Program Progress Performance Report

To US DOT/OST-R, University Transportation Centers

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1. Accomplishments

What are the major goals and objectives of the program?

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

Under this theme, the MTC’s objectives are to

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

What was accomplished under these goals?

The MTC accomplishes these goals by focusing on the following five activities:
A. Research (goals 1, 2, 3)
B. Outreach/technology transfer (goals 3, 4)
C. Education (goals 6, 7)
D. Workforce development (goals 5, 6)
E. Center management (all goals)

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

- **MTC & IHRB Combine Funds for Innovative Research Projects** (page 6)
- **InTrans and Iowa DOT Host Iowa Evening Reception at TRB** (page 8)
- **Traffic and Safety Research Focus Group Prioritizes Research Ideas** (page 8)
- **Transportation Innovations Conference in Ames, Iowa, Planned for October** (page 8)
- **Study Abroad Students to Visit Italy** (page 9)
- **Ready, Set, Build!: Bridge-Building Challenge Held November 2017** (page 12)

A. Research

The MTC’s lead organization Iowa State University (ISU) is working with partners Wichita State University and Creighton University to help them develop transportation-focused research programs; partner organizations University of Missouri–Columbia (UMC) and the University of Missouri–St. Louis (UMSL) are working with partner Harris-Stowe State University.

The total number of projects funded under this grant to date is 75. All MTC-funded research projects, completed and in-progress, are listed at intrans.iastate.edu/mtc/index.cfm/research.

Completed Research

During this reporting period, 13 final reports, 12 technology transfer documents, and 3 tech briefs were submitted for research projects funded under this UTC grant, bringing the total to 31 final reports to date (“Products” on page 13).

Current Projects

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

**Hybrid Concrete for Advancing Pavement Performance**

PIs: Kejin Wang, Iowa State University

Rutting, caused by a depression or groove of traveling wheels worn into a road, is a major problem of conventional asphalt or flexible pavements, and it is primarily due to plastic deformation of the asphalt concrete near the pavement surface. To overcome this problem, a hybrid, made with asphalt (flexible) pervious concrete filled with Portland cement (rigid) mortar, called a casting cement asphalt mixture (CCAM), was developed. During the development, various CCAMs were made with Iowa concrete materials. Experiments were conducted to achieve optimal porosity of asphalt pervious concrete and optimal flowability of mortar. Basic engineering properties, such as strength, shrinkage, and freeze-thaw durability, were evaluated.

Although CCAM has attracted great attention in Europe and Asia, most applications are in warm climate regions, and little to no applications of CCAM have been conducted in the United States—especially in cold climate regions. A systematic investigation needs to be conducted on CCAM freeze-thaw durability before this new material can be fully applied to Iowa pavements.

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

PI: Ashley Buss, Iowa State University

This project aimed to better understand asphalt emulsions and their formulations. Asphalt emulsions are used in sustainable pavement recycling strategies and for pavement
preservation. With the broader use of polymers and the development of biopolymers, a better understanding of polymer modified emulsions would create more sustainable solutions to pavement rehabilitation. In general, asphalt emulsions are a poorly understood material and most of the information about emulsions comes from industry. There is a need to enhance understanding of asphalt emulsions to facilitate technology transfer to local agencies who employ pavement preservation strategies.

Through a detailed literature review, collaboration with industries and local agencies, and careful well-structured procedures, emulsions will be formulated using state-of-the-art equipment. The effect of particle size, emulsifier type, and asphalt content on the stability of the emulsion will be studied in detail. Different types of emulsions, which include slow set and rapid set emulsions, will be produced. This project will also aim to compare two benchmark emulsions (one non-modified and one polymer modified) to better understand the effect of polymers on emulsion properties, especially in the scope of pavement preservation. The potential to use biopolymers with emulsions will also be investigated.

Estimating Energy Efficiency of Connected and Autonomous Vehicles in a Mixed Fleet
PI: Jing Dong, Iowa State University

Connected and autonomous vehicle (CAV) technologies are likely to be gradually implemented over time and in a traffic environment consisting of a significant share of alternative fuel vehicles, such as plug-in electric vehicles. In order to improve the energy efficiency of an individual vehicle and traffic flow, rule-based ecological adaptive cruise control strategies like an Ecological Smart Driver Model (Eco-SDM) for gasoline CAVs and Energy-Efficient Electric Driving Model (E3DM) for electric CAVs (e-CAVs) were proposed.

By adjusting the spacing between the leading and the following vehicles, Eco-SDM provided smoother deceleration and acceleration than other adaptive cruise control strategies based on an Intelligent Driver Model (IDM-ACC) and Nissan Model (Nissan-ACC). E3DM was also able to maintain high energy efficiency of regenerative braking by adjusting the spacing between the leading and the following vehicles. To estimate vehicle energy consumption in a mixed traffic stream, a Virginia Tech Microscopic Energy and Emission (VT-Micro) Model was calibrated for gasoline vehicles and a power-based electricity consumption model that considers the impact of ambient temperature on auxiliary load was proposed for battery electric vehicles (BEVs). Single-lane vehicle dynamics in a traffic stream with a mix of CAVs and human-driven vehicles were simulated.

Initial Characterization of Geo-polymer Based UHPC Material Properties
PI: Jay Shen, Iowa State University

Ultra-high performance concrete (UHPC) has been attracting more and more interest in the bridge engineering community over the past decade due to its strength, ductility, and durability. However, the high material costs associated with UHPC have prevented it from completely replacing more conventional concrete mix designs. Recently, research has indicated a low-cost, geo-polymer-based UHPC (Geo-UHPC) that might have the potential to reduce the cost of conventional UHPC. Geo-polymer components may replace the cement found in traditional UHPC. If successful, introducing geo-polymer material into UHPC may not only reduce costs but also promote sustainable construction practices.

This project was the first step in developing the Geo-UHPC into a practical structural material for bridge application (i.e., to understand the material properties of Geo-UHPC, such as strength and ductility). Research results showed that Geo-UHPC can reach as high as 18,000 psi, with much reduced cost. The failure patterns of the material under compression appeared to be ductile. The results indicated that the material has strength and ductility suitable for structural material, and that further development for structural application would include investigating bond strength through pull-out testing.

Mill for making emulsions

Failure pattern of project specimens

Designing and Applying a Decision Support System for DOT Fleet Assignment and Operation
PI: Ron McGarvey, University of Missouri–Columbia

Road line striping operations comprise a significant maintenance workload for the Missouri Department of Transportation (MoDOT). Each year, MoDOT has to stripe more than 60,000 line-miles of roads, including both reapplication
of paint to existing road surfaces, and also (in some instances) a requirement to paint newly constructed road surfaces. These requirements generate the potential for inefficiencies in the form of “deadhead miles” that road striping crew vehicles must travel while not actively applying pavement markings. Moreover, due to the slow-moving nature of road striping vehicles, it is often necessary to park the equipment at “overnight” locations at the end of each working day. This adds more “deadhead miles” at the start and stop of each day into total travel distance. At the time this research project began, managers and engineers of MoDOT manually created the striping schedule (sequence of segments) for each crew member based on their experience and judgement.

The main contribution of this research was the development of an optimization model that identified optimal routing and scheduling of road striping crews. This model identified scheduling (optimal striping sequence of road segments) of the crew for each working shift, chose the best “overnight location” (maintenance sheds or bulk storage area) for each day, and selected the best starting point for the next day. The model’s objective was to minimize the “deadhead miles” travelled by crews, improve the utilization of striping equipment, and decrease the cost of striping operations. This optimization tool will help managers of MoDOT automatically find an optimal schedule whenever striping requirements change. A decision support tool was delivered to MoDOT, providing output visualization, including maps and turn-by-turn directions for striping crews.

Traffic Impact Assessment of Moving Work Zone Operations
PI: Praveen Edara, University of Missouri–Columbia

Road maintenance activities involve both short-term stationary work zones and moving work zones. While stationary work zones have been the predominant focus of work zone research and development efforts, knowledge about the mobility and safety impacts of moving work zone (MWZ) operations such as striping, sweeping, pothole filling, shoulder repairs, and other quick maintenance activities is limited. The objective of this project was to develop guidance for practitioners on how to assess the traffic impacts and improve the scheduling of MWZs.

The development of this guidance included two approaches: calibration of the VISSIM simulation tool for analyzing MWZs and estimation of regression models of work zone speeds. Four different data sources were used: Missouri Department of Transportation electronic alerts (e-alerts), probe-based travel times, data from point detectors, and field videos of moving work zones recorded from the back of a truck-mounted attenuator. Predictor variables in the developed regression models included historical speed, number of lanes, type of lane closure, and time of day.
Emerging Freight Truck Technologies: Effects on Relative Freight Costs
PI: Ray Mundy, University of Missouri–St. Louis

The adoption of autonomous and connected vehicle technology can have an enormous financial impact on both the motor carrier and rail industries. Since the development and adoption of these technologies are likely to be gradual, three phases were posited and briefly analyzed. Depending on the degree of autonomy that is available, the motor carrier industry could achieve an immediate 20% reduction in over-the-road labor costs and up to a 42.1% reduction in average cost per mile under fully deployed systems. As fully autonomous technology is available for use in the motor carrier industry, it is estimated that the American rail freight industry could see a 19 to 45 percent drop in long-haul demand if motor carrier rates were significantly reduced.

The implications for the American railroad industry are significant, since investments in rail infrastructure and running stock are typically of long duration—some as much as 50 years. With some predictions of autonomous and connected vehicle technologies being fully implemented for the motor carrier industry within 25 to 30 years, the risk of long-term rail investments become significantly greater.

Paving the Way for Autonomous and Connected Vehicle Technologies in the Motor Carrier Industry
PI: Ray Mundy, University of Missouri–St. Louis

In order for autonomous cars and trucks to become a reality, a number of safety considerations and infrastructure needs will support the mass adoption of autonomous vehicle (AV) and connected vehicle (CV) technologies in the motor carrier industry. However, the projected savings in the form of lives and physical injuries may be so persuasive that these necessary infrastructure systems will be built sooner rather than later.

Using large truck crash data from 2013 through 2015 obtained from the Missouri State Highway Patrol, Chi-square Automatic Interaction Detection decision trees were estimated to examine the effect of AV and CV technologies on motor carrier crash severity. Results suggest that the greatest contributory predictors of crash severity outcomes are driving too fast for conditions, distracted/inattentive driving, over-correcting, and driving under the influence of alcohol. If these circumstances are altered by AV and CV technologies, it is suggested that between 117 and 193 severe crashes involving large trucks could be prevented annually in Missouri alone. To render such safety benefits, key vehicle needs include autonomously controlling acceleration and steering, monitoring of the environment, and responding to dynamic driving environments without the need for human intervention. Importantly, the safe operations of a system that can perform such AV and CV tasks require readable lane markings, traffic signals and signs, managed/dedicated lane usage, and dedicated refueling and/or recharging facilities. This will require massive infusion of capital and technology, but the financial and human benefits from autonomous vehicles, especially large commercial trucks, may well be worth it.

Other Research-Related Activities

Innovative Research Projects with Joint Funding: MTC and Iowa Highway Research Board

The Iowa Highway Research Board (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.

The Region VII MTC is one of 10 regional University Transportation Centers sponsored by the U.S. Department of Transportation Office of the Assistant Secretary for Research and Technology and is led by the Iowa State University Institute for Transportation. The research focus area for the MTC is “State of Good Repair,” a key program under the 2012 Moving Ahead for Progress in the 21st Century Act (MAP-21).

To support innovation and advances, the IHRB and MTC provided seed funding for four projects that are innovative or explore long-range advances in highway transportation. These projects may be “high-risk, high-reward” in nature, or they may be basic research that can lead to new fundamental insights that, in due course, will result in substantive advances.
in the design, construction, instrumentation and monitoring, modeling, or management of highway-related projects. These projects are not necessarily expected to lead to results that are of immediate use in highway transportation, but produce results that hold promise for further useful development. We will continue to report on these innovative research projects.

**Moving Research into Practice**

- **Date:** TBD
- **PIs:** Ahmad Abu-Hawash and Sri Sritharan, ISU
- **Title:** TBD

The advanced properties of ultra-high performance concrete provides various opportunities for the development of new structural shapes and bridge applications focused on addressing important infrastructure issues. Topics such as creating longer-lasting bridges through enhanced durability or allowing for the spanning of longer distances with more shallow superstructures can be addressed using UHPC. In a systematic sense, UHPC also presents ways to create new structural forms that facilitate accelerated construction and rapid renewal of the highway infrastructure. The webinar will discuss implementation sites in Iowa and the impact it has had.

The principal investigators are waiting on applications to be installed before hosting the webinar. Contractors were supposed to install by October 2017 but did not complete at that time. They are anticipated to install at the beginning of construction season 2018. The webinar will be conducted shortly thereafter.

- **Date:** May 23, 2018
- **PI:** Peter Taylor, Iowa State University
- **Title:** Integrated Materials and Construction Practices for Concrete Pavement Manual (2006)

This extensive guide was developed under the sponsorship of the Federal Highway Administration and was accompanied by both in-person and online training opportunities. The document provides guidance and information on the selection, design, and construction of cost-effective concrete pavement preservation treatments. It is based on a document prepared in 2008, but was updated in 2014 and expanded to include information to assist state highway agencies in effectively managing their concrete pavement network through the application of timely and effective preservation treatments. The preservation approach typically uses low-cost, minimally invasive techniques to improve the overall condition of the pavement.

This is a manual that is used nationally. The PI and a number of practitioners and agencies have been involved and promoting the updates to the manual recently. It’s very anticipated release is coming up soon and they feel that a webinar for this would be perfect timing. They anticipate a large number of participants for the webinar nationally. They are currently working on logistics, with an initial meeting to determine needs and tasks completed.

- **Date:** June 27, 2018
- **PI:** Peter Taylor
- **Title:** Performance Engineered Mixtures (PEM) for Concrete Pavements in the US

An Innovative Program for Pavement Reliability: The Performance Engineered Mixtures (PEM) program is designed to provide the tools for agencies to specify, and contractors to deliver, concrete mixtures that reliably and sustainably meet the needs for concrete infrastructure. The PEM program will result in concrete pavements consistently achieving the performance life of the design. The webinar will discuss implementation and its impact. The PI is currently working on logistics, with an initial meeting to determine needs and tasks completed.

**B. Outreach/Technology Transfer**

**130 Attend Traffic and Safety Forum**

The annual Traffic and Safety Forum, hosted by the Institute for Transportation and the Iowa Department of Transportation, had another successful event on November 15, 2017. The forum brought together more than 130 city and county engineers, Iowa DOT staff, consultants, vendors, and researchers from InTrans and other Iowa universities. Traffic and safety engineering professionals learned about new systems and innovations, shared experiences, and addressed areas of concern at the forum.

Joe Kearney, a professor in the Department of Computer Science at the University of Iowa, was the forum keynote. He discussed safety possibilities for vulnerable road users—including pedestrians and bicyclists—utilizing new technologies.

The forum attendees also held a facilitated discussion on the challenges and concerns they’re facing, from advancing technologies in autonomous vehicles to funding concerns to engaging the public. Attendees also heard updates on new research in the field.

[Keynote speaker Joe Kearney from the University of Iowa at 2017 Traffic and Safety Forum]
InTrans and Iowa DOT Host Iowa Evening Reception at TRB

Transportation researchers and other staff from throughout the United States attended the Iowa Evening reception at the 2018 Transportation Research Board Annual Meeting on January 9, 2018, in Washington, DC. ISU’s Institute for Transportation and the Iowa Department of Transportation were the lead sponsors of this yearly event. Other hosts were the ISU Department of Civil, Construction, and Environmental Engineering and the University of Iowa's National Advanced Driving Simulator.

The reception is a good avenue to inform transportation professionals across the nation about the projects, programs, and priorities taking place in Iowa, said Shauna Hallmark, MTC/InTrans director.

Breakout discussion during the Traffic and Safety Research Focus Group meeting

County Engineers Research Focus Group Holds Annual Meeting

The Iowa DOT and the Iowa Local Technical Assistance Program at the Institute for Transportation annually sponsor the County Engineers Research Focus Group meeting in Ames. The 8th annual event, February 14, 2018, hosted 58 local Iowa engineers. Participants heard about research updates and had the opportunity to share ideas, tools, and techniques that improved their operations or saved money for their departments. They also participated in a brainstorming session to identify priority research projects that will be presented to the Iowa Highway Research Board for consideration.

Traffic and Safety Research Focus Group Prioritizes Research Ideas

About 40 people aiming to make roadways safer and traveling more efficient met at Iowa State University’s Institute for Transportation on February 7, 2018, to discuss research opportunities. The objective of the Traffic and Safety Research Focus Group, led by Omar Smadi, interim director for the Center for Transportation Research and Education at InTrans, was to discuss, develop, and prioritize research topic ideas to present for future funding opportunities. People from the Iowa Department of Transportation, city and county government, consulting firms, the Federal Highway Administration, University of Iowa, law enforcement, Iowa Governor’s Traffic Safety Bureau, and InTrans spent the day developing research priorities. The focus group held targeted discussions on traffic engineering and operations, safety, and enforcement before selecting three to four research ideas to prioritize and turn into research problem statements.

ISU Day at the Iowa Statehouse

The Institute for Transportation participated in the annual Iowa State University Day at the State Capitol on February 26, 2018, in Des Moines. Shauna Hallmark, MTC/InTrans director, and Theresa Litteral, statewide multidisciplinary safety teams (MDST) facilitator, staffed a display explaining the Iowa Statewide Multi-Disciplinary Safety Team program and other high priority InTrans programs. Several Iowa legislators stopped at the InTrans display in the Capitol Rotunda. InTrans joined other major university research institutes, academic colleges, statewide services, the Alumni Association, and Cyclone athletics at the Statehouse.
Development of New MTC Website Under Way

The MTC will have a new website in late 2018. The MTC and the other centers and programs at the Institute for Transportation will benefit from a new user-friendly and state-of-the-art web environment that will work on desktop, tablet, and smartphone platforms. The new websites are under development now and will be ADA compliant, with improved databases and other systems. The sites also will have an easy-to-use CMS (content management system), allowing staff to easily change and update their sites.

C. Education

ASCE Engineering Day for Kids

The University of Missouri–Columbia student chapter of the American Society of Civil Engineers (ASCE), with support from the Midwest Transportation Center, held its Engineering Day for Kids on December 2, 2017. There were over 60 3rd- to 5th-grade participants. ASCE student members assisted the students as they learned about what civil engineers actually do. They built bridges and structures out of toothpicks and gumdrops, setup and ran cars on a simulated highway, built retaining walls with sand and paper, and measured and calculated material properties.

MTC Transportation Scholars Program Enhances Student Experience

The MTC continues to sponsor and manage the Transportation Scholars program at Iowa State University, the University of Missouri–Columbia, and University of Missouri–St. Louis. The program requires students to demonstrate excellence in coursework, research, leadership, and community outreach.

Freshman Research Initiative (FRI)

During the 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 focused on various aspects of traffic safety. These students participated in a special session of the 7th Annual Graduate Student Poster Competition for ISU’s Civil, Construction, and Environmental Engineering Department. They will also participate in the university-wide FRI Symposium in spring 2018.
InTrans Student Earns Prestigious Eisenhower Fellowship

The Federal Highway Administration has chosen Jacob Warner, a graduate student studying transportation engineering at ISU, as a recipient of the Dwight David Eisenhower Transportation Fellowship. Warner conducts research at ISU’s Institute for Transportation. Associate Professor Peter Savolainen is his adviser.

TSA Success Stories

The Transportation Student Association is the student-operated Iowa State chapter of the Institute of Transportation Engineers 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. TSA co-founded the Midwestern and Great Lakes ITE President's Council and initiated a set of events for its members, including software training sessions, a career panel forum, technical writing and poster design seminars, safety educational workshops for high school students, and a roadside clean up event.

Fall Transportation Graduate Student Research Seminar

The 2017 fall semester began the third year of ISU’s weekly Transportation Graduate Student Research Seminar. This series, which is led by ISU’s Peter Savolainen, was developed by the transportation division of the Department of Civil, Construction, and Environmental Engineering. Graduate students in transportation, including MTC Transportation Scholars, present their research results, allowing them to develop presentation skills and receive feedback from students and faculty on their research. Each transportation student must participate in this seminar at least once during their degree program. Eight student presentations were made during the current reporting period with an average of 38 attendees.

Two Students Win Lifesavers Award

Iowa State University's Institute for Transportation graduate student Georges Bou-Saab knows first-hand how improvements in transportation can make the world a safer and healthier place. It is the subject of his dissertation. It's also the subject of an essay he wrote that led him to become a 2018 Lifesavers Traffic Safety Scholar. The scholarship grants $1,000 toward a trip to the largest traffic safety conference in the US. This year’s 36th annual conference was held April 22–24 in San Antonio, Texas.

Ashirwad Barnwal is another recipient of the Lifesavers award. He has worked on several studies to reduce roadway fatalities while working to earn his doctorate under the direction of research scientist Anuj Sharma at ISU.

MTC Students Win Awards, Gain Valuable Experience

MTC students are actively participating in competitions and presenting their research. During the current reporting period, MTC students had several major accomplishments:

- TSA hosted two Python workshops on October 28 and November 4 in Ames, Iowa.
- 30 ISU students attended the 2018 Transportation Board (TRB) Annual Meeting in Washington, DC, from January 7–11.
- More than 10 students from the University of Missouri-Columbia attended the 2018 TRB Annual Meeting.
- Four UMC students presented a poster on wrong way driving, taking third place at the 2018 TRB Annual Meeting.
ISU’s Katelyn Freeseman visits RET teacher classroom

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

Applications for elementary teachers are currently being reviewed for participation in the MTC-sponsored Teaching in the Fast Lane: Summer Workshop for Elementary School Teachers from July 16–20, 2018. The workshop, now in its fourth year, introduces 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. Hands-on activities come from the AASHTO Roadways in Developing Elementary Students (AASHTO RIDES) kit. Each participant will receive a modified version of the AASHTO RIDES kit, which includes ready-to-use supplies for implementation of newly learned activities. Each kit includes items such as a set of engineering process flash cards, Hot Wheels cars, spring scales, stopwatches, and other items.

D. Workforce Development

High Schoolers Do Research in Young Engineers and Scientists Program

The MTC and ISU’s Center for Biorenewable Chemicals will collaborate again in summer 2018 on the YES (Young Engineers and Scientists) program. In this partnership with Iowa high schools, the program offers six-week research internships to participating students who can work up to 40 hours a week under the supervision of a mentor. At the session’s end, each student will present a poster outlining his or her research. One high school student has been selected for placement with ISU’s Institute for Transportation for summer 2018.

Three STEM Educators in Research Experience for Teachers Program

For the fifth year, the MTC will participate in the Research for Teachers program offered in summer 2018 by ISU’s Center for Biorenewable Chemicals and funded by the National Science Foundation. Two Iowa public high school math and science teachers worked on active research projects while building their science and engineering knowledge base for use in their classrooms. MTC/InTranS Director Shauna Hallmark, and MTC affiliate researcher Basak Aldemir-Bektas will host the teachers for six weeks at ISU’s Institute for Transportation.

GO! Further: Workshop for High School Students Develops Leadership Skills

The MTC will again offer two weeklong GO! Further workshop sessions at ISU during summer 2018 in partnership with the Office of Precollegiate Program for Talented and Gifted (OPPTAG) at ISU. Each session provides a leadership and learning experience for high school students. Students learn about the world of engineering and take part in hands-on

UMC student Yohan Chang won a best presentation award by the Korean Transportation Association in America for his poster titled “Traffic Flow Modelling of Diverse Work Zone Activities.”

TSA students volunteered for an ISU Science Bound event October 21.

ISU’s TSA won the ITE Best Student Chapter Award from the ITE Missouri Valley Section (MOVITE).

PhD student and TSA member Tingting Huang traveled to Hot Springs, Arkansas, to attend the MOVITE Fall Meeting and present her research October 4–6.

PhD student and TSA member Ashirwad Barnwal received an honorable mention on November 29, during the 7th Annual Graduate Student Poster Competition for ISU’s Department of Civil, Construction, and Environmental Engineering.

UMC students and faculty at 2018 TRB Annual Meeting

Iowa DOT engineers with Fast Lane teachers in 2017
activities to develop leadership and teamwork skills. To ensure diversity, the MTC is collaborating 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.

Ready, Set, Build!: Bridge-Building Challenge Held November 2017

Expanded in 2016 to a two-day event, the Ready, Set, Build!: Bridge-Building Challenge was held from November 3–4 at the Science Center of Iowa (SCI). On November 3, school groups from across Iowa (a total of 28 teams and 107 participants) participated in a stand-alone session. Then, on November 4, families and after-school groups (a total of 20 teams and 75 participants) participated in their own session. Participants were divided into four categories: 1st–3rd grades, 4th–6th grades, 7th–8th grades, and family. 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).

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

Through hands-on learning booths at the main entrance, the Iowa DOT, InTrans, ISU Transportation Student Association, and the Women in Science and Engineering (WiSE) provided over 1,200 SCI attendees with learning opportunities about transportation and bridges.

This event was 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.

GO! Online Magazine

GO! online magazine has become the MTC’s premier tool for informing young people about careers in transportation. Through articles and resources, GO! provides information about a variety of transportation-related careers and academic programs. GO! is financially and academically supported by the MTC, initiative partners at MTC consortium universities, and ISU’s Department of World Languages and Cultures. GO! also partners with the accelerated bridge construction–themed University Transportation Center at Florida International University, which provides ABC-related articles.

During this reporting period,

- At least one new article was published, disseminated, and marketed to potential users monthly.
- On social media, the GO! Facebook page has 307 followers and the Twitter page has tweeted 1,344 times and has 355 followers.
- The GO! website was accessed by 2,052 unique users who viewed 3,271 pages.

A panel from GO!’s web comic
What activities are planned for the next reporting period?

The following activities are planned for the next reporting period:

**Center Management**
- Continue showcasing MTC products/activities

**Research**
- Continue to monitor progress of the research program

**Education**
- Hold the summer 2018 Study Abroad program to Italy (May 2018)
- Track Transportation Scholar participation in required and recommended activities

**Workforce Development/Diversity**
- Continue producing content for GO! magazine
- Hold summer 2018 workforce development activities like GO! Further and Teaching in the Fast Lane

**Outreach**
- Develop brochures to highlight the impact of research projects
- Hold Innovations in Transportation Conference (August 2018)

2. Products

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

**Presentations (in chronological order)**
- Shauna Hallmark – “Safety Effectiveness of Beacons on Stop Sign - A Cross-Sectional Study,” Road Safety & Simulation International Conference, October 2017, The Hague, Netherlands
- Sunanda Dissenayake – “Crash Modification Factors for Lane Departure Countermeasures in Kansas,” Road Safety & Simulation International Conference, October 2017, The Hague, Netherlands
- William Buttlar – “Performance characteristics of modern recycled asphalt mixes in Missouri, including ground tire rubber, recycled roofing shingles, and rejuvenators,” Two MAPA presentations were made in October 2017, MAPA lunch and learn seminar series to be presented at four locations spring 2018
Presentations made at 2018 TRB Annual Meeting

- Basak Aldemir-Bektas – “Scour Management in Iowa Using Modified HYRISK”
- Fatih Bektas – “Relating Iowa Pore Index to Concrete Aggregate Pore Structure”
- Behrouz Shafei – “Impact of Extreme Events on Transportation Infrastructure in Iowa: A Bayesian Network Approach”
- Behrouz Shafei – “Impact of Extreme Events on Transportation Infrastructure in Iowa: A Bayesian Network Approach”
- Jennifer Shane – “Improving the Effectiveness and Quality of Supportive Services for the Iowa Department of Transportation Disadvantaged Business Enterprise Program”
- Peter Savolainen – “An Examination of the Cost-Effectiveness of Median Cable Barrier Systems”
- Ahmad Alhasan – “Pavement Friction Modeling Using Texture Measurements and Pendulum Skid Tester”
- Anuj Sharma – “Building Intelligence in the Automated Traffic Signal Performance Measures with Advanced Data Analytics”
- Shauna Hallmark “Exploring Freeway Entrance Ramps as Emission Hotspots with Vehicle Trajectory and Road Grade Information”
- Peter Savolainen – “Access Separation at Interchanges: Examining Crash Rates on the Cross-Street and in the Transition Areas from Full to Partial Access Control”
- Shauna Hallmark – “Empirical Bayes Before and After Method to Evaluate Edge Treatment”
- Bora Cetin – “The Use of Lime Sludge Alone and with Class C Fly Ash for Subgrade Soil Stabilization”
- Anuj Sharma – “Implementing Big Data Quality Assurance with Visualization Tools”
- Jacob Warner – “A Longitudinal Analysis of the Relationship between Maximum Speed Limits and Traffic Fatalities on High-Speed Rural Highways”
- Peter Savolainen – “Operational Impacts of Rumble Strip Installations on Narrow Pavements”
- Anuj Sharma – “Software-Based Challenges Faced by Traffic Incident Managers”
- Peter Savolainen – “An Examination of the Cost-Effectiveness of Median Cable Barrier Systems”
- Anuj Sharma – “Crash-Based Guidance for Rumble Strip Installation on Narrow Pavement”
- Peter Savolainen – “Safety Analysis of Interchange Functional Areas”
- Anuj Sharma – “Comparison of Machine Learning Algorithms to Determine Traffic Congestion from Camera Images”
- Mohamed Ahmed – “Complementary Methodologies to Identify Weather Conditions in Naturalistic Driving Study Trips: Lessons Learned from the SHRP 2 Naturalistic Driving Study and Roadway Information Database”
- Peter Savolainen – “Crash-Based Guidance for Rumble Strip Installation on Narrow Pavement”
- Omar Smadi – “Comparing Objective and Subjective Roadway Data Collection Methods Using the U.S. Road Assessment Program”
- Peter Savolainen – “Operational Impacts of Rumble Strip Installations on Narrow Pavements”
- Shauna Hallmark – “Empirical Bayes Before and After Method to Evaluate Edge Treatment”
- Alice Alipour – “Application of Novel Recovery Techniques to Enhance the Resilience of Transportation Networks”
- Anuj Sharma – “Traffic Congestion Detection from Camera Images Using Deep Convolution Neural Networks”
- Anuj Sharma – “Deep Learning in Transportation”
- Shauna Hallmark – “Safety Evaluation of the Safety Edge Treatment for Pavement Edge Drop-Offs on Two-Lane Rural Roads”
- Basak Aldemir-Bektas – “Characteristics of Decommissioned Bridges: Findings from a National Survey and Analysis of the NBI Archive”
- Anuj Sharma – “Building Intelligence in the Automated Traffic Signal Performance Measures with Advanced Data Analytics”
- Basak Aldemir-Bektas – “Characteristics of Decommissioned Bridges: Findings from a National Survey and Analysis of the NBI Archive”
- Jing Dong – “Ecological Adaptive Cruise Control in a Traffic Stream with Mixed Autonomous and Manually Driven Vehicles”
- Peter Savolainen – “Safety Performance Functions for Rural Two-Lane County Road Segments”
- Praveen Edara – “Freeway Work Zone Crash Prediction Models Using Missouri Data”

Other

- Guiping Hu – “Data driven highway infrastructure resilience assessment,” team has designed an interactive software for demonstration, which can be accessed at charliexu.github.io/ReleaseWebpage4IDot/!
- Shauna Hallmark – “Development of Crash Modification Factors for Lane Departure Countermeasures,” three tech briefs were produced
• In-Ho Cho – "Initiative for Big Data-Driven Prediction of Long-Term Bridge Performance and Management Improvement," a hybrid database was created by merging the bridge sensor data and traffic sensor data, related webinar was hosted in February 2018
• Jing Dong – Presented “Energy-Efficient Adaptive Cruise Control for Electric Connected and Autonomous Vehicles” at USDOT T3e Webinar on March 8, 2018, with over 100 participants

**ISU Student Activities**
• Mostafa Amin-Naseri – Attended the Midwest Big Data Hub, October 2017
• Pranamesh Chakrabory – Attended Transportation Data Challenge in Lincoln, Nebraska, October 2017
• Chenhui Liu – Attended Amazon 5th Annual Graduate Research Symposium in Seattle, Washington, October 2017
• Chenhui Liu – Received ITS Minnesota Graduate Student Scholarship Award, Bloomington, Minnesota, October 17, 2017
• Liang Hu – Presented at INFORMS 2017 in Houston, Texas, October 2017
• Payam Vosoughi – Attended ACI Fall 2017 Convention in Anaheim, California, October 2017
• Michael Dopko – Attended Iowa Better Concrete Conference in Ames, Iowa, November 2017
• Payam Vosoughi – Presented at Iowa Better Concrete Conference in Ames, Iowa, November 2017
• Andrew Boeckmann – “Implementation Evaluation of Rustic Road Geosynthetic Reinforced Soil Integrated Bridge System,” presentation for the Missouri legislature at “Undergraduate Research Day at the Capitol”
• Andrew Boeckmann – Presented at TEAM (Transportation Engineers Association of Missouri) Conference, third place in student poster competition
• Michael Dopko & Ning Zhang – Attended 2017 National Accelerated Bridge Construction Conference in Miami, Florida, December 2017
• Mostafa Amin-Naseri – Presented during 2018 Transportation Research Board Annual Meeting Poster Session
• Michael Dopko – Participated in 2018 Transportation Research Board Annual Meeting, runner up for best student paper for AFN10
• Jacob Warner – Participated in 2018 Transportation Research Board Annual Meeting, presentation as part of award for the Dwight D. Eisenhower Transportation Fellowship
• Milagro Pinto-Nunez – Attended LADR Workshop Construction Institute in Fort Worth, Texas, March 2018
• Payam Vosoughi – Attended ACI Spring 2018 Convention in Salt Lake City, Utah, March 2018
• Iowa State University had 30 students attend the 2018 Transportation Research Board Annual Meeting in January
• ISU Transportation Students Association awarded Outstanding Student Chapter by MOVITE for 2017/2018 academic year

**UMC Student TRB Activities**
• Student presented PhD thesis “Statistical and Simulation Methods for Evaluating Stationary and Mobile Work Zone Impacts” for doctoral student research in transportation operations and control
• Students presented a poster at a poster session for the Traffic Control Device Challenge, with the group receiving 3rd for the contest and went on to present the poster at the American Traffic Safety Services Association (ATSSA)
• Student presented a poster: “Simulator and Field Study of Truck-Mounted Automated Flagger Assistance Devices in Missouri”
• Student attended 2nd Annual TRB-ATSSA TCD Challenge and presented a poster: “A Design of Prevent-Alert-Disable (PAD) Wrong Way Crash Stopper”
• Student presented a poster in the wrong way driving competition, taking 3rd place
• Yohan Chang – Presented poster that won the best presentation award by The Korean Transportation Association in America (KOTAA): “Traffic Flow Modelling of Diverse Work Zone Activities”

3. Participants and Collaborating Organizations

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

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

<table>
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<th>External Partners/ Collaborators</th>
<th>Partner Type</th>
<th>State/Country</th>
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<th>In-Kind Contributor</th>
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4. Impacts

What is the impact on the development of the principal discipline(s) of the program?
The results of MTC-sponsored research conducted by faculty in transportation-related disciplines at all partner institutions fundamentally affect the understanding, teaching, and ultimately the state-of-practice related to enhancing infrastructure condition, safety, and project delivery. As a consequence, the state of transportation infrastructure and operations is enhanced.

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

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

What is the impact on transportation workforce development?
Although long-term impacts of the Midwest Transportation Center’s workforce development activities is difficult to quantify, a direct result of these activities is that hundreds of public school students are now being exposed to information about transportation-related careers and encouraged to pursue studies in disciplines that will help them succeed in such careers. In addition, university students pursuing transportation-related programs of study are being reinforced and challenged to higher achievements in such pursuits. For example, students who will be participating in the Study Abroad in Italy in summer 2018 will broaden their understanding of the complexities of transportation infrastructure construction and operations outside the US to an extent that wouldn’t have been possible without the MTC sponsorship.
Some of the specific numbers include the following:

- Over 1,000 K–12 teachers were passively reached through GO!
- 262 K–12 students actively participated in targeted activities
- The MTC is working with the regional transportation workforce center to coordinate workforce development activities
- 44 students are participating in the MTC Transportation Scholars Program
- 65 students participated in each of 4 spring semester seminar activities/presentations
- 38 students participated in each of 6 fall semester seminar presentations
- 15 students will attend the Study Abroad in Italy in May 2018
- MTC supports various activities for transportation student organizations

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

See the lists in Section 2, Products.

What is the impact on technology transfer?

Through direct Midwest Transportation Center sponsorship and management of workshops and other events, approximately 550 people received face-to-face training during the reporting period. See the complete discussion of Outreach/Technology Transfer (page 7) in Section 1, Accomplishments, and the lists in Section 2, Products (page 13).

Three webinars are scheduled for summer 2018 that seek to move research into practice. One scheduled for June 27 involves the Performance Engineered Mixtures (PEM) program, which is designed to provide the tools for agencies to specify, and contractors to deliver, concrete mixtures that reliably and sustainably meet the needs for concrete infrastructure. This webinar, as well as the other two, will provide overviews of current and past projects and discuss details at length. The material will be presented first from a researcher's perspective and then followed by a practitioner's perspective. This will demonstrate how the research had been implemented.

The future of transportation and current practical applications will be presented at the upcoming Transportation Innovations Conference in Ames, Iowa, from October 9–10. Held on the ISU campus, speakers from around the nation, including MTC researchers and Institute for Transportation staff and faculty, will engage participants in contemporary topics such as mobility and accessibility, connected and autonomous vehicles, organizational change, and data analytics.

What is the impact on society beyond science and technology?

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

5. Changes/Problems

Nothing to report.

6. Special Reporting Requirements

Nothing to report.