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UNIVERSITY OF MICHIGAN

Driven By Success

From the Director

At Mcity, we bring together industry, government, and academia to advance transportation safety, sustainability, and accessibility for the benefit of society.

These diverse partnerships form the foundation of our work…

and drive our success.

Our model is working. The University of Michigan five years ago announced plans to launch an advanced mobility research center. Today, Mcity has established itself as a leading voice in connected and automated vehicles (CAVs).

The public-private partnership we've created with industry, government, and the academic research community is successfully working to address questions that no single company or industry can effectively resolve alone.

The value of our work is clear as a second round of industry funding, with investments from both new and returning Mcity Leadership Circle and Affiliate members, is secure.

As we reflect on Mcity's progress, we are deeply grateful to our partners for their confidence, and for joining us in our work to advance the future of CAVs that will improve traffic safety, conserve energy, and increase accessibility to transportation.

Notable achievements. Use of the Mcity Test Facility is growing. Nearly 4,400 hours have been logged since January 2017, with 70 percent of that for testing. We've hosted hundreds of educational tours for industry, government, media, and private groups.

In addition, we completed the buildout of more testing capabilities in 2017 and 2018, including the addition of a Traffic Control Center and augmented-reality testing technology. A highlight of 2018 was the launch of the Mcity Driverless Shuttle, a research project designed to help us gauge user acceptance of automated vehicle technology.

Top: Mcity evaluated NAVYA's Autonom driverless shuttle for more than a year inside the Mcity Test Facility before launching our driverless shuttle research project.

Above left: Shaobing Xu, left, U-M research fellow in mechanical engineering, and Mcity Director Huei Peng, at work in the Mcity Test Facility.

Above right: Nat Beuse, associate administrator, vehicle safety research, National Highway Transportation Safety Administration (NHTSA), addresses the Mcity Congress in November 2017.

We introduced a white paper series in 2017 to share insights from Mcity-funded research. Topics so far include accelerated AV testing and cybersecurity. Legal and liability issues are an important focus, and we're working with several law firms to share their research findings. The first legal white paper focused on consumer perceptions about who is liable when an automated vehicle crashes. Mcity also helped establish the new digital Michigan Journal of Law and Mobility, in collaboration with the U-M Law School.

Challenges remain. Obstacles affecting progress in the CAV space are universal and not faced by Mcity alone. Progress toward establishing federal standards for vehicle-to-vehicle (V2V) communications has stalled in the absence of a mandate requiring the technology, also delaying the availability of In-vehicle V2V devices. And it is still unclear which communications technology is likely to emerge as the industry choice for V2V: Dedicated Short-Range Communications (DSRC) or cellular vehicle-to-everything (C-V2X).

Our outlook. Mcity believes connected vehicle communications will improve traffic safety, and efficiency. We remain committed to studying the best use of these technologies in the future, and we are expanding Mcity's focus beyond DSRC. But DSRC is the only technology readily available in the market today, and we believe it should be deployed as soon as possible. Any delay is projected to result in lost opportunities for saving lives.

Several recent highly-publicized AV crashes highlight the need for careful and thorough research – through simulation, in controlled test environments like the Mcity Test Facility, and on the road – to verify and validate technologies for the safe deployment of CAVs. Mcity has the space, the leadership, and the voice to make a difference.

The road ahead. We will continue to research and collaborate with our partners, share what we discover for the greater good, and refine our goals to advance Mcity in a constantly evolving space.

By the Numbers
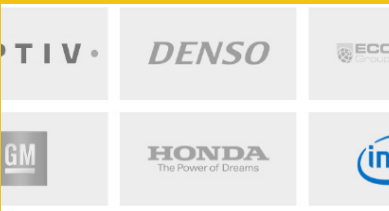
$26.5M
Investment by Mcity in research, development and deployment projects

59
Industry partners collaborating with Mcity on future mobility solutions

4,400
Hours of testing and engagement logged at the Mcity Test Facility since January 2017

100+
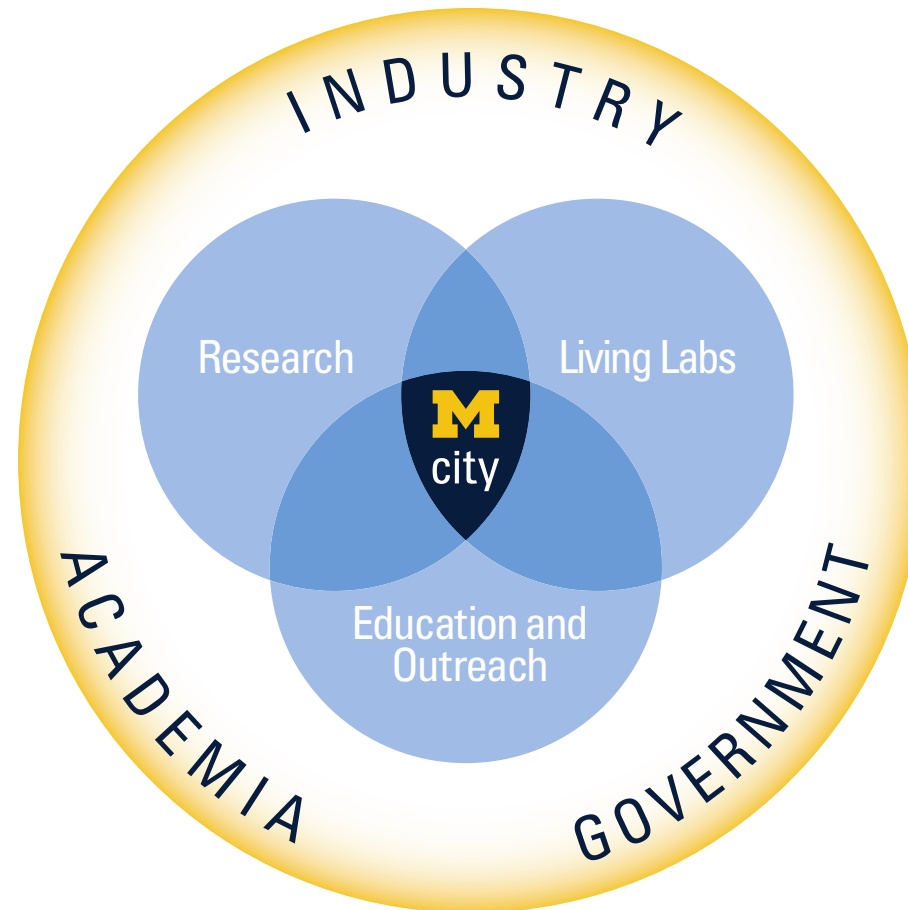U-M graduate and undergraduate students involved in Mcity activities

50
U-M faculty across campus involved in Mcity-funded research

21
Mcity-funded research projects active at this time

Three aspects of Mcity make it unique: early stage testing in our living labs, opportunities for a breadth of research, and our commitment to education and outreach. Our partners in industry, government, and academia are Mcity's foundation.

Living Labs
From controlled conditions to real world environments.

Mcity's one-of-a-kind proving ground for safe, controlled testing, plus on-road test capabilities are an essential combination for evaluating new technologies driving the future of mobility

At the Mcity Test Facility. New patent-pending augmented reality technology allows physical test vehicles to interact with virtual connected vehicles in real time inside the Mcity Test Facility. The technology makes testing safer and more-cost-efficient. Enhancements at the test facility include limited 5G capabilities, power access at all intersections, and construction has begun on a garage for working on and storing test vehicles. For the future, we're exploring rain and fog simulation, and a video data collection system. Mcity's Lincoln MKZ Open CAV research platform is used extensively by faculty and students inside the test facility. Its fast and accurate steering, braking, and throttle control enables rapid testing and development, and interaction with augmented reality.

On the road. We continue to develop the Ann Arbor Connected Vehicle Test Environment (AACVTE), supporting the U-M Transportation Research Institute (UMTRI). AACVTE leads the way in commercialization milestones: The first certified CV pilot environment, and the first production Security Certificate Management System for CAVs.

Opposite from top: Mcity's open-source Lincoln CAV research platform inside the Mcity Test Facility.

Mcity's living labs extend to the Ann Arbor community through AACVTE, the world's largest connected vehicle deployment

The Mcity Test Facility, located on the University of Michigan's North Campus, offers more than 16 acres of roads and traffic infrastructure on a 32-acre site.

A new transportation experience. In June 2018, Mcity launched the first driverless shuttle in the United States focused on user behavior research and extensive data collection. The Mcity Driverless Shuttle research project works to understand how passengers, pedestrians, bicyclists and other drivers interact with the shuttle as a way to gauge consumer acceptance of the technology. We published a case study detailing what we learned about what it takes to launch a driverless shuttle to help others considering similar projects. Mcity's ultimate goal is long-term deployment of driverless shuttles in the real world.
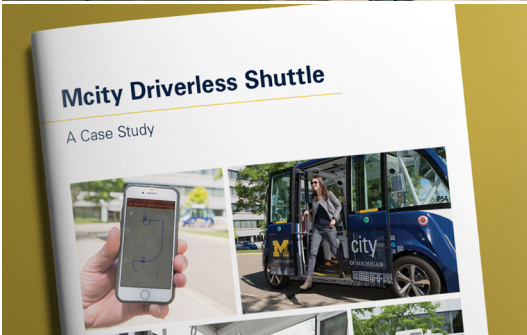

Above: The Mcity Driverless Shuttle project uses two NAVYA Autonom driverless electric shuttles to transport students, faculty, and staff on a non-stop one-mile route on U-M's North Campus.

Opposite from top: Passengers board the 11-seat, all-electric vehicles at two stops along the shuttle route.

The Mcity Driverless Shuttle case study, unveiled at ITS World Congress 2018, Copenhagen, Denmark. Download Case Study

Shuttle safety conductors are trained to oversee the operation and safety of the shuttle during active use. Conductors manually control the shuttle when necessary using a hand-held unit.

Living Labs Achievements

- Instrumented and developed a fleet of three CAV research vehicles.

- Launched the Mcity Driverless Shuttle research project

- Helped establish the AACTVE, the largest connected vehicle deployment in the United States

- Added augmented reality testing capability at the Mcity Test Facility

Research
Defining questions and finding answers.

Mcity-funded research covers a broad range of CAV topics, such as safety, human factors (understanding how humans respond physically and psychologically to new technologies), simulation, testing, and legal and consumer issues – all leveraging the breadth of the U-M community. Five notable projects include:

Pedestrian Detection and Avoidance
OBJECTIVE: Use multiple sensors to construct an algorithm to detect and predict the motion of pedestrians and cyclists for collision avoidance.
OUTCOMES: Build a 10,000-hour dataset of pedestrian and cyclist motion; a multi-sensor fusion based approach to detect and predict the motion of pedestrians and cyclists and a real-time numerical optimization scheme that can safely avoid probabilistic predictions of pedestrian motion.

Driver Safety and Trust
OBJECTIVE: Examine the effectiveness of various training methods on drivers' safe operation and level of trust when interacting with partial vehicle automation.
OUTCOMES: Develop training materials about the function and limitations of partially automated vehicles; develop a training platform that allows drivers to interact with a simulated automated in-vehicle system; measure driver performance and trust toward partially automated vehicles; and recommend training for emerging automated driving concepts.

Opposite from top: Mcity industry partners discuss potential research topics during the twice annual Mcity Research Review.

At the Michigan Traffic Lab, the traffic control center for Mcity, a researcher reviews data.

Augmented reality testing brings virtual connected vehicles to the real world Mcity Test Facility.
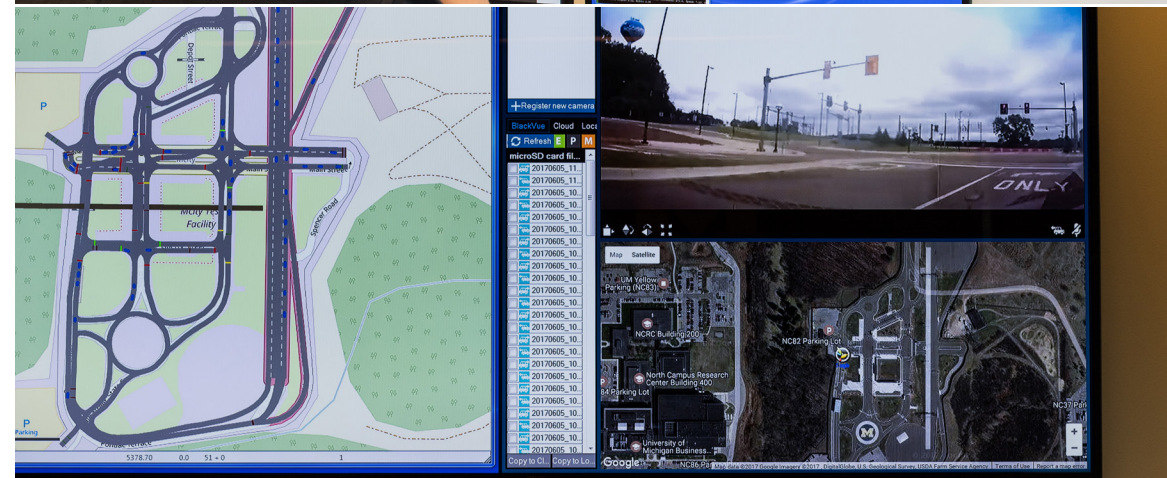
Motion Sickness in AVs

OBJECTIVE: Develop an experimental platform to evaluate motion sickness susceptibility in a range of driving conditions.

OUTCOMES: Quantifying the motion of the vehicle, passenger response, onset and severity of motion sickness, and relationships among these factors. The testing platform will make it easier to evaluate actions that could reduce motion sickness in future AVs. Additionally, this work conducted inside the Mcity Test Facility significantly reduces the time needed to replicate turns and maneuvers on-road.

Accelerated AV Testing

OBJECTIVE: Develop test approaches to evaluate the safety of AVs that reduce test duration from months to days, without sacrificing accuracy.

OUTCOMES: Developed new methods for accelerating AV test procedures that integrate novel techniques in statistical learning, optimization, and experimental design. The proposed methods have the potential to significantly improve the efficiency of an AV safety evaluation procedure.

Liability in AV Crashes

OBJECTIVE: Research led by JD Power and law firm Miller Canfield, in collaboration with Mcity, explored feedback from more than 1,500 drivers regarding automated vehicle technology and how liability claims may be resolved.

OUTCOMES: Offers guidance for the legal community and the automotive industry regarding automated driving systems (ADS) to help the industry move forward together and maximize consumers' trust in AV technology.

Opposite from top: Volunteers participate in a study about motion sickness in automated vehicles.

These images are part of a training dataset Mcity is developing that can be used to "teach" a driverless vehicle how to identify pedestrians and other vehicles in its path.
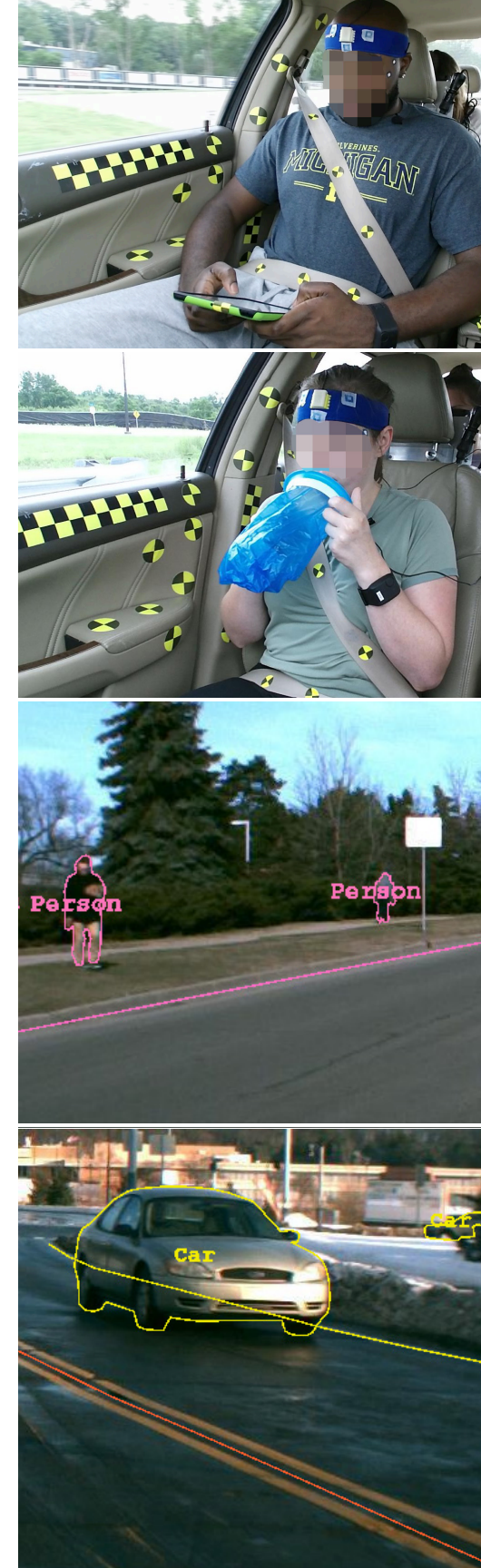
Research Achievements

- Developed an accelerated evaluation approach for AVs

- Developed an accurate localization method for collaborative connected vehicles using low-cost Global Navigation Satellite Systems (GNSS)

- Developed an Android-based vehicular data collection platform for CAVs

- Developed effective driver training methods for partial automation to improve user understanding and acceptance

- Developed fuel-saving algorithms for heavy trucks using CV technology

- Developed an advanced parking detection algorithm based on CAV sensors to reduce dependency on parking infrastructure

- Developed algorithms for dynamic map updates and incident detection using CV data from infrastructure

- Collected a data set that captures the interactions of drivers and pedestrians or bicyclists at intersections

Education and Outreach
Sharing our knowledge and insights.

A critical element of Mcity's mission is to inform and educate key stakeholders about advanced mobility vehicles, and their potential benefit to society. This includes all levels of government, industry, academia, and the general public.

Education. Across the U-M campus, we are working to educate and train the next generation of leaders and innovators in mobility. New courses about CAVs and the future of mobility have been added to the Michigan Engineering and Michigan Law curriculum.

We introduced a series of white papers to share the work of Mcity-funded researchers, including their approach and conclusions. The first Mcity white paper focused on the development of a process to accelerate AV testing: a groundbreaking paper on identifying and assessing cybersecurity risks followed.

We are also collaborating with law firm members of Mcity to produce white papers focused on timely legal topics related to transforming mobility. The first, a joint project of Mcity affiliates J.D. Power and law firm Miller Canfield, studied consumer attitudes about who's liable in crashes involving a driverless vehicle.

Opposite from top: U.S. Transportation Secretary Elaine L. Chao announces updated AV guidance at Mcity.

U-M Law School in collaboration with Mcity launched a new digital journal devoted to mobility issues.

More than a thousand people checked out the Mcity Test Facility at the 2017 Mcity Open House.
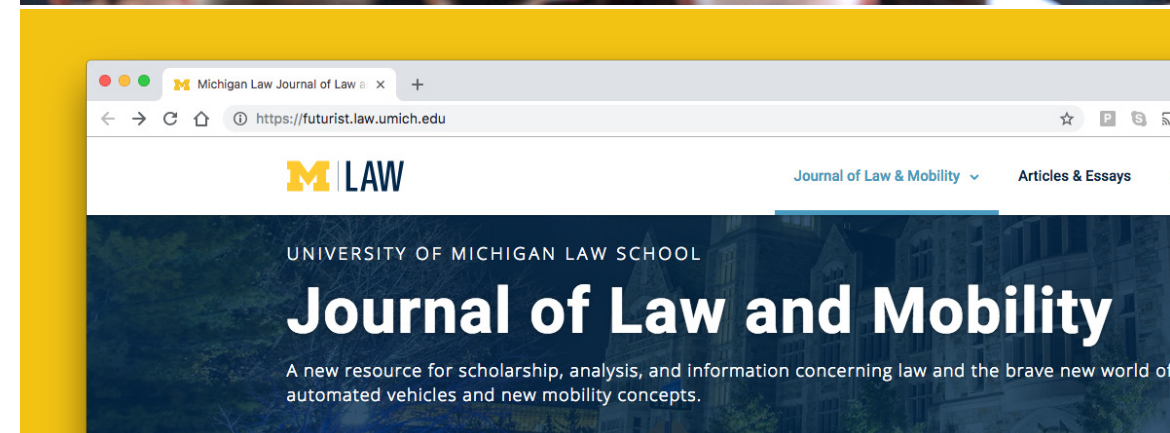
Other initiatives include increasing awareness and understanding of CAVs among our key audiences through media relations. In 2017, we hosted a technology demonstration day for reporters that showcased the safety benefits of combining vehicle connectivity and automation. The event drew local and national media attention. On a regular basis, we host media visits and facilitate expert interviews and share video and photo resources.

VIP visitors. Since January 2017, we've fielded hundreds of requests for visits and tours of the Mcity Test Facility. A highlight of recent outreach events was U.S. Transportation Secretary Elaine L. Chao's visit to announce the Department of Transportation's latest AV guidelines in September 2017. That she chose Mcity to announce new guidance reflects our position as a thought leader in mobility.

In June 2018, Mcity hosted the Federal Motor Carrier Safety Administration (FMCSA). Agency Administrator Ray Martinez and his team had an opportunity to learn about state-of-the-art activities in CAV research. The visit included a public panel discussion, providing FMCSA an opportunity to engage the public in dialog regarding automated driving systems.

Left: About 30 reporters attended Mcity Media Day 2017.

Opposite from top: Panel discussion at the 2017 Mcity Congress

Prepping a pedestrian dummy at 2017 Mcity Open House.

TechLab at Mcity is an incubator for mobility startups.

Mcity white paper outlining a methodology for assessing cybersecurity risks in AVs.

Outreach Snapshot

- Conducted 39 media visits and special events in Mcity Test Facility

- Hosted more than 50 government and industry groups interested in Mcity's work

- Participated in AutoMobili-D in partnership with PlanetM at the North American International Auto Show (NAIAS), as well as other conferences

- Launched Michigan Economic Development Corporation funding support

OUR PARTNERS

Companies representing a wide range of industries come together to collaborate and help shape the future of mobility as Mcity Leadership Circle Partners or as Affiliate members.

LEADERSHIP CIRCLE

- Aptiv
- Denso
- Econolite
- Ford
- GM
- Honda
- Intel
- LG
- State Farm
- Toyota
- Verizon

AFFILIATE MEMBERS

- 3M
- AISIN Group
- Analog Devices, Inc.
- BMW
- Changan Automobile
- Cohda Wireless
- Covington & Burling, LLP
- Danlaw, Inc.
- Deloitte Consulting LLP
- Desjardins General Insurance Group, Inc.
- Dykema
- Fortive
- Goodyear Tire & Rubber Company
- Harada Industry of America, Inc.
- Harman International Industries
- HERE
- Hitachi, Ltd.
- Iteris, Inc.
- Isuzu Tech Center of America, Inc.
- JD Power
- Latham & Watkins LLP
- Lear Corporation
- Magna International Inc.
- Marathon Petroleum Corporation
- Mechanical Simulation Corporation
- Microsoft Corporation
- Mighty AI
- Miller, Canfield, Paddock and Stone, PLC
- NAVYA
- Nexteer Automotive
- NovAtel
- OnBoard Security
- PolySync Technologies, Inc.
- PPG
- Progressive Casualty Insurance Company
- RAB Lighting Inc.
- Renesas Electronics America Inc.
- SAIC Motor Corporation Limited
- Savari Inc.
- SF Motors, Inc.
- Subaru
- Swift Navigation
- TASS International, A Siemens Business
- Veoneer (formerly Autoliv Electronics)
- Visteon
- Warner, Norcross & Judd LLP
- Zenuity
- ZF

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