

Semi-Annual Progress Report for University Transportation Centers



- **Federal Agency and Organization Element to which Report is Submitted**
United States Department of Transportation, Office of the Assistant Secretary for Research and Technology
- **Federal Grant or Other Identifying Number Assigned by Agency**
69A3551747107
- **Project Title**
University Transportation Centers Open Competition 2016
- **Program Director (PD) Name, Title, and Contact Information**
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- **Submission Date**
October 30, 2021
- **DUNS and EIN Numbers**
DUNS: 55-545-6995
EIN: 47-0049123
- **Recipient Organization**
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- **Recipient Identifying Number or Account Number**
25-1121-0005-001
- **Project/Grant Period**
December 5, 2016 – September 30, 2023
- **Reporting Period End Date**
September 30, 2021
- **Report Term or Frequency (annual, semi-annual, quarterly, other)**
Semi-annual
- **Signature of Submitting Official (signature shall be submitted in accordance with agency- specific instructions)**

A handwritten signature in blue ink, appearing to read "A. Khattak", is written over a horizontal line.

Aemal Khattak, MATC Director

1. ACCOMPLISHMENTS

What are the major goals of the program?

The major goals of the Mid-America Transportation Center (MATC), which were outlined in the MATC proposal, are indicated in the table below. Activities related to research, education, technology transfer, and USDOT requirements are well underway. Please refer to the table below for an update on the status of each activity.

Table 1: Status of MATC's Research, Educational, and Technology Transfer Activities and Reporting Requirements

Research Activities	Status	Percent Completed for Years 1-5
Call for Problem Statements	On Schedule	100%
Request for Proposals	On Schedule	100%
Final Proposal Ranking & Selection	On Schedule	100%
Data Management Plan (DMP) - Overarching Plan for MATC	On Schedule	100%
Collect DMPs from PIs for Individual Research Projects	On Schedule	53%
Collect ORCID's from all MATC Researchers	On Schedule	69%
Submit Project Descriptions to TRB's RiP Database	On Schedule	100%
Submit Final Research Reports	On Schedule	84%
Collect & Store Final Data in UNL Data Repository	On Schedule	100%
Education and Outreach Activities		
Grad/Undergrad MATC Course Development & Implementation	In Process	25%
MATC Undergraduate Summer Internship Program	On Schedule	100%
MATC Scholars Program	On Schedule	100%
MATC/UTC Outstanding Student of the Year	On Schedule	100%
MATC Roads, Rails, and Race Cars After-School Program	On Schedule	100%
MATC/NCIA Sovereign Native Youth STEM Leadership Academy	On Schedule	100%
MATC Summer Institute	In Process	75%
MATC Research Experience for Undergraduates (REU) Program	On Schedule	100%
MATC Joint Activities with Student Chapters	On Schedule	100%
Technology Transfer Activities		
Technology Transfer Plan – Overarching Plan for MATC (Approved October 19, 2018)	On Schedule	100%
Collect Tech Transfer Plans from PIs for Individual Research Projects	On Schedule	34%
Technology Transfer Tech Briefs, Webinars & Presentations on Research Results	On Schedule	100%
Roadside Safety Short Course (UNL)	On Schedule	100%
Roadside Safety Workshop (UNL)	On Schedule	100%
Traffic Safety Classes (KU)	On Schedule	100%
Structural Condition Assessment Short Course (MS&T)	On Schedule	20%

LTAP Workshop	On Schedule	100%
USDOT OST-R Reporting Requirements:		
Federal Financial Reports	On Schedule	100%
Post Research Project Descriptions on MATC Website	On Schedule	80%
UTC Program Progress Performance Reports (Semi-annually)	On Schedule	100%
Annual Performance Indicators Reports	On Schedule	100%
Additional USDOT OST-R Requirements:		
Establish and Maintain Center Website	On Schedule	100%
Directory of Key Center Personnel	On Schedule	100%
Attendance at UTC Grantees' Meetings	On Schedule	100%

What was accomplished under these goals?

Research Activities

Although hindered by the COVID-19 Pandemic, all research activities have continued and the following research activities were accomplished during the reporting period of April 1, 2021 – September 30, 2021.

USDOT funding research projects through MATC are committed to having a sustained impact on the transportation system through technology transfer and workforce development efforts. Principal Investigators (PIs) have either submitted or are in the process of completing Data Management and Technology Transfer Plans for their individual research projects, which are in accordance with USDOT requirements and the Center’s overarching plan. For example, under the direction of Dr. Cody Stolle from the University of Nebraska-Lincoln (UNL), MATC researchers have designed a new, reduced-cost barrier which is designed to safely capture and contain an impacting tractor and tank trailer combination vehicle. The design has been developed into a full-scale test plan and subject to full-scale testing.

In July 2021, MATC sent out the call for internal research proposals. Fourteen (14) UNL MATC research project proposals were received for which external reviews were solicited; the selection is underway.

In August 2021, MATC sent out the call for subaward research proposals. Although we expect to receive approximately fifteen (15) additional proposals in the coming weeks, to date we have received five (5) for funding consideration. MATC expects to have the remainder of the proposals approved by the end of the calendar year for an anticipated start date of January 1, 2022.

UNL, University of Nebraska-Omaha (UNO), and the University of Nebraska Medical Center (UNMC) currently have seventeen (17) new and ongoing USDOT-MATC funded projects, supported by twenty-five (25) PI’s and Co-PI’s. The University of Iowa (UI) currently has five (5) ongoing USDOT-MATC funded projects, supported by nine (9) PI’s and Co-PI’s. The University of Kansas (KU) and University of Kansas Medical Center (KUMC) currently have six (6) ongoing USDOT-MATC funded projects, supported by eleven (11) PI’s and Co-PI’s. The Missouri University of Science & Technology (MS&T) currently has eleven (11) ongoing USDOT-MATC funded projects, supported by nine (9) PI’s and Co-PI’s.

Throughout the reporting period, individual project PIs from Nebraska, Iowa, Kansas, and Missouri submitted quarterly reports detailing the progress, activities, and outcomes of their individual research projects. Some of the accomplishments reported by PIs are outlined below.

Specific Research Objectives, Significant Results, and Key Outcomes

In addition to ongoing extensive literature reviews, experiment development, data collection, and data analysis, MATC Researchers reported the following project objectives, results, and key outcomes for this reporting period.

At the University of Kansas, a graduate student working with Dr. Chris Depcik has developed a functional, high accuracy, low cost LIDAR prototype. This system is capable of multiple large scans in off-grid situations using a commercially available power bank. In addition, a second LIDAR prototype has been constructed by undergraduates and is available for use and comparison to the graduate student's efforts.

MATC research being conducted at the Missouri University of Science and Technology, has allowed Dr. Lesley Sneed to provide informed teaching of the new graduate courses she developed: Wind Engineering and Bridge Engineering. This curriculum is used to train Structural Engineers to design tornado-resistant structures.

At the University of Omaha, Dr. Ann Fruhling and her research team successfully completed coding and constructing technology to capture heat index data in real-time from sensors to be sent to the REaCH database and displayed on a dashboard in real time; alert notifications worked correctly. Additionally, this research team completed an in-depth test plan for the REaCH Application including test scenarios, test plan and test data, and inserting data analytics approaches to visualize health trends. They plan to automate benchmark testing when feasible.

MATC research being conducted at the University of Iowa has allowed Dr. Ann Campbell to develop a method to quickly determine the roads and bridges that must be mitigated (i.e. increase elevation, set up flood wall, etc.) for all citizens to have access to a hospital if a flooding event occurs.

MATC research at UNL under Dr. Aemal Khattak has focused on assessing the risk of highway based transportation of hazardous materials to small (population less than 5,000) and tribal communities. The research effort has successfully created a GIS-based database of relevant crashes, population, and socioeconomic characteristics of the subject communities. The research will identify small and tribal communities that may be vulnerable to the effects of crashes involving hazardous materials besides developing an emergency plan framework for dealing with the outcomes of such events.

Education and Outreach Activities

MATC has implemented several educational outreach programs in support of USDOT's Strategic Plan and the center's mission to increase the number of students from underrepresented groups in STEM education and transportation-related careers. Descriptions of each educational program and the activities that took place during April 1, 2021 – September 30, 2021 are detailed below.

MATC After-School Program - Road, Rails, and Race Cars (RRRC)

MATC's after-school program combines the talents of 4-12th grade teachers, engineering graduate and undergraduate college and university student mentors, and professional and industry partners to educate the diverse leaders of tomorrow about STEM principles. Each participating school offers the

club for an hour every week. Mentors present on an engineering or transportation-related topic and lead students in an interactive activity that encompasses the concepts of the lesson. Examples of activities include constructing bridges and conducting strength tests, creating towers that can withstand simulated earthquakes, and building race cars powered by potential energy stored in rubber bands. This reporting period coincides with the Covid-19 pandemic. The pandemic caused school closures and restrictions on access to school sites at most of our 9 locations in 4 cities across Nebraska. However, a limited number of sites implemented RRRC utilizing online lessons and materials supplied by MATC staff. The programming details are as follows.

Spring 2021 Programming

The spring semester portion of RRRC was implemented at three (3) sites in Lincoln, NE: Culler Middle School, Mickle Middle School, and Park Middle School. Weekly implementation was carried out on-site, with teachers leading clubs with MATC support.

For the spring 2021 semester, RRRC at Culler Middle School was offered on Thursdays from 3:15 p.m. to 4:15 p.m. A total of one (1) implementation dates were completed during the spring iteration, with the total attendance being 6 by 6 students. The curriculum included an activity related to transportation safety.

For the spring 2021 semester, RRRC at Mickle Middle School was offered on Wednesdays from 3:15 p.m. to 4:15 p.m. A total of five (5) implementation dates were completed during the spring iteration, with the total attendance being 10 by 2 students. The typical weekly participation was approximately 2 students. The curriculum included activities related to several topics in transportation safety.

For the spring 2021 semester, RRRC at Park Middle School was offered on Wednesday from 3:15 p.m. to 4:15 p.m. Complete attendance records were not kept at this site. The curriculum included activities related to several topics in transportation safety.

For the spring 2021 programming, RRRC employed: one (1) Education and Outreach Coordinator, and four (4) on-site teachers. Additional RRRC tasks completed included revising existing lessons and activities, developing an online curriculum of lessons and activities, and coordinating with teachers and CLC staff.

Summer 2021 Programming

During the reporting period, RRRC was offered at four sites: Culler Middle School; Goodrich Middle School; Park Middle School; and the University of Nebraska-Lincoln through a partnership with the *Girls Inc! of Lincoln* program. A partnership between MATC and Lincoln Public School's Federal Programs Division was established that sponsored the program at Culler, Goodrich, and Park Middle School.

For the summer 2021 semester, RRRC was offered daily (except Fridays) at Culler Middle School from June 1st to June 11th from 11:30 am to 1:00 PM. Total attendance was 16 by 9 students. The curriculum was focused on robotics, where students built and programmed robots, then performed various tasks with them.

For the summer 2021 semester, RRRC was offered daily at Goodrich Middle School from June 14th to June 17th from 11:30 am to 1:00 PM. Total attendance was 42 by 11 students. The curriculum was focused on robotics, where students built and programmed robots, then performed various tasks with them.

For the summer 2021 semester, RRRRC was offered daily at Park Middle School from June 21st to June 25th from 11:30 am to 1:00 PM. Total attendance was 16 by 5 students. The curriculum was focused on robotics, where students built and programmed robots, then performed various tasks with them.

For the summer 2021 semester, RRRRC was offered daily at the University of Nebraska-Lincoln in partnership with *Girls Inc! of Lincoln* from July 12-15th, 10:00-11:30. Total attendance was 54 by 14 students. The curriculum included lessons and activities under the topics of civil engineering, city planning, roadway planning, and transportation safety.

For the summer 2021 programming, RRRRC employed: one (1) Education and Outreach Coordinator, and three (3) student mentors. Additional RRRRC tasks completed included revising existing lessons and activities, developing an online curriculum of lessons and activities, and coordinating with teachers and CLC staff.

Fall 2021 Programming

During the reporting period, in-person programming resumed at Lincoln-Area schools. One (1) site in offered RRRRC during this period, which was Mickle Middle School. Club began during Lincoln Public School's second quarter, beginning October 19, 2021.

For the fall 2021 semester, RRRRC at Mickle Middle School was offered on Wednesdays from 3:15 p.m. to 4:15 p.m., beginning on August 25, 2021. A total of six (6) implementation dates were completed during the fall iteration, with the total attendance being 17 by 4 students. The typical weekly participation was approximately 3 students. The curriculum included activities under the topics of civil engineering, structural engineering, mechanical engineering, railway safety, city planning, physics, and material science

For the fall 2021 programming, RRRRC employed: one (1) Education and Outreach Coordinator, and three (3) on-site teachers. Additional RRRRC tasks completed included revising existing lessons and activities, developing an online curriculum of lessons and activities, and coordinating with teachers and CLC staff.

MATC Scholars Program

The MATC Scholars Program is a multi-day conference that brings students from underrepresented groups together with diverse faculty. MATC's Scholars Program fills an existing gap for minority students by encouraging them to attend graduate school and teaching them necessary skills to succeed in obtaining graduate degrees in their chosen STEM-related fields. Students from historically black colleges and universities, tribal colleges, and other minority-serving institutions across the country are given the opportunity to network and attend seminars led by experienced faculty members and educational administrators at the University of Nebraska-Lincoln campus.

The fall 2021 Scholars Program for Tribal College and University (TCU) students was scheduled to be held on the UNL campus during October 13-16. Given concerns for the recent outbreak of Covid-19 variants, as well as recruitment issues, it was decided to postpone the program until spring 2022. Future report updates will include information on the program.

MATC Intern Program

The MATC Intern Program partners with private companies, local government, and academia to provide undergraduate students with paid summer internship opportunities in the transportation and

engineering fields. During this 12-week program, students gain hands-on experience in their area of interest under the mentorship of a professional. Students work 40 hours per week while experiencing the day-to-day tasks and responsibilities of their desired career. The program culminates in a written paper and presentation detailing the student's internship experience.

The 2021 program took place from May 24th – August 13th. Ten (10) UNL undergraduate students applied for a MATC Internship opportunity, of which four (4) interviews resulted in internships with three (3) sponsoring organizations; the City of Omaha, Schemmer & Associates, and MATC.

Due to restrictions with in-person gatherings on the UNL campus, a virtual kick-off meeting and orientation was held with the four students. Individual internships were conducted as prescribed by the sponsor and were held as a hybrid of in-person and remote learning.

The program culminated in a virtual closing ceremony on August 13th. Each of the interns gave a PowerPoint presentation to supervisors and fellow interns about what they accomplished and learned over the summer. To view interns' reports, visit http://matc.unl.edu/internship/internship_success.php. MATC has already begun connecting with sponsors and will begin recruiting interns in November, 2021 for the 2022 summer Internship program.

NCIA/MATC Sovereign Native Youth STEM Leadership Academy

The Nebraska Commission on Indian Affairs (NCIA)/MATC Sovereign Native Youth STEM Leadership Academy is a six-day summer program held on the UNL campus. The mission is two-fold: (1) to provide an extended learning opportunity in science, technology, engineering, and math (STEM) subjects, and (2) explore a wide-range of education and career options after high school. The academy offers a broad range of hands-on activities that build leadership skills and interest in STEM subjects and transportation-related careers while engaging with Native American history and culture. The curriculum is developed and implemented by Native American faculty, students, and leaders from across the country. Attendees have the unique opportunity to build a professional network with Native American guest speakers and panelists, who provide mentorship by sharing their education and career success.

Due to restrictions with in-person gatherings on the UNL campus, a virtual leadership academy was considered however, efforts to recruit students for a virtual program were unsuccessful.

UNL hopes to resume an in-person leadership academy in the summer of 2022.

MATC Summer Institute

MATC is actively working to expand the MATC Summer Institute, which unites transportation professionals and K-12 educators to develop classroom materials based on transportation research at the member institutions. Teachers work closely with both MATC faculty and graduate students to develop grade-level-appropriate transportation-oriented lesson plans. These lesson plans meet all state curriculum standards, and are available on the MATC website for any interested teacher to utilize. MATC is committed to working with middle- and high-school math, science, and industrial technology teachers from schools that have significant populations of underrepresented groups.

MATC Research Experience for Undergraduates (REU)

MATC was not able to support an REU student during this reporting period. We are reviewing undergraduate options and hope to support a summer 2022 MATC REU student.

How have the results been disseminated?

MATC staff continue to maintain individual project records on the Transportation Research Board's Research in Progress (RiP) database and on MATC's online database at http://matc.unl.edu/research/research_search.php. Links to the individual RiP and TRID records are provided on their corresponding project page in the MATC research database.

MATC projects are committed to having a sustained impact on the transportation system through technology transfer and workforce development efforts. MATC PIs are developing technology transfer plans for their individual projects to ensure transferability of their research to other regions. For example, recent technology transfer plans include projects focusing on infrastructure inspections during and after unexpected events, and protecting critical civil infrastructure against impact from commercial vehicles.

MATC Research Webinars

No USDOT funded research webinars were hosted by MATC during this reporting period. Previously hosted webinars are uploaded to the MATC YouTube channel (<https://www.youtube.com/user/MidAmericaTrans/videos>) with full research briefs and presenter bios available on the MATC website (<http://matc.unl.edu/webinarseries.php>).

2. PARTICIPANTS & COLLABORATING ORGANIZATIONS

What organizations have been involved as partners?

During the reporting period, MATC worked with 42 organizations to develop and implement research, education, and technology transfer activities. Each organization and its location are listed in Table 2 along with information describing the specific area or capacity in which the respective organization is committed to supporting the center.

MATC's education programs have an especially strong history of forming significant partnerships with professionals from a wide range of disciplines across the public and private sectors. MATC's partnership with the NCIA and tribal schools across Nebraska has led to several expansions of the STEM Academy, RRRC, and Scholars Program. Initial collaboration with NCIA on the first MATC/NCIA STEM Academy led to MATC's introduction with Umó^Nho^N Nation Public School, Santee Community School, and Winnebago Public School. RRRC was implemented at each of these schools following the participation of STEM teachers in the Academy. A representative from Little Priest Tribal College also served on a panel during the 2019 Academy. MATC continued collaborating with Little Priest through recruitment efforts for the 2019 Scholars Program and it was the first time Little Priest students participated in the program.

Table 2: MATC Partners and Type of Collaboration

MATC Program Affiliation	Organization Name	City	State	Financial	In-Kind Support	Contribution Facilities	Collaborative Research	Personnel Exchanges
All Programs	University of Nebraska-Lincoln	Lincoln	NE	X	X	X	X	X

All Programs	Nebraska Transportation Center	Lincoln	NE		X	X	X	X
Roads, Rails, and Race Cars Program (RRRC)	Culler Middle School	Lincoln	NE		X	X		
RRRC	Lefler Middle School	Lincoln	NE		X	X		
RRRC	Mickle Middle School	Lincoln	NE		X	X		
RRRC	Goodrich Middle School	Lincoln	NE		X	X		
RRRC	Dawes Middle School	Lincoln	NE		X	X		
RRRC	Park Middle School	Lincoln	NE		X	X		
RRRC	Umó ^N ho ^N Nation Public School	Macy	NE	X	X	X	X	
RRRC	Community Learning Center	Lincoln	NE				X	
RRRC; Academy	Lincoln Public Schools	Lincoln	NE	X			X	
RRRC; Academy	Winnebago Public School	Winnebago	NE	X	X	X	X	
RRRC; Academy	Santee Community School	Santee	NE	X	X	X	X	
RRRC; Academy	Nebraska Indian Community College	Macy	NE	X			X	
Academy	Union Pacific	Omaha	NE	X				
Academy	University of Nebraska Medical Center	Omaha	NE	X		X		
Academy	Little Priest Tribal College	Winnebago	NE				X	
Academy	Claire M. Hubbard Foundation	Omaha	NE	X				
Academy	Lincoln Bike Kitchen	Lincoln	NE	X				
Academy	National Institutes of Health (Worlds of Connections)	Lincoln	NE	X				
Academy; Scholars	Nebraska Commission on Indian Affairs	Lincoln	NE				X	
Scholars	Encompas Architects, P.C.	Lincoln	NE				X	

Scholars	Kansas Office of the Governor	Topeka	KS			X		
Intern Program	City of Lincoln Public Works	Lincoln	NE		X	X		
Intern Program	City of Omaha Public Works	Omaha	NE		X	X		
Intern Program	Nebraska Department of Transportation	Lincoln	NE	X	X	X		
Intern Program	Felsburg Holt & Ullevig	Omaha	NE		X	X		
Research	KUMC Research Institute	Kansas City	KS	X				
Research	Durham Buses	Kansas City	KS	X				X
Research	Wichita State University	Wichita	KS				X	
Research	Alaska DOT & Public Facilities	Juneau	AK					
Research	Iowa DOT	Des Moines	IA	X				
Research	Kansas DOT	Kansas City	KS	X				
Research	Missouri DOT	Jefferson City	MO	X	X		X	
Research	Virginia DOT	Richmond	VA			X		
Research	Utah DOT	Salt Lake City	UT			X		
Research	National Institute of Standards and Technology	Gaithersburg	MD				X	
Research	U.S. Geological Survey	Rolla	MO		X	X	X	
Research	National Weather Service	Springfield	MO		X	X	X	
Research	MicroSystem Inc.	Fort Walton Beach	FL				X	
Research	Iowa Flood Center	Iowa City	IA		X	X	X	
Research	University of Iowa Computer Science Department	Iowa City	IA			X	X	
Research	University of Iowa Hydroinformatics Lab	Iowa City	IA			X	X	
Research	United States Army Corps of Engineers	Kansas City	MO		X	X	X	
Research	United States Army Corps of Engineers	Washington	DC				X	
Research	Santa Catarina State University	Florianópolis	Brazil		X			
Research	Marshall University	Marshalltown	WV		X			
Research	Liquid Bulk and Tank, Inc.	Omaha	NE		X	X		

Research	Nebraska State Patrol	Lincoln	NE		X	X	X	
Research	National Instruments	Austin	TX			X		
Research	Velodyne Lidar	Mill Valley	CA			X		
Research	OGRA	Ontario	Canada			X		
Research	MACAVO	Ontario	Canada			X		
Research	FARO Technologies, Inc.	Lake Mary	FL		X			
Research	Hunt Transport Services, Inc.	Lowell	AR		X			
Tech Transfer	Florida Atlantic University	Boca Raton	FL			X		
Tech Transfer	Tran-SET at Louisiana State University	Baton Rouge	LA				X	

3. OUTPUTS

In the center’s overarching Technology Transfer Plan, MATC identified three performance measures and three corresponding goals related to the outputs, or products, resulting from research and development activities. Table 3 contains a description of each performance measure, the associated goal, and the center total for the reporting period.

Table 3: Performance Measures, Goals, and Totals for MATC Outputs

	Performance Measure	Description	Goal	Center Total for April 1, 2021 – September 30, 2021
Output 1	Products and Processes	Quantity of new or improved processes, practices, technologies, software, training aids, or other tangible products.	Thirty (30) new products and processes by the end of the grant period.	Zero (0) MATC is on schedule to develop new and improved processes, practices, technologies, and other products by the end of the grant cycle.
Output 2	Technical Communications	Number of technical communications (journal papers, conference papers, final reports, etc.)	Fifteen (15) technical communications each year of the grant period.	Fifteen (15) During the reporting period, 3 final reports and 11 peer reviewed journal papers and 1 conference paper was published.
Output 3	Outreach Activities	Number of outreach activities (webinars, social	Fifteen (15) outreach activities for	Fourteen (14) During the reporting period, 4 presentations and 10

		media, workshops, newsletters, and presentations, etc.)	each year of the grant period.	websites and social media platforms were utilized.
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Publications, conference papers, and presentations

Journal Publications

Kummetha, V.C., A. Kondyli, and H. Devos, "Evaluating Driver Comprehension of the Roadway Environment to Retain Accountability of Safety During Driving Automation". *Transportation Research Part F*, July 2021. DOI: 10.1016/j.trf.2021.07.007

Kummetha, V.C. and A. Kondyli, "Developing and Validating a Biobehavioral Extension to the Intelligent Driver Model (IDM) Using Driving Simulator Trajectories". Submitted to *Transportation Research Part C*, May 2021.

Wu, H., J. Zeng, and G. Constantinescu, "A Multiparameter Design Formula for Riprap Size Selection at Wing-wall Abutments". *Journal Hydraulic Research*, December 3, 2020. DOI: 10.1080/00221686.2020.1818310

Wu, H., J. Zeng, and G. Constantinescu "A Design Formula for Sizing Rock Riprap at Spill-Through Abutments in Compound Channels". *Journal Hydraulic Engineering*, July 16, 2021. DOI: 10.1061/(ASCE)HY.1943-7000.0001919

ASM Parveg, N. Hentges, and A. Ratner, "Experimental Investigation of the Combustion Behavior of Jet-A/water Emulsified Fuel and Ethanol-Blended Jet-A/water Emulsified Fuel Droplets". ASME IMECE 2021, 1-5 November 2021, virtual conference. Paper accepted. Acknowledgement of Federal support: Yes.

Fang, C., TY Yosef, DG Linzell, and JD Rasmussen, "Computational Modeling and Simulation of Isolated Highway Bridge Columns Subjected to Vehicle Collision and Air Blast". *Journal of Engineering Failure Analysis*, Volume 125, July 2021. DOI: 10.1016/j.engfailanal.2021.105389

Fang, C., TY Yosef, DG Linzell, and JD Rasmussen, "Residual Axial Capacity Estimates for Bridge Columns Subjected to Vehicle Collision and Air Blast". *ASCE Journal of Bridge Engineering*, V26, July 2021. DOI: 10.1061/(ASCE)BE.1943-5592.0001735

Alabbad, Y., J. Mount, AM Campbell, and I. Demir, "Assessment of Transportation System Disruption and Accessibility to Critical Amenities During Flooding: Iowa Case Study". *Science of The Total Environment*, Volume 793, November 2021. DOI: 10.1016/j.scitotenv.2021.148476

Conference Papers

Bennett, J., M. Saladin, D. Sizoo, S. Stewart, G. Wood, T. DeAgostino, and C. Depcik, "Design of an Efficient, Low-Cost, Stationary Lidar System for Roadway Condition Monitoring". ASME 2021 International Mechanical Engineering Congress & Exposition Conference, 1-5 November 2021, virtual conference. Paper accepted. Acknowledgment of Federal support: Yes.

Hentges, N., ASM Parveg, and A. Ratner, "Experimental Investigation of Multi-Component Emulsion Fuel Stability". ASME IMECE 2021, 1-5 November 2021, virtual conference. Paper accepted. Acknowledgement of Federal support: Yes.

Parveg, ASM, CY Oztan, VL Coverstone, and A. Ratner, "Experimental Investigation of Effects of Carbon Dot (CD) on the Combustion Behavior of Jet-A Fuel Droplets". 12th U.S. National Combustion Meeting, May 24, 2021 - May 26, 2021, virtual conference. Paper accepted. Acknowledgement of Federal support: Yes.

Hentges, N., ASM Parveg, and A. Ratner, "Experimental Investigation of Multi-Component Emulsion Fuel Stability". 12th U.S. National Combustion Meeting, May 24, 2021 - May 26, 2021, virtual conference. Paper accepted. Acknowledgement of Federal support: Yes.

Presentations

KUMC medical students formed two teams and submitted two posters to the University of Kansas School of Medicine's Student Research Forum in April 2021; they received 2nd place for one of them!

1. Chase Branstetter, M2; Corinna Lemke, M2; and Mathew Kranick, M1; "Assessing the Driving Fitness of CDL Drivers in the Midwest". Mentor: Shelley Bhattacharya, DO, MPH
2. Rachel Jenkins, M3; Robert Gibson M2; Jake Rooker M1; Nidhi Patel M1; Hannes Devos, Ph.D., DRS; Abiodun Akinwuntan, Ph.D., MPH, MBA, FASAHP; and Shelley Bhattacharya, DO, MPH, FAAFP, "AGSF Association of CDL Drivers' Self-Reported Tickets & Accident History with Cognitive Function Testing"

**2nd place winner

Harvey, K., T. Roy, and S. Rasiya Koya, "Research Towards an Integrated Flood Information System for Nebraska", NEASCE/NITE Transportation Conference, June 4, 2021, Virtual.

Jacome, RO, CS Stolle, RK Faller, and G. Grispos, "A Dynamically-Concise Roadmap Framework for Guiding Connected and Automated Vehicles", 4th International Workshop on Intelligent Transportation and Autonomous Vehicles Technologies (IM2021-ITAVT), Accepted January 13, 2021.

Website(s) or other Internet site(s):

MATC maintains five online sites that distribute information utilizing the internet. Links to each site as well as report period information can be found below.

MATC Website

By clicking the following link, <http://matc.unl.edu>, you will be directed to MATC's website. Below is highlighted information from Google Analytics about the website's traffic from April 1, 2021 – September 30, 2021. By understanding and capitalizing on this knowledge, we are able to make our homepage engaging, relevant, and resourceful to our viewers. Since our last progress report, the total number of site visits increased by 188.

Visits: 18,838	Page views: 41,385	Pages per visit: 2.20	Average visit duration: 00:00:22
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SlideShare

The top 5 countries that viewed our SlideShare presentations during the reporting period are: the United States, Germany, Netherlands, India, and Brazil. Below is a snapshot of MATC’s SlideShare activity and the link to view the page: <https://www.slideshare.net/matcRegion7UTC/presentations/>. MATC’s SlideShare views have increased by 766 since the last progress report.

Total Views: 3,174	New Uploads: 19	Downloads: 7	Favorites: 0
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Facebook

Metrics for the MATC Facebook page can be viewed below, and the page can be accessed by clicking on the following link. MATC’s reach increased by 997 since the last reporting period. <https://www.facebook.com/pages/Mid-America-Transportation-Center-MATC/141238439284182>.

Total Page Likes: 416	Reach: 1,874	Total Counties (of Followers): 10
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Twitter

MATC’s Twitter handle is @MATCNews. The page can be viewed by clicking the following link: <https://twitter.com/MATCNews>. The highlighted numbers for MATC’s Twitter activity can be seen below. The number of tweets MATC produced increased by 7 and the number of profile visits increased by 584 since the last reporting period.

New Followers: 3	Tweet Impressions: 470	Profile Visits: 707	Tweets: 7
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YouTube

MATC’s YouTube feed can be viewed by clicking the following link: http://www.youtube.com/user/midamericatrans?feature=results_main. MATC uploaded 2 more videos and minutes watched increased by 12,278 compared to the last reporting period.

New Videos: 20	Views: 2,022	Minutes Watched: 12,576	New Subscribers: 7
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Additional Partner Websites

Several MATC Principal Investigators created websites to share information about their research projects. The links to these websites are provided in Table 4 along with the corresponding MATC project.

Table 4: Websites for Individual MATC Research Projects Created by Principal Investigators

Project Title	Principal Investigator	Website Link
Transportation Planning with Floods	Ann Campbell and Ibrahim Demir	http://iihr-vl01.iihr.uiowa.edu/dev/routing/
Crash Prediction and Avoidance by Identifying and Evaluating Risk Factors from Onboard Cameras	Ruwen Qin	https://sites.google.com/view/yuli1102/projects/matc?authuser=0
Assessing and improving the cognitive and visual driving fitness of CDL drivers	Shelley Bhattacharya	http://www.kumc.edu/landon-center-on-aging/research/truck-safety-

		study.html .
Real-time Flood Forecasting for River Crossings	Witold Krajewski	http://sihr50.ihr.uiowa.edu/smap/demo/
Low Cost 3-D LIDAR Development for Transportation	Chris Depcik	https://depcik.ku.edu/lidar

4. OUTCOMES

MATC identified three performance measures and three corresponding goals related to program outcomes in the center’s Technology Transfer Plan. Table 5 contains a description of each performance measure, the associated goal, and the center total for the reporting period.

Table 5: Performance Measures, Goals, and Totals for MATC Outcomes

	Performance Measure	Description	Goal	Center Total for April 1, 2021 – September 30, 2021
Outcome 1	Commercialized Products	Quantity of invention disclosures, patent disclosures, patents issued, cooperative research and/or user agreements, and new business entities created.	Ten (10) products that are commercialized or in the commercialization process by end of grant period.	Zero (0) MATC is on schedule to develop commercialized products by the end of the grant period. This process is reflected in each PI’s individual tech transfer plan.
Outcome 2	Output Adoption	Number of changes made to the transportation system (including regulations, legislation, standard plans, technical guides, or policy) resulting from MATC research.	Ten (10) that have been adopted or in the process of adoption by the end of grant period.	Zero (0) MATC is on schedule to implement changes to the transportation system by the end of the grant period.
Outcome 3	Product Utilization	Number of MATC products utilized (including citations, references, views, report downloads, and report requests).	Forty (40) by the end of the grant period.	Eight (8) Including unique downloads of MATC research reports and unique clicks on the links to final data.

5. IMPACTS

MATC identified three performance measures and three corresponding goals related to program impacts in the center’s Technology Transfer Plan. Table 6 contains a description of each performance measure, the associated goal, and the center total for the reporting period.

Table 6: Performance Measures, Goals, and Totals for MATC Impacts

	Performance Measure	Description	Goal	Center Total for April 1, 2021 – September 30, 2021
Impact 1	Public Stakeholder Participation	Number of public organizations serving as sponsors of research and T2 programs.	Five (5) public sector external partners providing support to MATC activities for each year of the grant period.	Forty-Seven (47) MATC partnered with 47 public organizations on research, education, and technology transfer activities. See Table 2 for the complete list.
Impact 2	Private Stakeholder Participation	Number of private organizations serving as sponsors of various research and T2 programs.	Five (5) private sector external partners providing support to MATC activities for each year of the grant period.	Ten (10) MATC partnered with 10 private organizations on research, education, and technology transfer activities. See Table 2 for the complete list.
Impact 3	Transportation Professional Participation	Number of transportation professionals who participate in MATC T2 activities.	One hundred (100) transportation professionals for each year of grant period.	One-Hundred Sixty-Nine (169) MATC partnered with 169 transportation professionals participated in MATC activities during the reporting period.

What is the impact on the effectiveness of the transportation system?

Ongoing MATC research projects will have a wide variety of impacts on the effectiveness of the transportation system. In a project led at the University of Kansas, Dr. Alexandra Kondyli is working on the development of more realistic car-following models that can better predict traffic flow phenomena, such as breakdown events. She also expect to reveal how vehicle automation affects car-following behavior, and quantify the impact of automation on highway capacity.

At the Missouri University of Science & Technology, Dr. Grace Yan’s expected results and products will include: 1) a high-fidelity CFD model to obtain the wind pressure distribution on

flexible bridges induced by tornadoes and straight-line winds; and 2) a modified equation for calculating the design wind pressure towards tornado-resistance design for bridges. Dr. Yan will contact AASHTO to promote this to be included in AASHTO Bridge Design Specifications.

At the University of Iowa, Dr. Al Ratner's research will result in making transportation of highly inflammable crude oil by rail safer. This is expected to increase the effectiveness of the transportation system by preventing fires resulting from crude oil train derailments, which in the past have caused several fatalities and serious damage to property and infrastructure.

In a project led at UNL by Dr. Dan Linzell, the overall purpose is to improve the resiliency and robustness of bridge pier columns in the event of intentional or accidental vehicle collision coupled with an explosive event and fire.

What is the impact on the adoption of new practices, or instances where research outcomes have led to the initiation of a start-up company?

Ongoing MATC research projects have a variety of impacts on the adoption of new practices and could lead to the initiation of a start-up company. In a project led by Dr. Chris Depcik at the University of Kansas, the capabilities of his LIDAR software device offer a solution to the data analysis problems found in camera-based object tracking. In vehicular applications, camera-based measurement systems are susceptible to misinterpretation of objects which can lead the vehicle to overestimate obstacle distance on the road. Eliminating the need for image processing for hazard detection, LIDAR offers precise and reliable obstacle detection.

Dr. Shelley Bhattacharya at the University of Kansas Medical Center expects their research data will show what specific clinical tests can make CDL drivers safer behind-the-wheel, which should help the DOT give guidance to clinicians of what tests to administer for their DOT physicals.

At UNL, Dr. Mojdeh Asadollahipajouh's final PCB design with improved crash performance, once tested, will be installed on roadside work zones throughout the country and the world, resolving safety concerns to prevent roadway accidents.

Dr. Genda Chen's ongoing MATC research at the Missouri University of Science & Technology is developing an innovative measure to mitigate both earthquake and tsunami/hurricane effects that could potentially save both bridge structures and the lives of travelers who drive through the affected bridges. The outcomes and benefits resulting from such an enabled measure could have a direct impact on MATC's theme of promoting safety. In addition, effective measures that can address the mitigation of multiple hazards are lacking in the literature. This study could bridge the gap between research and the growing need for multi-hazards mitigation.

Based on the results of MATC research conducted at the University of Iowa, Dr. George Constantinescu believes that recommendations will be made for implementing modifications in the methodology used to calculate variables in existing design formulas for riprap based protection of spill-through and wing-wall bridge abutments against erosion and/or for inclusion of additional factors of safety or modified versions of the formulas to account for cases not covered by existing design formulas. In particular, they are focusing on quantifying the effect of channel curvature on the maximum bed shear stress around the abutment situated at the outer bank of the curved channel. They envision having the recommendations and revised guidelines for protection of abutments against erosion implemented in future updates (e.g., via a Technical Brief) of HEC-23. HEC-23 is the main standard used by state and

government agencies for implementing measures against erosion at bridge sites and in natural channels. Such new recommendations will enhance the capabilities of state DOTs to develop more reliable approaches to protect small bridges against possible failure induced by severe erosion associated with flood events. A second main goal of this project is to understand how the critical Froude number decreases with increasing free surface elevation for cases when the flow regime beneath the bridge deck connecting the two abutments changes from free surface flow to orifice flow or to fully-pressurized flow. Most of the scour occurs at high flow conditions and basically no design formulas or even simplified corrections are available for cases when the flow at the bridge site becomes pressurized.

What is the impact on the body of scientific knowledge?

MATC's current and ongoing transportation research will have a variety of safety-related impacts on the current body of scientific knowledge. Research led by Dr. Alexandra Kondyli at the University of Kansas could be used as a starting guideline for car-following preferences in automation. Since the sample size of the study is relatively high, the data can be used to comment on gap preferences of various drivers (classes of drivers). Insights on driver workload and its influence on following gaps/speeds can suggest preferred thresholds for autonomous driving especially where the driver still plays a key role in the vehicle. The results could provide specifics on the behavior of drivers (car-following, gap acceptance, speed preference, and lane changing) in areas surrounding/neighborhood Kansas and how autonomous vehicles could be initially tailored to bridge the gap between human and machine.

At UNL, Dr. Jongwan Eun believes his study will develop, investigate, and refine the understanding of underlying the mechanical behavior and performance of the geosynthetic-reinforced pavement system. The mechanical performance of a geosynthetic-reinforced pavement system will be evaluated at different layers of the pavement in the controlled condition from the LSTW test installed with various sensors such as fiber optic cables, ultrasonic sensors, LVDTs, pressure cells, etc.

Research being conducted by Dr. Steven Corns at the Missouri University of Science & Technology will create a hybrid method for using deep learning algorithms, leveraging the strengths of different deep learning algorithms to generate information vital to predicting water levels near road networks with an acceptable level of accuracy.

Dr. Al Ratner at the University of Iowa expects that his development of a crude oil combustion substitute, which entails original research in the field of experimental fluid mechanics, will contribute to the understanding of nanoparticle and other additives' impact on the burning properties of different organic solvents as well as crude oils. A crude oil substitute for combustion hasn't been identified yet in existing literature. We expect the development of a crude oil splashing substitute, which entails original research in the field of experimental fluid mechanics, will contribute to the understanding of nanoparticle and other additives' impact on the fluid properties of different organic solvents. A crude oil substitute for splashing hasn't been identified yet in existing literature. Until now, testing suspension stability was done by visual inspection, specialized instruments, or by the "dipping rod" method, but our non-contact, non-interfering experimental setup is able to quantify the process and identify optimum additive concentrations, thereby adding to the science behind fluid properties of such suspensions.

What is the impact on transportation workforce development?

MATC's research and education activities play a vital role in inspiring and preparing students to become future professionals of the transportation workforce. The MATC Scholars Program, STEM Academy,

Intern Program, and After-School Program are designed to increase access and retain students from underrepresented groups in STEM and transportation-related degree granting programs and careers. MATC research projects provide graduate students with the opportunity to gain hands-on research experience in the field of transportation. The interdisciplinary projects completed during program activities bolstered students' conceptual and practical skills in STEM subjects. Students were encouraged to reconfigure their expectations of STEM subjects and perceived barriers and extend their interest beyond classroom experiences.

6. CHANGES/PROBLEMS

COVID-19 has negatively impacted the operations of all MATC institutions. Essentially all universities remained closed for the majority of this reporting period (except for essential services). Although some services resumed during the report period, MATC research and outreach activities are primarily being conducted in a hybrid form of in-person and remote research and learning.

7. SPECIAL REPORTING REQUIREMENTS

Nothing to report.