Semi-Annual Progress Report for University Transportation Centers

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- **Program Director (PD) Name, Title, and Contact Information**
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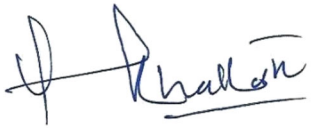

Aemal Khattak, MATC Director

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	80%
Submit Project Descriptions to TRB's RiP Database	On Schedule	100%
Submit Final Research Reports	On Schedule	81%
Collect & Store Final Data in UNL Data Repository	On Schedule	100%
Education and Outreach Activities		
Grad/Undergrad MATC Course Development & Implementation	In Process	75%
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	On Schedule	100%
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 progress had been 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, 2023 – March 31, 2024.

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.

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, data analysis, and drafting their final research reports, 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 submitted drafts of their final project reports.

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

In a research project tilted *Quantifying Soil Moisture Reduction by Wicking Geotextile to Minimize Pavement Distresses,* Dr. Jie Han and his team worked to accomplish the preparation of a research report to summarize all the test data, results, findings, as well as the recommendations for future applications of the simple test method and the fine content limit for the wicking geotextile to be effective. In addition to the completion of research work about contact angle tests of wicking and non-wicking geotextiles and field moisture capacity tests, the findings from the moisture reduction tests include 1) the wicking geotextile removed moisture from the silty sands prepared at their average field moisture capacities while moisture accumulated on top of the non-wicking woven geotextile as a barrier. 2) Moisture reduction was more pronounced when the silty sand contained fines up to 5%. The wicking geotextile was able to reduce moisture in the silty sand with 10% fines but at a slower rate and smaller amount. 3) The influence zone above the wicking geotextile was larger than that below the geotextile and the influence distance decreased with the increase of fines in the silty sands. 4) The wicking geotextile reduced the maximum amount of moisture from the silty sand containing fines up to 5% at 14 days and from silty sand containing fines 10% or more by 7 days. 5) The percentage moisture content reduction in the silty sand by the wicking geotextile decreased significantly as the fines content increased from 0% to 15%. The fines content of 15% is considered as the limit for the effectiveness of this wicking geotextile.

In a research project titled *Investigation of Driver Adaptations in a Mixed Traffic Environment,* Dr. Alexandra Kondyli and her team are conducting the driving simulator experiments with the specific objective data collection using the driver simulator. They fine-tuned the simulator scenarios through testing with a small sample of graduate students that provided feedback on the driving experience.

In a research project titled *Automated Bridge Inspection Using Digital Image Correlations Part III: Examination of Alternative Vision-Based Methods and Deployment Mechanisms for Field Implementation*, Dr. William Collins and his team focused on data analysis during this reporting period. This includes the evaluation of the full-size sign structure fatigue test DIC data, as well as development and generation and evaluation of synthetic fatigue data for DIC deep learning applications. This includes developing a methodology to generate a synthetic data set comprising high contrast images, and the training of a convolution neural network aimed at predicting displacement fields with accuracy similar to commercial hardware and software solutions.

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.

In a research project titled *Earthquake-induced Damage Classification of Bridges Using Artificial Neural Networks,* Dr. Genda Chen and his team selected and modeled two representative bridges along an emergency designated route (U.S. Hwy63 and 60 to New Madrid Seismic Zone). Finite element models including foundation stiffness specific to the project site near New Madrid Seismic Zone have started. Modeling work of the second bridge was completed. Neural network training began.

In a research project titled *SMART Shear Keys for Multi-Hazards Mitigation of Diaphragm-Free Girder Bridges – Phase III,* Dr. Genda Chen and his team completed computation modeling and began

summarizing numerical results in a final report. The effect of prestress on the SMART shear keys is being investigated. This phase aims to prepare a tsunami test in a large flume by conducting computational fluid dynamics modeling and simulations. The tsunami behavior of bridge superstructures with SMART keys can be understood from computational modeling. The numerical simulation results allow the proper design of SMART shear keys for the laboratory testing of a 1/5-scale bridge superstructure in a large flume. After the tsunami tests, additional computational simulations are needed to fully understand the tsunami behavior of SMART shear keys.

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 titled *Performance Reliability and Safety Index for Region VII Highways,* Dr. MM Shakiul Haque and his team studied travel time reliability metrics such as travel time index, planning time index, buffer index, level of travel time reliability, and coefficient of variation were quantified for weekdays (of November 2021) for five consecutive intersections for four test segments along the Highway 2 corridor in Lincoln, Nebraska. These metrics were quantified and compared using two different sources: empirical travel time data extracted from Miovision Unit and INRIX data from National Performance Management Research Data Set (NPMRDS). The goal was to validate travel time data from INRIX using empirical data. In addition, different travel time metrics found from these two sources were compared. The travel time reliability metrics derived from INRIX were compared with empirical study-based metrics. These observations will help transportation agency to compare which types of metrics were similar and different from the two sources. This will provide a better understanding of usage of a particular travel time reliability metric to represent a facility's performance.

In a research project titled *Evaluation of Driveway Assistance Device (DAD) Systems in One-Lane Two-Way Work Zone,* Dr. Aemal Khattak and his team reported that the operational impacts of traffic and work zone characteristics on DAD-operated work zone have been evaluated in terms of practical application. The findings are written as manuscript for submission to the Journal of Transportation Engineering, Part A: Systems. A poster presentation for this project was made at the Annual Meeting of the Transportation Research Board during January 2024 in Washington, D.C.

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 June 1, 2023 – March 31, 2024, are detailed below.

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

MATC's after-school program combines the talents of middle school teachers and the MATC Education and Outreach Program Manager to educate the diverse leaders of tomorrow about STEM principles. Each participating school offers the club for an hour every week. Teachers 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.

During the academic year portion of the reporting period of June 1, 2023 – March 31, 2024, a limited number of sites implemented RRRC on a weekly basis with materials supplied by MATC staff. The programming details are as follows.

Fall 2023 and Spring 2024 Roads, Rails, and Racecars (RRRC) Programming
During the reporting period October 1, 2023 – March 31, 2024, RRRC programming occurred at three (3) participating sites in Lincoln, Nebraska; Park Middle School, Mickle Middle School, and Culler Middle School for students in grades 6, 7, and 8. Topics and hands-on activities included civil engineering and towers and bridges; engineering and art; city planning and skylines; city planning and transportation systems; city planning and levees; bridges and roadways; electricity and circuits; paper airplane; paper and straw rockets; building cars; Duct tape bridges; hot wheels racetrack loops; measuring and designing cars from pop sticks and straws; and productive instructing: Bristlebot.

The after-school program at Park Middle School was offered on Mondays from 3:15 PM – 4:15 PM. The total attendance of students was 68 students (39 female and 29 male) who attended 10 sessions.

The after-school program at Culler Middle School was offered on Wednesdays from 3:15 PM – 4:15 PM. The total attendance of students was 28 students (24 male and 4 female) who attended 9 sessions.

The after-school program at Mickle Middle School was offered on Thursdays from 3:15 PM – 4:15 PM. The total attendance of students was 26 students (15 female and 11 male) who attended seventeen (17) sessions.

MATC Sovereign Native Youth Leadership Academy (SNYLA)
The MATC Sovereign Native Youth STEM Leadership Academy is a multi-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.

The 2023 Sovereign Native Youth Leadership Academy took place at the University of Nebraska-Lincoln campus from Sunday, June 18, 2023 – Thursday, June 22, 2023. High School students from High Schools in Nebraska were invited to attend. The program featured Engineering lab tours and activities, a Plant Science activity, and a GIS Story Mapping activity. Thirty-three students completed the program. A full program of the event can be found at: https://matc.unl.edu/2023-academy.

The 2024 Sovereign Native Youth STEM Leadership Academy is expected to occur at the University of Nebraska–Lincoln campus from Sunday, June 23, 2024 – Thursday, June 27, 2024. The program requirements, policies, and procedures can be found at https://matc.unl.edu/about-sovereign-native-youth-stem-leadership-academy.

We are currently receiving applications from area high school students. We plan to admit 30 – 35 students to this year's academy. To increase diversity and inclusion, we are reaching out to many schools in our districts and reservation areas to have more people apply for representation. To date, 24 students have applied for this opportunity.

Activities for the 2024 program include Engineering lab tours and activities, a food sovereignty activity, and a GIS Story Mapping activity. These activities aim to build students' interest and awareness of the engineering and transportation field. Further, students will participate in a leadership activity game

called StarPower. The goal of this game is to learn both about the abuse of power and powerlessness. Finally, students will attend activities at Nebraska Innovation Campus to learn about and use various high technology and hands-on maker space equipment.

At the end of the program, each student will be asked to participate in a post-survey to provide their input on the program and how we can make it better going forward.

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 2023 Scholars Program for Tribal College and University (TCU) students was postponed due to staffing shortfall within MATC.

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 2024 Summer Program began in October 2023 with three (3) students applying for positions. To date, none of the students have yet accepted internship positions.

MATC Summer Institute
The MATC Summer Institute 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. The program has been put on hold post COVID-19.

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 2024.

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	Pendergrass	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, 2023 – March 31, 2024
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

Conference Papers

Presentations

TRBAM-24-02184: "Modeling and Operational Evaluations of Driveway Assistance Device (DAD) System for Lane Closure on Two-Lane Highway Work Zone" was accepted for poster presentation at the conference of Transportation Research Board 103rd Annual Meeting, January 7-11, 2024, Washington, D.C., United States.

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.

SlideShare

Below is a snapshot of MATC's SlideShare activity and the link to view the page: https://www.slideshare.net/matcRegion7UTC/presentations/.

Total Views: 419	New Uploads: 0	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.
https://www.facebook.com/pages/Mid-America-Transportation-Center-MATC/141238439284182.

Total Page Followers: 449	Reach: 579	Content Interactions: 61

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.

New Followers: 0	Tweet Impressions: 171	Profile Visits: 0	Tweets: 0

YouTube

MATC's YouTube feed can be viewed by clicking the following link: http://www.youtube.com/user/midamericatrans?feature=results_main.

New Videos: 0	Views: 803	Minutes Watched: 2,776	New Subscribers: 6

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, 2023 – March 31, 2024
Outcome 1	Commercialized Products	Quantity of invention disclosures, patent disclosures, patents issued, cooperative	Ten (10) products that are commercialized or in the	Zero (0) MATC is on schedule to develop commercialized

		research and/or user agreements, and new business entities created.	commercialization process by end of grant period.	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, 2023 – March 31, 2024
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	One (1) MATC partnered with one (1) private organization on research, education, and technology transfer

			for each year of the grant period.	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 set up 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.