

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

1. Serve as a focal point within the region and nationally for research that develops data performance measures for infrastructure condition, safety, and project delivery.
2. Ensure efficient use of funds by building on existing programs, avoiding duplication, leveraging existing resources, and developing creative cooperative activities with industry.
3. Develop products that are useful and relevant to stakeholders including national, state, regional, and local transportation agencies as well as industry and other researchers.
4. Provide leadership in the next generation of technology transfer, beginning with the research itself—involving the user, innovative outreach, and new communications technology.
5. Develop the next generation of transportation professionals and provide opportunities for current professionals.
6. Provide leadership opportunities for students and young professionals.
7. 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:

- Crash Modification Factors for Lane Departure Countermeasures in Kansas (page 4)
- Strategic Design for Delivery with Linked Transportation Assets: Trucks and Drones (page 5)
- Transportation Safety Webinar Series Helps Move Research to Implementation (page 6)
- MTC a Sponsor of Innovations in Transportation Conference (page 6)
- High Schoolers Do Research in Young Engineers and Scientists Program (page 11)

A. Research

The total number of projects funded under this grant to date is 101, with 53 being led by ISU and 48 being led by partner or other institutions. During this reporting period, 15 new projects were initiated. All MTC-funded research projects, completed and in-progress, are listed at intrans.iastate.edu/mtc/index.cfm/research.

Request for Proposals for Innovative Projects Program for 2016

A primary goal of the Iowa Highway Research Board is to encourage innovation and longer-range technological advances in the field of highway transportation. Basic research is also a focus of the MTC. To support this goal, the IHRB and MTC teamed up and pooled resources to provide a round of seed funding for projects that are innovative or explore longer-range advances in transportation. A Call for Proposals for Innovative Projects was released for innovative or exploratory aspects of highway transportation. The intent of the program is to provide resources so that researchers are able to conduct preliminary stages of high-risk/high-reward research that cannot be funded by current Iowa DOT funds. A call for proposals was sent to all researchers in Region 7 in August 2016. Twenty-one proposals were received under the solicitation and are currently being reviewed.

Completed Research

During this reporting period, six final reports, five technology transfer documents, and one Tech Brief were submitted for research projects funded under this UTC grant, bringing the total to 18 final reports to date (Products on page 14).

Current Projects

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

Risk-Based Bridge Management: A Methodology to Assess and Incorporate Risk in Decision-Making

PI: Basak Aldemir Bektas, Iowa State University

In recent years, risk-based management of infrastructure assets has gained precedence in infrastructure asset management. The Moving Ahead for Progress in the 21st Century Act (MAP-21) required state transportation agencies to incorporate risk-based management in planning systematic preventative maintenance, replacement, or rehabilitation decisions for their bridge networks. However, states have flexibility in the type of methodology they choose or how they define risk. At present, state agencies are challenged by identifying and quantifying these risks and developing procedures to address these risks at the network level.

There is need for imminent research in developing methodologies and guidance that would allow state transportation agencies to develop a risk-based approach in managing bridge networks. So far, the research team identified scour and deterioration as the most relevant regional risks for network-level bridge management, with guidance from the Iowa DOT.

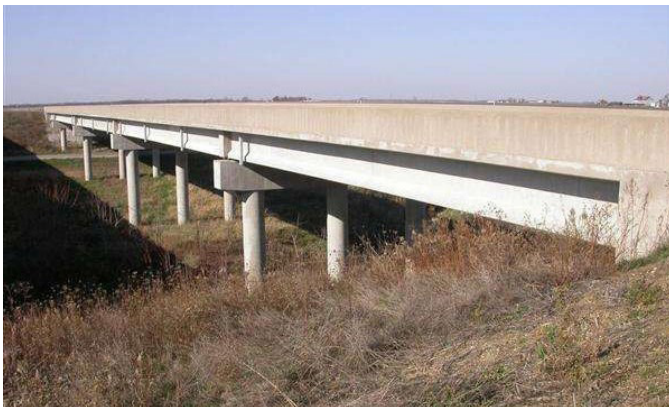
Parametric and time-dependent NBI condition rating deterioration models have been developed for Iowa bridges, based on 1980-2013 data. Applying these models with significant parameters such as age, truck average daily traffic, existence of an overlay, or number of joints on the structure facilitates assigning bridge-specific risks of transitioning from one condition rating to another. The final step will be a methodology to address these risks together to assist short- and long-term asset management decisions.

Economic Impact of Multi-span, Pre-stressed Concrete Girder Bridges Designed as Simple Span vs. Continuous Span

PIs: Travis Hosteng, Brent Phares, Iowa State University

The Iowa DOT's current practice for designing multi-span, pre-stressed (P/S) concrete girder bridges is to design them as simply supported spans. Further, design assumptions are that once the deck is cured, the bridge acts as independent, simply supported spans to resist post-deck construction dead loads and the application of live loads. At the same time, to resist cracking of the deck over piers, additional deck steel is added in the negative moment regions. These bridges are known to truly act as composite spans.

The objective of this project is to investigate the economic impact of designing multi-span, P/S concrete girder bridges as simply supported versus taking advantage of their truly fully continuous condition. To accomplish this, two aspects must be considered. First, because continuous spans are more efficient, they utilize fewer (or more optimized) beams, which can result in significant cost savings (both material and construction). Second, designing a bridge considering full continuity requires that each bridge be designed for the specific combination and number of spans and span lengths as opposed to using standardized designs. This additional design requirement results in more engineering, drafting, and detailing time. By comparing data and information associated with each aspect, this work will provide designers and decision makers with data and tools to understand the cost-implications with two fundamentally different design philosophies.



Five-span pre-tensioned, pre-stressed concrete beam bridge in southeast Iowa

Installation Guidance for Centerline and Edgeline Rumble Strips in Narrow Pavements

PI: Peter Savolainen, Iowa State University

The installation of centerline and shoulder rumble strips on two-lane rural highways is a proven safety countermeasure. Placement of both can usually be accommodated within wide pavements without issue. However, proper placement of one or both is less straightforward for highways with narrower paved widths. Guidance is currently limited regarding the minimum paved width necessary to install either, or which one to install when the installation of both is not feasible. The purpose of this study is to provide guidance to assist county road agencies, and the Iowa DOT, in determining when to install rumble strips based on various site-specific factors.

To date, driver behavioral data have been collected from approximately 50 locations across Iowa to assess the influence of rumble strips on driver speed and lateral position. The results of this analysis will be paired with results from a crash analysis, as well as a public road user survey, to develop guidelines for assisting road agencies in determining optimal installation criteria based upon site-specific factors such as volume, lane width, and shoulder width.



Shoulder rumble strips

Crash Modification Factors for Lane Departure Countermeasures in Kansas

PI: Sunanda Disanayake, Kansas State University

Lane departure crashes are the predominant fatal crash type in Kansas and several countermeasures have been implemented. However, their effectiveness is not fully known. Even though Crash Modification Factors (CMFs) are popular in evaluating safety effectiveness of countermeasures, more accurate CMFs for lane departure countermeasures in Kansas have not yet been fully accomplished. This study focused on the effect of paved shoulders and rumble strips on reducing lane departure crashes. Under the paved shoulders, the presence of two-foot-wide paved shoulders were considered and to evaluate the effect of rumble strips on lane departure crashes, the presence of centerline rumble strips, shoulder rumble strips, and both centerline and shoulder rumble strips were considered.

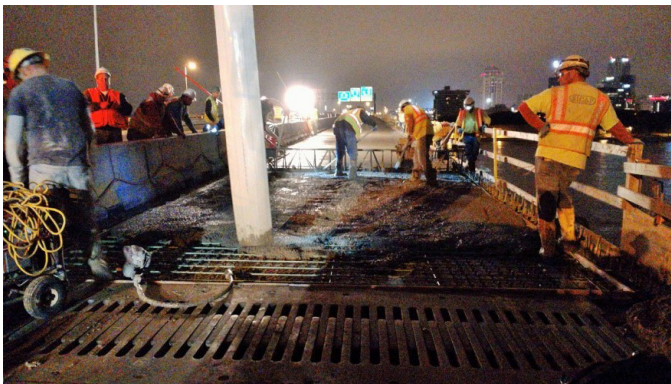
Paved shoulders, centerline rumble strips, and both centerline and shoulder rumble strips combined were found to be effective in reducing all severity crashes and fatal and injury crashes at both tangent and curved road segments. Also, the shoulder rumble strips were found to be effective in reducing all severity and fatal and injury lane departure crashes except all severity lane departure crashes in curved road segments.

Optimizing Steel Fiber Reinforced Lightweight Concrete Wearing Surface for use on Steel Orthotropic Decks

PI: Ran Dai, Iowa State University

Proper design and selection of wearing surfaces can significantly enhance the fatigue life of steel orthotropic deck bridges, contributing to a cost-effective rehabilitation of such bridges. A Steel Fiber Reinforced Light Weight Concrete (SFRLWC) wearing surface recently designed for use on the Poplar Street Bridge (PSB) in St. Louis, Missouri, provides stiffness to the flexible orthotropic steel deck while at the same time exhibiting less sensitive thermal softening characteristics compared to polymeric or asphalt-based wearing surfaces. The wearing surface on the bridge also uses continuous steel reinforcing bars and shear studs to anchor the wearing surface to the deck plate. Optimizing the design of the fiber reinforced concrete composite for this application will allow superior performance and reduced costs by also allowing a potential redesign of the currently used shear-stud-based anchoring system.

The current MTC-funded project is aimed at optimizing the mechanical and physical characteristics of the SFRLWC mix to facilitate improved fatigue performance of the steel deck. It should be noted that no data on the use of fibers to reinforce light-weight concrete are available in public domain and data developed by the PI for the PSB project have been used for baseline comparisons during this MTC-funded study.



SFRLWC mix being placed on the Poplar Street Bridge deck

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

Home delivery by drones is being promoted and researched by a growing number of firms as an alternative or complement to traditional delivery by trucks. As a result, researchers developed continuous approximation models for the strategic design of drone and hybrid truck-drone delivery systems to evaluate

optimal system designs. In contrast to discrete VRP-based optimization models, the demand for deliveries were treated as a continuous spatial density over a region and formulate models for the expected distance and cost. Analytical results identify the best mix of drones and trucks, document the benefits from using drones, and provide strategic managerial insights. Results highlight the key tradeoffs in the use of the trucks and drones and their dependence on operating characteristics and costs.

The analysis suggests that for typical drone operating parameters, drones should be heavily used and can provide a significant benefit for home deliveries, with savings over truck deliveries of up to 30%. However, the benefits depend on the density of customers, the magnitude of the drone stop costs, and the system design. In summary, the results show how truck-drone combinations can facilitate more efficient home delivery.

Economic Sustainability to Inner City Streets: A Collaborative Transportation and Safety Model

PIs: Fara Zakery and Joyce Eisel, Harris-Stowe State University

This phase of the research project includes the study of pedestrian control, sidewalks, bike paths, street lighting, cameras, and utilities. These priorities relate first to safety in an urban area, which then will apply to social and economic variables within the community. The sidewalk assessment method utilized in this study includes identification of areas to be assessed, pavement serviceability rating, and priority rating based on pavement condi-



Harris-Stowe students participating on the research team

tion. The research team composed of faculty and students, after conducting field assessment, organized the results into five ratings and three repair categories. These ratings and categories were then transferred into a multi-factored matrix, which was used in the formula to calculate the cost of sidewalk repairs.

The research team will continue the study exploring historical, social, and economic variables including accidents, crime statistics, and real estate values. It is expected this economic, safety, and social model will be implemented and will have a positive impact on improving the social and economic conditions of the citizens living in the St. Louis inner city and the metropolitan region as a whole.

Models to Predict Pavement Performance–Iowa Roads

PIs: William Duckworth and Ravi Nath, Creighton University

The Pavement Condition Index (PCI) indicates the general condition of a pavement with values near 100 indicating excellent condition with the condition worsening as the value decreases to 0. As PCI decreases for a certain stretch of pavement, plans to repair the road at some point become

increasingly important. The goal of this data-driven project is to investigate the viability of creating statistical models for predicting future PCI values for roadways under the care of the Iowa DOT. Initial analyses indicate that using past PCI values as well as variables such as the time since the last resurfacing, average daily traffic, speed limit, and pavement width to predict PCI values one or two years into the future, is promising. The derived models have predictive power at least as good as more traditional models for predicting PCI with a much simpler formula expression than those traditional models. The main implication of the findings is that it may not be necessary to measure PCI every year and a two-year cycle may be more than adequate.

Highway Incident Management System for the City of Wichita

PI: Pingfeng Wang, Wichita State University

The objective of this project is to develop a Highway Incident Management System (HIMS) through collaboration with the Kansas DOT Traffic Management Center (TMC) in Wichita. The anticipated functions of the HIMS are, (1) conveniently extract specific incident-relevant record data from high-dimensional, high-volume time series datasets, (2) autonomous analysis of online traffic-related data (e.g. volume and speed) for incident diagnosis and identification, and (3) autonomous optimization that facilitates traffic control decision making, to reduce average incident clearance and traffic recovery time.

The research team conducted the following three tasks: (1) analyzed the multidimensional high-volume time series data from real-time traffic monitoring, (2) conducted analysis for one-month raw data and extracted the traffic related features (e.g. volume and speed) over time that is relevant to a highway incident, and (3) developed data-driven modeling and autonomous signal processing techniques for the traffic control decision-making upon occurrence of accidents.

Other Research-Related Activities

Traffic and Safety Research Focus Group Meets to Identify Priorities

ISU's InTrans and the MTC took the lead in organizing a Traffic and Safety Research Focus Group meeting, June 13, 2016 in Ames, Iowa, for transportation personnel from the Iowa DOT, ISU, University of Iowa, and Federal Highway Administration. The focus group consisted of two tracks: intersection safety and lane departures. In addition, operations-related research opportunities were identified. Among the intersection research ideas identified were prioritizing collision near-misses, safety of alternative intersection designs, and multi-lane roundabout user guidance. Among the lane departure ideas were pavement marking maintenance, weather and safety relationships, and signing and delineation of local roads. Results of the meeting helped determine the research areas that advanced for application for traffic safety funds to the Iowa DOT and other sources to support research of the identified needs.

B. Outreach/Technology Transfer

MTC a Sponsor of Innovations in Transportation Conference

So state and local agencies can better address future trends in transportation, ISU's Institute for Transportation and the Iowa DOT, with sponsorship from the MTC, co-hosted the Innovations in Transportation Conference, August 16, 2016 in Ames, Iowa. More than 200 attended the meeting, which included author and futurist Jack Uldrich, whose keynote address looked at "transformational transportation trends."

Twelve speakers represented the FHWA, U.S. Department of Energy, research universities, Ford Motor Company, 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.



Carlton Reeves, U.S. Department of Energy, at the Innovations in Transportation Conference

Transportation Safety Webinar Series Helps Move Research to Implementation

The Transportation Safety Webinar Series titled Moving Research into Implementation was a joint effort between the MTC and UTC Region 5 partner, Roadway Safety Institute at the University of Minnesota-Twin Cities. The webinar series showcased innovative research that has the potential for immediate implementation. Each webinar featured a research project with commentary on implementation from researchers and also practitioners and implementers. Four free webcasts were produced in spring 2016 to a total of 348 participants. The webcasts examined how and where research has been implemented, or how the research can be successfully implemented in the future. Two webinars took place during this reporting period: "Evaluation of Low-Cost Traffic Calming for Small Rural Communities" and "Computerized Crash Reports Usability and Design Investigation."

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

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, May 24-26, 2016. The Iowa DOT hosted the event and the MTC and the ISU Institute for Transportation jointly served as one of the meeting's sponsors. AASHTO president Paul Trombino III, Iowa DOT director and member of the MTC Advisory Council, presided over the meeting. MTC director Shauna Hallmark and co-principal investigator Omar Smadi participated in the meeting.

One-Page MTC Briefs Aim to Help Implement Research Results

The MTC has begun developing one-page Implementation Briefs that are available for professionals to review for their project needs. The content is based upon information gathered from researchers, professionals who have helped implement the project or technology, and professionals who have reaped rewards in the field directly from the research. Two briefs released during this reporting period are, for example, "Machine-Vision-Based Roadway Health Monitoring and Assessment" from ISU and "Economic Impact for the Region of Replacement of the Merchants Bridge" from the University of Missouri–St. Louis.



Paul Trombino III, AASHTO president, MTC Advisory Council member

C. Education

Study Abroad Students Examine Rome's Transportation System, History

The MTC conducted its second study abroad program in May 2016, taking students to Rome for the two-week course International Experiences in Transportation. Nine students, led by five MTC-affiliated faculty, gained a global perspective of transportation systems and how they vary from the U.S. The students learned about engineering, historical, cultural, social, economic, and political issues related to design and construction. They visited 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 similar course is planned for spring 2017 to Great Britain.



Transportation students and faculty visit Rome

Students Flip for Principles of Transportation Engineering Intro Course

ISU's Department of Civil, Construction, and Environmental Engineering is continuing to enhance the innovative "flipped" classroom design for the 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 in June. The course content has subsequently been utilized by ISU transportation faculty Omar Smadi and Jing Dong and is available for use by faculty at other institutions.

MTC Transportation Scholars Program Enhances Student Experience

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 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 September 8, 2016 in Washington, D.C., by President Obama. A seventh-grade science teacher at Parkview Middle School in Ankeny, Iowa, Bleeker received the prestigious Presidential Award for Excellence in Mathematics and Science Teaching. The award honors outstanding K-12 science and mathematics teachers. She facilitated the MTC-sponsored Teaching in the Fast Lane Workshop in 2015 and 2016. Educators in the workshop learned about transportation and civil engineering concepts for use in their classrooms. Winners of the Presidential Award receive a \$10,000 award from the National Science Foundation to be used at their discretion.



Lynne Bleeker, Presidential Award winner

ITE Midwest Student Leadership Summit is Successful

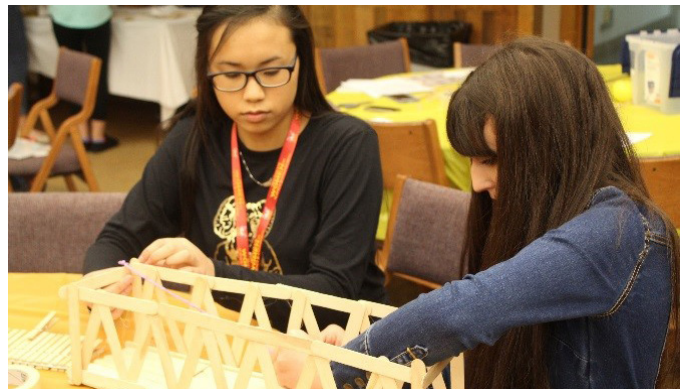
The ISU Transportation Student Association hosted the first Institute for Transportation Engineers Midwest Student Leadership Summit in September 2016. The successful summit, sponsored in part by ISU's Institute for Transportation and the MTC, attracted 82 students from 13 universities representing the 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.



Ellen Nightingale, MTC Scholar, moderates a Leadership Summit panel

MTC Teams with Program for Women in Science and Engineering

The MTC teamed with the ISU Program for Women in Science and Engineering (WiSE) to offer the Ready, Set, Build!: Bridge-Building Challenge. The event was April 28, 2016 at ISU during the WiSE-sponsored Taking the Road Less Traveled Career Conference, which hosted 350 9th and 10th graders, 90 of whom participated in the bridge challenge. WiSE collaborates with other groups to increase the participation of women in STEM fields. One of the goals of the conference (held multiple times in spring and fall) is to expand awareness of STEM careers.



WiSE bridge-building challenge participants

Fall Transportation Graduate Student Research Seminar

ISU started the second year of its weekly Transportation Graduate Student Research Seminar in fall 2016. Led by associate professor Peter Savolainen, MTC educational coordinator, the seminar was developed by the transportation division of the Department of Civil, Construction, and Environmental Engineering. Each week, graduate students present their

research results, allowing them to develop their presentation skills and receive feedback from other students and faculty. Each transportation student must participate in this seminar at least once.

Two Female Students Again Win Eisenhower Transportation Fellowship Awards

ISU masters students Ellen Nightingale and Patricia Thompson received 2016 Dwight David Eisenhower Transportation Fellowships. The Eisenhower Fellowship is among the most prestigious awards for transportation graduate students in the U.S. The program aims to advance the transportation workforce by attracting the brightest minds to the field through education, research, and workforce development. Nightingale and Thompson have the distinction of being two-time Eisenhower fellows, having both received the same award in 2015. Both students will be invited to present their research at the 2017 TRB Annual Meeting in Washington, D.C.

AASHTO Bridge Competition Students Tour Central Iowa

The MTC helped host students from around the U.S. 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-building competition students at ISU

MTC Beginning Third Year of Undergraduate Research Program

The MTC is starting the third year of its Undergraduate Research Program at ISU. Seed funding is allocated to faculty who engage undergraduate students in research projects under the thematic focus of the MTC. Faculty provide matching funds and this project is oriented toward facilitating broader opportunities for undergraduate research and encouraging students to consider graduate school opportunities. Funding is available for up to 10 projects per year.

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:

- ISU's chapter of the Institute for Transportation Engineers (ITE) was named the 2016 Outstanding Student Chapter by MOVITE, the Missouri Valley Section of ITE. This award is the ISU group's fourth consecutive outstanding student chapter honor from MOVITE.
- The ITE chapter was also awarded the 2016 ITE Midwestern District Student Chapter Activities Award, presented at the ITE Midwestern/Great Lakes Annual Joint Meeting in June. Also at the meeting, Ellen Nightingale won the Student Poster Competition for the poster "Evaluation of Cable Median Barriers on the Iowa Interstate System." In addition, students Patricia Thompson, Amrita Goswamy, and Mehrdad Morshedi were winners of the Student Design Competition. The ISU chapter also placed third in the Midwestern District Traffic Bowl.
- During this reporting period, six members of the University of Missouri's ITE student chapter began preparing research posters for display at Missouri's 2016 Traffic Safety and Blueprint Conference, held in October.
- PhD student 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.
- During May 17-19, 2016 Georges Bou-Saab made three research presentations at the 17th Road Safety on Five Continents Conference in Rio de Janeiro. ISU's Timothy Barrette and Tingting Huang also presented at the conference.
- ISU PhD student Raha Hamzeie presented her research at the Fifth International Symposium on Naturalistic Driving Research, July 31-August 1, 2016, at the Virginia Tech Transportation Institute. Hamzeie was one of six winners from the SHRP2 Safety Data Bonanza, a student paper competition at the 2016 TRB Annual Meeting. Her paper was titled "Examination of the Factors Determining Fault in Multi-Vehicle Conflicts." Additional papers presented at the symposium were authored by PhD students Amrita Goswamy and Raju Thapa.

D. Workforce Development

MTC Researchers Contribute to Midwest Transportation Workforce Center Report

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

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 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 listed five action plans, which could be utilized to help start addressing the skills and job needs in the transportation sector in the Midwest.

Nicole Oneyear Serves on Two ITE Meeting Panels as Recent PhD Graduate

Nicole Oneyear, an associate scientist for ISU’s Institute for Transportation, participated as a recent PhD graduate on two panels at the ITE Annual Meeting in Anaheim, California, in August 2016. The former MTC Scholar served on the Student Leadership Panel, where she discussed how students can get involved and improve their leadership skills. She also was part of the Transportation University Research Network sessions that looked at the issues and challenges between the practicing element of the transportation community and the transportation education and research functions of the university community.

Go! Online Magazine Brings the World of Transportation and Careers to Youth

Go! magazine is the MTC’s premier tool for developing the transportation workforce by stimulating young minds about the educational and career possibilities in transportation. Go! presents transportation from different angles such as the infrastructure, vehicles, designers, and transportation users. With information on scholarships, internships, and other educational resources, teachers from Iowa and across the country can rely on Go! as a steady resource highlighting STEM in transportation.

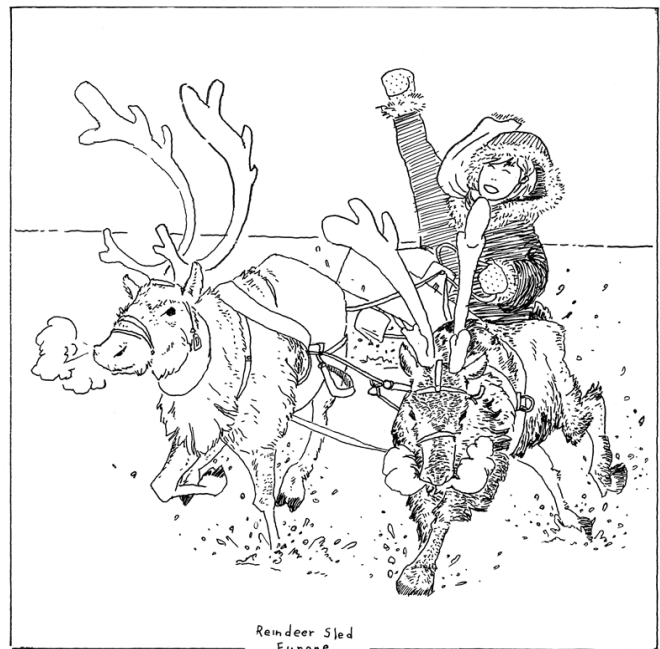
Go! started this reporting period with a totally revamped online magazine. Nearly all of the content was retooled with a more diverse selection of articles, a new section titled “Ask An Engineer,” an enhanced careers, internships, and scholarships database, and other improvements.

Financially supported by the MTC, Go!’s partners and collaborating organizations are ISU’s Institute for Transportation, Iowa DOT, ISU Department of World Languages and Cultures, ChickTech (a nonprofit with the goal of increasing the number of women and girls pursuing technology-based careers), and OnlineColleges.net (a resource of STEM

opportunities for women and minorities). Go! also partners with the accelerated bridge construction-themed UTC at Florida International University, which provides one ABC-related article every quarter.

During this reporting period,

- At least four new articles were published, disseminated, and marketed to potential users monthly.
- Go! reached 1,377 teachers and transportation professionals monthly.
- The web comic “Dot’s Adventures with Transportation,” written by Go! program coordinator Brandy Haenlein and illustrated by Stephen Post, was published monthly.
- On social media, the newsletter had 297 total page “likes” on Facebook and it was tweeted 1,252 times and had 353 followers on Twitter.
- The Go! website was accessed by 4,002 unique users who viewed 12,509 pages.



A panel from *Dot’s Adventures with Transportation*

Transportation Institute: Summer Workshop for High School Educators

The 2016 Summer Workshop for High School Educators was sponsored by the MTC and the Iowa DOT. It gave teachers from across Iowa the opportunity to explore a range of educational activities relating to transportation and suitable for use in high school physics curricula and afterschool STEM programs. The teachers gained a better understanding of transportation concepts associated with physics, supplemented with presentations from Iowa DOT and ISU staff and faculty. 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.

Go! Magazine Content During Reporting Period

April	
Articles	Great American Adventures: The Appalachian Trail Great American Adventures: The Grand Canyon Great American Adventures: The American road trip The new dawn of self-driving cars
Review	Porco Rosso review: Whole-hogged
Interview	Great American Adventures: A week at the Grand Canyon (w/Jane Dawson, Department of Geological & Atmospheric Sciences, Iowa State University)
Dot	Dot's Adventures with Transportation: Uber (relates to January 2016 article series)
May	
Articles	Whatever floats your boat: Solar energy It's electric: Battery power This will blow you away: Wind energy
Careers	Renew, Reuse, Employ: Renewable energy facts and careers
Dot	Dot's Adventures with Transportation: Let's Go! Vacation (relates to February 2016 article series)
June	
Articles	Exploring Europe: Unique transportation Exploring Asia: Unique transportation Exploring the Americas: Unique transportation Fossil Fuels=Fossil Earth?
Careers	Exploring Asia: A Filipina perspective
Dot	Dot's Adventures with Transportation: A History (relates to March 2016 article series)
July	
Articles	Claymation transportation: Fantastic Mr. Fox Claymation transportation: Chicken Run Claymation transportation: Wallace and Gromit ABC: Fiber diet for bridges
Interview	Claymation transportation: An interview with Jack Skellington
Dot	Dot's Adventures with Transportation: The Great American Road Trip (relates to April 2016 article series)
August	
Articles	Trains: A history Trains: Today Trains: The future?
Review	Book stop: The Little Engine that Could
Dot	Dot's Adventures with Transportation: Pokémon Power (relates to May 2016 article series)

Missouri Traffic Safety and Blueprint Conference

Preparations and plans have been under way during this reporting period for the annual Traffic and Safety Conference, Oct. 18–20, 2016, in Columbia, Missouri. The event has been expanded and will be joined by Missouri's Blueprint Conference (biannual). The new format will bring in an expanded audience and will allow more opportunities for networking. The event is supported in part by the MTC through the event coordination of Charles Nemmers (the University of Missouri–Columbia MTC partner leader) and Henry Brown. The university was the conference host and has been very active in the program development and the handling of conference logistics.

High Schoolers Do Research in Young Engineers and Scientists Program

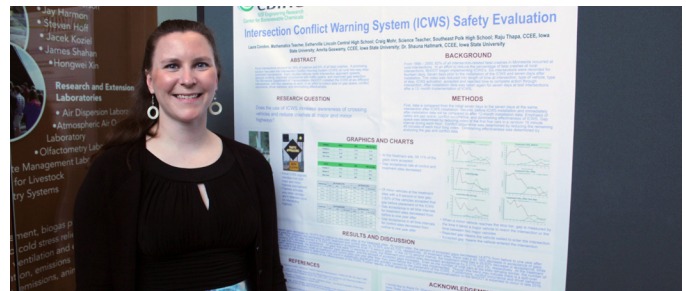
The MTC and ISU's Center for Biorenewable Chemicals collaborated in summer 2016 on the YES (Young Engineers and Scientists) program. In this partnership with Iowa high schools, the program offered six-week research internships to participating students who could work up to 40 hours a week under the supervision of a mentor. At the session's end, each student presented a poster outlining his or her research. Four high school students were selected for placement with ISU's Institute for Transportation for summer 2016. Also, a 2015 YES program participant, Jacob Hess, has continued to work at InTrans as a student employee.



High school student during the YES research internship

Three STEM Educators in Research Experience for Teachers program

For the third year, the MTC participated in the Research for Teachers program offered in summer 2016 by ISU's Center for Biorenewable Chemicals and funded by the National Science Foundation. Three 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 director Shauna Hallmark and MTC affiliate Basak Aldemir-Bektas hosted the teachers for six weeks at ISU's Institute for Transportation.



Laura Condon, Research Experience for Teachers participant

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

Twenty-two elementary teachers were invited to participate in the MTC-sponsored Teaching in the Fast Lane: Summer Workshop for Elementary School Teachers, July 11–15, 2016. The workshop introduced 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 came from the AASHTO Roadways in Developing Elementary Students (AASHTO RIDES) kit. New this year, each participant received a modified version of the AASHTO RIDES kit, which included ready-to-use supplies for implementation of newly learned activities. Each kit included items such as a set of engineering process flash cards, Hot Wheels cars, spring scales, stopwatches, and other items.

“This workshop has inspired me to get my young students excited about solving problems and being creative in their thinking. I want to create a classroom environment in which students value systems thinking, optimism, creativity, collaboration, and communication.”

—Brett Thompson, Oviatt Elementary, Norwalk, Iowa



Learning about bridges in Teaching in the Fast Lane

National Safety Month Features Use of MiniCym Driving Simulator

As part National Safety Month in June 2016, ISU’s Institute for Transportation (InTrans) partnered with the ISU Department of Environmental Health and Safety on the theme of Share the Road Safely, which focused on making good choices while driving. InTrans demonstrated distracted driving simulations with its portable MiniCym. Participants from age 10-77 tested the driving simulator, with many favorable comments. Many of the “drivers” were future students attending orientation with their parents. In all, 79 people stopped at the campus display and 59 took the simulator for a “drive.”

Plans Set for another Ready, Set, Build! Bridge-Building Challenge

The Ready, Set, Build! Bridge-Building Challenge at the Science Center of Iowa in Des Moines is November 11-12, 2016. The popular event, co-sponsored by the MTC, has expanded to two days. School teams will participate on the first day, and families and after-school groups will compete on the second day. Teams, consisting of two to four students and also families, have three hours to build a bridge out of Popsicle sticks, wooden dowels, masking tape, glue, string, and poster board.

Teams are divided into four categories: 1st–3rd grades, 4th–6th grades, 7th–8th grades, and family. Awards will be given for bridge efficiency, most innovative bridge, and teamwork.

Participants will have the opportunity to interact with engineering professionals from the Iowa DOT and ISU’s Institute for Transportation (InTrans) and learn more about bridges and other transportation-related topics. Through hands-on learning displays, the Iowa DOT and InTrans provided more than 1,200 Science Center attendees with learning opportunities about transportation and bridges in 2015. For the 2016 event additional booth spaces are being arranged to include the ISU Transportation Students Association, ISU Women in Science and Engineering, and additional STEM partners.

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

EXPANDING

The MTC offered two weeklong GO! Further workshop sessions at ISU during summer 2016. One session provided a leadership and learning experience for 19 high school students in the Young Engineers and Scientists (YES) Program. Students learned about the world of engineering and also took part in hands-on activities to develop leadership and teamwork skills. The additional session included 13 students. 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.



Go! Further students visit ISU’s Institute for Transportation

“We focused on providing the students with experiences designed to foster leadership development, teamwork, collaborative problem solving, and personal growth—all while having a whole lot of fun.”

—Maureen Griffin, Course Facilitator and STEM Academy Director, Hoover High School, Des Moines

E. Center Management

Quarterly Partner Meetings

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

RFP Includes MTC Website to Better Showcase MTC Products and Information

In August 2016 ISU's Institute for Transportation released a request for proposals for a web design and development firm to conduct a thorough assessment of InTrans' websites, including the MTC website. The new MTC website will better present its products, services, and information to its diverse audiences. The new site also will have improved user features and be more mobile friendly.

Efforts to showcase MTC products on the MTC website continue, with an emphasis to reflect research progress, educational and workforce development activities, and outreach initiatives. Some examples of new or updated content in the current reporting period:

- Safety Edge implementation "brief" publication
- New editions of *GO!* e-magazine, which features Dot's Adventures in Transportation comic
- Latest issues of MTC e-news
- News story on MTC workshop facilitator receiving Presidential Award
- Feature story on MTC summer programs for teachers, high school students
- Promotional information for the Innovations in Transportation Conference, held August 16, 2016
- Transportation Safety Webinar Series Moving Research into Implementation
- Tom Maze Transportation Seminars for students, named after the MTC founder

How were results disseminated?

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

- *GO!* online magazine for teens
- MTC e-newsletter
- Website
- Research reports
- Most of the activities described under Outreach/Technology Transfer (page 6) and Workforce Development (page 10)

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

What activities are planned for the next reporting period?

The MTC will continue to report on its activities for this grant.

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)

- Khatami and Shafei - Third Graduate and Professional Research Conference, Ames, Iowa, April 12, 2016
- Williams - Sixth Transportation Research Arena, Warsaw, Poland, April 18-21, 2016
- Zhu - 2016 International Conference & Workshop on Winter Maintenance and Surface Transportation Weather, February 2016 online conference and April 2016 in-person workshop
- Williams - Transportation Research Congress, Beijing, China, June 6-8, 2016
- Khatami and Shafei - 11th National Conference on Transportation Asset Management, Minneapolis, Minnesota, July 10-12, 2016
- Hu - Innovations in Biomedical Materials 2016, Chicago, Illinois, July 29-31, 2016
- Hu - ASME International Design Engineering Technical Conferences & Computers and Information in Engineering Conference, Charlotte, North Carolina, August 21-24, 2016
- Ceylan et al. - 11th International Conference on Concrete Pavements, San Antonio, Texas, August 28-31, 2016
- Campbell - Council of Supply Chain Management Professionals Educator's Conference, Orlando, Florida, September 25, 2016
- Mundy - Fall Meeting of the Airport Ground Transportation Association, Denver, Colorado, September 11-14, 2016
- Smith - Nanjing, China, Airport Authority, on Strategic Decision Support for Airport Capacity Planning, September 19-23, 2016

Articles and Papers

- Mundy - "Airport Drop-Off Charges in Great Britain – Are they Coming to America?" Article accepted for publication during this reporting period for the Journal of Airport Management fall 2016 edition.
- Midwest Transportation Workforce Center – MTWC (University of Wisconsin) published two website articles about MTC programs: Teachers in the Fast Lane (May 2016) and Bridge-Building Competition (July 2016).
- UTC Spotlight – The May 2016 edition of the newsletter featured all MTC programs.

Other

- Jeong - Real-Time Energy-Efficient Traffic Control via Convex Optimization - Integrated databases for raw pavement condition data and treatment projects.
- McGarvey - Designing and Applying a Decision Support System for DOT Fleet Assignment and Operation: Phase 2. Transferred to the Missouri DOT and installed on MoDOT computers for implementation.
- Edara - Data-driven Traffic Impact Assessment for Work Zones, a data-driven traffic impact assessment tool for work zones.

3. Participants and Collaborating Organizations

Internal ISU Collaborative Efforts

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

Other collaborative efforts with external entities (other than collaborations among MTC partner universities) are summarized in the table beginning on page 15:

Summary of Collaborative Activities

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

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

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

4. Impacts

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

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

What is the impact on other disciplines?

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

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

What is the impact on transportation workforce development?

Although long-term impacts of the MTC's workforce development activities are 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 experience to Great Britain in summer 2017 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!*
- 213 K–12 students actively participated in targeted activities
- The MTC is working with the regional transportation workforce center to coordinate workforce development activities

- 49 students are participating in the MTC Transportation Scholars Program
- 38 students participated in spring semester seminar activities
- 9 students participated in the transportation study abroad trip to Rome, Italy
- MTC supports various activities for transportation student organizations

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

See the lists in Section 2, Products.

What is the impact on technology transfer?

Through direct MTC sponsorship and management of workshops and conferences, nearly 800 people received face-to-face training during the reporting period. See the complete discussion of Outreach/Technology Transfer (page 6) in Section 1, Accomplishments, and the lists in Section 2, Products (page 14). In particular, with MTC support, the Innovations Conference, which was August, 16, 2016, focused on how new and emerging technologies will dramatically change the face of transportation (page 6).

In spring 2016, practitioners learned about transferring research to practice through the four Transportation Research Webinars: Moving Research into Practice. Two of seminars took place during this reporting period, attracting 206 participants.

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.