Semi-Annual Progress Report for University Transportation Centers

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- **Project Title**
  University Transportation Centers Open Competition 2016

- **Program Director (PD) Name, Title, and Contact Information**
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- **Recipient Organization**
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  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 1-5**
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	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	86%
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	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 October 1, 2021 – March 31, 2022.

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 was developed into a full-scale test plan and full-scale testing was successfully conducted on December 8, 2021.

In July 2021, MATC sent out the call for internal research proposals. Fourteen (14) UNL MATC research project proposals were received and considered for funding by the MATC External Review Committee. Effective November 1, 2021, six (6) of these proposals were selected for funding.

In August 2021, MATC sent out the call for subaward research proposals. Ten (10) UNL MATC subaward proposals were received and considered for funding by the MATC Executive Committee. Effective January 1, 2022, all ten (10) of these proposals were selected for funding.

As of this reporting period UNL, University of Nebraska-Omaha (UNO), and the University of Nebraska Medical Center (UNMC) currently have twenty-three (23) active USDOT-MATC funded projects, supported by twenty-four (24) 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 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 seventeen (17) ongoing USDOT-MATC funded projects, supported by ten (10) 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, Dr. Serban Constantinescu performed simulations of flow in a straight channel containing a wing-wall abutment using a deformable free surface algorithm. Simulations were conducted with different flow depth in the approach flow and diameter of the rip rap stone for cases when the bridge deck supported by the abutment is fully or partially submerged (orifice flow regime). The goal of these simulations was to investigate how the critical discharge corresponding to entrainment of riprap stone of a certain size decreases with increasing water elevation upstream of the abutments. Simulations were conducted with the same incoming flow depths but without a bridge deck to be able to quantify the effect of pressurized flow conditions beneath the bridge deck on the critical discharge and critical Froude number corresponding to shear failure of the riprap stone.

Additionally, Dr. Witold Krajewski developed an algorithm to perform a conflation between the Hillslope-Link Model (HLM) and the official streamflow network of the U.S. (NHDplusV2) networks. The detailed description of the network allowed his team to perform hydrological simulations at a scale that corresponds with the observed features of the landscape. In the process, they assign NHDplus IDS to each HLM network element. The conflation connects HLM and NHDplusV2 segments allowing them to perform future comparisons with the National Water Model (NWM). Furthermore, they established a link between the HLM segments and the names of the rivers allowing more interaction in the communication of the forecasts. The described connection represents a significant advance that allows performing regional flood forecasts on a human scale. Currently, they are using the conflated network in some regions of Iowa. The described approach represents a significant step forward in developing a floods forecasting system. Following the observed streamflow network closely allows increased model performance and more accurate forecasts. Moreover, it also allows better communication with the authorities and communities. On the other hand, the conflation represents a significant advance that allows performing regional flood forecasts on a human scale and using automated systems. The methodology described here can be easily extended to other areas of the contiguous U.S. It only uses NHDplus products that are available in the country. In this case, researchers limit the regions using HUCs level four to reduce the number of elements simulated in HLM. With this approach, each region has around 200K elements, which allows researchers to explore HLM results without having long execution times.

MATC research being conducted at the Missouri University of Science and Technology has allowed Dr. Guirong Yan to conduct a small-scale simulation to capture the physics of wind-wave-surge interaction and to develop parametrizations for wave-scale phenomena. To achieve this, Direct Numerical Simulations (DNS) that resolves the complete two-phase flow is conducted. This includes both the water and wind dynamics in the computational domain. Consider a wave of height a_0 approaching a uniform beach of slope θ, in the presence of a storm surge of depth h_s and wind of speed U. As the wave approaches the beach, it will steepen and break if h_s is small enough, even if wind is not present, but the presence of wind may affect the dynamics of the wave breaking process. To investigate this, DNS will be conducted using the Basilisk library to solve the two-phase variable-density Navier-Stokes equations, including surface tension, in two and three dimensions.

At the University of Kansas, Dr. Christopher Depcik and Dr. Hongsheng He's team focused on developing and evaluating depth completion models using deep convolutional neural network architecture with spatial propagation mechanisms. This can theoretically improve the point cloud sampling speed of the current moving LIDAR system using additional RGB image integration. One potential use of this LIDAR technology would be to detect threats of landslide or avalanche based on the shape of their respective formations.

MATC research conducted at the University of Nebraska-Lincoln under the direction of Dr. Ronald Faller allowed the research team to acquire materials for the MASH TL-6 barrier, construct the barrier at the Midwest Roadside Safety Facility (MwRSF) Outdoor test site, and prepare for the full-scale test. A vehicle was purchased, ballasted, prepared, instrumented, and aligned for testing. On December 8, 2021, a full-scale crash test was performed according to MASH TL-6 impact conditions at the MwRSF Outdoor Test Site. The crash test was witnessed broadly in the roadside safety and protective systems communities using livestreaming and in-person observation. The crash test was the first MASH TL-6 test to be conducted and the first tank-trailer test conducted in more than 30 years. This was also the first "elliptical-body" truck-tank trailer test ever conducted on a roadside system. The vehicle was smoothly contained and redirected by the barrier system. Subsequently, after disengaging from the barrier, the vehicle traveled downstream and rolled 270 degrees onto its side. The evaluation of a significantly-reduced height, optimized shape for containing and redirecting tank-truck trailer vehicles offers an affordable option for state Departments of Transportation (DOTs) to contain and redirect heavy trucks. The design successfully captured the vehicle with no significant damage to the barrier and would have successfully prevented a catastrophic outcome from a cross-median crash, collision with critical infrastructure located behind the barrier, or potential for the large truck to fall off an elevated structure like a bridge or overpass.

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, 2021 – March 31, 2022 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 10/1/2021 – 3/31/2022 coincides with the COVID-19 pandemic. 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 2021 Programming
During the reporting period, in-person programming occurred at two sites. One (1) site in Lincoln, and one (1) site in Macy, NE implemented RRRC. Weekly implementation was carried out on-site, with MATC's Education and Outreach Coordinator leading clubs. Clubs began during these schools' 2nd Quarter.

For the Fall 2021 semester, RRRC at Park Middle School was offered on Thursdays from 3:15 p.m. to 4:15 p.m., beginning on November 11. A total of four (4) implementation dates were completed during the fall iteration, with the total attendance being thirty-seven (37) by twenty-three (23) students. The typical weekly participation was approximately nine (9) students. The curriculum included activities under the topics of civil engineering, and structural engineering.

For the Fall 2021 semester, RRRC at Omaha Nation Public School was offered on Tuesdays from 3:45 p.m. to 5:15 p.m., beginning on October 12. A total of seven (7) implementation dates were completed during the fall iteration. The curriculum included activities under the topics of civil engineering, structural engineering, buoyancy, and aviation.

For the Fall 2021 programming, RRRC employed: one (1) Education and Outreach Coordinator, and two (2) 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.

Spring 2022 Programming
The spring semester portion of RRRC was implemented at three (3) sites in Lincoln, NE: Mickle Middle School, Park Middle School, Saratoga Elementary School; and one (1) site in Macy, NE: Omaha Nation Public School. Weekly implementation was carried out on-site, with MATC's Education and Outreach Coordinator leading clubs. Clubs were scheduled to begin in each school's third quarter, but due to the outbreak of the Omicron variant in early 2022, clubs were postponed until fourth quarter.

For the Spring 2022 semester, RRRC at Park Middle School was offered on Wednesdays from 3:15 p.m. to 4:15 p.m. A total of one (1) implementation date was completed during the reporting period ending March 31, 2022, with the total attendance being twelve (12) by twelve (12) students. The curriculum included an activity related to earthquake engineering.

For the Spring 2022 semester, RRRC at Mickle Middle School was offered on Thursday from 3:15 p.m. to 4:15 p.m. A total of one (1) implementation date was completed during the reporting period ending March 31, 2022, with the total attendance being one (1) student. The curriculum included an activity related to earthquake engineering.

On February 18th, RRRC partnered with Lincoln Public Schools' Indian Education Program to host a STEM Fun Day for Native American elementary students at Saratoga Elementary School. Fifteen (15) K-5 students attended the event. The curriculum included activities that combined science and engineering with Native American cultural history, including Tipi building, catapults, and travois building.

For the Spring 2022 semester, RRRC at Omaha Nation Public School was offered on Tuesdays from 3:45 p.m. to 5:15 p.m. A total of two (2) implementation dates were completed during the reporting period ending March 31, 2022. The curriculum included activities under the topics of civil engineering and buoyancy.

For the Spring 2021 programming, RRRC employed: one (1) Education and Outreach Coordinator, and three (3) 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.

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 Spring 2022 Scholars Program for Tribal College and University (TCU) students was scheduled to be held on the campus of the University of Nebraska-Lincoln during March 23-25, 2022. Given concerns for the recent outbreak of COVID-19 variants and resulting travel restrictions, it was decided to postpone the program until Fall 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 2022 program is scheduled to take place from May 23rd – August 12th. Fourteen (14) UNL undergraduate students applied for a MATC Internship opportunity, of which six (6) have been hired to complete internships with five (5) sponsoring organizations; Benesch, Nebraska Department of Transportation, JEO-Omaha, the City of Lincoln, and Felsburg, Holt & Ullevig.

A 2022 kick-off meeting and orientation is scheduled for Friday, May 20th. Individual internships will be conducted as prescribed by the sponsor and may be held as a hybrid of in-person and remote learning.

The 2022 program will culminated in a closing ceremony, tentatively scheduled for August 12th. Each of the interns will give a PowerPoint presentation to supervisors and fellow interns about what they accomplished and learned over the summer. To view past interns' reports, visit http://matc.unl.edu/internship/internship_success.php.

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.

MATC staff are in the process of organizing an in-person leadership academy to be held on the University of Nebraska-Lincoln campus from June 26th to July 1st.

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 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	Umóᴺhoᴺ 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			

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, 2021 – March 31, 2022
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-nine (29) During the reporting period, nine (9) final reports; nine (9) peer reviewed journal papers and; eleven (11) conference papers were submitted/published.
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.	Nine (9) During the reporting period, nine (9) websites and social media platforms were utilized.

Publications, conference papers, and presentations

Journal Publications

1. Al-Kady, K., Wittich, C.E., Wood, R.L., and Morcous, G. (202x). "Field Monitoring of Traffic-Induced Vibration during Phased Construction of Bridges." Status: In Preparation for Submission to: Journal of Bridge Engineering. Acknowledgment: Yes.
2. Alabbad, Y., Mount, J., Campbell, A.M. and Demir, I., 2021. Assessment of transportation system disruption and accessibility to critical amenities during flooding: Iowa case study. Science of The Total Environment, p.148476. (published)
3. Fang, C., Yosef, T.Y., Linzell, D.G., and Rasmussen, J.D., "Computational Modeling and Simulation of Isolated Highway Bridge Columns Subjected to Vehicle Collision and Air

Blast," Journal of Engineering Failure Analysis, Volume 125, July, 105389, https://doi.org/10.1016/j.engfailanal.2021.105389, 2021.
4. Fang, C., Yosef, T.Y., Linzell, D.G., and Rasmussen, J.D., "Residual Axial Capacity Estimates for Bridge Columns Subjected to Vehicle Collision and Air Blast," ASCE Journal of Bridge Engineering, V26. n7, July, https://doi.org/10.1061/(ASCE)BE.1943-5592.0001735, 2021.
5. Medcalf, S., Hale, M. L., Achutan, C., Yoder, A. M., Fruhling, A., & Shearer, S. W. (2021). Requirements Gathering Through Focus Groups for a Real Time Emergency Communication System for HAZMAT Incidents (REACH). J Pub Health Issue Pract, 5(2), 188.
6. Qing Tang, Xianbiao Hu, Hong Yang. Identification of Operational Design Domain for Autonomous Truck Mounted Attenuator System on Multilane Highways. Transportation Research Record. 2021.
7. Velásquez, N., Mantilla, R., Krajewski, W., Quintero, F., Zanchetta, A.D.L. (2022). "Identification and Regionalization of Streamflow Routing Parameters for the HLM Hydrological Model in Iowa". JAMES. First reviewers round.
8. Wu, H., Zeng, J. and Constantinescu, G. (2021). A multiparameter design formula for riprap size selection at wing-wall abutments, Journal Hydraulic Research59(4), 651-661, DOI: 10.1080/00221686.2020.1818310
9. Wu, H., Zeng, J. and Constantinescu, G. (2021). A design formula for sizing rock riprap at spill-through abutments in compund channels,', Journal Hydraulic Engineering, 147(10), https://doi.org/10.1061/(ASCE)HY.1943-7900.0001919

Conference Papers

1. Alkady, K., Wittich, C.E., and Wood, R.L. (2022). System identification of a highway bridge undergoing phased construction. 8th World Conference on Structural Control and Monitoring. Orlando, FL, June. (Abstract In Review).
2. Alkady, K., Wittich, C.E., Wood, R.L., and Morcous, G. (2022). Phased-construction bridges: field monitoring of traffic-induced vibration and large-scale experimental testing. 11th International Conference on Short and Medium Span Bridges, Toronto, Ontario, July. (Abstract Accepted, Paper In Review).
3. Alomari, Q. and Linzell, D.G, "Bridge Pier Column Multi-Hazard Response – Fire, Impact and Blast", the 11th International IABMAS Conference, Barcelona, Spain, 2022.
4. Bennett, J., Saladin, M., Sizoo, D., Stewart, S., Wood, G., DeAgostino, T. and Depcik, C. "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 (IMECE 2021-69308)
5. Bhattacharya, S; Devos, H; Lemke, C; Branstetter, C; Jenkins, R; Rooker, J; Kranick, M; Patel, N; Gibson, R; Akinwuntan, A. "Correlation between clinical tests and driving simulator performance of commercial drivers in the United States." Road Safety and Simulation, June 2022.
6. Hentges, N., Singh, G., and Ratner, A. "Experimental Investigation of the Settling Characteristics of carbon-based nanoparticle in renewable jet fuel". ASME IMECE 2020, Portland, Oregon, USA, 16-19 November 2020, Final paper presented. Acknowledgement of Federal support: Yes.
7. Kanwar, Bhanu and Corns, Steven (2021) "Deep Learning-based Disaster Management Planning and Risk Analysis of Flash Flood-Prone Regions", Proceedings of the 2021 ASEM International Annual Conference.

8. Parveg, ASM, Singh, G., Ratner, A. "Experimental investigation of effect of Graphene Nano particles (GNP) on the combustion behavior of renewable jet fuel droplets". ASME IMECE 2020, Portland, Oregon, USA, 16-19 November 2020, Final paper presented. Acknowledgement of Federal support: Yes.
9. Wu, H., Zeng, J. and Constantinescu, G. (2022). 'Use of CFD to understand conditions for riprap entrainment at bridge abutments in straight and curved channels,' 39th IAHR Congress, Granada, Spain 2022.
10. Wu, H., Zeng, J. and Constantinescu, G. (2022). 'Use of CFD to understand conditions for riprap entrainment at bridge abutments in straight and curved channels,' 39th IAHR Congress, Granada, Spain 2022.
11. Zhu, Y. and Chen, G. Distributed fiber optic sensors assisted the post-tensioned force monitoring in cables, 8th World Conference on Structural Control and Monitoring. (under review)

Presentations

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 October 1, 2021 – March 31, 2022. 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 5,280.

Visits: 24,118	Page views: 50,325	Pages per visit: 1.99	Average visit duration: 00:00:23

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 831 since the last progress report.

Total Views: 4,005	New Uploads: 0	Downloads: 2	Favorites: 124

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 declined by 1,104 since the last reporting period. https://www.facebook.com/pages/Mid-America-Transportation-Center-MATC/141238439284182.

Total Page Likes: 420	Reach: 770	Total Counties (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 declined by 4 and the number of profile visits declined by 170 since the last reporting period.

New Followers: 3	Tweet Impressions: 1,168	Profile Visits: 537	Tweets: 3

YouTube

MATC's YouTube feed can be viewed by clicking the following link: http://www.youtube.com/user/midamericatrans?feature=results_main. MATC uploaded 16 fewer videos and minutes watched decreased by 2,028 compared to the last reporting period.

New Videos: 4	Views: 5,000	Minutes Watched: 10,548	New Subscribers: 10

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/
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

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, 2021 –

				March 31, 2022
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, 2021 – March 31, 2022
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 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 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.

At the Missouri University of Science and Technology, Dr. Suzanna Long's anticipated research contributions will be an understanding of the comparative effectiveness of VR driving training as compared to traditional simulative training methods; particularly their ability to cost effectively improve the driving behaviors and safety of operatives in rural roadway conditions. To conduct this study, a prototype VR driver training simulator will be developed serving as the second proposal deliverable. This prototype will incorporate elements and scenarios affecting rural road travel safety but will be tunable to the conditions incumbent of other environments.

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.

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. Through studying the ATMA technology operation domain and the deployment guideline in a project led by Dr. Xianbiao Hu at the Missouri University of Science and Technology, he expects his research to help state DOT and industry vendor paves the foundation for autonomous vehicle development and promotion. The proposed technology is jointly funded by a pool fund of 12 state DOT and has the potential of being widely adopted national-wide and internationally.

At the University of Kansas Medical Center, Dr. Shelley Bhattacharya expects her 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.

Through research conducted at the University of Nebraska-Lincoln, Dr. Mojdeh Asadollahi Pajouh'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 of roadways accidents.

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. Dr. Steven Corns at the Missouri University of Science and Technology has developed research that 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.

Experimental data collected at the University of Nebraska-Lincoln conducted by Dr. Joshua Steelman will be generated for large-scale dynamic impact behavior of soft soils. Information available in literature for roadside safety hardware focuses on strong soils, and soft soil experimental data has only been produced at small scales, requiring unvalidated extrapolation for large-scale application in engineering research and practice. Additionally, this research will provide insight into performance of foundations supporting breakaway features. Breakaway hardware is typically mounted to rigid or very stiff foundations in strong soil, leaving performance of foundations in weak soil as a gap in knowledge.

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. Ernest Tufuor and 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 COVID-19 pandemic and business responses play a factor in ongoing and future efforts. The research teams have not been shut down and are working effectively however, much of the personnel have transitioned to working remotely, as has much of the country during this time of social distancing. These are unprecedented times. Testing activities have been slowed by the pandemic, and may require delays in testing and data collection. As such, it is difficult to predict how long it will last and how it will affect research projects moving forward.

7. SPECIAL REPORTING REQUIREMENTS

Nothing to report.