MwRSF Research Culminates in Full-Scale Tractor-Tanker Crash Test

Researchers at Midwest Roadside Safety Facility (MwRSF) are in the fourth year of the project "Investigation and Development of a MASH Test Level 6, Cost-Effective, Barrier System for Containing Heavy Tractor Tanker Vehicles and Mitigating Catastrophic Crash Event". After performing numerous calculations and simulations, they were finally ready to do a full-scale test early December at the Outdoor Proving Ground facility.

Previous research involved replicating the dynamic behavior of a truck-tank trailer combination in computer simulations. Since these trailers are designed to transport fluids, this setup can be difficult and requires various fluid modeling techniques that take into account the elliptical shape of the trailer. The 62-inch barrier must account for these challenges to prevent the vehicle from disturbing other lanes of traffic.

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The high performance, high energy test was performed using an 80,000 pound tractor-tanker vehicle. It impacted the barrier at 50 mph and a 15-degree angle. This type of test is especially rare, as it is classified as Test Level 6 by the Manual for Assessing Safety Hardware (MASH) and uses a tanker trailer rather than a box trailer, and has only been performed two other times.

The concrete barrier was created with the optimum height and reinforcements in mind. The goal was to create a shorter barrier that uses less material, therefore costing less, but that is still tall enough and strong enough to keep the vehicle upright.

The barrier test proved successful. The tanker vehicle was prevented from crossing the line of the barrier into opposing traffic. After the crash, the team will analyze the crash data before working with transportation departments to accept the design. Next, a bid letting process for road installation begins and could take six to 18 months. Interest has already been expressed in the design, so road users can expect to see these barriers soon.

**Roads, Rails, and Race Cars Back in Transit**

The MATC after school Roads, Rails, and Race Cars (RRRC) program returned to in-person lessons at a few middle schools this semester. Mickle Middle School was the only school to start in the program during the first quarter. In October, Culler and Park Middle Schools and UMÔPHO® Nation Public School joined in the fun and had a chance to learn through RRRC’s interactive lessons.

Some of the projects included creating cars out of popsicle sticks and plastic wheels powered by the kinetic energy in rubber bands. In another lesson they modified the car with safety features to keep Lego passengers safe during a crash. While learning about air resistance, students made parachutes out of tissue paper, and aluminum foil boats taught the students about buoyancy on a larger surface area when they competed to make a boat that would hold the most weight. More projects like these will continue to be offered during the spring program and each of these four schools are excited to participate.

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**Share your News with MATC!**

If you are a student, faculty member, or other affiliate of the Mid-America Transportation Center, we are eager to share news of your work and accomplishments.

Send your information to Madison Schmidt at mschmidt24@unl.edu and it could appear in the next issue as well as MATC’s website, Facebook, and Twitter.

Facebook: MidAmericaTransportationCenter
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Spring 2021 was the last semester MATC would be led by Dr. Laurence Rilett. He has served as the director since 2004 and is responsible for its success in gaining University Transportation Centers (UTC) funding and spearheading the many educational outreach programs. In the spring he received the 2021 Frank M. Masters Transportation Engineering Award for "contributions to innovative research on transportation systems and collaborative leadership to develop a diverse workforce in transportation engineering." His new position marks him as leader of the recently established Auburn University Transportation Research Institute within the College of Engineering.

Under Dr. Rilett’s directorship, MATC was designated as the U.S. Department of Transportation (USDOT) Region VII University Transportation Center in 2006, 2011, and 2016. He is responsible for developing the Roads Rails and Race Cars after-school program for middle-school students, a week-long STEM summer academy for Native American high school students, and the Scholars programs designed for students in historically black colleges and universities and tribal colleges and universities to advance their education to a higher degree. Rilett’s research focuses on transportation system analysis, mainly divided into Intelligent Transportation Systems applications and large-scale transportation system modeling.

At the beginning of the semester, Dr. Rilett left MATC in the capable hands of Dr. Aemal Khattak to serve as the interim director. Khattak is a Professor of Civil and Environmental Engineering and has been part of UNL faculty for 21 years, also serving as MATC Assistant Director. His expertise is in transportation safety engineering and he has extensive leadership experience as the head of multiple research projects that have taken place during his time here. Now Dr. Khattak has been officially appointed as the Director of MATC, and remains the interim director of NTC.

Dr. Khattak’s research interests specialize in Transportation Safety, Transportation Infrastructure Planning, and Intelligent Transportation Systems. He has been part of the Transportation Research Board as an Inaugural Editorial Board Member since 2020 and was a past chair of the Transportation Research Board Standing Committee on Highway/Rail Grade Crossings. Dr. Khattak earned his Bachelor of Science with honors in Civil Engineering from the University of Engineering and Technology in Peshawar, Pakistan, his Master of Science in Civil Engineering from Pennsylvania State University, and a PhD in Transportation Civil Engineering from North Carolina State University. In 2015 he received the UNL University-Wide Distinguished Teaching Award, and in 2016 he received the UNL College of Engineering Faculty Service Award.

Since acquiring Interim Director and Director status, Dr. Khattak has become involved with MATC’s outreach programs, such as planning of the Tribal Colleges and Universities Scholars Program to take place in the Spring semester. He has also organized a series of webinars for his students and engineering professionals at UNL, hosting NTC Post-Doctoral researcher Dr. Ernest Tufuor, a research scientist at the Connecticut Transportation Safety Research Center Dr. Shanshan Zhao, and University of Tennessee, Knoxville Professor Dr. Asad Khattak.

As Dr. Aemal Khattak continues his Directorship, he will work closely with the NTC Director, a position that is currently available and will be responsible for the administration and leadership of NTC operations.
MATC Sponsors Seven New Research Projects

New research projects are beginning this year at Mid-America Transportation Center, many of which are led by researchers who are the principal investigators for the first time. They cover a variety of subjects in the transportation field and address gaps in current engineering research.

Chung Song is beginning a new project titled “Enhancing Erosion Resistance of Rock Shoulder by Considering Hydrodynamics”. It aims to address the problems created by unpredictable and extreme weather events and patterns in the pavement system. Specifically, the harsh winter of 2019 in Nebraska unexpectedly eroded and dislodged shoulder aggregates. This research combines dedicated testing methods to obtain hydrodynamic rock shoulder that provides fast drainage and superior erosion protection at the surface but provides high strength below the surface.

Richard Wood is leading a project titled “Shallow River Ice Flow Impacts on Critical Infrastructure”. It provides better predictive models for ice flows and ice jams causing floods that damage critical infrastructure and threaten lives. It does this by incorporating high-accuracy field measurements with detailed hydraulics models, focusing on shallow, alluvial streams subject to the widespread grounding of floating ice.

Jongwan Eun’s new project, “Application of Microfiber Reinforcement to Weak Soils for Alternative Road Stabilization” aims to identify the effectiveness of fiber reinforcement on reducing swelling/shrinkage potentials and control the plasticity of poor subgrade soils. It fills the gap in research where there are no well-defined provisions regarding microfiber reinforcement design for subgrade soils.

Li Zhao is leading her first MATC project, “Safety and Mobility Improvement at Highway-rail Grade Crossings Using Real-Time Optimized Preemption of Traffic Signal Strategies”. Her project addresses the dangers that occur at urban highway-rail grade crossings in close proximity to signalized intersections where traffic queues may block the crossing area. This study aims at optimizing preemption strategies to maximize the separation of traffic hazards between the rail crossings and traffic intersections.

Eric Thompson has a project investigating the contribution of logistics facilities to safety and health benefits in the transportation of hazardous materials and other freight. Titled “Logistics Solutions in the Supply Chain: Economic Benefits of Safety and Environmental Impacts”, it’s goal is to create a supplement to existing supply chain models to account for safety and health benefits in addition to the operating costs and internalized worker travel time they already evaluate.

Ernest Tufuor has been part of many projects at MATC, but this is his first time as Principal Investigator. His project “Performance Reliability and Safety Index for Region VII Highways” addresses the inadequate statistics of performance metrics such as travel time, speed, delays, congestions, and crashes. The study assesses data on performance measures from state Departments of Transportation within Region VII to determine if the existing data can be used for real-time performance reliability monitoring.

Tirthankar Roy is the Principal Investigator of “A Machine Learning-Based System for Predicting Peak Flowrates of Nebraska Streams”. The Iowa Flood Information System (IFIS) developed by researchers at the University of Iowa is already used to help predict floods and which roads should be closed in preparation. This project investigates how IFIS could be improved by incorporating snow processes into its hydrologic model for use in Nebraska by first modeling peak flowrates in Nebraska streams using new high-resolution datasets and a suite of machine learning algorithms.
Assessing and Improving the Cognitive and Visual Fitness of CDL Drivers

This article was written for the UTC Spotlight Newsletter to be published late 2022. It was written and reviewed by the described project’s principal investigator, co-principle investigators, and students.

Drivers with a Commercial Driver’s License (CDL) carry significant loads, including hazardous freight, and, thereby, have a potential for significant motor vehicle accidents. This is why the U.S. Department of Transportation (DOT) is continually looking for ways to improve highway safety in commercial drivers. The study, Assessing and Improving the Cognitive and Visual Fitness of CDL Drivers at the University of Kansas Medical Center is one project the University Transportation Center (UTC) sponsors. It is currently in its third year of a five-year grant. The ultimate goal of the research is to develop clinical tools to predict the on-the-road driving safety for CDL drivers. This information can then be used by health care providers and the DOT as a framework for commercial truck drivers to improve their driving fitness and, in turn, prevent future accidents.

The study design consists of a battery of motor, cognitive, visual, and driving tests done annually for three years to active CDL drivers. These results are compared to their on-the-road driving performance using a Driver’s Assessment Questionnaire and log data to look for predictive variables for road safety. The cognitive tests consist of the Montreal Cognitive Assessment (MOCA), Stroke Drivers Screening Assessment (the dot cancellation, dot matrices, road-sign recognition tests), Trails A, Trails B and Snellgrove Maze test.

Our team also conducts driving tests via simulation using three driving scenario runs. During the runs, each participant is monitored with a Tobii eye tracking system. The Tobii generates measurable reflection patterns on the eye and processes them through complex algorithms and 3D-modeling. This technology allows the team to evaluate physiologic eye position and point of gaze in real-time with driving simulation performance. The data is then used as a metric to analyze potential associations and risk factors. Additionally, it allows for the testing of innovative instruments that may track inattention and drowsiness.

In addition to cognitive and simulator examinations, there are tests centered on motor function and visual performance. The visual aspect involves a field of vision examination using Useful Field of View and a formal eye examination using the Keystone system, focusing on functions such as depth-perception, night vision, color, and refractive errors.

Top: Iarina Devos (right) and Rob Gibson (left) at a recruitment station at a local truck stop in Kansas City.

Bottom: Truck stop in Kansas City.
All of these tests, with the exception of the MOCA, are graded for number of errors and are timed—in addition to other data points when the study design calls for it—and analyzed in relation to driving simulation performance. There are many factors that contribute to commercial driving safety. The study plans to identify these factors, including cognitive aspects, and apply them to a framework for improving safety, health, and wellness of commercial truck drivers. By identifying potential markers, the study will analyze the data in coordination with the driving simulation information and provide a key link to understanding the framework of driving safety. The study is designed to help determine what tests affect fitness-to-drive and how we can maintain safety on the road by improving these skills—be it visual, cognitive, general health, or motor.

After each subject completes their annual assessment, they are given a summary sheet with their respective scores in each domain. This is reviewed with the subject and research team, emphasizing their strengths and providing tools to help them improve any weaknesses. Results are not reported to the Department of Motor Vehicles, the Department of Transportation or their employer.

The research project, Assessing and Improving the Cognitive and Visual Fitness of CDL Drivers, takes place at the University of Kansas Medical Center, in the Laboratory for Advanced Rehabilitation and Research (LARRS). Dr. Shelley Bhattacharya, the Principal Investigator for the study, is a board-certified physician in Family Medicine and holds a Certificate of Added Qualifications in Geriatric Medicine, issued by the American Board of Family Medicine. Dr. Hannes Devos and Dr. Abiodun Akinwuntan are director and co-director of the LARRS lab, respectively. Medical students Rob Gibson, Payton Lancaster, Corrina Lemke, Chris Denton and Chase Branstetter are involved in data collection, recruitment, and day-to-day operations.

Xianbiao Hu Research Publication Highlighted in TRB News

Dr. Xianbiao Hu, formerly a researcher at the MATC affiliated Missouri University of Science & Technology, published his article “Development of Operation Guidelines for Leader-Follower Autonomous Maintenance Vehicles at Work Zone Locations” on his research conducted with Ruwen Qin, formerly at MS&T and now residing at Stony Brook University in New York, and Qing Tang, a colleague of Hu’s at his current professorship in Pennsylvania State University.

The paper analyzes the rapidly developing industry of connected and autonomous vehicle (CAV) technologies. This study specifically explores their use by Departments of Transportation (DOT) to reduce fatalities of DOT workers in work zone locations. This research addresses the lack of practical driving guidance for autonomous truck mounted attenuator (ATMA) system operators by modeling and developing a set of rules and instructions when it comes to critical locations where essential decision making is needed. Specifically, three technical requirements are investigated: car-following distance, critical lane-changing gap distance, and intersection clearance time. The team collected data from real-world field testing to calibrate and validate the developed models. The study resulted in suggested thresholds for ATMA system operators to follow.

This publication is in Sage Journals as part of the Transportation Research Record. It can be viewed here: https://journals.sagepub.com/doi/epub/10.1177/03611981211056644