2021-2022
PROGRESS REPORT

LEADING
THE MOBILITY
TRANSFORMATION

Mcity
UNIVERSITY OF MICHIGAN
What remained constant throughout 2022, however, as it has since Mcity was established as a public-private research partnership almost a decade ago, was our dedication to collaborating with and serving our partners in industry, government and academia.

NOTABLE ACHIEVEMENTS

Research. Mcity provides its members with access to research at the local level through projects funded by Mcity; at the regional level through the Center for Connected and Automated Transportation (CCAT), a regional transportation research center funded by the U.S. Department of Transportation where I also serve as director; and at the national level through the National Science Foundation (NSF).

Since 2020, Mcity has invested $3.5 million to fund 17 research projects across a range of topics from cybersecurity to pedestrian detection to design guidelines for developing accessible automated vehicles.

Notably, about 25 percent of Mcity’s research portfolio now encompasses the social sciences, moving us closer to realizing our goal of supporting multidisciplinary projects and demonstrating the societal benefit of our work.

Mcity initiated a project designed to deepen our understanding of transportation insecurity, how to measure it effectively and better understand how future mobility technologies could improve access to transportation options and potentially improve quality of life. The project builds on the Transportation Security Index developed by Alexandra Murphy, assistant professor of sociology in U-M’s College of Literature, Science and the Arts. Professor Murphy is lead researcher on the Mcity-funded project.

Another research focus area was, and continues to be, AV safety. The Mcity ABC Test, and the SAFE TEST, developed through CCAT, together comprise the Mcity Safety Assessment Program. The program is a methodology for demonstrating the safety of AVs before testing on public roads, a crucial need as concerns about AV safety stall widespread rollout of the technology.

Most recently, Mcity was awarded $5.1 million by the NSF to enhance the physical infrastructure of the Mcity Test Facility, while adding digital infrastructure that will enable remote use of the testing environment. This will increase access to AV testing resources.

FROM THE DIRECTOR

HENRY LIU
MCITY DIRECTOR
DIRECTOR OF THE CENTER FOR CONNECTED AND AUTOMATED TRANSPORTATION (CCAT); PROFESSOR OF CIVIL AND ENVIRONMENTAL ENGINEERING
while accelerating adoption of new mobility technologies. We call it Mcity 2.0.

Workforce Development. TechLab at Mcity has grown annually since launching in 2016 in partnership with Michigan Engineering’s Center for Entrepreneurship. The company-in-residence program brings together early-stage advanced mobility companies and highly talented students to work on company-sponsored technical projects involving connected and automated vehicles at Mcity. Developing the talent pipeline for mobility is a priority for Mcity, and TechLab is prime for growth with the addition of two major funding sponsors: Perot Jain, a venture capital firm, and Ford Motor Co. Their support will allow TechLab to expand its unique entrepreneurial educational experience to other emerging tech-driven markets while enhancing the current partnership with Mcity.

Testing Resources. Mcity provides a variety of mobility test beds including the safe, controlled conditions of the Mcity Test Facility and on-road vehicle deployments in Ann Arbor and beyond. The Mcity Test Facility remains the best-equipped and most innovative test environment for connected and automated vehicles and technologies. In addition to developing Mcity 2.0, we’ve upgraded the track with features that include:
- Commercial 5G network
- State-of-the-art instrumentation and sensors
- House and garage exterior with accessibility ramp
- Digital twin of the test facility to run off-site testing scenarios
- Patent-pending augmented reality that allows physical test vehicles to interact with virtually connected vehicles in real time inside the test facility
- Mobile on-site workstation with WiFi, plug-in network, and power source

In addition, we opened a new Mcity Auxiliary Building adjacent to the test facility that has become a venue for researchers to work on projects, as well as a space to host events. Most recently, we welcomed the U.S. General Services Administration, the National Transportation Safety Board, and the NSF.

Deployments. In a year-long project that began in October 2021, Mcity was a partner in A2GO with May Mobility, the city of Ann Arbor, and others, to explore uses of AV data as part of a last-mile autonomous vehicle service connecting the U-M campus with downtown Ann Arbor. Now we’re working with the Michigan Mobility Collaborative to launch an autonomous ride service to serve the senior population in select Detroit neighborhoods. Once a vendor is selected, vehicle safety testing will take place at Mcity.

OUTLOOK

Today, the mobility landscape is shifting. Unbridled enthusiasm for widespread deployment of robotics within a few years has given way to a more realistic vision of what might be possible over time. While some companies remain committed to go-anywhere, anytime automation, others have shifted their focus to automated driver assistance systems (ADAS). At the same time, investments in electric vehicle development are growing dramatically. The federal government has set an ambitious goal: That electric vehicles comprise half of all new car and light truck sales in the United States by 2030. Mcity’s accomplishments in recent years leave us well-positioned to maintain leadership in the mobility space, and prepared to focus on new areas when it makes sense to do so as the mobility landscape changes. Mcity has long recognized and spoken of the complexity of automation, a reality reflected in the slowing momentum of AVs. We have put Mcity 2.0 in place explicitly to tackle the fundamental scientific barriers that have prevented widespread AV deployment. In a paper published in Nature magazine in March, I refer to the “curse of rarity” in describing the safety challenges for AVs. Because safety-critical events are rare in everyday driving, it is difficult to test AVs against their ability to handle the most dangerous situations. The paper also explores possible solutions that could help accelerate AV development and deployment. A critical question for Mcity today is, “What’s next?” Our current three-year membership runs through June 2024. We are committed to demonstrating the value of being a partner with Mcity. As transportation and mobility solutions of the future evolve, Mcity will evolve as well.
OUR NEW HOME

On January 1, 2022, Mcity joined the University of Michigan’s College of Engineering, and Henry Liu, professor of civil and environmental engineering, became Mcity’s third director.

Dr. Liu succeeded Huei Peng, the Roger L. McCarthy Professor of Mechanical Engineering, who stepped down on December 31, 2021. The public-private mobility research partnership launched in 2013 under the leadership of the Office of the Vice President for Research. The Mcity Test Facility opened in 2015.

"Mcity … has become synonymous with mobility innovation," Liu said when his appointment was announced. "I will do my best to work together with our partners … to maintain that lead, and continue to strengthen Mcity’s interdisciplinary initiatives."

Alec D. Gallimore, Robert J. Vlasic Dean of Engineering, said Mcity’s move to the College of Engineering brings together two key players in advanced transportation and mobility research at U-M. "Being part of Michigan Engineering will bring Mcity greater access to engineering resources, supporting our shared goals of advancing safety, sustainability and accessibility in mobility to serve the common good," said Gallimore, who is also the Richard F. and Eleanor A. Towner Professor of Engineering, and Arthur F. Thurnau Professor of Aerospace Engineering.
Thanks to a $5.1 million grant from the National Science Foundation (NSF), the Mcity Test Facility is evolving into a next-generation autonomous vehicle test track. Mcity 2.0 will give academic researchers and institutions nationwide, many without their own test facilities and vehicles, remote access to the facility and Mcity test vehicles.

Mcity Director Henry Liu, Managing Director Greg McGuire and the Mcity team are developing digital infrastructure to overlay the physical test facility and create a cloud-based, augmented-reality CAV testbed – enabling a more equitable playing field for mobility research.

Dubbed Mcity 2.0, this digital infrastructure provides access to three critical tools researchers may lack:

- Data to build algorithms, train systems and validate that they will behave in ways expected by other road users
- A good simulation environment for quickly, accurately, and repeatedly testing assumptions
- A world-class test facility where assumptions can be tested on a physical vehicle on real roads

Read more about Mcity 2.0
MCITY PARTNER IDENTIFIES BARRIERS TO TRANSPORTATION DATA ACCESS

Municipal transportation data is a treasure trove for planners — if they can get to it.

Smart infrastructure produces a vast array of data — from traffic volumes and crash statistics to pedestrian counts, bike counts, street mapping information and more. City governments, nonprofit organizations and businesses rely on this data to develop ways to reduce traffic congestion, improve road safety and make mobility more accessible, but using this data is difficult.

Mcity published the second in a series of four white papers by Covington & Burling LLP, a Washington, D.C.-based global law firm and a member of Mcity’s Leadership Circle of industry partners. Contracting Tools for Transportation Data identifies barriers to the accessibility of transportation data including the lack of standardization and clarity in the permissions granted when transportation data is made available, as well as privacy and other concerns that prevent data that could be useful from being made available.

For example, a smart streetlights project in San Diego was discontinued due to concerns about the potential use of transportation data for surveillance purposes.
A LAST-MILE AUTONOMOUS SOLUTION

Mcity joined May Mobility and several other partners in October 2021 to launch A2GO, a free, public, on-demand autonomous shuttle service that connects the University of Michigan campus, Kerrytown, and the State Street Corridor in Ann Arbor.

The A2GO service demonstrates how communities can work together to incorporate transportation, safety, land use and economic development into the mobility landscape.

At launch, the fleet included five autonomous, shared vehicles – four hybrid-electric Lexus RX 450h SUVs each carrying up to three passengers, and one fully electric, wheelchair-accessible, one-passenger Polaris GEM.

A2GO partners included Ann Arbor SPARK, Important Safety Technologies, 4M, the State of Michigan’s Office of Future Mobility and Electrification, the Michigan Economic Development Corporation and Mcity. While Mcity’s work with A2GO ended in early 2022, the service continues to operate.

Rides are requested via a free May Mobility app available through Apple’s App Store or Google Play.
GRADUATE STUDENT DEVELOPS LOW-COST ROBOTIC PROXY

The Cozy Coupe is just one of dozens of potential robotic proxies researchers will be able to deploy on the Mcity test track to gauge how accurately self-driving cars and trucks recognize obstacles in the road.

Before fully autonomous vehicles become a reality on the road, their control systems need to be able to avoid hazardous obstacles in the road (a wandering toddler, a distracted pedestrian, an oblivious cyclist, a wayward shopping cart, a stray dog, etc.). Testing these systems requires proxy objects – small robotic platforms that can be programmed to accurately repeat the same set of behaviors time after time. Commercially available models cost as much as $250,000 each and often run on proprietary software.

Ryan Lewis, a 25-year-old Michigan Robotics master’s student, intentionally selected a relatively inexpensive existing commercial robotics platform with open-source software that can be customized to fit Mcity’s needs and simplify the ongoing maintenance and development of new proxies.

- Robotic proxies are designed to be “run-overable” – durable and flat to prevent damage when hit at high speeds.
- This example includes a 24-inch-tall customizable, programmable robotic platform manufactured by SEGWAY.
- In addition to the Little Tikes® Cozy Coupe®, the 16-acre Mcity test track has a number of obstacles to simulate real-world urban, suburban, and rural driving, including a robotic deer.
### RESEARCH HIGHLIGHTS

**LEADING THE MOBILITY TRANSFORMATION 2021-2022 PROGRESS REPORT**

Since 2020, Mcity has invested $3.5 million to fund 17 research projects across a range of topics.

#### SAFETY

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<thead>
<tr>
<th>Project Title</th>
<th>Project Abstract</th>
<th>Status</th>
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<tbody>
<tr>
<td>Exploring Standards and Guidance for Automotive Ethernet Security</td>
<td>Automotive Ethernet is considered the next-generation in-vehicle network because of its high bandwidth, high throughput, and low-cost characteristics. While the technology could greatly improve in-vehicle communication, no common standard for a security protocol has been established. Security is critical to prevent sophisticated cyber attacks, such as remote braking. The objective of this project was to establish a favored protocol candidate, supported by thorough evaluation, and propose standardization for secure Ethernet protocol in automotive use cases.</td>
<td>Completed</td>
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#### ACCESSIBILITY

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<tr>
<td>The Impact of Future Mobility Technologies on Transportation Insecurity</td>
<td>Deploying mobility technologies to promote transportation equity requires understanding the landscape of transportation insecurity in the United States, and developing tools to evaluate whether these technologies move people from transportation insecurity to security. This research will use national data from 2018, plan new data collected in 2022, to better understand how factors such as where people live and the modes of transportation they use contribute to transportation insecurity. The work will also further develop the Transportation Security Index, the first validated individual measure of transportation insecurity.</td>
<td>In Progress</td>
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#### EFFICIENCY

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<td>Cooperative Driving for CAVs</td>
<td>For the foreseeable future, connected and autonomous vehicles (CAVs) will share the road with human drivers. But can CAVs interact, even cooperate, with human drivers for safer, smoother driving? In this project, CAVs will combine observed positions and velocities with a behavior prediction algorithm to predict human drivers’ future movements statistically and plan a safe path. Project goals are to develop a trajectory prediction algorithm and a cooperative motion planning algorithm, then validate both on a CAV at the Mcity Test Facility.</td>
<td>In Progress</td>
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#### COMMERCIAL/ECONOMIC VIABILITY

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<td>Automated Driving Effect and Motion Sickness Response</td>
<td>Engineering models that control vehicle movement parameters in a manner that meets consumers’ expectations and mitigates the onset of motion sickness are needed to guide AV design. Current engineering approaches involve control inputs for vehicle route and speed. This project will identify metrics that meaningfully characterize vehicle dynamics, particularly acceleration, which could be modeled in AV control algorithms, and provide preliminary definitions of acceptable acceleration limits.</td>
<td>In Progress</td>
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LEADING THE MOBILITY TRANSFORMATION 2021-2022 PROGRESS REPORT

PRESS CONFERENCE FOR MCYT 2.0 LAUNCH
On October 24, 2022, Mcity, together with the National Science Foundation and State of Michigan representatives including U.S. Congresswoman Debbie Dingell and others, celebrated the launch of Mcity 2.0. Funded by a $5.1 million NSF grant, the Mcity Test Facility is evolving into a next-generation autonomous vehicle test track that will provide researchers nationwide with remote access to the test facility. In the photo above, Mcity Managing Director Greg McGuire explains how Mcity 2.0 works to media who attended the launch event.

MCITY HOSTS STUDENT TEAMS
In June 2022, Mcity hosted AutoDrive Challenge TM II at the Mcity Test Facility. The event, sponsored by General Motors Co. and SAE International, brought ten student teams from colleges across the United States and Canada to compete in the first year of the three-year challenge to develop and demonstrate a Level 4 AV – a vehicle that can operate without any human intervention – capable of navigating urban driving courses. AutoDrive Challenge TM II returns to Ann Arbor in June 2023.

MCITY AT AUTOMOBILI-D
In September 2022, AutoMobili-D returned to Huntington Place (formerly known as Cobo Center) in Detroit for the first time since 2019 as part of the 2022 North American International Auto Show. Above, Mcity Director Henry Liu, right center, speaks with members of a delegation representing Michigan’s state legislature. Mcity and the State of Michigan’s University Research Corridor institutions showcased their work in transportation and mobility. Mcity 2.0, Mcity’s NSF-funded next-generation test facility, was included at the University of Michigan’s exhibit.

ITS WORLD CONGRESS
The ITS World Congress, presented by ITS America, is an annual global conference that allows the smart mobility community to come together to explore the deployment of intelligent transportation technologies. Mcity presented at two panels at the August 2022 event in Los Angeles: “Methods for Improving Road Safety: Smart Infrastructure, Crowdsourced Data, and Safety Metrics” and “Live, Virtual, and Constructive Evaluation of Connected and Automated Vehicles.” Mcity shared a booth with the Center for Connected and Automated Transportation (CCAT), a regional transportation research center funded by the U.S. Department of Transportation. Above, CCAT Managing Director Debby Bezzina speaks with booth visitors.

NTSB COMES TO MCITY
The National Transportation Safety Board (NTSB) visited the University of Michigan in October 2022 to meet with representatives from Mcity, the Center for Connected and Automated Transportation (CCAT), the U-M Transportation Research Institute (UMTRI) and Ford Motor Co. The visit included a discussion on the current state of connected vehicle technology with NTSB Board Member Michael Graham, pictured above, and NTSB staffers. Demonstrations at the Mcity Test Facility highlighted the benefits of connected vehicle (CV) technology, ahead of a presentation about what is still needed to achieve wide-scale deployment of CV technology in the United States.

EVENTS

GSA HOSTS EV ROUNDTABLE AT MCITY
In July 2022, U.S. General Services Administrator (GSA) Robin Carnahan, at the center of the table in the above photo, met with auto industry stakeholders at the Mcity Test Facility to discuss accelerating efforts to transition the federal fleet to an all-electric, zero-emissions fleet by 2035. GSA is working to streamline this transition by streamlining the necessary infrastructure, including charging stations, for federal facilities. The visit to Mcity was a meaningful step in working to advance American manufacturing and clean energy innovation, which has never been more important in the fight against the climate crisis.

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IN MEMORY OF HUEI PENG

Former Mcity director was an innovative researcher, leader and educator in vehicle controls and connected/automated vehicles.

Professor Huei Peng, who died November 17, 2022, served as director of Mcity from 2016-2021. He led the Mcity team with passion for our mission, bringing his intellect to the work and his generosity and kindness to his role as a leader.

Among his many achievements, Huei built strong relationships with Mcity partners in industry and government that were instrumental in establishing Mcity as a leading public-private mobility research partnership. In addition, Mcity added a host of new technologies and capabilities at the Mcity Test Facility for connected and automated vehicles during Huei’s tenure, funded nearly 90 research projects and published more than a dozen white papers.

Huei led the Mcity Driverless Shuttle research project to learn more about consumer attitudes toward driverless technology, and he spearheaded development of a testing methodology — the Mcity ABC Test — that could be

Through his leadership and scholarship, Huei made an impact on our campus and in the field of engineering. He was an innovative researcher and a kind person, and we will miss him greatly.”

ALEC D. GALLIMORE
ROBERT J. VLASIC DEAN OF ENGINEERING UNIVERSITY OF MICHIGAN
Huei's work focused on adaptive control and optimal control, with emphasis on their applications to vehicular and transportation systems. His latest research included design and control of electrified vehicles and connected and automated vehicles.

Huei joined the Department of Mechanical Engineering at the University of Michigan in 1993. He was the Roger L. McCarthy Professor of Mechanical Engineering and among the top 25 mechanical and aerospace engineering scientists in the United States according to research.com.

Under Huei’s leadership, Mcity grew from being known primarily for its test facility for connected and automated vehicles to a full-fledged research collaboration with partners from the public, private and academic sectors.

Huei’s tireless efforts to share Mcity’s story and vision of making transportation safer, greener, more equitable and accessible will not be forgotten.

Read more about Huei’s impact at: mcity.umich.edu/in-memory-of-huei-peng/
Huei was a kind, dedicated, visionary leader, and a source of inspiration for many in both academia and the automotive industry. His memory will be forever treasured for what he had accomplished at Mcity. "

HENRY LIU

HUEI was a friend of Toyota."

JEFF HOOD

Huei mentored and inspired us with such humility, and for that we are forever grateful. You may be gone from our sight, but never from our hearts and minds. We will continue pursuing your vision for a world of safer and more sustainable mobility."

EHSAN MORADI PARI

Leads Principal Scientist, Honda Research Institute USA, Inc.

Huei was an accomplished academic, a collaborative research partner and mentor to many students through the years. His passion has had a profound impact on all who knew and worked with him."

JIM SAYER

CAROLINE MORTON

ChevronTexaco, Accessibly General Motors Co., and Former Deputy Director, Mcity

Huei was a brilliant researcher – principled, passionate and always curious. As a teacher, colleague, husband and father, he was caring and fun-loving. What made Huei so special was not that he possessed any one of these qualities, but that he exhibited all of them, often simultaneously. We were incredibly lucky to have Huei in our lives and his legacy to society will live on through our actions."

HUEI was a great catalyst to transform the mobility industry from connected and automated to connected and autonomous vehicle industry. He had a profound impact on my thinking, and I’ll always be appreciative of how he approached research, focusing on what would make the world a better place. He was wonderful to work with and a great supporter. I’ll miss him a great deal."

NICHOLAS MOROZ

Director of Entrepreneurial Practice, University of Michigan Center for Entrepreneurship

Huei was deeply saddened by the tragic passing of Huei Peng. Huei led Mcity’s rapid growth both in size and impact, transforming the research partnership into a broad coalition of public, private and academic entities committed to creating safer and more sustainable mobility. We were proud to collaborate with him on a number of research projects focused on autonomous driving and vehicle connectivity. In addition to his professional accomplishments, Huei was a friend."

PAT BASSETT

Senior Vice President, Denso International America, Inc.

Huei was a great leader and friend. We will be missed tremendously by the community."}

KOMAL (ANAND) DOSHI

Director of Mobility, Walker Miller Energy Services

Huei’s dedication and work in the mechanical engineering department and at Mcity over the last 30 years were unparalleled, and he always had such a kind presence about him. He will be dearly missed.”

ELLEN ARRIGA, PHD, NAE

Department Chair and Professor, Mechanical Engineering, University of Michigan

We are deeply saddened by the loss of such a great industry leader and friend of Toyota."

SHINICHI YASUI

Senior Vice President, Toyota Motor North America - R&D

Very sad news. Professor Peng was a key industry and academic leader and a great contributor and supporter of the Ford-UM Research Collaboration program for many years. He will be missed by our research community.

LIZ PULVER

Program Manager Research in Driving Safety, Public Policy, Product Development, State Farm

Huei was a great leader of Mcity, a rigorous mechanical engineering department and at Mcity over the last 30 years were unparalleled, and he always had such a kind presence about him. He will be dearly missed.”

H. SAM HAMADE

Executive Vice President, State Farm

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HUEI was a great ambassador for ‘mobility for all’ technology research and a great friend of Toyota.”

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LEADING THE FUTURE OF MOBILITY

Mcity’s Leadership Circle industry partners join with the University of Michigan and government entities to serve as collaborators and thought leaders in guiding and shaping all facets of the future of mobility. Members invest $600,000 over three years. The current term is July 2022–June 2025.

Mcity Affiliate members participate in a variety of focused activities. Affiliate members invest $150,000 over three years.

3D MAPPING SOLUTIONS
- AARP
- ANALOG DEVICES INC.
- BITSENSING
- VICTORINOX
- DANLAW INC.
- DYKEMA
- GENERAL MOTORS

As of December 31, 2022

EXECUTIVE BOARD
- PAUL AJEGBA
- KATHLEEN CAGNEY
- CHRIS KOLB
- GHASSAN KRIOLI
- ERIC MICHIELSEN
- BRAD ORR
- TREVOR PAWL
- JIM SAYER

RESEARCH & VEHICLE DEPLOYMENT LEADERS
- DEBRA BEZZINA
- TIFFANI SADIK
- VICTORIA WATERS

STAFF
- VINCE BELANGER: NETWORK ENGINEER
- MEGAN HARTER: ADMINISTRATIVE ASSISTANT
- SARAH HODGE: SOFTWARE ENGINEER
- RYAN LEWIS: WEB DEVELOPER
- KASIE MESSAROS: BUSINESS ADMINISTRATOR
- RAJANIKANT PATNAIK: SOFTWARE ENGINEER
- ALEX ROZELLE: TEST FACILITIES OPERATING ENGINEER

As of December 31, 2022
REGENTS OF THE UNIVERSITY OF MICHIGAN
(effective October 14, 2022–January 1, 2025)
Jordan B. Acker, Huntington Woods; Michael J. Behm, Grand Blanc; Mark J. Bernstein, Ann Arbor;
Paul W. Brown, Ann Arbor; Sara Hubbard, Okemos; Denise Ilitch, Bingham Farms; Ron Weiser,
Ann Arbor; Katherine E. White, Ann Arbor; Santa J. Ono, ex officio.

NONDISCRIMINATION POLICY STATEMENT
The University of Michigan, as an equal opportunity/affirmative action employer, complies with all
applicable federal and state laws regarding nondiscrimination and affirmative action. The University
of Michigan is committed to a policy of equal opportunity for all persons and does not discriminate
on the basis of race, color, national origin, age, marital status, sex, sexual orientation, gender
identity, gender expression, disability, religion, height, weight, or veteran status in employment,
educational programs and activities, and admissions. Inquiries or complaints may be addressed
to the Senior Director for Institutional Equity, and Title IX/Section 504/ADA Coordinator, Office
for Institutional Equity, 2072 Administrative Services Building, Ann Arbor, Michigan 48109-1432,
734-763-0235, TTY 734-647-1388, institutional.equity@umich.edu. For other University of Michigan
information call 734-764-1817.