff, and students attend this event along with a few serving as presenters. There were over 60 podium presentations and several poster sessions, and, again, over 300 participants.

“Every year we have a wonderful symposium with a great turnout,” said Hallmark. “It’s great to see state and federal DOT professionals, university researchers, industry representatives, and students all together networking and learning about a broad range of transportation issues.”

A few other highlights from later symposiums include the following:

The 2017 event featured 81 research presentations, including 26 poster presentations. Keynote speaker Ben Pierce, Transportation Technology Program Lead at HDR, talked about the Smart City Challenge and the winning Columbus, Ohio, application. Symposium registrants came from 14 states, the District of Columbia, and the United Kingdom.

More than 250 participants attended the 2019 event, which featured keynote speaker Bo Wang, a mobility analytics manager at the Global Data Insight & Analytics (GDIA) organization at the Ford Motor Company.

The key takeaway from the 2019 event was that now is a great time to be a transportation engineer, which was further reflected in a poster session at the end of the first day (including 18 diverse topics and projects), which offered participants opportunities to learn more about current research. ●



## ENGINEERING STUDENTS TAKE THE WORLD BY PLANE, TRAIN, BUS, OR BUST!—MTC'S STUDY ABROAD PROGRAM



*InTrans and MTC director Shauna Hallmark with study abroad students during the 2018 trip to Rome, Italy*



*2015 study abroad leaders and students at the Bosphorus Bridge in Istanbul, Turkey*

“Civil engineering is an increasingly global profession, and what better way to understand that than by seeing it firsthand,” said Shauna Hallmark, director of Iowa State University’s Institute for Transportation and Midwest Transportation Center.

The MTC’s Study Abroad program has led a total of 82 students on five study abroad opportunities. In 2015 it was Turkey, in 2016 and 2018 it was Italy, and in 2017 and 2019 it was Great Britain and Scotland. The trips provided students with an international understanding of the impact different historical, cultural, environmental, and political factors have on transportation and infrastructure projects.

“Each time I feel they have returned with a better understanding of transportation engineering history. And that’s important, because as engineers we rely a lot on past research,” said Hallmark.

And one student, Brianna Lawton, who attended the study abroad to Italy in summer 2018 agreed, “After graduating with my PhD, I plan to work abroad in various countries. I think this trip helped expose me to how life is outside the United States, especially cultural practices. I had the chance to visit the Italy Transportation Management Center and talk with their leadership team about different methods of mitigating traffic within Rome, which is a huge challenge for them. It was great to learn and compare transportation practices here in the United States versus Italy.”

How did the Romans create buildings that stand the test of time? Or, how does London, one of the busiest cities in the world, keep their roadways running smoothly? These questions and more were asked over the course of each two-week study abroad trip. During each trip, the students had different experiences—after all Istanbul’s Haggia Sophia is much different than Rome’s Appian Way. Each included its own attractions and learning opportunities. For example, during the trips to Great Britain, students have had the opportunity to tour London’s traffic operations center.

“We try to visit as many places as we can on our study abroad opportunities and cover a wide range of topics too, so our students can better see for themselves the variety of opportunities the field of engineering has to offer,” said Hallmark.

Anna Bilek, a student who attended the study abroad trip to Great Britain in summer 2017, added that one of her favorite memories was a 5K/10K run around the moat of the Tower of London. “I think this study abroad trip helped prepare me for my future career because it provided exposure to international engineering and processes. This gave us the awareness and understanding of how civil engineering can be utilized in many different ways in many different places.”

The course, called Global Perspectives in Transportation, covered topics like data analytics and image processing, as well as transportation issues like safety, asset management, and transit and logistics. It was co-coordinated with ISU’s Department of Civil, Construction and Environmental Engineering.

*Study abroad continued on page 18*

# • EDUCATION •

*Study abroad continued from page 17*

“It’s all about perspective,” said Keith Knapp, a study abroad leader and director of Iowa’s Local Technical Assistance Program, which works with local governments to keep up with the growing demands of the state’s roads, streets, bridges, and public transportation. “Roads in Iowa are much different than in England or Scotland, but the essential problems remain the same—such as safety.”

## PROGRAM HIGHLIGHTS:

- Breakdown of student participants by year: 10 in 2015, 9 in 2016, 25 in 2017, 15 in 2018, and 23 in 2019
- The Great Britain and Scotland programs (in 2017 & 2019) included trips to Stonehenge, the Roman Baths, the Tower of London, Falkirk Wheel, Forth Bridge, and more
- The Istanbul, Turkey, program (in 2015) included trips to some of the largest airport construction projects ever undertaken, the regional transit center, and several ancient civil engineering projects, including the Hagia Sophia, Roman walls, aqueducts, and an underground cistern
- The Rome, Italy, program (in 2016 & 2018) included trips to the aqueducts and the Appian Way, Rome’s traffic management facilities, the subway system, and the Trenitalia train station (in addition to other popular destinations) ●



*A few students pose on a bridge in St. Andrews, Scotland, during the 2017 trip*



*2018 study abroad students with leader and CTRE director Omar Smadi in Rome, Italy*

## TRANS 691: SEMINAR IN TRANSPORTATION PLANNING

According to one 2017 student participant, the seminar was “enlightening and a great opportunity for [us] to learn about transportation firsthand—from the experts.”

Named after the Midwest Transportation Center founder, the Tom Maze Transportation Seminar has occurred weekly during the spring and has featured nationally recognized speakers.



*Tom Maze*

Held annually from 2015 through 2019, the seminar impacted 427 student participants, bringing in over 50 notable speakers from across the country.

In addition, the seminar series has been broadcast online in real time to students at MTC partner institutions, with broadcast locations rotating among Iowa State University, University of Missouri–Columbia, and University of Missouri–St. Louis. Each presentation was recorded for those unable to attend the seminar directly via Adobe Connect and is still available on the MTC website as a PDF for download.

*Trans 691 continued on page 19*

*Trans 691 continued from page 18*



*Imad Al-Qadi, of the University of Illinois, center, closes out the final Tom Maze seminar of the 2019 semester*

### **TRANS 691 IN 2015**

Led by MTC director Shauna Hallmark, the Tom Maze Transportation Seminar was originally started in order to bring engineering students and experienced transportation experts together to create a space for communication and learning.

“Networking is so very important, and we are happy to have continued this successful seminar all these years under the Tom Maze name,” said Hallmark.

Although there were only two presentations in 2015, there was an average of 66 participants each. Speakers included Jim Noble and Ron McGarvey from the Department of Industrial and Manufacturing Systems Engineering at the University of Missouri. Their topic was “Center for Excellence in Logistics and Design.” The second presentation included speaker Jiangping Zhou from ISU’s Department of Community and Regional Planning. The topic was “Big Data and Collaborative Research via a Visual Lab: The Strength of Weak Ties.”

In 2015, students participating in the seminar series were also responsible for helping develop curriculum for the Transportation Institute, a summer program that included 12 high school instructors from across Iowa exploring a broad range of educational activities related to transportation suitable for integration into high school physics curricula and after-school STEM programs.

“The programs that we host at InTrans with the support of the MTC have really made an impact on the teachers, and through them, the students,” said Jennifer Serra, co-coordinator of both the Seminar Series and the Transportation Institute.

### **TRANS 691 TODAY**

In 2017, four presentations were made, and each presentation had an average of 61 participants. Presenters participating were from the Washington State Department of Transportation, consultancy Demographia, the University of Missouri-Columbia, and Iowa State University.

Jim Nelson, of the Iowa Department of Transportation’s Office of Bridges and Structures, and Travis Hosteng, a research specialist for the InTrans’ Bridge Engineering Center, were the first speakers in the 2017 Tom Maze Transportation Seminar Series. Nelson and Hosteng spoke on the construction of the Massena Bridge and the development of an accelerated bridge construction (ABC) integral abutment connection.

In 2018, again four presentations were made, with an average of 58 participants per presentation. Presenters were from the Texas Transportation Institute, the Washington State Transportation Center, Traffic Tech Services, and Kittleson & Associates.

The seminar continues to be an influential part of the MTC’s Transportation Scholars Program and is an important feature of graduate transportation education at ISU and the MTC’s partner universities. ●

## TSA SUCCESS STORIES



*TSA-ISU ITE student chapter in spring of 2018*

The Transportation Student Association is the student-operated Iowa State chapter of the Institute of Transportation Engineers (ITE) and the Intelligent Transportation Systems of America (ITS|A). The organization cultivates the advancement of transportation ideas through interactions with members of academia, industry, and the public through meetings, sponsored conferences, and outreach initiatives.

“The Transportation Student Association is able to continue as a strong organization thanks to the support from the Institute of Transportation Engineers, the transportation faculty at Iowa State, and every student member who works to diligently prioritize the advancement of professionalism and development in transportation,” said Ellen Nightingale, 2017 TSA President.

TSA co-founded the Midwestern and Great Lakes ITE President’s Council and initiated a set of annual events for its members, including software training sessions, a career panel forum, technical writing and poster seminars, safety educational workshops for high school students, and a roadside clean-up event.

“These students are doing an incredible job of conducting activities on campus...plus their research is phenomenal,” said Michael S. Hofener, 2016 ITE Missouri Valley Section (MOVITE) President.

Many TSA members have been involved in MTC-sponsored events and educational activities. In addition, the Midwest Transportation Center has helped support the TSA by providing opportunities for students to meet experts in the transportation field and volunteers to assist during workshops as well as cohosting seminars.

Jing Dong, TSA’s primary faculty advisor, says the group is self-motivated and enthusiastic, needing little encouragement as they accomplish great things each year.

“They are well-organized and hardworking. I am very proud of our TSA.”

### IMPACT & NOTEWORTHY ACCOMPLISHMENTS

- Nearly all of the MTC Transportation Scholars are also TSA members, as some of the requirements of the program include being involved in extracurricular activities, research, and volunteerism.

- The TSA routinely boasts 40+ active members.
- The TSA provides a multidisciplinary (engineering, design, and business) annual forum for promoting student involvement in transportation research with an average of 40+ participants each year.
- The TSA consecutively has won the Outstanding Student Chapter Award from the ITE Missouri Valley Section (MOVITE) each year (from 2015 to 2018).
- In 2014, 2015, and 2018, TSA competed in and won the Collegiate Traffic Bowl at the ITE’s Midwestern District meeting.
- PhD student and MTC scholar Georges Bou-Saab from ISU spent two months in summer 2016 in an EPA research internship in Ann Arbor, Michigan. He conducted emissions modeling research, specifically data analysis and software development, for the EPA’s Office of Transportation and Air Quality at the National Vehicle and Fuel Emissions Laboratory. Bou-Saab was one of two graduate students chosen nationally for the EPA program.

*TSA continued on page 21*

# • EDUCATION •

*TSA continued from page 20*



*TSA roadside clean-up event in fall of 2018*

- MTC students presented research and won awards at a variety of conferences, including the 17th Road Safety on Five Continents conference in Rio de Janeiro, the 5th International Symposium on Naturalistic Driving Research at the Virginia Tech Transportation Institute, various TRB Annual Meetings, the 2017 Mid-Continent Transportation Research Symposium, and ITE Midwest District competitions. In addition, students from the MTC's partner university, the University of Missouri–Columbia, presented results of their infrastructure project to the Missouri legislature through the University's "Undergraduate Research Day at the Capitol" in April 2017. ●



*TSA members competing at the 2018 Collegiate Traffic Bowl at the ITE's Midwestern District meeting*

## **MORE EDUCATION EVENTS AND ACTIVITIES ACCOMPLISHED OVER THE GRANT PERIOD**

### **Research Experience for Teachers**

The Center for Biorenewable Chemicals (CBiRC) at ISU offers "Research Experiences for Teachers" (RET), which is funded by the National Science Foundation. Each participating teacher is partnered with an ISU faculty mentor with whom they conduct research over a six-week period during the summer. Teachers build on their current knowledge base and learn new science/engineering skills that they take back to the classroom. MTC-affiliated faculty routinely hosted an average of two teachers each summer over the course of the grant period.

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

ISU's Department of Civil, Construction and Environmental Engineering enhanced the innovative "flipped" classroom design for its introductory transportation engineering course. MTC Educational Coordinator Peter Savolainen taught the first offering of CE 355: Principles of Transportation Engineering, which involved the conversion of approximately five hours of traditional lecture content into an online, video lecture format. This allowed for traditional out-of-classroom activities, such as homework and group projects, to be brought into the classroom. The effectiveness of the flipped classroom approach tested in this course was evaluated in a manuscript titled "A Flipped Classroom Approach to Teaching Transportation Engineering," which was presented at the 2016 American Society for Engineering Education Annual Meeting in New Orleans.

### **MTC Transportation Scholars Program**

The MTC continues to sponsor and manage the Transportation Scholars program at ISU, University of Missouri–Columbia, and the University of Missouri–St. Louis. 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, present research results at a conference or through a journal article, mentor other students or participate in K–12 workforce development activities, and participate in a research project or research group, various educational seminars, a transportation student organization, and in the Leadership Institute, a set of online self-directed courses for public agency managers.

### **Fall Transportation Graduate Student Research Seminar**

This seminar, led by the MTC's Dr. Peter Savolainen and later Omar Smadi, was developed by the transportation division of the Department of Civil, Construction and Environmental Engineering at ISU. Graduate students in transportation, including MTC Transportation Scholars, present 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. On average, nine student presentations are made each fall, with an average of 40 attendees. This event was first started in 2015.

*Education products continued on page 22*

*Education products continued from page 21*

### **MTC Undergraduate Research Program**

Seed funding for the Undergraduate Research Program at Iowa State University has been allocated to faculty who engage undergraduate students in research projects under the thematic focus of the MTC. Faculty have provided matching funds and this project has been oriented toward facilitating broader opportunities for undergraduate research and encouraging students to consider graduate school opportunities. The MTC originally began this program in 2015, with funding available for up to 10 projects per year.

### **Freshman Research Initiative (FRI)**

During the 2017 fall semester, the second iteration of “Safe and Efficient Transportation: An Undergraduate Program (SETUP)” was completed under the direction of Peter Savolainen from ISU. Over the course of the semester, 31 students completed 7 projects in teams of 4 to 5 students focusing on various aspects of traffic safety. These students also participated in the university-wide FRI Symposium in spring 2018.

### **Undergraduate Research Networking Event**

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.

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

Twelve Transportation Scholars from the University of Missouri–Columbia 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).

### **ITE Midwest Student Leadership Summit**

The ISU Transportation Student Association hosted the first Institute for Transportation Engineers Midwest Student Leadership Summit in September 2016. The successful summit, sponsored in part by ISU’s InTrans and the MTC, attracted 82 students from 13 universities representing the Great Lakes and Midwestern ITE Districts. During the three-day event, 38 engineering professionals critiqued resumes, conducted mock interviews, and explored industry trends with students.

### **AASHTO Bridge Competition Students Tour Central Iowa**

The MTC helped host students from around the US who were in Iowa in May to participate in the AASHTO bridge-building competition during the 2016 AASHTO Spring Meeting in Des Moines. Prior to the competition, the Iowa DOT and the MTC hosted a central Iowa tour for the students that included visits to ISU’s Virtual Reality Applications Center and bio-research farm in addition to a ride on the Boone and Scenic Valley Railroad.

### **AASHTO Bridge Competition Teams**

As part of a pilot program, the MTC partnered with the Iowa DOT to fund three ISU graduate students to work with teachers and mentor students in order to encourage participation in this transportation opportunity. The

AASHTO National Bridge and Structure Competition is held annually for students from participating Transportation and Civil Engineering (TRAC) and Roadways In Developing Elementary Students (RIDES) states. Five groups from this new program completed the required digital design, model, and proposal for submission. Of the 18 teams chosen to compete, one of ISU’s Science Bound teams was selected as a finalist for the competition held during the annual AASHTO meeting in 2017.

### **2017 ITE Midwest/Great Lakes District Student Leadership Summit**

The ISU Transportation Student Association (TSA) attended the Institute of Transportation Engineers (ITE) Midwest/Great Lakes District Student Leadership Summit (SLS) at Purdue University in September 2017. This was the second annual SLS (the first was held in 2016 at ISU), which was planned and executed entirely by students. The purpose of the summit was to prepare students to make an impact in the transportation industry, develop professional and leadership skills, and promote networking between future and current transportation professionals.

### **MTC Summer Program Facilitator Honored by President Obama for Excellence in Science Teaching**

Lynne Bleeker, who facilitated an MTC summer professional development program for teachers the past two years, was one of 213 educators honored on September 8, 2016, in Washington, DC, by then President Barack Obama. Bleeker received the prestigious Presidential Award for Excellence in Mathematics and Science Teaching. The award honors outstanding K–12 science and mathematics teachers. Bleeker facilitated the MTC-sponsored Teaching in the Fast Lane Workshop in 2015 and 2016. ●

# • WORKFORCE DEVELOPMENT •

## INTRANS AND IOWA DOT IMPACT IOWA TEACHERS AND STUDENTS THROUGH SUMMER WORKSHOPS



*Fast Lane participating teachers during a field outing at a local bridge in 2019*

Staff at the Institute for Transportation and the Iowa Department of Transportation are no strangers to the importance of education. Their partnership, in fact, partly focuses on education, which has also been a key element of the activities conducted by InTrans for the Midwest Transportation Center and the efforts of the Iowa DOT.

It all started in the summer of 2015, when three educational workshops were offered with the goal of educating students on engineering concepts and transportation-related professions while providing teachers the tools to stimulate team-building, critical thinking, and interest in the transportation field. Because of their success, each workshop has been expanded and offered again, and each year the programs have become more focused and tailored to better address the needs of Iowa educators. See below for more details on each program.

### **TEACHING IN THE FAST LANE WORKSHOP FOR ELEMENTARY TEACHERS (2015–2019)**

With an average of 20 participating teachers each year, this program has helped to introduce teachers to engineering concepts and engineering professions with the goal of equipping them to enrich their classrooms and raise awareness and enthusiasm among young students about engineering.

The workshop itself was based on the American Association of State Highway and Transportation Officials (AASHTO) Roadways in Developing Elementary

Students (RIDES) kit, which is aligned with national math and science standards and the core curriculum standards and takes students on multiple adventures learning about transportation in relation to both math and science concepts. After the workshop, teachers were provided with a mini kit that provided them with these materials, enabling them to implement transportation and engineering lessons easily into their classrooms. It included items such as a set of engineering process flash cards, Hot Wheels cars, spring scales, stopwatches, and other fun and educational items.

*Summer workshops continued on page 24*

# • WORKFORCE DEVELOPMENT •

*Summer workshops continued from page 23*



*Fast Lane teachers during a classroom exercise in 2018 at the Portland Cement Concrete (PCC) Pavement and Materials Research Laboratory on the ISU campus*



*Fast Lane teachers busy at work building a bridge from only toothpicks and glue during the 2019 session*



*Transportation Institute participants during a falling weight deflectometer (FWD) demonstration by the Iowa DOT*

Molly Barton, a second-grade teacher from Studebaker Elementary School in Des Moines, Iowa, knew little about engineering, and even less about what engineers actually do, before attending the Fast Lane Workshop. However, she quickly learned that opening the door to future careers like engineering starts early.

“Engineering is solving a problem by making or improving something. I’ve learned what an engineer really is and how many different engineering paths there actually are. I hope that my experiences [from Fast Lane] will inspire my students to become engineers.”

Due to the success of the program, the Fast Lane Workshop was further developed and expanded by the Midwest Transportation Center and was ultimately offered to Iowa teachers from 2015 through 2019. There were 24 participating elementary school teachers in 2015, 22 in 2016, 24 in 2017, 15 in 2018, and 22 in 2019.

“Engineering is everywhere! This class opened my eyes to the many parts of our daily lives encompassed under the umbrella of ‘engineering.’ I feel like I am walking away from this class with the confidence, knowledge, and tools and activities needed to bring engineering into my 1st grade classroom,” said Carrie Jones, a 1st grade teacher during the summer 2017 workshop.

## **TRANSPORTATION INSTITUTE FOR HIGH SCHOOL EDUCATORS (2015–2017, 2019)**

In the summer of 2015, 12 high school instructors from across Iowa explored a broad range of educational activities relating to transportation suitable for integration into high school physics curricula and after-school STEM programs. Workshop facilitator Shannon McLaughlin (high school physics teacher, Norwalk, Iowa) was brought on to guide participants in relevant content and pedagogy to help them gain a better understanding of transportation concepts associated with physics, supplemented with presentations from staff and faculty from the Iowa DOT and ISU.

The goal was for teachers to use this knowledge to integrate transportation-related activities into the classroom and after-school programs. Participating teachers were given pre- and post-content knowledge tests about the goals of science, engineering, and technology; historical examples of science, engineering, and technology; and reasons why students might be confused about the goals of science, math, engineering, and technology. Educators scored significantly higher on the post-program test compared to their preprogram scores.

“I was exceptionally impressed with the speakers at the Transportation Institute and their ability to bring complex material down to a very understandable level. They were quick to answer questions, helpful in suggesting solutions to our problems, and very entertaining in their presentations,” said one 2015 workshop participant.

*Summer workshops continued on page 25*



# • WORKFORCE DEVELOPMENT •

*Summer workshops continued from page 24*

Due to the success and interest in the program, the Transportation Institute was continued in summer 2016 as a three-week professional development workshop where a total of nine high school teachers participated in transportation-related activities (e.g., collision and accident safety, super elevation, etc.) that they would later bring into their classrooms and after-school programs.

New for 2016 was that each participant received a \$500 grant to help bring transportation concepts into their classrooms. One teacher purchased a dynamics system for experiments with motion, collisions, velocity, and acceleration. Another bought a radio-controlled car to help students better understand the laws of motion and engineering mechanics.

“This was truly a great workshop. I learned how to guide students in creating their own mathematical models, which I previously would have deemed impossible! If another workshop similar to this is offered in the future, I will definitely participate,” said one 2016 workshop participant.

## **GO! FURTHER WORKSHOP FOR HIGH SCHOOL STUDENTS (2015–2019)**

What started as a week-long program in 2015 was later expanded in 2016 to a two-week-long multisponsored event that brought an average of 22 Iowa students to the Iowa State University campus to learn about the world of engineering and take part in hands-on activities to develop leadership and teamwork skills.

In 2015, 19 students, working in teams, participated in a ropes



*GO! participants after completing ropes obstacle course in Marshalltown, Iowa*

course in Marshalltown, Iowa, where they traversed through a challenging rope climbing obstacle course. While visiting a local wetland mitigation site, the students learned the importance of sustainability. Then students were able to see what a snow plow operator really does by “driving” in a snow plow simulator housed at the Iowa DOT. And students learned the true value of leadership by “giving forward” as volunteers at a local area food pantry.

“It’s interesting to think of leadership as an everyday occurrence, not just a quality held by important people like political leaders and CEOs. I can be a leader at school and camp,” said Jonathan Zaugg (Southeast Polk High School) during the summer 2015 workshop.

Later, the two-week-long GO! Further Workshops hosted in 2016–2019 included two sessions and included the support of ISU’s Young Engineers and Scientists (YES) Program. In addition, to ensure diversity, the MTC collaborated with ISU’s Science Bound program, which partners with schools to increase the number of ethnically diverse Iowa students pursuing STEM careers, and with ISU’s Program for Women in Science and Engineering to appeal to young women across Iowa. The Iowa Department of Transportation was also a key sponsor of these highly anticipated summer workshops.

“The students were successful and collaborated effectively during the workshop while learning more about their potential to be great leaders. One activity that was particularly effective was Lollipop Leadership, which focused on sharing moments when someone said or did something that fundamentally changed their lives for the better,” said Jennifer Lillo, facilitator. ●

# • WORKFORCE DEVELOPMENT •

## GO!—MTC'S PREMIER K–12 MAGAZINE

### ABOUT GO!

GO! is a free, not-for-profit, online magazine (e-zine) for teens focusing on education and career opportunities in transportation. GO! aims to develop the transportation workforce by educating and stimulating young minds about the vast educational and career possibilities in transportation.

Presenting transportation from different angles such as infrastructure, vehicles, designers, as well as the users of transportation, GO! includes information on scholarships, internships, and other educational resources, like Curriculum Connections, which take a technical look into popular STEM (Science, Technology, Engineering, and Mathematics) topics. It also boasts a variety of articles written by students for students about transportation. For the K–8 students, GO! even publishes its own web adventure comic featuring a spunky, teenage heroine named Dot.

“One of the most influential things about GO!’s content is its diverse topics. We strongly believe it is never too early to be introduced to transportation, engineering, and careers in STEM fields,” said Brandy Haenlein, GO! Program Coordinator.

“We pride ourselves on producing content that is informative, entertaining, and most importantly relatable to students at any level.”

Throughout GO!’s history, this e-zine has aimed at inspiration, for both students and teachers. It has produced a number of tangible materials for teachers, including posters and brochures, to help bring transportation concepts into their classroom.

“In 2016, GO! started really focusing on 10 core article types: blogs, book reviews, interviews, and articles focusing on accelerated bridge construction (ABC), careers, exploration, green energy, history, safety, and tech trends,” said Haenlein. “And our subscribers and teachers have really appreciated the variety.”

One of the most popular article series to date was the seven articles published in 2017 that focused on “Transportation Feats of the World.” GO! writers took an in-depth look at the Trans-Siberian Railroad, International Space Station, Long Underground, among others, and led readers on fact-filled journeys of exploration.

### ENHANCEMENT OF GO!

The MTC’s support of the e-zine, GO!, has helped to (a) develop over 250 articles, (b) interview 30 role models with unique jobs (for example, GO! interviewed engineers Christopher Whitmer and Sheldon Kunkel of the Design of Aerospace Vehicles for in Classroom Interaction [DAVINCI] Flight project), (c) increase visitors by 10 percent annually through social media and marketing, (d) develop an internship program for journalism and graphic arts majors, and (e) collaborate with other UTCs (e.g., the team collaborated with



Snapshots of various GO! articles

the Accelerated Bridge Construction University Transportation Center [ABC-UTC] at Florida International University where researchers wrote ABC-related articles).

### PERFORMANCE METRICS FOR GO!

- Number of unique users annually: approx. 9,000
- Number of page views annually: approx. 25,000
- On average, most unique users visit 2 to 3 article pages per session
- On average (annually), over 85 percent of visitors to the website are new
- Twitter: 340 followers; Facebook: 306 followers
- Monthly newsletter is sent out to over 1,200 teachers and transportation professionals across the country ●

# • WORKFORCE DEVELOPMENT •

## READY, SET, BUILD!—BRIDGE-BUILDING CHALLENGE



*Team of students hard at work during the 2017 Bridge Building Competition*

Since 2015, the Midwest Transportation Center has helped Iowa students “build their dreams.” With every year, interest in this original program has only grown. In fact, in November 2018 it was finally expanded to a three-day event where school groups from across Iowa participated in a stand-alone session the first two days and then families and after-school groups participated in their own session on the final day.

With the help of the Iowa Department of Transportation as well as of the competition host, the Science Center of Iowa (SCI), the program has been an ongoing success.

### **ABOUT THE CHALLENGE**

Participants were divided into three general categories: 4th–6th grades, 7th–8th grades, and families. Each team had three hours to build a bridge out of provided materials (e.g., popsicle sticks, wooden dowels, masking tape, glue, string, and poster board).

“The competition supported everything that we have been learning in school. The kids were able to apply all that they learned about the engineering design process in a collaborative learning space,” said one teacher (grades 4–6) during the 2016 competition.

Participants have also had the opportunity to interact with engineering professionals from the Iowa Department of Transportation and the Institute for Transportation and learn more about bridges and other transportation-related topics.

Iowa State engineering graduate students have also volunteered for the day to assist the young designers/builders.

“[This] event was very deep, rich, and we got some great hands-on enrichment,” added one family team participant during the 2017 competition.

Each grade level received awards in innovation, truss teamwork, and highest structural efficiency. This was also expanded to the family group competition (along with a few special awards for “Best Adult Team” and “Best Team Name”).

Since 2015, the program has been sponsored in part by the Iowa DOT and supported by ISU 4U Promise, which helps prepare students from communities with historically lower attendance or academic success in higher education for college.

*Ready, Set, Build! continued on page 28*

# • WORKFORCE DEVELOPMENT •

*Ready, Set, Build! continued from page 27*

## PERFORMANCE METRICS FOR THE CHALLENGE:

- Number in 2015: 76 participants
- Numbers in 2016: 43 teams, 158 participants
- Numbers in 2017: 48 teams, 182 participants
- Numbers in 2018: 52 teams, 180+ participants
- Each year, through additional hands-on learning booths at the main entrance, over 1,200 SCI attendees have been provided with learning opportunities about transportation and bridges
- Each year, the Iowa DOT, InTrans, ISU Transportation Student Association, and the ISU Women in Science and Engineering (WiSE) have helped provide staff and program support ●



*Students receiving guidance from a volunteer on their bridge during the 2018 challenge*

## MORE WORKFORCE DEVELOPMENT ACTIVITIES AND WORKSHOPS ACCOMPLISHED

### High Schoolers Do Research in Young Engineers and Scientists (YES) Program

In 2015, the MTC and ISU's Center for Biorenewable Chemicals started a collaborative event called the Young Engineers and Scientists (YES) program. In this partnership with Iowa high schools, the program has offered six-week research internships to participating students who worked up to 40 hours a week under the supervision of a mentor. At the end of the session, each student prepared a poster outlining their research to present at an open reception. Each year, the Institute for Transportation has hosted a number of students, and MTC faculty, such as MTC Director Shauna Hallmark, have served as mentors. Two students have even been asked to stay on at InTrans as student employees following completion of the program.

### Annual Missouri Traffic Safety and Blueprint Conference

Hosted by the Transportation Infrastructure Center at the University of Missouri, in cooperation with the Midwest Transportation Center, Missouri Department of Transportation, Federal Highway Administration, National Highway Traffic Safety Administration, and the Missouri State Highway Patrol, the Missouri Traffic Safety and Blueprint Conference is held annually in the fall in Columbia, Missouri. Generally, over 400 people have attended. In 2017, a total of 48 speakers coming from as far as Seattle, Washington, and Washington, DC, were in attendance. Having MTC support was significant in assuring a successful conference.

### MTC Teams with Program for Women in Science and Engineering (WiSE)

The MTC teamed with ISU's WiSE to offer the Ready, Set, Build!—Bridge-Building Challenge. The event is held twice yearly in spring and fall at ISU during the WiSE-sponsored Taking the Road Less Traveled (TRLT) Career Conference, which hosts approximately 350 9th and 10th graders, about 48 of whom participate in the bridge challenge. WiSE also collaborates with other groups to increase the participation of women in STEM fields. One of the goals of the conference is to expand awareness of STEM careers. The Institute for Transportation has conducted this activity as part of the TRLT Career Conference four times over the course of the grant period.

### Annual Missouri Bridge Conference in Columbia, Missouri

Each April/May, an annual conference is hosted by the University of Missouri, with funding from the Missouri Department of Transportation (with some matching funds from the MTC technology transfer project). The conference serves as a forum for bridge engineers to hear from leaders in their profession, discuss best practices, learn about new bridge engineering technologies, and more. Each year over 200 people attend, with representatives from the American Council of Engineering Companies, Missouri DOT, University of Missouri—Columbia, and the Society of Women Engineers. In 2015, five University of Missouri—Columbia MTC Transportation Scholars entered the poster competition, with one student taking second place. In 2017, there were several presentations about research work conducted on MTC-funded projects.

*Workforce development products continued on page 29*

# • WORKFORCE DEVELOPMENT •

*Workforce development products continued from page 28*

## **ASCE Engineering Day for Kids**

Each fall, the MTC partner the University of Missouri–Columbia hosts approximately 60 3rd–5th grade students for their annual, free, Engineering Day for Kids. Student members of UMC’s chapter of the American Society of Civil Engineers (ASCE) assist the students as they learn about what civil engineers actually do. They build bridges and structures out of toothpicks and gumdrops, set up and run cars on a simulated highway, build retaining walls with sand and paper, and measure and calculate material properties.

## **Midwest Transportation Workforce Center (MTWC) and Midwestern Transportation Workforce Summit**

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 Federal Highway Administration, 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 to 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. Additionally, the summit hosted a showcase of workforce development initiatives. The MTC’s booth showcased its K–12 initiatives, which included its series of summer workshops and *GO!* magazine.

## **Research Experience for Teachers (RET)**

For five years, the MTC and InTrans have participated in this program offered by ISU’s Center for Biorenewable Chemicals and funded by the National Science Foundation. The program has provided an opportunity for public school teachers to work on active research projects, building their knowledge base and science/engineering skills, which they can then use in their own classrooms. During summer 2018, MTC Director Shauna Hallmark, MTC affiliate researcher Basak Aldemir Bektas, and Associate Director of the Bridge Engineering Center Katelyn Freeseaman hosted three teachers for six weeks at ISU’s Institute for Transportation.

## **Science Bound Saturday**

As a part of Science Bound, a weekend event hosted annually in the summer at Iowa State University, Bob Steffes, a research engineer for the National Concrete Pavement Technology Center at InTrans, hosted an activity for a visiting 9th grade student group. His “Introduction to Concrete” activity included a tour of the PCC Pavement and Materials Research Laboratory, which is located on the ISU campus.

## **MTC Researchers Contribute to Midwest Transportation Workforce Center Report**

MTC researchers helped contribute to the Phase 2 Job Needs and Priorities Report as part of the MTWC. This included helping to summarize resources available for priority transportation occupations in the Midwest and helping to identify programs that could be expanded or used as an example to help address the job needs in the Midwest. Gaps in resources and issues with retention were also addressed as part of the report. The report included five action plans, which can be utilized to help start addressing the skills and job needs in the transportation sector in the Midwest. ●



*Students conducting experiments during the 2018 ASCE Engineering Day for Kids*



*MTC affiliate researcher Basak Aldemir Bektas visits a high school class of RET program participant*



*9th grade students working on a concrete activity during the 2017 Science Bound Saturday*

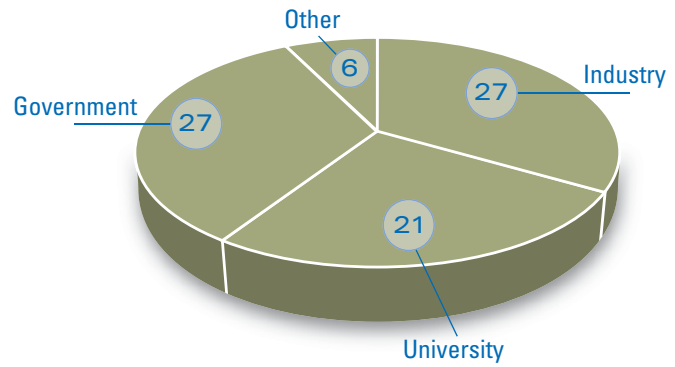
## • PARTICIPANTS AND COLLABORATING ORGANIZATIONS •

The Midwest Transportation Center has worked with many colleges, departments, and centers at Iowa State University as internal partners throughout the six-year grant period:

- Bioeconomy Institute
- Bridge Engineering Center
- Center for Biorenewable Chemicals
- Center for Earthworks Engineering Research
- Center for Transportation Research and Education
- Center for Weather Impacts on Mobility and Safety
- College of Business
- Department of Aerospace Engineering
- Department of Agricultural and Biosystems Engineering
- Department of Chemical and Biological Engineering
- Department of Civil, Construction, and Environmental Engineering
- Department of Electrical and Computer Engineering
- Engineering Research Institute
- Department of Environmental Health and Safety
- Department of Food Science and Human Nutrition
- Department of Industrial and Manufacturing Systems Engineering
- Department of Landscape Architecture
- Department of Statistics
- Department of Supply Chain and Information Systems
- National Center for Wood Transportation Structures
- National Concrete Pavement Technology Center
- Transportation Services
- Virtual Reality Application Center

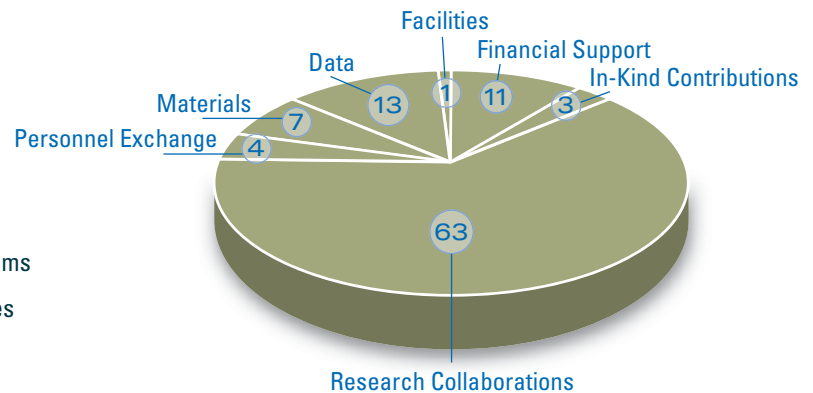
Other collaborative efforts with external partners (other than collaborations among MTC partner universities) are summarized in the pie charts on the right. ●

### EXTERNAL PARTNERS/COLLABORATORS



TOTAL COLLABORATORS: 81

### COLLABORATIVE ACTIVITIES WITH EXTERNAL PARTNERS



TOTAL ACTIVITIES: 102

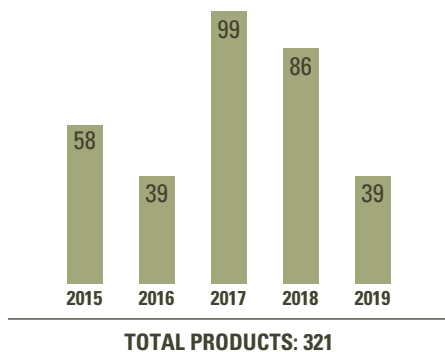
## • PRODUCTS •

In addition to products and activities discussed previously, the MTC has generated and/or funded the following types of products during the six-year grant period:

- Faculty and students speaking and giving poster presentations at conferences, meetings, and other events
- Articles and papers for technical publications and conference proceedings
- Student attendance, participation, and awards at various events
- Other assorted products such as webinars, software, workshops, databases, and newsletters

The count of these product offerings is shown in the bar chart below. ●

### PRODUCT TALLY DURING GRANT PERIOD



Members of InTrans reviewing a poster presentation at the 2017 Mid-Continent Transportation Research Symposium

## • IMPACTS •

Midwest Transportation Center sponsorship and management has led to the following:

- Enhancement of the state of transportation infrastructure and operations through research conducted by faculty in transportation-related disciplines at all partner institutions
- Integration of a multidisciplinary approach to transportation-related problem-solving by partnering with faculty in other disciplines and related organizations on various activities
- Exposure to information about transportation-related careers for hundreds of K–12 students
- Reinforcing and challenging university students pursuing transportation-related programs of study by offering Study Abroad opportunities and participation at MTC-sponsored events
- Conducting workshops and other events that have allowed face-to-face training on an assortment of transportation-related topics from MTC researchers and other speakers from around the nation
- Providing information that agencies can utilize to improve traffic safety, reduce the impact of construction, and minimize overall costs ●

The Midwest Transportation Center (MTC) is a regional University Transportation Center (UTC) sponsored by the U.S. Department of Transportation Office of the Assistant Secretary for Research and Technology (USDOT/OST-R). The mission of the UTC program is to advance U.S. technology and expertise in the many disciplines comprising transportation through the mechanisms of education, research, and technology transfer at university-based centers of excellence. Iowa State University, through its Institute for Transportation (InTrans), is the MTC lead institution.

*Students and volunteers at the 2016 Ready, Set, Build!—Bridge Building Challenge*



**IOWA STATE UNIVERSITY**  
**Institute for Transportation**