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

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- **Submission Date**
  April 30, 2023

- **DUNS and EIN Numbers**
  DUNS: 55-545-6995
  EIN: 47-0049123

- **Recipient Organization**
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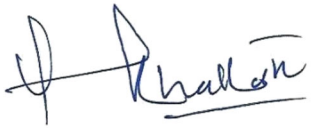
- **Recipient Identifying Number or Account Number**
  25-1121-0005-001

- **Project/Grant Period**
  December 5, 2016 – September 30, 2024

- **Reporting Period End Date**
  March 31, 2023

- **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)**



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 1-6**
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	82%
Collect ORCIDs from all MATC Researchers	On Schedule	71%
Submit Project Descriptions to TRB's RiP Database	On Schedule	100%
Submit Final Research Reports	On Schedule	79%
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	59%
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	100%
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 October 1, 2022 – March 31, 2023.

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. Li Zhao from the University of Nebraska-Lincoln (UNL), MATC researchers identified and developed several different signal control techniques between Driveway Assistance Device (DAD) signals for single or multiple driveways and mainline temporary traffic signals. Based on the preliminary research, it was found that the signal timing technique is one of the important contributing factors to the operational impacts of the DAD system and driver compliance rate along with other factors, such as traffic volume (e.g., mainline and driveway(s)), work zone length, and number of DADs).

As of this reporting period UNL, University of Nebraska-Omaha (UNO), and the University of Nebraska Medical Center (UNMC) currently have thirteen (13) active USDOT-MATC funded projects, supported by sixteen (16) PI's and Co-PI's. The University of Iowa (UI) currently has five (5) ongoing USDOT-MATC funded projects, supported by eight (8) PI's and Co-PI's. The University of Kansas (KU) and University of Kansas Medical Center (KUMC) currently have ten (10) ongoing USDOT-MATC funded projects, supported by fourteen (14) 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 seven (7) 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 Iowa, PIs Ann Campbell, George Constantinescu, Witold Krajewski, Salam Rahmatalla, and Albert Ratner worked hard to meet the deliverables of their ongoing research projects.

In a research project titled *Transportation Planning with Floods*, Dr. Campbell and her team finalized their analysis of transportation network and mitigation and can quickly determine the roads and bridges that must be upgraded (i.e., increase elevation, set up floodwalls, etc.) for all citizens to access healthcare or other facilities of a flooding event occurs. They are currently working on a web-based infrastructure to create an interactive platform for users to evaluate flood scenarios and their impact on transportation network and routing alternatives.

In a project titled *Development of new design guidelines for protection against erosion at bridge abutments and embankments*, Dr. Constantinescu and his team finished all simulations with a deformable free surface for cases with a spill-through abutment. They also analyzed about 80% of these solutions and started to create the main plots for the Year 5 Report, and also started working on a paper summarizing our research conducted for wing-wall abutments for cases when the flow becomes pressurized at the bridge site.

In a project titled *Reducing Flammability for Bakken Crude Oil for Train Transport*, Dr. Ratner completed a comprehensive review on droplet combustion behavior of liquid hydrocarbon fuels with carbon-based nano-additives. Key outcomes are reported in a review article titled “A Review of the Droplet Combustion Behavior of Liquid Hydrocarbon Fuels with Carbon-Based Nano-Additives” to illustrate the effect of carbon nano-additives on combustion behaviors modification of liquid hydrocarbon fuel based on nanomaterial types, morphological characteristics, thermos-physical properties, particle concentration, and base fuel properties. Comparison of single and multicomponent diesel surrogates illustrate that the target combustion characteristics of diesel fuel can be reproduced with multicomponent surrogates at the droplet scale and particular aspects can be captured by single component surrogates. Bio-compatible carbon-based nanomaterial (Carbon dot) can modify the combustion behavior of both diesel and jet fuel at low particle concentration (≤1% w/w). Re-ultrasonication of the nanofuels follow the similar settling/sedimentation trend as freshly prepared nanofuels through ultrasonication though the stability period decreases after re-ultrasonication.

At the University of Kansas (KU) and University of Kansas Medical Center (KUMC), PIs Steven Schrock, Mario Medina, Christopher Depcik, Alexandra Kondyli, William Collins, and Shelley Bhattacharya worked hard to meet the deliverables of their ongoing research projects.

In a research project tilted *Low cost 3-D LIDAR Development for Transportation*, Dr. Christopher Depcik worked to finalize the physical design of the LIDAR prototype and began preparing the final report. Additionally, the team evaluated a depth estimation approach on real-world data and had issues integrating the RGB sensor into existing MATC system; therefore, the experiment was conducted solely on RGB-D sensor to demonstrate the feasibility of depth estimation in real-time application. Data is collected from Wichita State University campus from both indoor and outdoor environments. The main difficulties for integrating external information, such as RGB into single-point LiDAR system, are scene scale and frequency. First, the average time for single-point LiDAR to capture a full scene is not sufficient for RGB integration. Second, the scale of capturing scene in RGB is different from single-point LiDAR.

The integration requires RGB and depth to be not only on the same size, but on the same view perspective (which is defined using intrinsic parameters in the camera).

At the Missouri University of Science and Technology (MS&T), PIs Genda Chen, Steven Corns, Mohamed ElGawady, Xianbiao Hu, Suzanna Long, Chenglin Wu, and Guirong Yan worked hard to meet the deliverables of their ongoing research projects. No updates to report at this time.

At the University of Nebraska-Lincoln (UNL), University of Nebraska-Omaha (UNO), and the University of Nebraska Medical Center (UNMC), PIs Aemal Khattak (MATC Director), Jongwan Eun, Ronald Faller, Ann Fruhling, Congrui Jin, Daniel Linzell, Sharon Metcalf, Tirthankar Roy, Chung Song, Joshua Steelman, Eric Thompson, Richard Wood, and Li Zhao worked hard to meet the deliverables of their ongoing research projects.

In a research project conducted by Dr. Eun titled *Assessing Performance of Geosynthetic Reinforced Pavement with a Large-Scale Track Wheel (LSTW) Test and Nondestructive Testing Tools*, the outer contractor installed a high voltage outlet and wiring cables to operate the motor of a large-scale track wheel (LSTW) testing apparatus at the PKI structural laboratory. There was an issue regarding the motor and electrical controller. Because of this issue, the actual testing was delayed. The team is assembling the gearbox and rotation to run the test. Also, as an alternative to LSTW tests, the team is conducting Dynamic Cone Penetrometer (DCP) test in a soil chamber simulating layered pavement to evaluate the correlations between the DCP index and the parameters obtained pullout and direct shear test. The testing results can be used to interpret the pavement's design factors.

In a research project conducted by Dr. Linzell titled *Protecting Critical Civil Infrastructure against Impact from Commercial Vehicles – Phase III, A Systems Based Approach Including Fire*, the following tasks were initiated/completed during the reporting period:

- Expanded investigations into fire/temperature effects on performance of bridge system supporting units subjected to impact and blast;
- Computed displacement response for RC bridge column subjected to combinations of fire, impact, and blast;
- Investigated column failure patterns and crack propagation for thermally damaged columns subjected to impact and blast;
- Conducted parametric studies investigating effects of (1) column numbers in a multi-column pier and (2) column diameter, fire duration, and exposure conditions on isolated column response.
- Evaluated performance of bridge components under post impact and blast by comparing damage propagation, final damage states, permanent set, concrete spalling severity, residual axial capacities, and shear resistance for all demand scenarios and column diameters.
- Investigated effectiveness of various retrofitting techniques to improve bridge column resistance to fire, impact and blast.

In this reporting period, numerical simulations of multi-column pier subjected to post-fire vehicle collision and subsequent air blast were completed. Simulations were used to examine the response of two, three, and four-column piers, when one of the columns being fire damaged prior to impact and blast. The effectiveness of in-situ retrofit schemes using FRP wrap were also explored, with multiple placement options being examined. Results from the studies completed up to date indicated that:
(1) Compared to columns subject to impact and blast, damage to the impacted column increased when it was exposed to fire prior to impact and blast. The two-column pier was vulnerable to collision and

blast, while three and four column piers were unlikely to collapse. (2) Wrapping the entire height of the impacted column can effectively mitigate effects of combined collision and blast. (3) Wrapping the bottom half of the column offered similar performance to full height wrapping when the same number of CFRP layers was used. Intermittent wrapping was effective when spacing between CFRP wraps did not exceed 500 mm.

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 October 1, 2022 through March 31, 2023 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 racecars powered by potential energy stored in a rubber band.

The reporting period of October 1, 2022 – March 31, 2023 coincides with some continuing COVID-19 pandemic community restrictions. The pandemic has caused school closures and restrictions on access to school sites at most of our nine (9) locations in four (4) cities across Nebraska. However, a limited number of sites implemented RRRC on an intermittent basis, combining in-person and online lessons with materials supplied by MATC staff. The programming details are as follows.

Fall 2022 and Spring 2023 RRRC Programming

During the reporting period, RRRC programming occurred at three (3) participating sites in Lincoln, Nebraska; Park Middle School, Mickle Middle School, and Culler Middle School. Topics and hands-on activities included civil engineering and towers and bridges; engineering and art; city planning and skylines; city planning and transportation systems; bridges and roadways; pasta car races; homemade lava lamps; balloon car races; marble life rafts; electricity and circuits and; parachutes.

- Park Middle School recorded an attendance of 45 students during the period 10/25/2023 – 12/20/2023.
- Mickle Middle School recorded an attendance of 41 students during the period 10/20/2023 – 12/15/2023.
- Culler Middle School recorded an attendance of 19 students during the period 11/16/2023 – 12/14/2023.
    - Spring 2023 attendance records are currently incomplete however, the numbers will be reported in the next semi-annual report.

MATC Sovereign Native Youth Leadership Academy (SNYLA)

The MATC Sovereign Native Youth STEM Leadership Academy is a six-day summer program held on the University of Nebraska-Lincoln 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 postsecondary education and career options after high school.

Planning for the Summer 2023 Sovereign Native Youth Leadership Academy is underway and is scheduled to take place on the University of Nebraska-Lincoln campus from Sunday, June 18, 2023 – Thursday, June 22, 2023. High School students from Native American Schools in Nebraska are invited to attend. This year's program will feature Engineering lab tours and activities, a day at that Air and Space Museum in Ashland, Nebraska, a Plant Science activity, and a GIS Story Mapping activity.

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 valuable opportunity to network and attend seminars led by experienced faculty members and educational administrators at the University of Nebraska-Lincoln campus.

The Fall 2022 Scholars Program for Tribal College and University (TCU) students was held on the campus of the University of Nebraska-Lincoln from October 5-7, 2022. The program focused on assisting Native American students with transitioning from 2-year to 4-year degree-granting institutions. Session topics included: (1) choosing a degree program and a 4-year institution that is right for you, (2) non-traditional and first-generation students, (3) and navigating the admissions process as a transfer student, (4) personal finances and budgeting, and (5) communication for success in college. Students also participated in a writing skills workshop to prepare personal essays for scholarship applications. Five (5) Native American UNL UNITE (University of Nebraska Inter-Tribal Exchange) Program students served on a panel to share their success stories and answer students' questions about what to expect at a 4-year institution. Keynote speakers included Dr. Margaret Jacobs, Professor of History and Director of the Center for Great Plains Studies at UNL, Ms. Angela Two Stars, Director of All My Relations Arts, a project of the Native American Community Development Institute in Minneapolis, MN. Nebraska Indian Community College attended. Additional information including the 2022 MATC Scholars Program booklet can be found at https://matc.unl.edu/2022-matc-scholars-program.

The Spring 2023 Scholars Program provided seminars, panels, workshops, and expos that informed and inspired students from Historically Black Colleges & Universities and Hispanic-Serving Institutions on their educational journey. The program was held on the University of Nebraska-Lincoln campus from March 15-18, 2023 and focused on topics including *Choosing a Graduate Program: Making a Short List*, *Choosing Faculty Mentors & Finding "Mentoring Communities" for Academic Success*, *Understanding Funding and Budgeting Finances*, and *Transportation Scholarships and Employment Opportunities*, to name a few.

Program presenters came together from the A.O. Maki & Associates, LLC., the City of Dallas Transportation Department, Florida A&M University, Lincoln University, the National GEM Consortium, New Mexico State University, North Carolina A&T State University, Prairie View A&M University, Southern University and A&M College, Tennessee State University, The Princeton Review, US Department of Transportation, University of Maryland Eastern Shore, University of Nebraska, and University of Nevada-Reno.

The twenty-eight (28) undergraduate students who attended were represented from eleven (11) institutions including Benedict College, Florida A&M University, Lincoln University, Missouri University of Science and Technology, New Mexico State University, North Carolina A&T State University, South

Carolina State University, Southern University A&M College, Tennessee State University, University of Iowa, and University of Maryland Eastern Shore.

The full agenda flipbook for the Spring 2023 program can be viewed at https://matc.unl.edu/2023-matc-scholars-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.

Recruitment for the 2023 Summer Program began in November 2022 with seven (7) students applying for positions. Three (3) of the applicants were selected to conduct summer research in the Midwest Roadside Safety Facility (MwRSF) at UNL.

A brief synopsis of the individual student's research experiences will be included in the next semi-annual progress report.

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 two (2) MATC REU students for Summer 2023.

A brief synopsis of the individual student's REU experiences will be included in the next semi-annual progress report.

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 forty (40) 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.

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	Mickle 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; 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	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	National Institutes of Health (Worlds of Connections)	Lincoln	NE	X				
Academy; Scholars	Nebraska Commission on Indian Affairs	Lincoln	NE				X	
Intern Program	City of Lincoln LTU Traffic Engr	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		
Intern Program	JEO Consulting Group	Omaha	NE	X		X		
Intern Program	Alfred Benesch & Co.	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	U.S. Geological Survey	Rolla	MO		X	X	X	
Research	National Weather Service	Springfield	MO		X	X	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	FARO Technologies, Inc.	Lake Mary	FL		X			
Research	University of Miami	Coral Gables	FL		X			
Research	Solmax	Pendeergrass	GA		X		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 October 1, 2022 – March 31, 2023
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.	Twenty-four (24) During the reporting period, sixteen (16) peer reviewed journal papers and; eight (8) conference papers/presentations were submitted/published/given.
Output 3	Outreach Activities	Number of outreach activities (webinars, social media, workshops, newsletters, and presentations, etc.).	Fifteen (15) outreach activities for each year of the grant period.	Eleven (11) During the reporting period, eleven (11) websites and social media platforms were utilized.

Publications, conference papers, and presentations

Journal Publications

1. A.S.M. Parveg, Ramin Ordikhani-Seyedlar, Tejasvi Sharma, Scott K. Shaw, and Albert Ratner. "A Recycling Pathway for Rare Earth Metals (REMs) from E-Waste through Co-Gasification with Biomass." Energies 15, no. 23 (2022): 9141.
2. ASM Parveg, A Ratner. "A Review of the Droplet Combustion Behavior of Liquid Hydrocarbon Fuels with Carbon-Based Nano-Additives". Submitted to Fuel.
3. Velasquez, N., Velez, I. J., Oscar, D. Á., & Salamanca, S. P. (2023). Comprehensive Analysis of Hydrological Processes in a Programmable Environment : The Watershed Modeling Framework. Hydrology, 10(76). https://doi.org/doi.org/10.3390/hydrology10040076
4. Koya, S. R., Velasquez, N., Mantilla, R. I., Rojas, M., Harvey, K., Ceynar, D., Krajewski, W. F., & Roy, T. (2023). A Prototype Flood Forecasting System for Nebraska Watersheds. Environmental Modelling and Software, 164(April), 105693. https://doi.org/10.1016/j.envsoft.2023.105693
5. Velasquez, N., Quintero, F., Koya, S.R., Roy, T., Mantilla, R, (2023) Snow-detonated floods: Assessment of the U.S. Midwest Mach 2019 event. Journal of Hydrology Regional Studies. Pending for publication.
6. Pensoneault, A.J., Velásquez, N., Mantilla, R., Zhu, X., Krajewski, W.F. (2023) Ensemble Kalman Inversion for Upstream Parameter Estimation and Indirect Streamflow Correction: A Simulation Study. Submitted to Advances in Water Resources.
7. Kummetha, V.C., A. Kondyli, "A Simulator-based Framework to Incorporate Driving Heterogeneity via a Biobehavioral Extension to the Intelligent Driver Model (IDM)". Transportation Research Record, Journal of the Transportation Research Board, 2022.
8. Dang Tran, Nate Ahlgren, Chris Depcik, Hongsheng He, Adaptive Active Fusion of Visual and Single-Point LiDAR Sensors, IEEE Transactions on Instrumentation and Measurement, 2022, under review.
9. Zaman, M. W., Han, J., & Zhang, X. (2022). Evaluating wettability of geotextiles with contact angles. Geotextiles and Geomembranes, 50(4), 825-833.
10. Akhlaghi, V.E., Campbell, A.M. and Demir, I., 2023. The Flood Mitigation Problem in a Road Network. arXiv preprint arXiv:2302.07983. (in review)
11. Alomari, Q. & Linzell, D. (2022, June). Bridge Pier Column Multi-Hazard Response – Fire, Impact and Blast. In Bridge Safety, Maintenance, Management, Life-Cycle, Resilience and Sustainability: Proceedings of the Eleventh International Conference on Bridge Maintenance, Safety and Management (IABMAS 2022), Barcelona, Spain, July 11-15, 2022 (p. 2276). CRC Press.
12. Alomari, Q., Linzell, D.G., and Fang, C. "Numerical Modeling and Performance Investigation of Fire Damaged Highway Bridge Pier Columns under Coupled Vehicle Collision and Air Blast", Structures. Under review.
13. Yusuf Alhowaidi, Jongwan Eun, Seunghee Kim, Chung Song, and Fouad Jaber (2023) "Field Monitoring and Analysis of Abutment Foundation Behavior for a Curved Integral Abutment Bridge under Thermal Loading." Transportation Research Record, Transportation Research Board https://doi.org/10.1177/0361198123115987
14. Yusuf Alhowaidi, Jongwan Eun, Seunghee Kim (2023) "Field Monitoring of Soil Response for Curved Integral Abutment Bridge during Seasonal Temperature Changes" GeoCongress 2023, ASCE, LA https://doi.org/10.1061/9780784484685.042

Conference Papers

1. ASM Parveg, A Ratner. "Combustion Characteristics of Single Isolated Fuel Droplets of Different Diesel-Biodiesel Blends Derived from Waste Vegetables Oil and Animal Fat". ASME IMECE 2022, October 30-November 3, 2022, Columbus, Ohio.
2. R Mollick, N Hentges, ASM Parveg, Y Zhou, RM Leblanc, A Ratner. "An experimental investigation on the stability of gel-like carbon dot based nanofluids". ASME IMECE 2022, October 30-November 3, 2022, Columbus, Ohio.
3. ASM Parveg, A Ratner. "Droplets combustion characteristics comparison of single component and multicomponent diesel surrogates with petroleum-based commercial diesel fuel". ASME IMECE 2023, October 29-November 2, 2023, Columbus, Ohio. Abstract accepted.
4. Rahat Mollick, Nitin Nagarkar, Albert Ratner. "Studying Reultrasonication Effects on the Suspension Stability of Stored Nanofuels Based on Optical Measurements". ASME IMECE 2023, October 29-November 2, 2023, Columbus, Ohio. Abstract accepted.
5. Kummetha, V.C., U. Durrani, J. Mason, S. Concas, A. Kondyli, "Driver Classification Using Self-reported, Phychophysiological, and Performance Metrics within a Simulated Environment". In Proceedings of the 102nd Annual Meeting of the Transportation Research Board, Washington, DC, January 2023.
6. Zaman, M.W., & Han, J. (2023) Investigation of Moisture Reduction in Unsaturated Soils using Geotextiles. Presented at the geo-poster session in the Geo-Congress 2023. March 26-29, Los Angeles, California, United States.
7. Zaman, M.W., & Han, J. (2023) Investigation of Moisture Reduction in Unsaturated Soils using Geotextiles. Presented at the student poster competition in the Geosynthetics conference 2023. February 5-8, Kansas City, Missouri, United States.
8. Fang, C., Alomari, Q., and Linzell, D.G., "Assessment of Bridge Pier Response to Fire, Vehicle Impact, and Air Blast" Proceedings of the 6th International Conference on Protective Structures, (ICPS), Alabama, 2023.

Presentations

1. ASM Parveg, A Ratner. "Comparison of droplets combustion characteristics for single component and multicomponent diesel surrogates with commercial petroleum-based diesel fuel". 13th U. S. National Combustion Meeting, March 19-20, 2023, College Station, Texas.
2. Rahat Mollick, Nitin Nagarkar, Albert Ratner. "An Experimental Investigation on the Effects of Reultrasonication on the Stability of Stored Nanofuels". 13th U. S. National Combustion Meeting, March 19-20, 2023, College Station, Texas.
3. Presented the results at AGU 2022 on December:
4. Pokharel, S., T. Roy, and D. Admiraal (2022), A Physics-guided Machine Learning Scheme for Predicting Peak Flow in Streams, AGU Fall Meeting, Dec 12-16, Chicago.

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. Google Analytics about the website's traffic from October 1, 2022 – March 31, 2023 is not available due to a server changeover. Analytics will be provided in the next semi-annual report.

SlideShare

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 uploads have increased by 2 since the last reporting period.

Total Views: 464	New Uploads: 9	Downloads: 0	Favorites: 0

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 total page followers increased by 441 since the last reporting period. https://www.facebook.com/pages/Mid-America-Transportation-Center-MATC/141238439284182.

Total Page Likes: 8	Total Page Followers: 441	Reach: 903	Total Countries (of Followers): 10

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 decreased by 6 since the last reporting period.

New Followers: 2	Tweet Impressions: 979	Profile Visits: 118	Tweets: 2

YouTube

MATC's YouTube feed can be viewed by clicking the following link: http://www.youtube.com/user/midamericatrans?feature=results_main. MATC uploaded 4 more videos compared to the last reporting period.

New Videos: 6	Views: 900	Minutes Watched: 2,682	New Subscribers: 0

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 Ibrahim Demir	http://iihr-vl01.iihr.uiowa.edu/dev/routing/
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://siihr50.iihr.uiowa.edu/smap/demo/
Low Cost 3-D LIDAR Development for Transportation	Chris Depcik	https://depcik.ku.edu/lidar https://github.com/depcik/lidar

Real-Time Emergency Communication System for HAZMAT Incidents (REaCH)	Ann Fruhling	https://afruhling.github.io/Reach.html

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 October 1, 2022 – March 31, 2023
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.	Sixty-six (66) Including sixty-one (61) unique downloads of MATC research reports and five (5) 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 October 1, 2022 – March 31, 2023
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.	Thirty-nine (39) MATC partnered with thirty-nine (39) 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.	One (1) MATC partnered with one (1) private organization 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.	Fifty (50) MATC partnered with fifty (50) transportation professionals 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 Iowa, Dr. Albert Ratner believes that his 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 by Dr. Christopher Depcik at the University of Kansas, sufficiently fast LIDAR systems would allow vehicles to measure proximity to road hazards without the complications of image processing. His developed device could be easily setup to monitor traffic and improve congestion by providing live feedback to the traffic lights and minimizing unnecessary wait times. In addition, an inexpensive system could be widely distributed within the transportation system fostering a greater ability to monitor threats to safety.

Additionally, Dr. Jie Han at the University of Kansas believe that the outcome of his research project titled *Quantifying Soil Moisture Reduction by Wicking Geotextile to Minimize Pavement Distresses,* will

help the transportation community to properly design and use wicking geotextiles to mitigate moisture-related problems, for example, freeze-thaw problems that cause many pavement distresses in cold regions, reduce the frequency and cost of pavement maintenance and repair, prolong pavement life, and improve safety.

At the University of Nebraska-Lincoln, Dr. Daniel Linzell's overall purpose of his research study 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.

Additionally, Dr. Tirthankar Roy believes the outcomes of this research will let transportation systems take precautions well before flood hazards are realized. Flood forecasting will be improved by replacing the old and outdated regression equations with advanced machine learning schemes.

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. Dr. Albert Ratner at University of Iowa feels that the droplet combustion process, and inherent thermo-physical mechanism is expected to make an impact on the science behind combustion and ignition of crude oil and other conventional hydrocarbon fuels; modifying crude oil combustion characteristics by additives is of obvious interest in the discipline of crude oil transportation by pipeline and; finding optimum concentrations of additives at which combustion characteristics and stability period of nanofuels are optimal would save costs during eventual industry technology implementation.

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. At the University of Iowa, Dr. Al Ratner plans to work with the Transportation Research Board (TRB) committees related to bridges (e.g., TRB-AFB60) and FHWA such that the main findings and the improved formulas will be published as a Technical Brief of HEC-23. Once adopted by state and federal agencies in charge of maintaining operational our bridges, the present research will increase the efficiency of scour protection measures at two main types of abutments used at bridges in the US. It will also decrease the costs associated with maintaining such bridges operational after flooding events (e.g., if the flood protection measure is not effective part of the abutment can be washed away during the flood and needs to be reconstructed, a procedure that involves large costs). The present procedure based on 3D simulations can be extended to other types of abutments and also to bridge piers of complex shape, or to cases when erosion at the abutment is due to more than one factor (e.g., there is a component associated with channel curvature in the vicinity of the abutment, or pressure scour effects are important if the bridge deck becomes submerged during the flood event). Such cases are not covered by existing design formulas which are mostly based on experiments conducted in straight channels. In the long term, the present procedure to estimate potential for erosion can provide a reliable approach to generate data needed to calibrate riprap design formulas which will complement and partially replace expensive scaled model studies conducted in the laboratory. Given that detailed information on the flow fields, turbulence and their effects on the bed shear stress distributions are available from these simulations, the present approach can lead to incorporating more physics into existing design formulas and proposing new design formulas for protection against local scour at hydraulic structures.

In a new project titled *Investigation of Driver Adaptations in a Mixed Traffic* Environment, Dr. Alexandra Kondyli at the University of Kansas hopes to develop new car algorithms for automated vehicles that better describe driver preferences and assist drivers in maintaining automation to receive the full safety and operational benefits.

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.

MATC research being conducted by Dr. Li Zhao at the University of Nebraska-Lincoln will enrich the capacity of transportation workforce to better understand and analyze reliability performance measures. Consequently, this will help to effectively report on the MAP21 and FAST ACT mobility performance monitoring indicators.

6. CHANGES/PROBLEMS
The research teams were affected by the COVID shutdowns and are now catching up with the research projects. However, there is a shortage of personnel available to work on research projects, which is a challenge, going forward.

7. SPECIAL REPORTING REQUIREMENTS
Nothing to report.