

Demonstration Day
Friday, October 3, 2024
UMTRI and Mcity Test Facility
DEMONSTRATION DESCRIPTIONS

Welcome and thank you for joining us for an exciting opportunity to discover the innovative testing and research happening at The University of Michigan Transportation Institute (UMTRI) and Mcity. Explore the future of transportation as you learn about our cutting-edge work in autonomous vehicles, intelligent traffic management, advanced modeling and simulation, and the transformative role of AI in revolutionizing the movement of people and goods worldwide. Experience firsthand how we're shaping mobility's next chapter!

UMTRI DEMONSTRATIONS

Ann Arbor Connected Environment (AACE)

Presenters

- Debby Bezzina, Senior Program Manager, Ann Arbor Connected Vehicle Environment
- Andrew Donaldson, Lead Engineer in Research, Human Factors Group

Attendees will hit the streets of Ann Arbor, home of the world's first large-scale, real-world deployment of connected vehicles. During this demonstration, UMTRI researchers will showcase the benefits of infrastructure-assisted technology, including: Congestion reduction through transit signal priority (TSP); Vulnerable road user protection; and Visualization of Signal Phase and Timing (SPaT), MAP, and sensor data sharing messages (SDSMs). Participants also will learn about the other technologies that make AACE world-class, including:

Heat Map Testing

UMTRI has partnered with several OEMs to conduct V2V testing in the environment. UMTRI utilizes AACE to create a concentration of connected vehicles to facilitate OEMs testing of their connected vehicle applications in a safe, naturalistic environment. This will help automotive OEMs to commercialize

their C-V2X products and support the U.S. DOT V2X Deployment Plan's goal of automotive OEMs deploying 5.9 GHz capable vehicles.

Near-miss Detection

UMTRI has developed and deployed a near-miss detection algorithm at one of the most congested intersections in Ann Arbor. This demonstration will highlight the tool's ability to detect risky driving behavior in real-time.

AACE Visualization Tool

This demonstration showcases two tools. The first tool visualizes the real-time status of AACE C-V2X roadside units and perception systems that are deployed in Ann Arbor. The second tool visualizes how SPAT and MAP are validated for the Ann Arbor C-V2X deployment to ensure that the data can be trusted by its users, such as OEMs. It will also demonstrate an instance where red light violation was detected by the system.

Ground Truth Trip Recorder

Presenter

- Arpan Kusari, PhD, Assistant Research Scientist, Engineering Systems Group

The UMTRI Ground Truth Trip Recorder (GTTR) is a groundbreaking system designed to bring a new level of insight and accountability to autonomous vehicles. The GTTR can be easily added to any AV, serving as an "automated driver's license test" that evaluates how these vehicles perform in real-world conditions. Following a successful feasibility study, we've shown that our technology delivers precise, comprehensive, and fully automated measurements, making it easier than ever to put AVs to the test. By providing unbiased data on on-road performance, the GTTR is helping shape a future where autonomous driving is both safer and more transparent.

Anthropometry: PassFit™

Presenter

- Daniel Park, PhD, Associate Research Scientist, Biosciences Group

UMTRI experts have developed a cutting-edge modeling framework that accurately simulates human body and vehicle physics during a crash and are setting the standard

for others in the field. These capabilities will transform occupant protection as we know it today. Having collected data from over 1,000 CT scans, 500+ body scans, engaged with over 10,000 research participants and have conducted over 5,000 crash simulations, UMTRI has already developed the world's best parametric model of the human body that can represent all of us. Today participants will experience PassFit™ a state-of-the-art, portable 3D anthropometry system designed to measure human body shape with remarkable efficiency and precision. Built to deliver results on par with ANSUR standards, PassFit™ uses advanced BioHuman™ models to create highly realistic 3D avatars while pinpointing anatomical joint locations, even when individuals are clothed or wearing equipment. This innovative tool provides detailed, accurate body measurements, making it an ideal solution for industries and researchers seeking reliable, real-world data on human body shape and form.

Road Roughness Index/Profiler

Presenter

- Mark Gilbert, Electronics Engineer Lead, Engineering Systems Group

UMTRI has shaped the field of road roughness measurement since developing the International Roughness Index (IRI) in the 1980s. The IRI measures pavement ride and surface quality, supporting investment decisions and ensuring newly built roads meet smoothness standards. Mandated for all roads within the U.S. Federal aid network and widely adopted worldwide, IRI relies on accurate longitudinal profile measurements to identify sources of roughness and select effective remedies. UMTRI has developed the two gold-standard longitudinal profile measurement systems, which provide reference-quality data and serve as the standard for production profilers in the U.S. These systems are central to the profiler certification program at the Illinois Certification and Research Track—the nation's largest. UMTRI is now developing a next-generation system for nationwide use..

Occupant Monitoring/Driver State Monitoring

Presenter

- Monica Jones, PhD, Associate Research Scientist, Biosciences Group

Will you spend your time in an autonomous vehicle (AV) reading or relaxing? Is that safe, and what should we know about posture as AVs become mainstream? Occupant monitoring is more crucial than ever, providing insights that not only enhance current safety, but also prepare us for the future of automated mobility.

This demonstration showcases how we're looking ahead at the occupant experience in AVs. Our research delves into occupant behavior, posture, state, and preferences, foundational knowledge for ensuring safety in automated vehicles. At UMTRI, experts use advanced simulations to study three key factors: motion sickness, monitoring occupant state, and occupant dynamics. As vehicles progress from Level 2 to Level 3 automation and beyond, understanding how posture changes in these environments is a vital frontier, ripe for exploration.

Future AI-Driven Digital Twin for Crash Injury Assessment

Presenter

- Jingwen Hu, PhD, Research Professor, Biosciences Group

Today there are only three accurate, validated models representing the myriad of human body shapes and sizes. That leaves many of us wondering if we are being truly reflected in transportation safety research and manufacturing. Imagine if we could build virtual human models that accurately reflect all people.

At UMTRI, we're making this vision a reality. By combining our world-class Human Body Model with physical crash testing, post-mortem human subject (PMHS) data, advanced simulation, and AI, we're developing highly accurate virtual models that represents all of us to improve occupant safety for all.

Our linear sled system simulates vehicle crashes in a controlled laboratory setting, letting researchers evaluate crash impacts in detail. Unlike conventional studies limited to just three standard body types (50th percentile male, 5th percentile female, 95th percentile male), our approach—powered by AI and next-generation simulation—captures the full range of human shapes and sizes. This breakthrough enables us to advance research for diverse impact directions, restraint systems, and equipment—including wheelchairs, child safety seats, and more.

By integrating cutting-edge simulation with physical testing, we can recreate a wide variety of crash scenarios—varying speed, force, and angles—without needing a full vehicle. These innovative tools are accelerating safety research and paving the way for a safer future for every occupant.

Simulation of Driving under Task Driven Cognitive-load for 6-Wheel Vehicles

Presenters:

- Paul Green, PhD, Research Professor, Human Factors Group
- Brodey Miller, Assistant in Research, Human Factors Group

Get ready to put your skills to the test as you take the wheel of a 6-wheel military vehicle and navigate an unfamiliar virtual landscape! Under the guidance of Paul Green and his students, your vision will be selectively restricted to simulate the real-time demands drivers face. Can you stay on course when you can't see it all?

UMTRI's innovative research driving simulator, developed with significant student involvement, offers unmatched flexibility for studying how people interact with all kinds of vehicles in a vast array of settings, far beyond just roads. For example, we have expanded the immersive virtual worlds to the rugged terrain of Yehorivka (Ukraine), a digital twin of Mcity, and a vibrant city with towering high-rises. Whether advancing research projects, or through use in special classes, this simulator is an asset for assessing driver demand.

Our ultimate goal: predictive models that pinpoint the moment-to-moment challenges drivers face based on road geometry, traffic, and visibility, on any terrain. Join us and help drive the future of research!

MCITY DEMONSTRATIONS

Seconds to Impact: Human Decisions in Mixed Reality

Presenter:

Derek Fraser, Global and North America User Experience and Ergonomics, Stellantis

In this live demo, Mcity explores one of the most critical challenges in autonomous driving: how to safely and quickly hand control back to a human driver. In today's vehicles at Level 2+ autonomy, this handoff can take up to 10 long seconds, an eternity when a serious crash is unfolding.

To tackle this problem, four design master's students from the University of Michigan's School of Information are rethinking the driver experience from the ground up. This group is mentored by Principal Investigator Derek Fraser of Stellantis and U of M School of Information Lecturer James Rampton. Together, they are exploring innovative alert

strategies like visual cues, sound patterns, and multi-modal sensory feedback, all in an effort to help drivers re-engage faster when every second counts.

Today's demo replicates a high-stakes scenario. A human participant, seated in the cockpit of a vehicle simulator and wearing a VR headset, starts in an autonomous driving mode. Their virtual vehicle follows behind a large delivery truck that blocks most of their forward view. Suddenly, the truck swerves at the last moment to avoid a disabled vehicle. Now, the autonomous car is seconds away from a collision. And the human driver must take control instantly to avoid disaster.

But this isn't just a simulation. The simulator is teleoperating a real vehicle on the Mcity test track, adding a layer of realism that changes how people behave. Test subjects act differently when they know there are real-world stakes, and today's demo gives researchers the tools to study exactly that.

Live From Buffalo to Ann Arbor: The Future of Mixed Reality

Presenter:

- Chaozhe He, PhD, Assistant Professor, Department of Mechanical and Aerospace Engineering, School of Engineering and Applied Sciences, University of Buffalo

In this live demo, Dr. He and his team from the University at Buffalo will showcase Mcity's cutting-edge capability: synchronizing remote simulators with real-world autonomous vehicles in a shared, mixed-reality environment.

From Buffalo, New York, Dr. Angulo will control a pedestrian simulator, while Dr. He navigates a virtual vehicle—both hundreds of miles away from the action at Mcity. Meanwhile, back at the Mcity test facility in Ann Arbor, a fully autonomous vehicle will be deployed in the real world. The real-time position of the Mcity vehicle and its orientation will be streamed to the simulators, allowing the Buffalo team to see and react to it in their virtual environment. The simulators will also transmit their positions back to the shared digital twin, enabling the real autonomous car to respond intelligently to these remote agents.

You'll witness the real AV recognize, yield, and wait for simulated pedestrians and vehicles—each controlled live by humans hundreds of miles away. It's a powerful demonstration of what's possible when autonomy, simulation, and connectivity converge.

Lifting the Curse of Rarity: Smarter Testing for Safer AVs

Presenters:

- Greg Stevens, Research Director, Mcity
- Haowei Sun, PhD, Co-founder, SaferDrive AI

One of the biggest challenges in AV testing is the “Curse of Rarity,” those dangerous edge cases that are so infrequent in the real world you’d have to drive millions of miles just to encounter one. Gathering data on these rare events is difficult and incredibly expensive.

That’s where Dr. Haowei Sun from SaferDrive AI steps in. In this demo, Dr. Sun will introduce two powerful tools: SaferDrive AI’s TeraSim and NVIDIA’s Cosmos World Foundation Model. He will then show how, together, they create a revolutionary new approach to AV testing.

TeraSim is an open-source traffic simulation platform, trained on real-world driving behaviors. It’s built specifically for naturalistic and adversarial testing, letting researchers push AVs into both everyday traffic and those rare, high-risk situations we desperately need to study.

While TeraSim exposes the AV to rare events, NVIDIA’s Cosmos fills in the world around them. Cosmos is a cutting-edge generative World Foundation Model (WFM) that creates richly detailed, realistic environments on demand, bringing those hypothetical edge cases to life with cinematic clarity.

Dr. Sun will share video scenarios that never actually happened, but absolutely could. And that’s the point: safer AVs, faster, through smart simulation and synthetic data generation.

Green Lights Ahead: Cooperative Autonomy in Action

Presenters:

- Jeff Ban, PhD, University of Washington
- Shakiba Naderian, Graduate Research Assistant, University of Washington

We’ve all been there, stuck at a red light, waiting 10... 20... even 30 seconds, with no one else at the intersection. It’s frustrating, inefficient, and avoidable. Now imagine a world where that never happens.

Dr. Jeff Ban from the University of Washington invites you to glimpse that future with a live demonstration of cooperative control between connected autonomous vehicles (CAVs) and smart traffic signals.

In this demo, a real Mcity vehicle will drive through the Mcity test facility. This vehicle will be our Vehicle Under Test (VUT). The demo will include six networked traffic signals and dozens of virtual background vehicles. Behind the scenes, Professor Ban's algorithm will orchestrate everything: dynamically adjusting signal timing and coordinating both the VUT and connected vehicles to optimize flow. The system reduces wait times and minimizes queue lengths all in real time.

Rather than traffic lights blindly cycling on timers, the signals respond intelligently to actual conditions, giving you a glimpse into a future where traffic just flows.