Semi-Annual Progress Report for University Transportation Centers

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  Aemal Khattak, MATC Director

1. ACCOMPLISHMENTS

What are the major goals of the program?

The original goals of the Mid-America Transportation Center (MATC) were modified considering the various Executive Orders (EOs) and directives from the USDOT. MATC will focus on new USDOT priorities and RD&T strategic goals when they are made available by the USDOT in Spring 2026. The modified activities related to research, education, technology transfer, and USDOT requirements are well underway. Table 1 presents 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 Year 1-2**
Data Management Plan (DMP) - Overarching Plan for MATC	Complete	100%
Collect DMPs from PIs for Individual Research Projects	In Process	60%
Collect ORCIDs from all MATC Researchers	In Process	100%
Submit Project Descriptions to TRB's Rip Database	Complete	100%
Education and Workforce Development Activities		
MATC Seminar Series	In Process	0%
MATC/UTC Outstanding Student of the Year	Complete	100%
MATC Roads, Rails, and Race Cars After-School Program	In Process	100%
MATC STEM Leadership Academy	In Process	100%
Technology Transfer Activities		
Technology Transfer Tech Briefs, Webinars & Presentations	In Process	30%
USDOT OST-R Reporting Requirements:		
Federal Financial Reports	In Process	100%
Post Research Project Descriptions on MATC Website	In Process	100%
Semi-Annual UTC Program Progress Performance Report	In Process	100%
Annual Performance Indicators Report	In Process	100%
Additional USDOT OST-R Requirements:		
Annual Progress Meetings	In Process	100%
UTC Director's Meetings	In Process	100%
Participation in UTC Symposiums	In Process	100%
Maintain Website (personnel directory, research pages and reports)	In Process	100%

What was accomplished under these goals?

Research Activities

The Mid-America Transportation Center (MATC) for USDOT Region 7 focuses on the statutory research priority area of *Promoting Safety*. During the reporting periods MATC has changed focus to comply with the various EOs and directives from the USDOT. MATC will focus on USDOT new priorities and RD&T

strategic goals when they are made available by the USDOT in Spring 2026. The MATC consortium consists of the University of Nebraska-Lincoln (UNL; lead institution), the Nebraska Indian Community College (NICC), the Missouri University of Science and Technology (MS&T), the University of Iowa (UI), the University of Kansas (KU), and the University of Missouri-St. Louis (UMSL).

As of this reporting period, UNL has seven (7) ongoing USDOT-funded projects, supported by fifteen (15) PI's and Co-PI's. The University of Iowa (UI) has eight (8) ongoing USDOT-funded projects, supported by eleven (11) PI's and Co-PI's. The University of Kansas (KU) has eight (8) ongoing USDOT-funded projects, supported by eleven (11) PI's and Co-PI's. The Missouri University of Science & Technology (MS&T) has nine (9) ongoing USDOT-funded projects, supported by five (5) PI's and Co-PI's. The University of Missouri-St. Louis (UMSL) has five (5) ongoing USDOT-funded projects, supported by six (6) PI's and Co-PI's. The Nebraska Indian Community College (NICC) currently has one (1) ongoing USDOT-funded project, supported by two (1) PI and two (2) 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 and case study reviews, experiment development, and data acquisition, MATC Researchers reported the following project objectives, results, and key outcomes for this reporting period.

In a research project titled Analyzing the Accessibility to Safe and Connected Biking Infrastructure Facilities at the University of Nebraska-Lincoln, Dr. Yongping Liang and his research team are addressing the issues identified from Round 1 analysis and further enhancement to promote access to safe biking facilities. They first used the collected kinematic data to calculate anomalies of biking lanes. The calculation uses protocols and algorithms that have been developed by the research team, featuring low-cost sensing and state-of-the-art accuracy. The collected biking lane quantity (miles) and quality (anomalies) data are then imported into a GIS platform to analyze their distribution across regions, with census data collected as explanatory variables.

Although they are still fine-tuning their analyses – which means the results may evolve – the research team has already observed promising findings. Their approach is entirely data-driven, contrasting with theoretical discussions or narrowly focused neighborhood case studies. Their results show that Lincoln, NE is doing well in providing bike lanes to those with the greatest need – such as households without vehicles and low-income families. In contrast, individuals or households with higher socioeconomic status—measured by income and educational attainment – tend to occupy significantly fewer bike lane miles. However, when examining the issue from a quality perspective, by analyzing the distribution of infrastructure anomalies, the pattern reverses. People with lower socioeconomic status or greater biking needs are more likely to live in areas with a higher density of biking infrastructure issues. This analysis focuses solely on biking as a commuting option and excludes recreational trails. It only considers areas that the City of Lincoln has identified as having medium or higher biking needs.

These findings have clear and significant implications for planning and policy. Based on their findings, Dr. Liang and the research team recommend prioritizing the maintenance and enhancement of biking infrastructure in high-demand areas, such as downtown, over expanding facilities in lower-demand areas.

Project Rural Omnichannel Healthcare: a Demand-Centric Approach in Transportation System Design led by Dr. Shakiba Enayati and her research team at the University of Missouri-St. Louis successfully analyzed the third and final focus group for the study Exploring the Adoption of Telehealth Kiosks to Improve Healthcare Access in Rural Missouri. The meeting brought together a diverse set of rural stakeholders—including healthcare professionals, local caregivers, community advocates, and county officials—to capture local perspectives on healthcare access challenges and the potential role of telehealth kiosks in improving service delivery. The research team has begun integrating findings from this session with data collected during earlier focus groups held in DeKalb/Daviess and St. Clair/Hickory counties. Together, these discussions provide a comparative understanding of healthcare access issues across different parts of rural Missouri. The emerging insights are guiding the identification of recurring themes and will inform evidence-based recommendations for future telehealth planning, implementation, and policy development in underserved areas. Furthermore, IRB approval was obtained for the discrete choice survey designed to elicit individuals' preferences for telehealth kiosks (TKBs), travel costs, and relevant access barriers. During this reporting period, the project advanced a key research objective: gathering community perspectives to understand how TKBs can enhance healthcare access in rural Missouri.

Also, at the University of Missouri-St. Louis, Dr. Trice Encarnacion leads project Optimal Design of Inland Waterway System to Increase Supply Chain Resilience from University of Missouri-St. Louis. During this reporting period, four major tasks were conducted to achieve the objectives. The tests helped identify parameter ranges and computational settings suitable for scaling up to larger network configurations. The project achieved several of the specific objectives outlined in the research proposal. The team successfully implemented the MILP framework in Python, translating the conceptual formulation into a functional model capable of evaluating freight network resilience through metrics such as redundancy, recovery time, and throughput. The data and coding pipeline connecting the synthetic network configurations to the Python model was also completed, allowing automated simulation and analysis across multiple network topologies. Initial small-scale network cases were successfully solved, confirming model feasibility, validating solver performance, and identifying suitable parameter ranges for larger-scale analyses. In addition, work began on the St. Louis regional case study, focusing on the Mississippi Waterway as a central network component. GIS data were collected and model inputs prepared to assess the potential of inland waterways to enhance resilience in regional freight systems. Collectively, these accomplishments advance the project toward its overarching goal of characterizing resilient network topologies and demonstrating how inland waterways can strengthen supply-chain robustness in disaster response.

The key outcome of project Understanding Moving/Damage Mechanism of Vehicles under Tornadoes for Enhancing Vehicle/Driver Safety, led by Dr. Grace Yan from Missouri University of Science and Technology, is the development of CFD simulations of the vehicle in straight-line wind fields. A preliminary analysis of the available results has also been conducted. Overall, the forward simulations generated significantly lower aerodynamic forces compared to the sideways simulations. In the 36 m/s forward simulation, the force in the x-direction was only 17% of that in the corresponding sideways simulation. In all three forward simulations, the force coefficients in the x-direction were also substantially smaller than those in the sideways simulations, primarily because the vehicle's shape is aerodynamically optimized to reduce drag in the forward direction. In the next reporting period, the team will begin simulating the vehicle under tornadic wind fields. In the next reporting period, the team will begin simulating the vehicle under tornadic wind fields.

In a research project titled Investing in Talent for Next-Generation Transportation Engineering, Dr. Logan Perry and the team at University of Nebraska-Lincoln accomplished specific objectives identified in their research proposal during this reporting period, including the design of interview protocols and compilation of documentation for recruitment. These are necessary steps towards the completion of data collection for this project. As data collection is currently in its beginning stages, the researchers have prepared the documentation and protocols necessary for an efficient (data collection) process. This includes consent forms, interview questions, recruitment information, and methods for participant screening and scheduling. Over the reporting period, the research team held regular meetings to finalize the criteria, screening and recruitment process, and interview protocol for research participants. The research team submitted for and received IRB approval to begin data collection for this project. An initial screening survey has been prepared for potential participants and informed consent forms, recruitment scripts, and interview questions have all been drafted. Additionally, a literature search was conducted to begin the initial writing of a literature review for project dissemination.

Dr. Andrea Hupman and her research team at the University of Missouri-St. Louis focused on Bayesian methods for predicting freight rates. Though project Decision Support for Dynamic Risks: Predicting Transportation Costs, they examined key computational tools such as dynamic Bayesian networks, Kalman filtering, and Hidden Markov Models (HMMs). A central objective—evaluating initial state priors in HMMs—was addressed through expert-informed, uniform, empirical, Dirichlet, and logistic-normal approaches. They assessed their performance using model fit and cross-validation. Advanced modeling activities included the use of Bayesian hierarchical approaches leveraging Dirichlet distributions, and the incorporation of logistic-normal functional priors that enable context-sensitive modeling of initial beliefs. Simulations were used to evaluate the impact of various prior specification strategies on model performance, particularly in algorithms like Viterbi decoding, forward-backward inference, and Baum-Welch estimation.

Their study yielded several findings related to Bayesian inference, Hidden Markov Models (HMMs), and their application to dynamic and uncertain data environments. The research team also explored multidimensional clustering for reducing large hidden state spaces, applying K-means, Gaussian Mixture Models, and spectral clustering to merge micro-states into macro-states. However, they observed that clustering results could be sensitive to feature selection and scaling, and there remains a trade-off between simplification and model interpretability. These findings inform ongoing research.

Regarding data quality, a small sample size proved to be a critical challenge in HMM initialization and training. Empirical priorities derived from incomplete sequences introduced instability in early iterations. While imputation and marginalization techniques partially alleviated this, they introduced added uncertainty to the posterior. Key progress during this reporting period included the development of the transition matrix for the Bayesian model, which is a key component of the predictive model. As the transition matrix becomes larger, it increases model accuracy but also necessitates a larger dataset to accurately estimate the increased number of transition probabilities. Balancing the size of the transition matrix with the available data, while pushing for the highest accuracy, has been identified as an important component of model construction. They also made progress in modeling with limited or missing data by combining simulation and smoothing methods. Traditional linear models like Kalman filters may not be reliable for forecasting logistics price indices, which are subject to sudden disruptions and non-linear trends.

Dr. Jian Li from the University of Kansas reported major activities in his project titled Enhancing Structural Safety in Infrastructure Maintenance through Human Centered Bridge Inspection Empowered by Artificial

Intelligence and Augmented Reality. Development of the AR infrastructure inspection tool has continued and progressed steadily. The transition from HoloLens to Magic Leap 2 platform has been going smoothly, with all features previously implemented working as expected on the new headset. In addition to preserving core functionality, a series of quality-of-life improvements have been integrated into our application to enhance the convenience of use during field inspections. Progress has been made with spatial persistence, particularly in the anchorage of Magic Leap's spatial mesh.

A new researcher has been brought on to focus on the development of the concrete bridge inspection model. Training of said model has begun and is building on the foundation established by their concrete damage identification model. With this, the team can now turn to implementing new features into the AR inspection tool.

Figure 1. User interface with updated functionality.

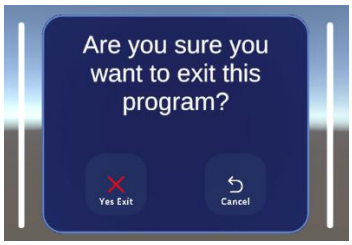

Figure 2. Confirmation of exit message.

Several changes were made to the functionality of the user interface panel seen in figure 1. Functionality has been given to the two buttons outlined in red, and the exit button has been altered for the comfort of the AR application user. To avoid interruption and active human centered inspection accidentally, the exit button will prompt the user, as seen in figure 2, and ask them if they are certain they want to quit and allow them to cancel this decision. Also in figure 1, the "delete cracks" and the "toggle overlay" buttons are outlined in red. These are also new additions and have recently been given functionality. This would serve useful if the inspector took a bad photo or wanted to redo inspection of a specific surface. Inspectors needed to be able to delete specific inspections/projections to not have undesired deletions.

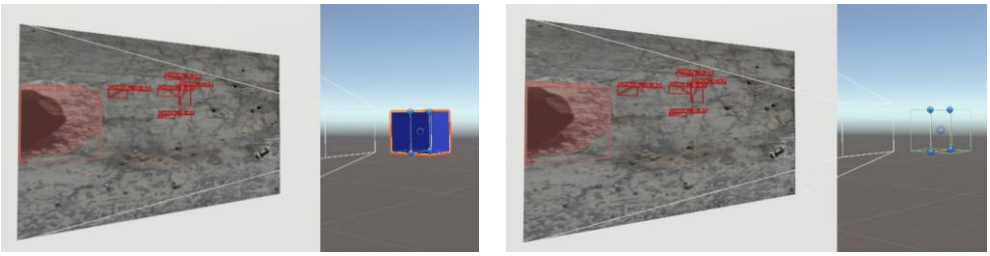

Figure 3. Left - Projectors before this update are visible and can be distracting. Right - Projectors when hidden.

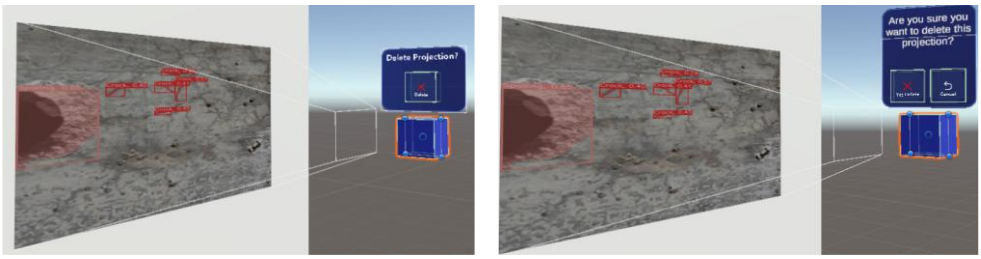

Figure 4. After pressing “delete cracks” inspectors can now interact with projectors and are able to delete them.

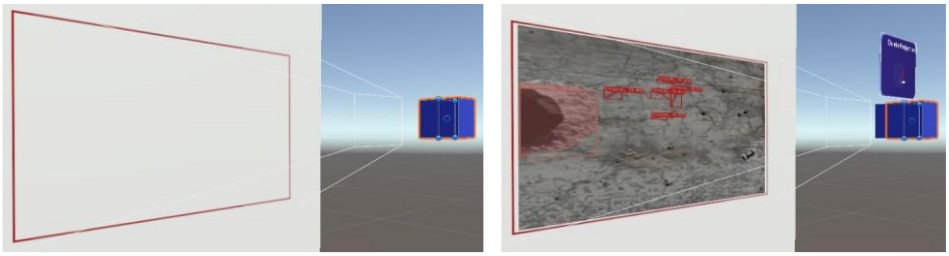
Figure 5. Image overlay demonstration. Left – projector attached to user’s head showing where images will be taken from and where they will be projected to. Right – after image is taken and inference is made projections are within bounds of the overlay.

To allow the user to see the dimensions and borders of the image before capture, the researchers attach a projector to the main camera of the unity scene (which aligns with the headset, or inspector’s head in the real world) and project a red rectangle with the same dimensions and aspect ratio as the camera that will be taking images for inspection. This can be seen in figure 5, where on the left the projector outlining where the projection will land once an inference is made on an image, and on the right how the projections align with each other's shape and size.

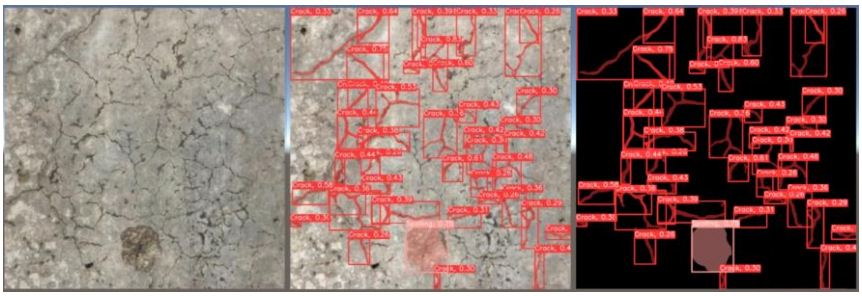
Figure 6. Left – example crack image. Middle – example of output with background image. Right – example of output with only inference mask.

Another alteration has been made to the inferences and their projections. The researchers have altered the inference/projection pipeline to instead allow them to only project the mask of the cracks and fatigue (as seen on the right in figure 6), and place those directly on top of the physical structure so the user isn’t forced to see features and objects duplicated on top of one another.

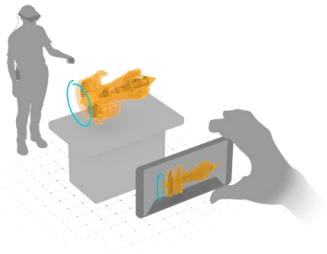

Figure 7. Magic Leap Spectator illustration
https://developer-docs.magicleap.cloud/docs/guides/features/magic-leap-spectator/ml-spectator/

While looking into solutions for this issue, their team discovered a feature known as Magic leap Spectator. Magic Leap Spectator is a plugin for the Magic Leap headset that allows users to pair a mobile device to the headset and view the hologram content produced by the headset as seen in figure 7. The team spent some time exploring this option not only for demonstration purposes but also to allow multiple inspectors to view inspection inferences and results in real time using only one headset.

Dr. Salam Rahmatalla at the University of Iowa leads a project titled Damage Progression of Highway Bridges and Operational Vibration-Waveforms. Preliminary data analysis found that the FHWA #700035, identified previously, did not provide strong Signal to Noise Ratio (SNR) as compared to FHWA #23850. As a result, the US20 Bridge was selected as a sample for multiple-span bridges. Additionally, a bridge in Keokuk County (FHWA #32600 carrying IA-21 highway, built in 1948) was selected. Both US20 Bridges in Dubuque and IA-21 highway bridges are shown in Fig. 1.

Figure (1). two bridge candidates which sensors mounted on, (a): three-span US20 Bridge in Dubuque FHWA #23850, (b): single span bridge IA-21 Hwy in Keokuk County FHWA #32600.

Both Bridges, US20 Bridge in Dubuque and IA-21 Hwy in Keokuk County, were instrumented with X16-1D accelerometer data logger developed by Gulf Coast Data Concepts (*GCDC Inc.* https://gulfcoastdataconcepts.com/). These three-dimensional sensors can record X-Y-Z translational acceleration level. In this system, it is possible to define a trigger, i.e., the sensor will collect data only if any directional vibration level passes its predefined threshold level.

Figure (2). Gulf Coast Data Concepts (GCDC) accelerometer mounted on Dubuque Bridge.
Figure (3): smart camera developed by Axis communication ® to detect vehicle type and speed; AXIS Q1656-DLE Radar-Video Fusion Camera.

Axis® video radar camera was installed and used for the US20 Bridge in Dubuque (Fig. 3). The Radar-Video Fusion Camera (Q1656-DLE) brings video and radar analytics together to provide precise localization and object classification powered by deep learning. The radar detects objects over wide areas with little or no light and it visualizes the speed and distance of moving objects directly in the application view (Axis Communication Inc®. https://www.axis.com/products/axis-q1656-dle).

The FEM of US20 bridge has been simulated in *Abaqus*® based on its blueprints received from Iowa DOT Bridge and Structure Bureau records. US-20 Bridge FEM consists of two major exterior continuous girders, two smaller interior girders that carry 3 span bridges with a rectangular deck, and eighteen cross/lateral beams distributed equally along bridge spans. Both pier caps boundary conditions were modeled as rocker bearings constrained in all direction; while bridge edge boundary conditions over abutment areas were modeled as roller bearings free for some axial deformation, required for thermal expansion, like the authentic bridge boundary conditions. 3D shell elements (type S4R) were used to model girders and cross beams flanges and webs, while 3D truss elements (type T3D2) were used to simulate reinforcement of rebar. All rebars and stirrups embedded in the concrete deck, were assigned to the concrete slab elements. In total, The FEM is made up of *25139* structural nodes and *19030* elements.

Site data were collected from US-20 bridge over two weeks period by both vibrations based as well as vision-based sensors. Since recording continuous raw vibration data of any bridge is both economically and computationally extremely expensive, vibration sensors programmed such that only vibration over "0.35g" of acceleration could trigger the sensors to start recording block of sample data. By this smart sensor option/setting, automatically discarded samples saving storage space and battery life for sensors to last several weeks on-site without any required maintenance. The significant blocks of vibration data were collected at 3-5 seconds time block and packed behind each other. In each block, the data is sorted from highest absolute value to the lowest value.

Field collected sensor datasets are plotted plus their time domain and frequency domain conversions required for condition monitoring. Due to the predefining of 0.35g threshold in the sensors setting, only vibrations over that specified threshold have been recorded and plotted packed behind each other. This data could be representative of heavy truck-induced vibration on the bridge.

Education and Outreach Activities

In 2023, MATC implemented educational outreach programs in support of USDOT's Strategic Plan and the center's mission to increase the number of students in STEM education and transportation-related careers. MATC programs have been changed in response to directives from USDOT to comply with the

various EOs. The Scholars program in its previous format has been discontinued while the format of the previous STEM summer academy (SNYLA) has been changed. The program, now called the MATC STEM Academy, is open to all students and in compliance with USDOT/EO directives. As a result of the changes, any savings are being invested in ongoing outreach efforts. Descriptions of each educational program funded by the MATC UTC program are detailed below.

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

MATC's after-school program combines the talents of local middle school teachers, UNL undergraduate student mentors, and the MATC Education and Outreach Program Manager to educate the diverse leaders about STEM principles. This program is for middle school students in grades 6, 7, and 8. Each participating school offers a club for an hour every week. Teachers and mentors present on an engineering or transportation-related topic and lead students in an interactive activity encompassing the lesson's concepts. Ten middle schools (Park, Culler, Mickle, Lefler, Goodrich, Scott, Schoo, Dawes, Irving, and Pound) implemented weekly RRRC programming with support from MATC staff and materials. Across all sites, a total of 193 students participated in 82 sessions, generating 532 total attendees. Sixth graders represented the largest group (124, 64.25%), followed by 43 (22.28%) seventh graders and 26 (13.47%) eighth graders. Gender distribution was evenly split, with 61.14% female and 38.86% male students. Attendance per school ranged from 8-172.

Students were engaged in a wide range of hands-on STEM and engineering activities designed to foster creativity, collaboration, and critical thinking. These included constructing bridges and conducting strength tests (Suspension Bridges, Eureka Bridge, Popsicle Stick Bridge); creating towers to withstand simulated earthquakes (Straw Tower, Tallest Paper Tower, Wood and Adhesive for Building Tower, Space Needle Tower, Noodle and Marshmallow Towers, Spaghetti Towers Challenge, Solar Updraft Tower, and Seismograph/earthquake); building a racetrack (Road Cant); building Levees to Protect Cities, Cranes for Lifting, and Animal Fencing; and exploring motion and energy through Fan Cars, Rubber Band Cars, Balloon Cars, Edible Cars, Rockets, Helicopters, Wind Turbines, Kites, Gliders (O-Wing, Styrofoam, and paper), and Craft Stick Launchers.

Creative and design-focused activities included arts and engineering, foil sculptures, balance and mobile structures, magnetic scenes, finger skateboards, paper windmills, pinwheels, and roller coasters. STEM-focused activities included time, speed, velocity, and acceleration; catapults; parachutes (including tissue paper versions); egg drops; straw-based design; mechanical hands; articulated grabbers; sleighs and ramps; traffic maps; gears; spectroscopes; and the Bernoulli principle.

MATC STEM Academy

The MATC STEM 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 program is open to any high school student in Federal Region VII. Students apply for admission to the academy. A committee reviews and admits students based on assessment of the application that includes an essay, GPA, reference checks from two teachers, and overall suitability for attendance.

The 2025 STEM Academy was hosted at the University of Nebraska–Lincoln from June 8-12, 2025. The program requirements, policies, and procedures can be found at STEM Academy | Mid-America Transportation Center | Nebraska.

Over sixty-two high school students from across Nebraska applied for this STEM and engineering opportunity. Thirty students (17 females and 13 males) were selected for this year's academy, representing thirteen high schools across Nebraska. The cohort included 14 Whites, 6 Native American, 4 Hispanic American, 3 Middle Eastern American, 2 African American, and 1 Asian American student. Five teachers and seven mentors assisted MATC staff in overseeing and guiding students during the five-day academy at UNL.

During the program, students engaged in a variety of STEM and engineering presentations, activities, workshops, and tours. Highlights from the 2025 STEM Academy included a one-day chemistry lab, presentations at Love Library, a tour and sessions at Spring Creek Prairie Audubon, a tour and hands-on activities at the Nebraska Innovation Center, a visit to the Strategic Air Command & Aerospace Museum, nature-based learning at Mahoney State Park, and more. For additional details about the MATC 2025 STEM Academy, please visit: 2025 Academy | Mid-America Transportation Center | Nebraska

MATC Research Experience for Undergraduates (REU)
MATC continues to support academic year undergraduate research assistantships and graduate research projects. While the REU program is not offered this year, future summer research opportunities are under consideration.

How have the results been disseminated?
The MATC Program Coordinator continues to maintain individual project records on the Transportation Research Board's Research in Progress (RiP) and Transportation Research Information Database (TRID), as well as on MATC's online database at https://matc-data.unl.edu/research-database.

MATC projects are committed to having a sustained impact on the transportation system through technology transfer and workforce development efforts. For example, proposals for this research included technology transfer plans. Although there are new projects where major results are yet to be produced, there has already been significant dissemination through weekly group meeting discussions, invited lectures and seminars, conference presentations. For instance, Dr. David Lee from the University of Iowa and Dr. Jie Han from the University of Kansas have presented preliminary findings at several international conferences. Some details are listed below:

At the University of Missouri-St. Louis, several PIs shared their findings through a variety of activities: Dr. Encarnacion and Dr. Jaramillo-Rios presented Enhancing safety, infrastructure, and intermodal connectivity in inland waterway freight transport at the TRB Conference on Innovative Science and Technologies to Improve Security and Safety in the Marine Transportation System, Washington, D.C., United States, in June 2025. Dr. Haitao Li gave an invited talk entitled "Quantum and QUBO Approaches for Supply Chain Applications", at the Quantum Day sponsored by Natural Resources Canada, in June 2025. Dr. Hupman indicated that an abstract has been accepted for the 2025 INFORMS Annual Meeting, where the research will be presented. This presentation will disseminate the work to a leading professional organization that includes both academics and industry professionals.

According to Dr. Enayati, preliminary findings during this reporting period from the focus group sessions were disseminated to internal and regional collaborators to inform ongoing planning and community engagement. Early insights—centered on healthcare access challenges, barriers to care, and perceptions of telehealth kiosks—were shared with MU Extension teams in both the West Central and Northeast

regions. These discussions helped shape local outreach strategies and facilitated cross-county learning among Extension personnel and other stakeholders.

To ensure that the findings are accessible and actionable, the research team is in the process of developing a comprehensive, synthesis-based final report that compares themes across all participating counties. This report will be shared with public health officials, rural healthcare providers, MU Extension, and other relevant state and regional partners. The goal is to provide a practical, evidence-based resource that highlights both commonalities and distinctions in rural healthcare needs and guides context-sensitive telehealth deployment.

Additionally, the team is preparing a peer-reviewed journal article that captures the perspectives of rural residents and community health actors across the study regions. The manuscript will emphasize community-identified strategies for overcoming implementation barriers and sustaining kiosk use over time. Following publication, the findings will be further disseminated through targeted outreach—such as policy briefs, summary materials, and invited presentations—to reach practitioners, policymakers, and rural health networks across Missouri.

At the University of Kansas, Dr. Jie Han, organized weekly group meetings where research results from their project are discussed. Students not directly involved in the research have also been exposed to findings from their research. Previously, Dr. Han has presented research outcomes at various professional events, including the Transportation Research Board meeting in Washington, DC (January 5–9, 2025), the Geotechnical Frontiers conference in Louisville, KY (March 2–5, 2025), and a seminar for the geotechnical engineering community in Honolulu, Hawaii (March 8, 2025). Additionally, some results were shared at the International Geotechnical Innovation Conference in Jeddah, Saudi Arabia (May 4–6, 2025), during a session on enhancing resilience of earth retaining structures with geosynthetic reinforcement. Recently, Dr. Han gave an invited presentation on Design of Geosynthetic-Reinforced Column-Supported Embankments at New Jersey Department of Transportation on July 17, 2025; keynote lectures on Geosynthetic Innovations for Sustainable, Resilient Infrastructure at the 1st International Conference on Interdisciplinary Enablement of Civil Engineering, Textile and Materials, Hangzhou, China, Sept. 26-28, 2025 (travel to the conference venue was not funded by MATC); and Geosynthetic Reinforcement to Enhance Resilience of Earth Structures at the 5th International Conference on Geotechnical Engineering - Iraq (5ICGE-Iraq), July 2nd, 2025 (travel to conference venue was not funded by MATC).

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). Planning for future (2026) webinars is underway.

2. PARTICIPANTS & COLLABORATING ORGANIZATIONS

What organizations have been involved as partners?

During the reporting period, MATC worked with twenty-nine (29) 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
Research	University of Missouri	Columbia	MO				X	
Research	The St. Louis Regional Freightway	St. Louis	MO				X	
Research	University of Wisconsin – Eau Claire	Eau Claire	WI				X	
Research	University of Southern California	Los Angeles	CA				X	
Research	CEMATRIX Inc.	CANADA			X		X	
Research	Tensar International Corp.	Alpharetta	GA		X		X	
Research	UMSL Bridge Program	St. Louis	MO		X			
Research	University of Missouri Extension	St. Louis	MO				X	
Research	Entanglement, Inc.	Miami	FL		X			
Research	University of Colorado-Denver	Denver	CO		X			
Research	Kansas Department of Transportation	Topeka	KS		X		X	
Research	Seatbelts Are For Everyone (SAFE)		KS				X	
Research	University of Kansas Medical Center	Kansas City	KS		X		X	
Research	University of Ulsan	SOUTH KOREA					X	
Research	IBM		NY		X		X	X
Research	Entanglement Inc.,	Denver	Co		X		X	
Research	Institution for Data Science and Informatics at UMC		MO				X	
Research	University of Saskatchewan	Canadian					X	
Research	Global Foundries	Malta	NY				X	
Research	University of Calgary	Calgary	Canada				x	

3. OUTPUTS

Publications, conference papers, and presentations

Journal Publications

1. Enayati, S., a peer-reviewed journal article based on the findings from the focus group discussions is currently under preparation.
2. Xie, F., Y. Li and H. Li (2025), Integrating Simulation, Optimization, and Reinforcement Learning for a General Class of Stochastic Scheduling Problems, Expert Systems with Applications, forthcoming.
3. Womer, K., J. Camm, B. Khalifeh and H. Li (2025), Estimating the Effects of Ramp-up and Learning using Performance Data, Journal of Defense Analytics and Logistics, forthcoming.

Books or other non-periodical Publications

Conference Papers

1. Lee, Myungwoo and Aemal J. Khattak. Motor vehicle traffic diversion to alternate routes for improving safety at highway-rail grade crossings. Transportation Research Record, Journal of the Transportation Research Board, July 2025.
2. Haque, MM Shakiul and Aemal J. Khattak. Modeling and operational performance evaluation of driveway assistance devices for lane closures on two-lane highway work zones. ASCE Journal of Transportation Engineering, Part A: Systems, Vol. 151(3), December 2024.
3. Chen, H., Han, J., and Parsons (2026). "Assessment of Analytical and Numerical Methods for Stability of Embankments over Deep Mixed Columns-Improved Soft Ground under Undrained Conditions." Submitted for GeoCongress 2026, accepted.
4. Chen, H., Han, J., Ye, Y., Parsons, R.L. (2026). "Numerical Assessment of Analysis Methods for Stability of Geosynthetic-Reinforced Embankments over Rigid Inclusions-Improved Soft Ground under Undrained Conditions." Abstract submitted for the 13th International Conference on Geosynthetics, Montreal, Canada, Sept. 13–17, 2026.
5. Han, J., Chen, H., and Parsons (2026). "Numerical Analysis of Stability of Embankments over Aggregate Columns-Improved Soft Ground under Linked, Undrained and Drained Conditions." Submitted for International Conference on Soil Mechanics and Geotechnical Engineering, Vienna, Austria, June 14 to 19, 2026. under review.
6. Stennett, S. and Tran, D. (2025). "Examining Safety Behaviors of Highway Construction Workers," 2025 Canadian Society for Civil Engineering (CSCE) International Construction Specialty Conference / ASCE Construction Research Congress, Montreal, Quebec July 28 – 31.

Seminars and Workshops

Jie Han, PI, Seminar: Design of Mechanically Stabilized Earth Walls under Special Conditions, Honolulu, Hi, April 19, 2025.

Jie Han, PI, Workshop: Evolution of Geosynthetic Materials, Innovations in Geosynthetic Reinforcement for MSE Structures, Geotechnical Frontiers, Louisville, KY, March 3, 2025.

Dr. Han was the chair for the workshop on Transportation Earthworks: Design, Installation, Evaluation, and Sustainability of Lightweight Fills held at the Transportation Research Board meeting on Jan. 5, 2025.

Presentations

1. Zhao, Li, Frank Selase Dzawu, Aemal J. Khattak, Bryan Guy, Nicholas Gordon, and Garret Schram. Are flashing yellow arrow signals effective in eliminating yellow traps for lead lag left turns? Presented at the 104th Annual Meeting of the Transportation Research Board, Washington DC, January 2025 (TRBAM-25-05151).

2. Zhao, Li, M. Umer Farooq, and Aemal J. Khattak. Signal preemption simulation at intersections near highway-rail grade crossings. Presented at the 104th annual meeting of the Transportation Research Board, Washington DC, January 2025 (TRBAM-25-03402).
3. Haitao Li, PI, of the University of Missouri-St. Louis, presented the Quantum and QUBO Approaches for Supply Chain Applications, Webinar, Quantum Day, Natural Resources Canada, June 2025.
4. David Lee, PI, of the University of Iowa, presented the Preliminary Findings at the US-Korea Conference in Atlanta, August 6-9, 2025.
5. Haitao Li, PI, of the University of Missouri-St. Louis, presented Quantum Optimization for Semiconductor Supply Chain Configuration, IEEE Quantum Week Conference, Quantum Computing in Practice Session, Albuquerque, NM, September 2025.

Patent Applications

Technologies or Techniques

Genda Chen of the University of Missouri Science & Technology -- Deployment of low-cost edge computing devices to fuse strain-gauge and accelerometer sensor data measurements for bridge weigh in motion calculations.

Hannes Devos of the University of Kansas – Development of a driving simulator scenario for the assessment of Level 3 AV driving, as well as Matlab code to automatically extract the driving simulator variables. They plan to share the code with the publication of our results in an open access database.

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

The MATC website was changed to comply with the various EOs 14148, 14153, and 14154 as outlined in the program guidance issued on by USDOT on March 25, 2025. The list of changes was submitted to the USDOT. MATC intends to continue maintenance of five online sites that distribute information utilizing the internet. Metrics for the period 4/1/2025-9/30/2025 can be found below.

MATC Website

By clicking the following link, http://matc.unl.edu, you will be directed to MATC's website.

SlideShare

https://www.slideshare.net/matcRegion7UTC/presentations/.

Total Views: 606	New Uploads: 0	Downloads: 0	Favorites: 0

Facebook

https://www.facebook.com/pages/Mid-America-Transportation-Center-MATC/141238439284182.

Total Page Followers: 466	Reach: 2,059	Content Interactions: 84

X.com (Twitter)

MATC's Twitter handle is @MATCNews. The page can be viewed by clicking the following link: https://x.com/MATCNews

Total Followers: 207	Posts: 13

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: 592	Hours Watched: 20.2	New Subscribers: 1

Additional Partner Websites

MATC partners institutions were requested to ensure compliance with EOs 14148, 14153, and 14154 as outlined in the program guidance issued on March 25, 2025, by USDOT. Several MATC Principal Investigators created websites to share information about their research projects. The links to these websites are provided in Table 3 along with the corresponding MATC project.

Table 3: Websites for Individual MATC Research Projects Created by Principal Investigators

Project Title	Principal Investigator	Website Link
Development of a Real-Time Flood Forecasting System for Railroad Crossings in the Midwest	Witold Krajewski Nicolas Velasquez	https://github.com/nicolas998/network_conditioning https://github.com/nicolas998/asynch/tree/distv2
Understanding Moving/Damage Mechanism of Vehicles under Tornadoes for Enhancing Vehicle/Driver Safety	Grace Yan	http://hmcr.mst.edu/ https://sites.google.com/a/mst.edu/wham/home

4. OUTCOMES

During this reporting period, several outcomes were identified through MATC projects. At the University of Nebraska-Lincoln, Dr. Brandon Perry and the research team uncovered critical evidence showing that many of the criteria used in roadside hardware evaluations were originally developed using male-only data and do not reflect the full range of real-world injury risks.

Their expanded literature review has laid the groundwork for the next phase of simulations, which will evaluate how well current crash test criteria protect occupants of different sizes, ages, and sexes. This work is setting the stage for more inclusive safety standards that can better serve all road users.

Additional achievements include:
1. Identification of diverse seated occupant positions for simulation based on real-world data.
2. Setup of FE dummy models for crash simulation.
3. Graduate student training in advanced simulation tools and injury biomechanics research

The project Rural Omnichannel Healthcare: A Demand-Centric Approach in Transportation System Design at the University of Missouri-St. Louis yielded early outcomes. Led by Dr. Shakiba Enayati, the research team advanced understanding of rural healthcare access and informed the potential application of telehealth kiosk (TKB) technologies within transportation and healthcare delivery systems. While long-term impacts—such as policy adoption and implementation—will materialize in later phases, meaningful short-term outcomes have already emerged across awareness, knowledge creation, process improvement, and capacity building.

1. Increased Understanding and Awareness of Access Disparities

Focus group activities have heightened awareness among regional stakeholders, including MU Extension staff, rural health administrators, and county officials—about the transportation and distance-related barriers. Through discussions and dissemination sessions, participants gained clearer insight into how mobility constraints, geographic isolation, and infrastructure gaps intersect with healthcare delivery challenges.

2. Expansion of the Knowledge Base

Preliminary findings have contributed to the growing body of knowledge on adoption of rural telehealth, revealing both structural barriers and community-driven strategies for overcoming them. The integration of insights across six Missouri counties provides one of the first qualitative baselines for assessing latent healthcare demand and telehealth readiness at the county level. These findings directly inform the design of the Discrete Choice Experiment (DCE) survey and subsequent optimization models.

3. Improved Methods and Analytical Capabilities

The project has advanced methodological approaches for linking community-based qualitative data with quantitative modeling. The upcoming Mixed-Integer Linear Programming (MILP) framework—guided by empirical findings—represents an innovative integration of behavioral insights into infrastructure planning, supporting more equitable and cost-efficient telehealth deployment strategies.

4. Strengthened Regional Collaboration and Stakeholder Capacity

The collaboration among MU Extension, healthcare providers, and academic researchers has strengthened inter-county communication and coordination. These partnerships have already informed outreach strategies and built local capacity for future implementation of telehealth initiatives, including planning for kiosk siting and service integration.

5. Preparation of Future Transportation and Healthcare Analytics Professionals

Graduate and undergraduate research assistants have gained hands-on experience in mixed-methods research, data analysis, and stakeholder engagement. Their involvement contributes to enlarging the pool of trained professionals capable of addressing transportation-enabled healthcare delivery challenges.

At the University of Kansas, Dr. Nikhila Gunda and his research team continued contributing to both academia and practical applications in safety and transportation logistics. In their project titled “SAFE Schools for Safer Future”, the data gathered through survey, demographic, and crash reports enhanced understanding and awareness of how teens perceive safe driving behaviors, as well as their own and their peers' driving habits. The team anticipates this research project’s findings will contribute meaningfully to the limited body of research on teen drivers. In addition, their analysis of crash data is expected to provide deeper insights into the factors contributing to teen driver crashes in Kansas. Collectively, these efforts aim to broaden awareness and knowledge of teen driving behaviors, perceptions of safety, and the effectiveness of teen driver education programs—informing parents, communities, schools, and decision-makers at local, regional, and state levels.

Another research project, Selecting Appropriate Mitigation Methods for Potential Soil Slope Failures, led by Dr. Jie Han and Dr. Robert L. Parsons at the University of Kansas provided the numerical results from the parametric study revealed that stone columns, deep mixed columns, and rigid inclusions with large size and small spacing could effectively increase the safety of the embankment and prevent deep-seated failure. The current design methods available in the literature overestimate the factor of safety, which is unsafe. This finding increases the body of knowledge and provides technical guidance for the design of stone columns, deep mixed columns, and rigid inclusions for preventing deep-seated failure of embankments over soft clays.

At the University of Missouri-St. Louri, Dr. Haitao Li and the research team have performed an extensive computational experiment of the QUBO approaches for UFLP through Gurobi's QUBO solver and D-Wave's quantum-classical hybrid solver (QCHS). They find that the QCHS has an average optimality gap of 30% for UFLP instances with large duality gap. This shows that the hardness for quantum- and quantum-inspired algorithms to solve UFLP is not only the problem size, but the polyhedral properties of the corresponding integer programming formulation. This calls for more efficient algorithms for solving large-scale QUBO instances, such as the Tabu search being developed and implemented in this project.

5. IMPACTS

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

Dr. Jian Li of the University of Kansas expects a positive impact on the effectiveness of the transportation system by creating an environment that allows inspectors to maintain the transportation system more effectively. Allowing inspectors to handle the large volume of inspections will allow for safer roadways to be maintained more efficiently.

In the project titled Optimal Design of Inland Waterway System to Increase Supply Chain Resilience at the University of Missouri-St. Louis, Dr. Encarnacion and her team expressed that their research would guide investment in inland waterway infrastructure by identifying needs such as upgrading locks and dams, enhancing ports, and improving multimodal connectivity to boost capacity and reliability. Research findings will provide policymakers with data-driven insights into the economic, environmental, and social impacts of inland waterway transport. This could lead to better-informed policies and regulations that support the growth and sustainability of these means of transport, leading to more cohesive and effective approaches to managing and utilizing inland waterways. The research aims to enhance this advantage by identifying strategies to shift to this mode and to leverage the inland waterway system to reduce operational costs by improving logistics transport efficiency.

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?

Dr. Jie Han and Dr. Robert L. Parsons of the University of Kansas believe that their project is expected to provide guidance for selecting stone columns, deep mixed columns, and rigid inclusions to prevent deep-seated failures of embankments over soft soil, lightweight fill and geosynthetics to mitigate surficial slope failures so that the safety to the public traveling on embankments will be enhanced. The outcome of this project is expected to promote the safe and economic uses of stone columns, deep mixed columns, rigid inclusions, lightweight fill, and geosynthetics for highway and railway embankments.

In the project titled Elder-3: Empowering Lifelong Driving Experiences with SAE Level 3 Automation at the University of Kansas, Dr. Hannes Devos and his research team aim to improve the safety and inclusivity of automated vehicles (AVs) for older adults, especially those with cognitive impairment (CI). The study will generate data on how CI affects the ability of older adults to respond to take-over requests (TOR) in Level 3 AVs. These findings will provide insights into human factors engineers and AV manufacturers on the design of AVs to meet the safety needs of this growing and vulnerable population. By predicting safe takeover performance using cognitive, visual, and motor assessments, the project aims to enhance road safety in the AV system for older adults.

What is the impact on the body of scientific knowledge?
MATC's current and ongoing transportation research will have several safety-related impacts on the current body of scientific knowledge. Through the "Elder-3" project at the University of Kansas, Dr. Hannes Devos and his research team aim to advance understanding of the cognitive and motor demands of older adults, especially those with CI, in responding to AV take-over requests. By identifying key clinical tests that predict take-over performance, the research will contribute to the development of screening protocols and safety measures for AV use in older adults. The project also aims to create an algorithm using eye-tracking data that could revolutionize AV design by enabling real-time monitoring of drivers' cognitive workload. This will expand knowledge in fields such as human factors engineering, geriatrics, occupational therapy, and automated driving.

Dr. Haitao Li of University of Missouri – St. Louis expects his project titled "Quantum Computing and Quantum-Inspired Algorithms for Transportation Network Design" provides the first empirical evidence that the existing quantum optimization algorithms, such as D-Wave's QCHS solver, have challenge to handle either large-scale supply chain network design problems/models, or the models with large duality gap. These findings provide information and guidance on the direction of research on using quantum computing for solving combinatorial optimization problems in supply chains.

What is the impact on transportation workforce development?
MATC's research and outreach activities play a vital role in inspiring and preparing students to become future professionals in 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 programs and careers. MATC research projects provide graduate students with hands-on experience in transportation research. The interdisciplinary projects completed during program activities bolstered students' conceptual and practical skills in STEM. Students were encouraged to reconfigure their expectations of STEM subjects and perceived barriers, and to extend their interest beyond classroom experiences.

Dr. Genda Chen's team at the Missouri University of Science and Technology intends to schedule a workshop training course with MoDOT staff regarding the adoption of the system, which will provide a platform to assess and obtain professional feedback. Their project has recruited research staff from under-represented groups to strengthen access and retention of transportation-related research.

Also, from the Missouri University of Science and Technology, Dr. Grace Yan's project provided opportunities for participants to research the impact of tornadoes on vehicles, advancing academic development in the field of transportation safety. This has enhanced the academic level of researchers and introduced new research directions and methods for the academic community. Their educational materials on extreme weather and transportation safety provide systematic resources for students and researchers and offer relevant scientific knowledge and technical applications for transportation practitioners, teachers, young people, and the public. This helps cultivate more professionals with expertise in the field for future development. Through its research and outreach, the program has raised public awareness of science, technology, and transportation safety during extreme weather, especially tornadoes and promoted innovation in the field.

At the University of Iowa, Dr. Jie Han plans to incorporate research results from this study into the graduate ground improvement course being taught in Fall 2025. Their project addresses the safety of embankment slopes in transportation applications. The knowledge and findings gained from this project

can be incorporated in undergraduate and graduate courses related to civil engineering materials, earth retaining structures, ground improvement, and geosynthetics, which enable the future workforce to properly address the safety of embankment slopes.

6. CHANGES/PROBLEMS

Initial delay in recruiting Graduate Research Assistants for multiple projects. We are seeing some resolution with the start of several new students working on various projects during the reporting period.

7. SPECIAL REPORTING REQUIREMENTS

Nothing to report.