Semi-Annual Progress Report for University Transportation Centers

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

- **Signature of Submitting Official (signature shall be submitted in accordance with agency- specific instructions)**

L.R. Rilett, Director, Mid-America Transportation Center

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 1-4**
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	80%
Collect ORCIDs from all MATC Researchers	On Schedule	97%
Submit Project Descriptions to TRB's RiP Database	On Schedule	90%
Submit Final Research Reports	On Schedule	93%
Collect & Store Final Data in UNL Data Repository	On Schedule	100%
Education and Outreach Activities		
Grad/Undergrad MATC Course Development & Implementation	Forthcoming	0%
MATC Undergraduate Summer Internship Program	On Schedule	100%
MATC Scholars Program	On Schedule	100%
MATC/UTC Outstanding Student of the Year	On Schedule	100%
MATC Roads, Rails, and Race Cars After-School Program	On Schedule	100%
MATC/NCIA Sovereign Native Youth STEM Leadership Academy	On Schedule	100%
MATC Summer Institute	In Process	75%
MATC Research Experience for Undergraduates (REU) Program	On Schedule	100%
MATC Joint Activities with Student Chapters	On Schedule	100%
Technology Transfer Activities		
Technology Transfer Plan – Overarching Plan for MATC (Approved October 19, 2018)	On Schedule	100%
Collect Tech Transfer Plans from PIs for Individual Research Projects	On Schedule	37%
Technology Transfer Tech Briefs, Webinars & Presentations on Research Results	On Schedule	100%

Roadside Safety Short Course (UNL)	On Schedule	100%
Roadside Safety Workshop (UNL)	On Schedule	100%
Traffic Safety Classes (KU)	On Schedule	100%
Structural Condition Assessment Short Course (MS&T)	On Schedule	20%
LTAP Workshop	On Schedule	100%
USDOT OST-R Reporting Requirements:		
Federal Financial Reports	On Schedule	100%
Post Research Project Descriptions on MATC Website	On Schedule	100%
UTC Program Progress Performance Reports (Semi-annually)	On Schedule	100%
Annual Performance Indicators Reports	On Schedule	100%
Additional USDOT OST-R Requirements:		
Establish and Maintain Center Website	On Schedule	100%
Directory of Key Center Personnel	On Schedule	100%
Attendance at UTC Grantees' Meetings	On Schedule	100%

What was accomplished under these goals?

Research Activities

Although hindered by the COVID-19 Pandemic, all research activities have continued and the following research activities were accomplished during the reporting period of April 1, 2020 – September 30, 2020.

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.

In June 2020, MATC sent out the call for internal research proposals. Nine (9) University of Nebraska-Lincoln (UNL) MATC research projects were reviewed by an External Review Committee; of which, seven (7) were approved. These projects are in addition to the seven (7) UNL MATC projects approved the by the External Review Committee in March 2020.

UNL/UNO/UNMC currently has fifteen (15) new and ongoing USDOT-MATC funded projects, supported by twenty-eight (28) PI's and Co-PI's. The University of Iowa (UI) currently has five (5) ongoing USDOT-MATC funded projects, supported by nine (9) PI's and Co-PI's. The University of Kansas (KU) and University of Kansas Medical Center (KUMC) currently have five (5) ongoing USDOT-MATC funded projects, supported by ten (10) PI's and Co-PI's. The Missouri University of Science & Technology (MS&T) currently has fifteen (15) ongoing USDOT-MATC funded projects, supported by ten (10) PI's and Co-PI's.

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

University of Nebraska-Lincoln (UNL)/University of Nebraska-Omaha (UNO)/University of Nebraska Medical Center (UNMC)

During this reporting period, new projects: started literature reviews; identified students to assist with research deliverables; generated design concepts; acquired necessary software; conducted preliminary planning for laboratory experimentations; and identified potential work zone sites for data collection.

Research conducted on existing and ongoing projects included: experimental planning for the development of a loading protocol to be applied to bridge slab specimens in the structures laboratory; creation of a portable concrete barrier model based on design concepts; implementation and verification of the Lagrangian computational method to analyze vehicle simulation impact barriers such as acceleration, loading force, and vehicular angular displacement; exploration of road modeling techniques, including augmentation with pitch and slope; seeking partnerships with multiple agencies to share road-specific geometric data; evaluation of vehicle tracking concepts and wireless exchange were digitally simulated and miniaturized models were constructed using on-hand equipment; developing coding for the real-time integrated first responder health and environmental monitoring dashboard interface; validating proposed numerical modeling approaches for predicting the impact load time histories from the combined vehicle collision and air blast; and evaluating AASHTO design impact load for bridge columns subjected to combined collision and blast.

Due to the effects of COVID, progress has been significantly delayed on testing and data collection due to lack of availability of and access to test vehicles, instrumentation processing and installation, and construction personnel. As well, remote work has slowed computational modeling discussions, reviews, and revisions that were previously conducted in person and require both additional time and effort to conduct virtually.

University of Iowa (UI)

During this reporting period, research conducted on existing and ongoing projects included: creation of a mathematical model of the flooding problem to decide which bridges have the most impact on transportation network for travel during a flooding event and should therefore be reinforced; advancing knowledge and training of *Gurobi*, which allowed researchers to gain progress in modeling the problem of choosing which bridges and roads to upgrade in advance of a flooding event; finishing all the spill-through abutment simulations in a straight channel; working on proposing a new modified riprap formula for riprap sizing that will explicitly incorporate the effects of relative abutment length, La/Bf, and floodplain width, Bf; generating combustion data from renewable jet fuel (soy and canola oil-based jet fuel) colloidal suspensions, made using carbon-based nanomaterials (Graphene Nanoparticle), using the droplet combustion setup; generating settling characteristics of renewable jet fuel (soy and canola oil-based jet fuel) and carbon-based nanomaterials at low and high temperatures; modeling the bridge finite element model (FEM) through commercial software (Abaqus ®) with accurate material models in which all nonlinearities are considered; and evaluating a new set of equations to better simulate subsurface flows including flows from tiled landscapes.

Experiments have experienced delays due to COVID-19 as university labs were temporarily closed.

University of Kansas (KU)/University of Kansas Medical Center (KUMC)

During this reporting period, research conducted on existing and ongoing projects included: submitting a modification to the KUMC protocol, which was ultimately accepted by IRB, to add an additional incentive to pay for a CDL renewal if the license is to expire within the subsequent 60 days of the study visit; and working with KUMC Frontiers to refresh our 2018 search for potential subjects, which resulted in 23 new prospects and; forging a collaboration with Iowa Department of Transportation for subject recruitment.

Due to COVID, it has been challenging to recruit subjects since the lab was closed from March 16th until June 30th, 2020. All testing was halted "indefinitely" impeding the ability to schedule subjects.

Missouri University of Science & Technology (MS&T)

During this reporting period, research conducted on existing and ongoing projects included: using historic flash flood data from Missouri Department of Transportation (MoDOT), United States Geological Survey (USGS), and other public data sources to determine geospatial characteristics of the region that can contribute to flash flood scenarios as well as develop inputs for rate of change and detour/rerouting algorithms; creating ArcGIS data layers to integrate data related to elevation, watersheds, annual rainfall, and road networks; repairing and testing three piles using pultruded FRP; preparing UHPC full-scale plates for repair of the piles; collecting and analyzing data from MoDOT; testing groups of dog-bone specimens to investigate the bond performance between an optical fiber and its surrounding cement matrix at high temperatures; studying the damage pattern of shear key concrete and the deformation of dowel bars to obtain the experimental force-displacement relationship of the shear keys; testing of a steel-concrete composite floor beam with double angle end connections and six load points at the ambient temperature; crash reporting analysis for Identification and assessment of risk indicators and risk scenes; improving the visualization of the spatio-temporal attention guidance which was learned through association rule mining; implementing and performing the incremental dynamic analysis on the 3-span concrete bridge system with combinations of unrepaired and repaired columns; establishing a tornadic wind field using CFD simulations and validating the model using the tangential velocity profile extracted from the radar-measured velocity data; and successfully characterizing a developed sensor and initiating field deployment with MoDOT using a bridge on campus.

Due to the COVID-19 impact, progress in the lab was quite slow due to lab closures and social distance requirements. MoDOT has limited crew for field deployment therefore, some research objectives have been delayed.

Specific Objectives

University of Nebraska-Lincoln (UNL)/University of Nebraska-Omaha (UNO)/University of Nebraska Medical Center (UNMC)

During this reporting period, specific objectives addressed on new projects included: starting literature reviews; considering acquisition methodology; experimental assessments; reviewing design criteria;

analyzing design concepts; developing computer simulations for selected concepts; and preparing preliminary models.

During this reporting period, specific objectives addressed on existing and ongoing projects included: completing model simulations and analysis of results; evaluation of Lagrangian fluid component using LS-DYNA with the new TL-6 tractor-tank trailer vehicle model; computer simulation of barrier designs in LS-DYNA with the detailed TL-6 truck model and refinements to designs; determination of lateral (shear) loads on the 90-in. tall barrier at wheel and tank heights for TL-6 vehicle; evaluation of vehicle extension into the Zone of Intrusion with TL-5 vehicle at varying barrier heights; road modeling using MATLAB; adjacent lanes were evaluated using Bertrand Curves and orthogonality relationships; remapping AI algorithms which smooth the input points to find smooth, continuous paths on roadways; speed optimization efforts which evaluated both friction supply and demand from the vehicle; optic recognition techniques exploration to validate vehicle guidance and localization models; developing a line-follower machine vision program which identifies vehicle offset from a target path; exploration of road data acquisition techniques; acquiring road data from NDOT and composition; segmentation, noise evaluation, and "remapping" functions applied to road data to improve numerical modeling and fit; documenting the requirements functionality of the dashboard using Protoshare and voice over; completion of coding the Dashboard shell for high fidelity prototype development using Angular; continuing to work on Reach Requirements and Design Documentation; UML diagramming: use cases, sequence diagrams, component diagrams, and security elements; preparing manuscripts for journal publication; developing a large-scale track wheel (LSTW) test with multiple non-destructive testing sensors to assess the performance of geosynthetic-reinforced pavement; evaluating the benefits of using geosynthetics to reinforce the surface, base layer and/or stabilize weak subgrade soil in a flexible pavement application; conceptualization of the design parameters for geosynthetic-reinforced pavement based on the testing results; exploring and, if needed, developing and recommending viable retrofitting techniques along with exploring, developing and recommending viable analysis and design procedures; computing the peak dynamic force and equivalent static force from numerical simulations for vehicle collision coupled with air blast; and assessing current AASHTO design impact load for bridge column in the event of vehicle collision coupled with air blast.

University of Iowa (UI)

During this reporting period, specific objectives addressed on existing and ongoing projects included: optimizing mitigation options with different objectives/constraints for communities in Iowa; proposing a new multi-parameter design formula that can be used for riprap design at spill through abutments placed in straight channels; generating combustion data from renewable jet fuel (soy and canola oil-based jet fuel) colloidal suspensions, made using carbon-based nanomaterials (Graphene Nanoparticle) using the droplet combustion setup; settling characteristics of renewable jet fuel (soy and canola oil-based jet fuel) and carbon-based nanomaterials at low and high temperatures; investigating combustion of renewable jet fuel (soy and canola oil-based jet fuel) colloidal suspensions, made using carbon-based nanomaterials (Multi Walled Nano Tubes-MWNT) using the droplet combustion setup; generating experimental settling data for jet fuel-nanomaterial (carbon dot) colloidal suspension data and; advancement of offline implementation of the HLM model for the four states.

University of Kansas (KU)/University of Kansas Medical Center (KUMC)

During this reporting period, specific objectives addressed on existing and ongoing projects included: coordinating with the Kansas Department of Transportation and Kansas Department of Health and Environment to work with trucking companies to recruit subjects; conducting the battery of cognitive and visual tests on a target goal of 85 subjects (28 to date); requesting driving record data annually for all subjects, without risk of penalty; collecting baseline data on the task-evoked pupillary response (TEPR) reflex; contacting the appropriate subjects for rehabilitation of cognitive, visual and TEPR tasks performed sub-optimally; performing rehabilitative tasks as appropriate; and collecting Year 2 data of cognitive and visual testing and correlate with driving performance.

Missouri University of Science & Technology (MS&T)

During this reporting period, specific objectives addressed on existing and ongoing projects included: analyzing data gathered and computational intelligence methods to develop a deep learning neural network to determine risk of flash flood in the pilot area; using historical weather and land cover data for the immediate area and in the vicinity of geospatial features hydrologically upstream of the basin; developing a traffic simulation model to link with the flash flood prediction to determine methods to reroute traffic; combining the rainfall data and hydrological data with the road network to determine locations likely to be subjected to flash flood events; manually extracting NOAA data from the text of the flash flood database and assigning it to local areas of low elevation; testing repaired piles under concentric axial loads; working with MoDOT on the field testing and data collection being used to calibrate the traffic flow mode; continuing data collection and model calibration; conducting tests to determine the effectiveness of embedded optical fiber sensors to measure strains in mortar at high temperatures, and determine the transition temperature at which the optical fiber sensors fail to measure strains accurately; characterizing novel SMART shear keys under pushover loads; developing a friction-gap model of the shear keys for inclusion in computational modeling and simulation of bridges; understanding and evaluating the effect of SMART keys on the seismic behavior of a small-scale bridge system subjected to ground accelerations; understanding the system behavior and responses of a simplified highway bridge, particularly the torsional effect of spatially-distributed SMART shear keys under strong multi-component earthquakes; developing a strategy and algorithm for optimal placement of SMART shear keys; understanding and developing a similitude law of SMART shear keys for the prediction of their behavior and responses through small-scale model tests; reproducing the flexural behavior of a steel-concrete composite floor beam previously tested using its finite element model; carrying out parametric studies using the developed model to investigate the critical parameters affecting the flexural behavior; analyzing crash reporting data for identification and assessment of risk indicators and risk scenes; analysis of road scene video for risk indicator detection; extending the finite element analysis code previously developed to replicate the results of experimental tests conducted on RC columns under cyclic load analysis to the analysis of the entire bridge system; pairing the finite element analysis code previously developed to simulate the seismic response of an RC bridge, with MATLAB script to perform incremental dynamic analysis (IDA); characterizing the developed prototype sensor; and extending the 3D printing technology to both energy storage and sensing functions.

Significant Results, including major findings, developments, or conclusions (both positive and negative)

University of Nebraska-Lincoln (UNL)/University of Nebraska-Omaha (UNO)/University of Nebraska Medical Center (UNMC)

During this reporting period, significant results for new projects included: completing literature review activities particularly with regard to full-scale transportation infrastructure; determining basic structural and overall geometry of selected design concepts; and design of a large-scale track wheel (LSTW) testing apparatus.

During this reporting period, significant results for existing and ongoing projects included: experimental planning and trial runs with the acquisition system; proof of technology and the methodology to acquire dynamic data from the lidar scanner; review of State DOTs survey responses to determine main design criterion; addressing inconsistent meshes in the fluid causing problems occurring in the model such as: mesh distortion, initial penetrations, and instabilities; a completed trailer assembly representing the first stable model of a tank-trailer vehicle which may be accessed and distributed; plotting large truck ZOI extensions for comparison with the TL-6 simulations; exploring a variety of circumstances related to algorithm continuity for optimization of road synthesis; developing a machine vision algorithm to track vehicle offsets from a reference line for full-scale vehicle testing; and analyzing numerical results which indicated that the impact load time histories included two primary peaks, one from vehicle engine collision and the other from the blast wave.

University of Iowa (UI)

During this reporting period, significant results from ongoing projects included: extensive survey on potential mitigation options and their cost; discovering that the basic mitigation model can solve instances on small cities in about one second; adding more detail to the model to better capture the different costs and constraints; working on scaling the model for solving larger networks and communities and; using cost of mitigation and number of amenities as criteria to optimize accessibility to amenities based on population.

Unfortunately, due to the COVID 19 situation, some of the simulations and data processing were delayed. This was especially the case for the scheduled curved-channel simulations. Access to the servers was not always easy and the system used to store and access the big files needed for data post-processing failed; trying to run as quickly as possible the proposed matrix of simulations (close to 50 cases) that will allow us to develop a riprap sizing formula that can be applied for spill-through abutments placed in a curved channel.

University of Kansas (KU)/University of Kansas Medical Center (KUMC)

Nothing to report.

Missouri University of Science & Technology (MS&T)

During this reporting period, significant results from ongoing projects included: determining the force-deformation of three full-scale piles repaired using pultruded FRP tubes; determining the force-deformation of full-scale pile subjected to eccentric loads; discovering that with the design of SMART shear keys and the cap base, a damaged shear key can be easily replaced, and the shear key will protect the cap beam from damaging; nonlinear material properties, and

interactions among various components proving reasonable in the finite element model; inferring from the location and time information of driving scenes, the likelihood of crash and crash types (first harmful events and manner of collision); and the capability of the numerical model to perform incremental dynamic analysis to study the collapse of the simulated bridge.

Key Outcomes or Other Achievements

University of Nebraska-Lincoln (UNL)/University of Nebraska-Omaha (UNO)/University of Nebraska Medical Center (UNMC)

During this reporting period, key outcomes and other achievements included: a detailed review of similar studies and technologies which highlighted that very little is currently available to extract information about a bridge's health from laser scan data; analyzing candidate PCB design concepts, including various shapes/profiles and joint systems and recommended for further development using computer simulations; evaluating the capacity of the new TL-6 barrier; using the LS-DYNA finite element analysis software to analyze the barrier; developing road modeling and mapping techniques which have the potential to be revolutionary for vehicle guidance; developing vehicle control and guidance models which adapt to the road geometries; finalizing UML modeling artifacts; validating replication of procedures to set up a development environment; completing User Interface Simulations using Protoshare for usability study; completing UI study design for user interaction testing; conducting full User Interface evaluation with Stan Shearer OFD and others (Incident Commanders and Medics) in July, 2020; installing Heroku (cloud-based) production environment; examining applicability of the AASHTO-LRFD design impact load to a combined vehicle collision and air blast event; refining candidate concepts; creation of 3-D models; development of preliminary LS-DYNA models; and verification that we can obtain dynamic displacement data from commercially available lidar scanners.

University of Iowa (UI)

During this reporting period, key outcomes and other achievements included: developing a new model based on the data on flooded roads; developing a data-based understanding of what bridges can have the most impact on travel time when a flooding event occurs; working on the implementation of road network analysis to the real-time flood mapping system; quickly determining the roads and bridges that must be mitigated (i.e. increase elevation, set up flood wall, etc.) for all citizens to have access to a hospital if a flooding event occurs; developing a general methodology based on 3-D non-hydrostatic RANS numerical simulations to determine the conditions for riprap shear failure for cases when a riprap apron is placed close to an abutment; exploring the modification of combustion characteristics of renewable jet fuel using Multi Wall Nano Tubes (MWNT); exploring the modification of combustion characteristics of renewable jet fuel using Graphene nanoparticle; investigating settling characteristics of renewable jet fuel-nanomaterial colloidal suspension data which will help explore the stability of such suspensions at winter and summer temperatures; a review on droplet combustion which will help to understand the effect of carbon-based nanomaterials and polymers on combustion characteristics of different fuels; and combining observations on streamflow (point measures) with spatial fields of precipitation (from weather radars) to test our transferable calibration-free hydrological model.

University of Kansas (KU)/University of Kansas Medical Center (KUMC)

During this reporting period, key outcomes and other achievements included: speaking to 244 potential participants from over 30 CDL companies, of which 31 subjects have completed their first assessments; beginning year 2 assessments for the 3 year follow-up period; recruiting four new medical students; and revision of phone triage and protocol systems.

Missouri University of Science & Technology (MS&T)

During this reporting period, key outcomes and other achievements included: working with USGS, MoDOT, and NOAA, which allows the project team to be responsible stewards of public funds and to prevent duplication of effort; recruiting two PhD engineering graduate students and one undergraduate student to contribute to workforce development in Missouri and the transportation community at large; developing precast pultruded FRP tubes to repair steel piles; developing repair techniques for steel piles subjected to eccentric axial loads; analyzing the performance of autonomous TMA vehicles under controlled environment, and use the analysis result for modeling; using the data collected from MoDOT field testing for model calibration; developing an attention guidance from crash data analysis, which can inform human drivers and autonomous driving systems of the likelihood of a fatal crash and crash types in high chances according to the time and location information captured and processed by vision sensor and AI algorithms; classifying driving scenes by classes of crashes such as no-crash, pre-crash, and crash will help to predict any possible crash in a near real-time manner; classifying complex driving scenes by the road function, weather, and time of day provide useful information for crash risk estimation and prevention; identifying risky pedestrians on the road which also helps to eliminate any possible crash in near real-time manner; demonstrating that simulation results are in general agreement with the radar-measured data; conversing with key personnel from army research office who are interested to see possible energy storage and sensing function of the 3D printed CFRP-concrete structures; characterizing the developed sensor and preparing it for field implementations; and locating a bridge on campus for field implementation.

Education and Outreach Activities

MATC has implemented several educational outreach programs in support of USDOT's Strategic Plan and the center's mission to increase the number of students from underrepresented groups in STEM education and transportation-related careers. Descriptions of each educational program and the activities that took place during April 1, 2020 – September 30, 2020 are detailed below.

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

MATC's after-school program combines the talents of 4-12th grade teachers, engineering graduate and undergraduate college and university student mentors, and professional and industry partners to educate the diverse leaders of tomorrow about STEM principles. Each participating school offers the club for an hour every week. Mentors present on an engineering or transportation-related topic and lead students in an interactive activity that encompasses the concepts of the lesson. Examples of activities include constructing bridges and conducting strength tests, creating towers that can withstand simulated earthquakes, and building race cars powered by potential energy stored in a rubber band.

The reporting period of 4/1/2020 – 9/30/2020 coincides with the Covid-19 pandemic. The pandemic has caused school closures and restrictions on access to school sites at each of our 9 locations in 4 cities across Nebraska. As a result, RRRC suspended in person programming during this period.

Spring 2020 RRRC Programming

The spring semester portion of RRRC was implemented at five (5) sites in Lincoln, NE: Culler Middle School, Goodrich Middle School, Lefler Middle School, Mickle Middle School, and Park Middle School. RRRC was also implemented at the reservation schools in Macy, Winnebago, and Santee this spring. During the week of March 9 - 13, 2020, each site announced a closure of after-school activities in response to the Covid-19 pandemic.

For the Spring 2020 programming, RRRC employed: one (1) Education and Outreach Coordinator, eight (8) on-site teachers, and ten (10) undergraduate engineering student mentors. Additional RRRC tasks completed included developing new curriculum, updating the MATC online curriculum database, daily meetings with mentors to develop strategies and track progress of the lessons and activities, and communication with mentors, teachers, CLC staff, and MATC staff.

Fall 2020 RRRC Programming

During the reporting period, preparations are underway to develop online lessons and activities that on-site teachers can implement. Three (3) sites in Lincoln, NE: Culler Middle School, Mickle Middle School, and Park Middle School will begin the online program during Lincoln Public School's 2nd Quarter, beginning October 19, 2020.
For the Fall 2020 programming, RRRC employed: one (1) Education and Outreach Coordinator, and eight (8) on-site teachers. Additional RRRC tasks completed included revising existing lessons and activities, developing an online curriculum of lessons and activities, and coordinating with teachers and CLC staff.

MATC Scholars Program

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

The Fall 2020 program is scheduled to be held during the period of October 9, 2020 through October 30, 2020, and will provide seminars, panels, and workshops that inform and inspire Native American students on their educational journeys. Due to COVID-19, the MATC Scholars Program is scheduled to be held virtually. There will be 13 videos posted during the period of October 9 to October 30, 2020. There will also be two live Zoom sessions for a total of 15 videos. Scheduled video content includes topics such as *Choosing a 4-Year Institution that is Right For You*, *A Look Into a Journalism Major and Native American Journalism*, *Study Skills in a 4-Year Institution*, and *Pursuing and Art Degree and Profile of a Native American Artist,* just to name a few.

MATC Intern Program

The MATC Intern Program partners with private companies, local government, and academia to provide undergraduate students with paid summer internship opportunities in the transportation and engineering fields. During this 12-week program, students gain hands-on experience in their area of interest under the mentorship of a professional. Students work 40 hours per week while experiencing the day-to-day tasks and responsibilities of their desired career. The program culminates in a written paper and presentation detailing the student's internship experience.

The Summer 2020 Virtual MATC Intern Program was held May 25th – August 14th. UNL received ten (10) student applications, and had initially received five (5) external sponsor applications to host Summer 2020 Interns. Due to the COVID-19 pandemic, all but one (1) external sponsors withdrew their ability to host interns via virtual methods. Ultimately, UNL MATC Faculty were able to support six (6) undergraduate students and an industry sponsor was able to support one (1) undergraduate student.

Summer 2020 internships were conducted remotely, offering students the opportunity to assist faculty researchers with data analysis, literature reviews, and familiarize themselves with various hardware and software platforms required for transportation research. For example, one student learned *Streetval* software to simulate travel time data, which was then used to produce travel time distributions based on the simulated data. Another student learned *Vissim* software for simulation of traffic at different work zone scenarios; to visualizes and obtain detailed data of the behaviors of drivers without having to set up a real-life scenario. A third student studied cybersecurity with the goal of exploiting and utilizing vulnerabilities in local vehicle networks and connections systems to initiate remote control of a vehicle. The primary technology for this project was Bluetooth, in combination with software programs such as *Wireshark, Bettercap, and Ubertooth*.

NCIA/MATC Sovereign Native Youth STEM Leadership Academy

The NCIA/MATC Sovereign Native Youth STEM Leadership Academy is a six-day summer program held on the University of Nebraska-Lincoln campus. The mission is two-fold: (1) to provide an extended learning opportunity in science, technology, engineering, and math (STEM) subjects, and (2) explore a wide-range of education and career options after high school. The academy offers a broad range of hands-on activities that build leadership skills and interest in STEM subjects and transportation-related careers while engaging with Native American history and culture. The curriculum is developed and implemented by Native American faculty, students, and leaders from across the country. Attendees have the unique opportunity to build a professional network with Native American guest speakers and panelists, who provide mentorship by sharing their education and career success.
The 2020 NCIA/MATC Sovereign Native Youth STEM Leadership Academy was originally scheduled for May 31 to June 5, 2020 on the campus of the University of Nebraska-Lincoln. Registration was anticipated to be 40 high-school students, primarily from reservation and rural schools in the state of Nebraska, with a smaller number anticipated from urban schools. Due to the university shut-down and general safety precautions during the Covid-19 pandemic, it was decided to reconfigure the program from in-person to online. A six-week program in which students would participate in weekly modules was developed and was scheduled to begin on June 29 and finish on August 7, 2020. Four students enrolled in the online version of the summer academy (3 from Winnebago, 1 from the city of Omaha), and partially completed the six-week program.

MATC Summer Institute

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

In Summer 2020, the MATC Summer Institute was reconvened with the goal of creating Native American culturally informed STEM curriculum for K-12 after school programs. The original proposal included a 6-week schedule that would proceed along four stages: 1) curriculum creation; 2) development; 3) review; and 4) implementation. One participant from the Omaha Nation Public School, located on the Omaha Indian Reservation, participated in the project. Due to scheduling uncertainty during the Covid-19 pandemic, the Summer Institute work schedule was extended into the fall school year. As of this reporting period the participant has completed the first three stages, and will implement the curriculum in future semesters.

MATC Research Experience for Undergraduates (REU)

MATC was not able to support an REU student during this reporting period. We are reviewing undergraduate options to support a Summer 2021 MATC REU student.

How have the results been disseminated?

MATC staff maintained 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 RiP records are provided on each 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.

University of Nebraska-Lincoln (UNL)/University of Nebraska-Omaha (UNO)/University of Nebraska Medical Center (UNMC)

During this reporting period, results were disseminated as follows: an abstract submitted for consideration at Structures Congress 2021; a conference sponsored by the Structural Engineering Institute at American Society of Civil Engineers; a journal manuscript drafted and is in the final stages for submission to the Journal of Bridge Engineering; a virtual meeting was held with Mr. Erik Emerson in WisDOT; an undergrad student will present the work through a virtual poster (SNERP UNL summer research experience) focused on his research about candidate concrete additives in new PCBs; a technical paper was submitted to the WCX SAE World Congress and was approved for presentation in April, 2020 however, due to COVID-19

outbreak, the SAE World Congress was cancelled; four (4) journal papers are in progress: *Modeling and Optimization of Road Point Collection*, *Vehicle Error Correction using Novel Guidance System*, *Ad Hoc Use of Road Geometry Data for Automated Vehicles*, and *Implementation of Novel Features in Dynamic Road Data Matrices*; a series of four CAV-related webinars were held in July with guest speakers from various industries and backgrounds; three (3) graduate students shared their research experience and IT development experience while interviewing for post-graduate positions at local businesses; an undergrad student presented his work on concept selection and literature search at Nebraska Summer Research Virtual Symposium August 5th, 2020, through an academic research video; and final research reports for multiple projects were published on the MATC research database website.

University of Iowa (UI)

During this reporting period, results were disseminated as follows: a plan to submit the real-time decision support framework paper, although progress has been affected by the current pandemic as both PIs have had additional work and challenges to handle during this time; a journal paper accepted subject to minor revisions in the J. Hydraulic Engineering reporting the main results for wing-wall abutments placed in straight and curved channels and proposed modifications of the riprap design formula; plans to work with the Transportation Research Board (TRB) committees related to bridges (e.g., TRB-AFB60) and FWHA such that the main findings and the improved formulas will be considered for adoption as a Technical Brief of HEC-23; scheduled to present a MATC webinar in October 2020; results formalized into two conference publications have been accepted for publication with final papers and presentations submitted; conference publications in progress; a review on droplet combustion is going on which will be published into a journal publication; and currently preparing a manuscript to be submitted to Journal of Hydrology.

University of Kansas (KU)/University of Kansas Medical Center (KUMC)

Nothing to report.

Missouri University of Science & Technology (MS&T)

During this reporting period, results were disseminated as follows: work will be presented at American Society of Engineering Management International Conference in October; one team has presented two papers during a TRB webinar online; a paper was submitted to the 2021 transportation research board meeting; submitted a paper to the Analytic Methods in Accident Research Journal titled *Crash Report Data Analysis for Creating a Spatio-Temporal Attention Guidance for Vision Based Real-Time Crash Risk Assessment* with pictures and the potential crash type results of the data analysis posted at https://sites.google.com/view/yuli1102/projects/matc?authuser; submitted a conference paper titled *A System of Vision Sensor Based Deep Neural Networks for Complex Driving Scene Analysis in Support of Crash Risk Assessment and Prevention* to 2021 Transportation Research Board Annual Meeting, which has been accepted for presentation; preparing a manuscript summarizing collected data; and incorporation of part of the proposed work into a graduate student thesis.

MATC Research Webinars

The webinars listed below were hosted by MATC during this reporting period. Closed captioned recordings of each webinar were 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).

Date	Title	Presenters
6/25/2020	Spatial Attention Mechanism for Weakly Supervised Fire and Traffic Accident Scene Classification	Dr. Zhaozheng Yin
7/15/2020	MATC Smart Barrier: Vehicle Autonomy and Lane-Keeping via Vehicle-to-Infrastructure Communication	Dr. Cody Stolle
7/31/2020	Design and Testing of Cost-Effective lidar Systems for Transportation	Dr. Christopher Depcik Ms. Deven Mittman
9/14/2020	Modeling Driver Behavior and Aggressiveness Using Biobehavioral Methods	Dr. Alexandra Kondyli Dr. Vishal Kummetha

What do you plan to do during the next reporting period to accomplish the goals?

University of Nebraska-Lincoln (UNL)/University of Nebraska-Omaha (UNO)/University of Nebraska Medical Center (UNMC)

During the next reporting period, MATC researchers at UNL/UNO/UNMC have reported that they intend to focus on the following: development of the acquisition methodology by writing an application to control the acquisition of point cloud data from an existing FARO Focus 3D x130; carry out the laboratory portion of the experimental assessment by enhancing the application to control the acquisition of point cloud data from an existing FARO Focus 3D x130; begin to implement the bridge slab tests in the structures laboratory which will provide necessary data to validate the methodology; project literature review and preliminary data collection through online sources utilizing a database of existing functionality data and relationships to be compiled for bridges and transportation systems; field reconnaissance reports and news reports will be compiled to provide additional evidence towards the functionality of bridges following various types of hazards; initiate simulation efforts and developing LS-DYNA models of candidate PCB design concepts; draft a report on literature search; finish the study impacts into barriers using TL-6 vehicle model to determine how the barrier performs; barrier geometry will be recommended based on optimization of the vehicle intrusion into ZOI and barrier structural adequacy; continued development of publications for submission; further development toward testing will be pursued on the road localization and optimization modules; summary reporting will be started to wrap up MATC Smart Barrier project; vehicle response models will be completed and submitted to MATC for documentation; continue design of Threshold User Interface and the process of entering thresholds and comparing first responder health biomarkers to thresholds; continuing to evaluate and test selected Internet of Things COTS (commercial-off-the-shelf) wearable sensors and customizable biosensor and environment sensors quality, accuracy, viability, ruggedness, and reliability; usability design review with Omaha Fire Department (OFD); survey first responders (specifically State Patrol personnel) on personal use of wearable technology (e.g. biosensors, fitness trackers) devices; continue the information technology design and development of a high fidelity REaCH Application including a test scenarios and plan and test data, and inserting data analytics approaches to visualize health trends; submit manuscript of the First Responders

Wearable Technology survey to Safety journal; submit manuscript of the Needs Assessment to Safety journal; meet with NSRI National Strategic Research Institute and NCITE to discuss DoD interests in the project; complete Notification on Invention; conduct usability on completed low fidelity REaCH system prototype; explore partnerships with companies that have off-the-shelf Wearables to be able to capture their data directly and integrate into the Dashboard; finish the design and order of fabrication for a large-scale track wheel (LSTW) testing apparatus in coming the reporting period; promote the apparatus to the Geosynthetic industries and other regional media; consider effects of fire/heat on material behavior and column performance; validate developed model using blast and fire tests from the literature; and reach out to agents such as Nebraska DOT, DOTs from Region VII (i.e., Kansas, Iowa, Missouri), Tier one Rail Company (e.g., BNSF, Union Pacific) to obtain the necessary data (e.g., hazardous material release, crashes at highway-rail grade crossings, etc.).

Due to the effects of COVID, it is uncertain whether the planned testing will be able to proceed due to significant restrictions on the workforce and accessibility to test site location. Researchers will continue to prepare in the event the opportunity arises. However, recent guidelines by the University and Test Site Managers suggest that restricted access and test capabilities may extend into the fall.

University of Iowa (UI)

During the next reporting period, MATC researchers at UI have reported that they intend to focus on the following: review the existing literature on road and bridge mitigation to develop more realistic models of the costs and constraints involved; continue simulations for cases when the spill-through abutments are placed in curved channels; concentrate on expanding the proposed two-parameter formula to include the effect of channel curvature; combustion properties of renewable jet fuel droplets to aid in eventual combustion modeling of crude oil; modification of droplet splashing properties of crude oils by adding nanomaterials to be formalized into a journal publication; estimation of BLCP method based on dynamics loading by testing the FE module using experiments; developing a straight flowchart for estimation of bridge rating factor applicable for DOT authorities; and parameterizing a missing process in our hydrological model, namely the effect of subsurface agricultural drainage.

University of Kansas (KU)/University of Kansas Medical Center (KUMC)

During the next reporting period, MATC researchers at KUMC have reported that they intend to focus on the following: continue to increase visibility of our study by meeting with more companies, drivers, and increasing awareness; continue year 2 data collection with the intent to end participant recruitment in November 2020; begin looking at the year 1 data for scholarly presentations to TRB and local research seminars.

Missouri University of Science & Technology (MS&T)

During the next reporting period, MATC researchers at MS&T have reported that they intend to focus on the following: submit two abstracts related to the project scope of work for consideration to be presented at the IEEE Symposium Series on Computational Intelligence slated for December of 2020; submit to MATC the final report related to repairing three piles using UHPC plates and prepare the remaining four piles; data collection and model calibration;

prepare a TRB paper to document the research outcomes from this project; continue to work on traffic flow modeling; summarize experimental results in a conference paper related to optical fiber with a white buffer coating only will be calibrated under various strains at each temperature; investigate in numerical simulations the performance of the SMART shear key on a bridge during earthquake/tsunami; develop an element of SMART shear key in OpenSEES and the performance of a bridge with SMART shear keys under earthquake will be investigated; the finite element model for the steel-concrete composite floor beam needs to be further calibrated to improve its accuracy; the parametric study needs to be expanded to investigate factors affecting the flexural behavior of the steel-composite floor beam; submit a journal article describing the work of developing a system of vision sensor based deep learning networks for multi-label classification of complex driving scenes; detect the risk factors from an image to give input to a recurrent neural network to predict future crashes more accurately; develop a method to determine the distance to the nearest vehicle; determine the quality of the developed classification model with quantitative assessment; continue disseminating the results and look for opportunities of technology transfer; attempt to implement the incremental dynamic analysis on the RC bridge with columns under different damage conditions; finish the IDA analysis, prepare the final report summarizing the work of this project, and prepare a journal paper for submission to disseminate the findings; further validation will be conducted and a finite element model of a cable-stayed bridge will be developed; seek other possibilities while MoDOT is on hold on the potential interests of field implementation of the proposed 3D printing technology; seek other possible site or bridge on campus for sensing system validation; extend the 3D printing technology to sensing and energy storage functions; and collect data and analyze the crack growth.

2. PARTICIPANTS & COLLABORATING ORGANIZATIONS

What organizations have been involved as partners?

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

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

Table 2: MATC Partners and Type of Collaboration

MATC Program Affiliation	Organization Name	City	State	Financial	In-Kind Support	Contribution Facilities	Collaborative Research	Personnel Exchanges
All Programs	University of Nebraska-Lincoln	Lincoln	NE	X	X	X	X	X
All Programs	Nebraska Transportation Center	Lincoln	NE		X	X	X	X
Roads, Rails, and Race Cars Program (RRRC)	Culler Middle School	Lincoln	NE		X	X		
RRRC	Lefler Middle School	Lincoln	NE		X	X		
RRRC	Mickle Middle School	Lincoln	NE		X	X		
RRRC	Goodrich Middle School	Lincoln	NE		X	X		
RRRC	Dawes Middle School	Lincoln	NE		X	X		
RRRC	Park Middle School	Lincoln	NE		X	X		
RRRC	Umó^{N}ho^{N} Nation Public School	Macy	NE	X	X	X	X	
RRRC	Community Learning Center	Lincoln	NE				X	
RRRC; Academy	Lincoln Public Schools	Lincoln	NE	X			X	
RRRC; Academy	Winnebago Public School	Winnebago	NE	X	X	X	X	
RRRC; Academy	Santee Community School	Santee	NE	X	X	X	X	
RRRC; Academy	Nebraska Indian Community College	Macy	NE	X			X	
Academy	Union Pacific	Omaha	NE	X				
Academy	University of Nebraska Medical Center	Omaha	NE	X		X		
Academy	Little Priest Tribal College	Winnebago	NE				X	
Academy	Claire M. Hubbard Foundation	Omaha	NE	X				
Academy	Lincoln Bike Kitchen	Lincoln	NE	X				
Academy	National Institutes of	Lincoln	NE	X				

	Health (Worlds of Connections)							
Academy; Scholars	Nebraska Commission on Indian Affairs	Lincoln	NE				X	
Scholars	Encompas Architects, P.C.	Lincoln	NE				X	
Scholars	Kansas Office of the Governor	Topeka	KS			X		
Intern Program	City of Lincoln Public Works	Lincoln	NE		X	X		
Intern Program	City of Omaha Public Works	Omaha	NE		X	X		
Intern Program	Nebraska Department of Transportation	Lincoln	NE	X	X	X		
Intern Program	Felsburg Holt & Ullevig	Omaha	NE		X	X		
Research	KUMC Research Institute	Kansas City	KS	X				
Research	Durham Buses	Kansas City	KS					X
Research	Missouri DOT	Jefferson City	MO	X	X		X	
Research	Virginia DOT	Richmond	VA			X		
Research	Utah DOT	Salt Lake City	UT			X		
Research	National Institute of Standards and Technology	Gaithersburg	MD				X	
Research	U.S. Geological Survey	Rolla	MO		X	X	X	
Research	National Weather Service	Springfield	MO		X	X	X	
Research	MicroSystem Inc.	Fort Walton Beach	FL				X	
Research	Iowa Flood Center	Iowa City	IA		X	X	X	
Research	University of Iowa Computer Science Department	Iowa City	IA			X	X	
Research	University of Iowa Hydroinformatics Lab	Iowa City	IA			X	X	
Research	United States Army Corps of Engineers	Washington, D.C.					X	
Research	Santa Catarina State University	Florianópolis	Brazil		X			
Research	Marshall University	Marshalltown	WV		X			
Research	Liquid Bulk and Tank, Inc.	Omaha	NE		X	X		
Research	Nebraska State Patrol	Lincoln	NE		X	X	X	

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

Have other collaborators or contacts been involved?

University of Nebraska-Lincoln (UNL)/University of Nebraska-Omaha (UNO)/University of Nebraska Medical Center (UNMC)

During this reporting period MATC Researchers at UNL/UNO/UNMC reported involvement with collaborators and/or contacts from the following:

- Andy Zickler from Virginia DOT and Shawn Debenham from Utah DOT both of whom provided some correspondence useful to the project.
- An additional proposal will be developed in partnership with UNL CSE department for further connected vehicle research with wireless capabilities. That proposal will be submitted to the NDOT program this fall.
- Jason Ellicott, a thesis student employed by Hunt Transport, Inc.
- The State Department of Transportation in Iowa, Kansas, and Missouri are collaborators who may assist in identifying test sites and adopt the DAD implementation guide that is expected to be developed as a result of USDOT research.

University of Iowa (UI)

During this reporting period MATC Researchers at UNL/UNO/UNMC reported involvement with collaborators and/or contacts from the following:

- Prof. Melville from Auckland University who is one of the top scientists working in this area and whose experiments were used by many groups doing work related to riprap design formulas, including by ours as part of the research performed during the 1st year of this project.
- Vahid Eghbal Akhlaghi – PhD student in the Department of Business Analytics
- Yazeed Alabbad, PhD student at the UI Hydroinformatics Lab, University of Iowa

University of Kansas (KU)/University of Kansas Medical Center (KUMC)

Nothing to report.

Missouri University of Science & Technology (MS&T)

Nothing to report.

3. OUTPUTS

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

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

	Performance Measure	Description	Goal	Center Total for April 1, 2020 – September 30, 2020
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-two (22) During the reporting period, 10 final reports and 9 peer reviewed journal papers and 3 conference papers were published.
Output 3	Outreach Activities	Number of outreach activities (webinars, social media, workshops, newsletters, and presentations, etc.)	Fifteen (15) outreach activities for each year of the grant period.	Eighteen (18) During the reporting period, 6 presentations, 3 webinars, and 2 workshops occurred; 7 websites and social media platforms were utilized.

Publications, conference papers, and presentations

Journal Publications

1. Submitted a manuscript entitled "Crash Report Data Analysis for Creating a Spatio-Temporal Attention Guidance for Vision Based Real-Time Crash Risk Assessment" Analytic Methods in Accident

Research Journal.

2. Yu Li, Muhammad Monjurul Karim, Ruwen Qin, Zuhui Wang, Zhaozheng Yin, Zeyi Sun. Crash Report Data Analysis for Creating a Scenario-wise, Spatio-Temporal Attention Guidance for Vision Based Real-Time Crash Risk Assessment and Prevention. Under revision. Acknowledgment of Federal support (yes).
3. Muhammad Monjurul Karim, Yu Li, Ruwen Qin, Zhaozheng Yin. A System of Vision Sensor Based Deep Neural Networks for Complex Driving Scene Analysis in Support of Crash Risk Assessment and Prevention. 2010 Transportation Research Board Annual Meeting. Accepted for presentation. Acknowledgment of Federal support (yes).
4. Wittich- Al-Kady, K., Wittich, C.E., Wood, R.L., and Morcous, G. (2021). "Impacts of Traffic-Induced Vibration on Phased Construction Bridges: Field Monitoring." ASCE Structures Congress, April 2021. Status: Abstract Submitted. Acknowledgment: N/A to Abstract, but will be included in paper if invited.
5. Curvature Decomposition for Autonomous Guidance was accepted to the WCX SAE World Congress.
6. Fruhling, Ann; Hall, Margeret; Medcalf, Sharon; and Yoder, Aaron. Designing a Real-time Integrated First Responder Health and Environmental Monitoring Dashboard, DESRIST (Design Science Research in Information Systems), 2020 proceedings. SUBMITTED and ACCEPTED.
7. Wu, H., Zeng, J. and Constantinescu, G. (2020). A multiparameter design formula for riprap size selection at wing-wall abutments, *Journal Hydraulic Research, in press.*
8. Fang, C., Yosef, T.Y., Linzell, D.G, Rasmussen, J.D., "Computational Modeling and Simulation of Isolated Highway Bridge Columns Subjected to Vehicle Collision and Air Blast," *Journal of Engineering Failure Analysis. Under review.*
9. Fang, C., Yosef, T.Y., Linzell, D.G., Rasmussen, J.D., "Residual Axial Capacity Estimates for Bridge Columns Subjected to Vehicle Collision and Air Blast," *ASCE Journal of Bridge Engineering. Under review*.
10. Fang, C., Yosef, T.Y., Linzell, D.G, Rasmussen, J.D., "Performance of Isolated Highway Bridge Columns Subjected to Vehicle Collision and Air Blast," *Manuscript in preparation.*
11. Fang, C., Yosef, T.Y., Rasmussen, J.D., Linzell, D.G., "Numerical Investigation of FRP-Coating Effectiveness for RC Bridge Column under Vehicle Collision and Air Blast". *Manuscript in preparation*.
12. Fang, C., Yosef, T.Y., Rasmussen, J.D., Linzell, D.G., "Dynamic Response and Damage Analysis for Multi-Column Bridge Pier under Vehicle Collision and Air Blast." *Manuscript in preparation*.
13. Fang, C., Yosef, T.Y., Rasmussen, J.D., Linzell, D.G., "Evaluation of In-Situ Retrofit Schemes for Multi-Column Bridge Pier under Vehicle Collision and Air Blast". *Manuscript in preparation*.
14. Fang, C., Linzell, D.G., Rasmussen, J.D., Tewodros, Y.Y., (2020). "Resiliency of Reinforced Concrete Bridge Frame Piers Subjected to Combined Vehicle Collision and Air Blast". *Proceedings of 6th International Conference on Protective Structures (ICPS6),* 10 – 13 May 2020, Auburn University. *Conference will occur in 2021.*

Conference Papers

1. A paper titled "Modeling and Development of Operation Guidelines for Leader-Follower Autonomous Truck-Mounted Attenuator Vehicles" was sent out to the 100th Transportation Research Board annual meeting.
2. N Hentges, G Singh, A Ratner. "Experimental Investigation of the Settling Characteristics of carbon-based nanoparticle in renewable jet fuel". ASME IMECE 2020, Portland, Oregon, USA, 16-19 November 2020, Abstract accepted and paper is under review. Acknowledgement of Federal support: Yes.
3. ASM Parveg, G Singh, A Ratner. "Experimental investigation of effect of Graphene Nano particles (GNP) on the combustion behavior of renewable jet fuel droplets". ASME IMECE 2020, Portland,

Oregon, USA, 16-19 November 2020, Abstract accepted and paper is under review. Acknowledgement of Federal support: Yes.

Presentations

1. Interactive and Real-time Flood Inundation Mapping on Client-Side Web Systems, ASFMP 2020 Conference, June 9-11, 2020.
2. UNL student presented at Nebraska Summer Research Virtual Symposium August 5th, 2020, detailing research efforts through an academic research video.
3. Researchers were originally anticipated to present results of the Road Decomposition for Autonomous Guidance at the WCX SAE World Congress, but due to COVID-19 outbreak, the conference was cancelled.
4. Work Zone Safety and How to Use New Technologies to Mitigate Work Zone Intrusion. Webinar invited by TRB Standing Committee on Maintenance and Operations Management.

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

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

MATC Website

By clicking the following link, http://matc.unl.edu, you will be directed to MATC's website. Below is highlighted information from Google Analytics about the website's traffic from April 1, 2020 – September 30, 2020. By understanding and capitalizing this knowledge, we are able to make our homepage engaging, relevant, and resourceful to our viewers. Since our last progress report, the total number of site visits increased by 255.

Visits: 12,957	Page views: 24,848	Pages per visit: 1.92	Average visit duration: 00:00:44

SlideShare

The top 5 countries that viewed our SlideShare presentations during the reporting period are: the United States, Germany, Netherlands, India, and Brazil. Below is a snapshot of MATC's SlideShare activity and the link to view the page: https://www.slideshare.net/matcRegion7UTC/presentations/. MATC's SlideShare views have decreased by 2,434 since the last progress report.

Total Views: 148	New Uploads: 1	Downloads: 0	Favorites: 0

Facebook

Metrics for the MATC Facebook page can be viewed below, and the page can be accessed by clicking on the following link. MATC's reach decreased by 1 since the last reporting period. https://www.facebook.com/pages/Mid-America-Transportation-Center-MATC/141238439284182.

Views: 572	Total Page Likes: 385	Reach: 2,292	Total Countries (of Followers): 38	Total Languages (of Followers): 17

Twitter

MATC's Twitter handle is @MATCNews. The page can be viewed by clicking the following link: https://twitter.com/MATCNews. The highlighted numbers for MATC's Twitter activity can be seen below. The number of tweets MATC produced decreased by 0 since the last reporting period. The number of profile visits decreased by 660.

New Followers: 0	Tweet Impressions: 5,299	Profile Visits: 71	Tweets: 0

YouTube

MATC's YouTube feed can be viewed by clicking the following link: http://www.youtube.com/user/midamericatrans?feature=results_main. MATC uploaded 12 fewer videos compared to the last reporting period.

New Videos: 9	Views: 904	Minutes Watched: 2,826	New Subscribers: 7

Additional Partner Websites

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

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

Project Title	Principal Investigator	Website Link
Transportation Planning with Floods	Ann Campbell and Ibrahim Demir	http://iihr-vl01.iihr.uiowa.edu/dev/routing/
Crash Prediction and Avoidance by Identifying and Evaluating Risk Factors from Onboard Cameras	Ruwen Qin	https://sites.google.com/view/yuli1102/projects/matc?authuser=0.
Assessing and improving the cognitive and visual driving fitness of CDL drivers	Shelley Bhattacharya	http://www.kumc.edu/landon-center-on aging/research/truck-safety-study.html.
Real-time Flood Forecasting for River Crossings	Witold Krajewski	http://siihr50.iihr.uiowa.edu/smap/demo/

4. OUTCOMES

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

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

	Performance Measure	Description	Goal	Center Total for April 1, 2020 – September 30, 2020
Outcome 1	Commercialized Products	Quantity of invention disclosures, patent disclosures, patents issued, cooperative research and/or user agreements, and new business entities created.	Ten (10) products that are commercialized or in the commercialization process by end of grant period.	Zero (0) MATC is on schedule to develop commercialized products by the end of the grant period. This process is reflected in each PI's individual tech transfer plan.
Outcome 2	Output Adoption	Number of changes made to the transportation system (including regulations, legislation, standard plans, technical guides, or policy) resulting from MATC research.	Ten (10) that have been adopted or in the process of adoption by the end of grant period.	Zero (0) MATC is on schedule to implement changes to the transportation system by the end of the grant period.
Outcome 3	Product Utilization	Number of MATC products utilized (including citations, references, views, report downloads, and report requests).	Forty (40) by the end of the grant period.	One-hundred thirteen (113) Including unique downloads of MATC research reports and unique clicks on the links to final data.

5. IMPACTS

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

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

	Performance Measure	Description	Goal	Center Total for April 1, 2020 – September 30, 2020
Impact 1	Public Stakeholder Participation	Number of public organizations serving as sponsors of research and T2 programs.	Five (5) public sector external partners providing support to MATC activities for each year of the grant period.	Forty-three (43) MATC partnered with 43 public organizations on research, education, and technology transfer activities. See Table 2 for the complete list.
Impact 2	Private Stakeholder Participation	Number of private organizations serving as sponsors of various research and T2 programs.	Five (5) private sector external partners providing support to MATC activities for each year of the grant period.	Ten (10) MATC partnered with 10 private organizations on research, education, and technology transfer activities. See Table 2 for the complete list.
Impact 3	Transportation Professional Participation	Number of transportation professionals who participate in MATC T2 activities.	One hundred (100) transportation professionals for each year of grant period.	One-Hundred Sixty-Nine (169) 169 transportation professionals participated in MATC activities during the reporting period.

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

Ongoing MATC research projects will have a wide variety of impacts on the effectiveness of the transportation system. In a project led at the University of Kansas, the 2-D lidar device could be a reliable way to detect unnoticed vehicles that can reduce the number of collisions. The third generation system has enough computing power that it could effectively give information in a timely manner and for a reasonable cost. It could be implemented on more than just bicycles, any vehicle with large blind spots (e.g., semi-trucks) could benefit from lidar to identify if an obstacle exists and how far away it is. The 3-D lidar system has the potential to map and keep track of road defects or structural damage on bridges and elevated roads. This information can be used to identify problem areas and decide when repairs are necessary before the roads become unsafe. With faster processing power, the system could potentially be mounted onto a mobile vehicle to map large sections of road at a time or monitor traffic.

At the Missouri University of Science & Technology, the proposed project will result in a series of tools and protocols based on deep learning methods. These materials will promote safety and economic viability of the surface roadways by providing real-time processes for flood control and driver rerouting

schemas. These processes are data driven and use geospatial data and information to fully model areas categorized as high risk for flooding.

At the University of Nebraska-Lincoln, the biggest impact will be the tank-trailer model that will be used further for simulation in LS-DYNA, which will help to design a new roadside containment barrier for tractor-tank trailer vehicles. Upon successful completion, the new barrier could be used to mitigate the effects of hazardous crash events from tank trailers carrying hazardous materials. The tank model could also be used by other transportation agencies to study other topics related to tank trailer vehicles.

Researchers at the University of Iowa, this 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.

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?

There is nothing to report yet on the center's impact on the adoption of new practices or instances where research outcomes have led to the initiation of a start-up company. MATC PIs are required to develop a Technology Transfer Plan for their individual project in accordance with the center's overarching plan and USDOT requirements. The process of implementing each project's research outcomes is reflected in these plans.

What is the impact on the body of scientific knowledge?

MATC's current and ongoing transportation research will have a wide variety of safety-related impacts on the current body of scientific knowledge. In the University of Kansas, the research could be used as a starting guideline for car-following preferences in automation. Since the sample size of the study is relatively high, the data can be used to comment on gap preferences of various drivers (classes of drivers). Insights on driver workload and its influence on following gaps/speeds can suggest preferred thresholds for SAE level 2 and 3 of automation (where driver still plays a key role in the vehicle).

At the Missouri University of Science & Technology, this project will help understand how this new autonomous driving technology will perform, interact and impact the general transportation systems.

At the University of Nebraska-Lincoln, all existing ADAS systems rely on the vehicle interpreting and understanding the environment. No existing ADAS systems reference external markers nor obtain guidance or road profile data from external databases. Thus, this project represents the first scientific attempt to evaluate an externally-source guidance and/or trilateration system for ground transportation.

The University of Iowa will 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 especially for small 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. More reliable design formulas for protection of bridges abutments against erosion will result in significant reduction of costs to maintain roads operational during and after flood events. It will also avoid structural failure of some of the bridges and thus reduce risk for hazard associated with bridge failure during floods

What is the impact on transportation workforce development?

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

6. CHANGES/PROBLEMS

COVID-19 has negatively impacted the operations of all MATC institutions. Essentially all universities were closed for the majority of this reporting period except for essential services. Although some services have resumed MATC research and outreach activities are primarily being conducted remotely.

With respect to research approximately six of our projects, that required laboratory work, were delayed by COVID-19. Although laboratories have reopened in recent weeks, social distancing is a requirement which hinders laboratory access. MATC researchers will continue their work remotely, as appropriate.

Our summer outreach programs, including the MATC Summer Institute, the NCIA/MATC Sovereign Native Youth STEM Leadership Academy, and the MATC Intern Program were held remotely and the efficacy of these programs was negatively impacted. At this time it is unclear what the overall effect on attendance/participation will be although we are expecting a significant drop in participation. At this time, future programs are being planned as though they will need to be held virtually as well.

7. SPECIAL REPORTING REQUIREMENTS

Nothing to report.