The National Advanced Driving Simulator

Annual Report 2018

20

YEARS

The University of Iowa | College of Engineering

What's Inside

On the cover: The showpiece of the National Advanced Driving Simulator, the NADS-1. Read more about it on pages 4-5.

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Fiscal Year 2018 Quick Stats

20
Years of the National Advanced Driving Simulator

4 Instrumented vehicles now in the NADS on-road fleet

24 Affiliated faculty across the University of Iowa

27 Students involved in NADS research

72 NADS-developed miniSims in use worldwide

100 Tours conducted during fiscal year 2018

3,226 Miles of HD mapped interstates in Iowa

9,801 Trips the NADS-1 has taken since 2007

Improving safety by researching the connection between drivers, motor vehicles, and road users

In 1998, we broke ground on the National Advanced Driving Simulator, an engineering wonder with the most advanced technologies to conduct driving safety research.

Time has passed in the blink of an eye and it's impressive how far technology has advanced over the past two decades. In 1998, the nation was bracing for Y2K, Google incorporated, the first portable MP3 players were released, the colorful iMac was introduced, and a gallon of gas cost $1.15. Mercedes was the first manufacturer to offer a smart key. Also that year, anti-lock brakes and airbags became standard on almost all passenger cars.

This year, we celebrate the 20th anniversary of our now world-renowned laboratories. NADS was founded after winning a highly-competitive grant through the National Science Foundation, far surpassing the competition. Since that time, NADS has evolved and we have grown our programs and diversified our partnerships.

But 1998 is not where we started our work here; not even close. Before we were known for our excellence at NADS, the University of Iowa had long contributed to driving safety research through faculty and student work, as well as at NADS' predecessor, the Iowa Driving Simulator. Before NADS existed, the UI had conducted vehicle dynamics and human factors research for years, contributing to a better understanding of how people interact with vehicles. Our work has influenced policy and provided insights into new technologies. Many of the safety features coming out in today's vehicles came through the UI on their development journeys long before they hit the market.

We have grown not only in terms of simulation capabilities, but also into more on-road research. In the last few years, we've acquired new specially-designed vehicles that are helping us to look at how drivers interact with interfaces and technologies through naturalistic driving studies.

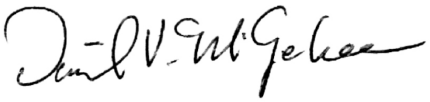
While we have a long history in driving safety research, longevity alone doesn't make you a leader. It's our people who give NADS its global reputation. Many members of our staff got their start at NADS and have remained here to change the future of driving safety and simulation. And these in-house experts are busy training the future of transportation safety researchers. In more than a dozen different departments and units across campus, students at all levels are playing critical roles in helping us to create the most innovative research methods, technologies, and analyses.

So much has happened during these last two decades. In celebration of this milestone, we used this annual report to take a look back at where we've been and what we've accomplished. I hope you enjoy reminiscing in some of the old stories and pictures with us, while reading more about all that makes us the leader in driving safety research that we are today.

Even before NADS opened its doors, our faculty, staff, and students have endeavored to be the best. Our dedication to the work we do truly sets us apart. I'm proud to be part of such a prestigious and growing center. Hard work, commitment, and a love for what we do are values that we continue to embrace today.

The past 20 years have been nothing short of remarkable. Looking back, our accomplishments are outstanding, but that's not the end of our story. As new technologies emerge, we'll continue to evolve and serve as influencers of driving safety, making the roadways safer for everyone.

Please, enjoy this annual report with its look back at some of the things we've done and all that lies ahead for us.



Daniel V. McGehee
Director, National Advanced Driving Simulator
Associate Professor
Industrial & Systems Engineering
Emergency Medicine
Public Health
Public Policy

A Look Back

The NADS-1 today and its predecessor, the Iowa Driving Simulator (left)

Above: Inside the NADS-1 today, a Toyota Camry

Inset Photos: Some of the first few NADS-1 cabs, a Jeep (left) and a Chevy Malibu (right)

This year, the National Advanced Driving Simulator celebrates its 20th anniversary. The facility is best known for its high-fidelity ground vehicle driving simulator, NADS-1. The NADS-1 has the largest motion envelope of any driving simulator that can be utilized by external sponsors. The NADS-1 uses an actual vehicle cab mounted on a 13 degree-of-freedom motion base that can independently provide yaw, roll, pitch, turning, lateral, and longitudinal cues to the driver. Scenery is projected in 360 degrees around the driver on interior walls of the dome. The combined motion, graphics, audio, driver controls, and software systems on the NADS-1 deliver the closest experience possible to driving an actual vehicle.

The NADS-1 motion system's unique capabilities enable the simulator to accurately reproduce motion cues for sustained acceleration and braking maneuvers, movement across multiple lanes of traffic, and interaction with varying road surfaces, realistic reproduction of which is not possible in fixed-base or limited lateral movement simulators. Motion cues for NADS-1 are therefore correlated with other sensory stimuli, providing the highest fidelity real-time driving experience in a simulated environment.

The NADS-1 has enough space to house a full-size vehicle cab which can be swapped in and out of the dome. The current collection of vehicle cabs include a passenger sedan, a mid-sized sports utility vehicle, a heavy truck semi cab, and an agricultural tractor cab. Each cab is instrumented to respond to driver inputs and provide feedback that replicates driving the vehicle on a real road.

Learn more about the NADS-1 and our other simulators and vehicles by visiting:
www.nads-sc.uiowa.edu

founding father *(noun)*

a person who starts or helps to start a movement or institution.

Schwarz adjusts virtual reality goggles on PhD student Wanxin Wang

More than two decades ago, Dr. Chris Schwarz was hired as one of the National Advanced Driving Simulator's original employees. Even before the first shovelful of dirt was moved, Schwarz and other staff were already hard at work, programming and preparing for NADS' opening. The new facility would be another tool in advancing the University of Iowa's reputation as a leader in independent and accurate study of emerging vehicle safety technologies.

Sometimes, this work happened in unforgettable places. One pre-NADS facility, a re-purposed building on the UI's research campus, was originally part of a tuberculosis hospital from long ago. In his current office at NADS, Schwarz can reminisce about those times now. "We've come a long way since then," he says.

IN THE BEGINNING

Before ground was broken on NADS, Schwarz was busy working on programming for a number of studies. He started with a group doing advanced hybrid electric Humvee powertrain modeling for the Defense Advanced Research Projects Agency (DARPA). Then, once the doors had opened, the inaugural study to run on the new NADS-1 simulator was part of the Crash Avoidance Metrics Partnership (CAMP). The CAMP partnership was formed in 1995 between the Ford Motor Company and General Motors Corporation. Its objective was to accelerate the implementation of crash avoidance countermeasures to improve traffic safety. The CAMP study on NADS-1 evaluated forward collision warning requirements, measuring last-second braking and driver steering associated with rear-end crash scenarios.

Schwarz spent a lot of attention on the motion in this study so that they could do a hard brake or lane change. "It involved a lot of hard steering, hard braking," he says. "It really exercised the motion base. The study was a good showpiece of our new system."

In the Beginning...

A few years after that, NADS was tasked with studying another new technology, Electronic Stability Control (ESC). On this project, Schwarz worked with the ESC software and its integration into the NADS-1. More than 500 participants drove through simulations of wet and dry pavement on a number of different vehicle types. As a result of the study's findings, NHTSA required all vehicles to have ESC by 2012.

Vehicles and their operation are becoming more complex as more systems are incorporated. And Schwarz notes that, at the same time, people are bringing more of their own screens into the car. Safety seems to be getting that much more complex. "My interests have evolved over the years, but I never really was a 'car' guy. Growing up, I couldn't have cared less about horsepower and turbocharging. What I really appreciate is the technology side of it. I'm very interested in making vehicles easier to interact with and understand," Schwarz says.

EMERGING TECH

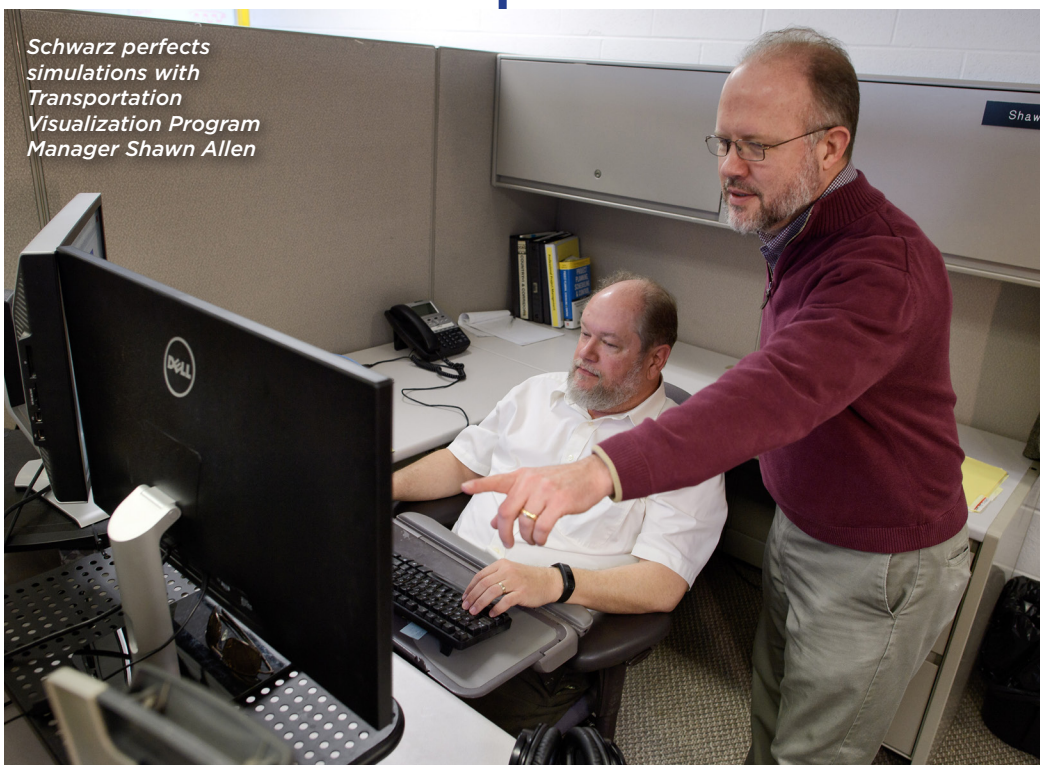
Today, Schwarz continues to be a pioneer in conducting research that improves safety for all road users. Currently, he's helping to lead a project that measures responses to adaptive headlamps. These innovative headlights probably aren't the kind you've heard about before, like those that simply bend their beams around curves or over hills. These adaptive headlamps are something few car companies have in production at the moment. From a driver's perspective, they project light or images at a vulnerable road user. If a car is overtaking a bicycle or a pedestrian, a bigger rectangle of light will be projected, which encourages the driver to give them more room. With this system in place, drivers in the study have responded earlier and stronger.

Additionally, some features of this emerging technology may be more useful for pedestrians or bicyclists, like icons the adaptive headlamps "paint" on the roadway. The responses of bicyclists and pedestrians to this aspect of the technology are being independently measured by the UI's Hank Virtual Environments Lab. Ultimately, the goal is to increase safety in all encounters.

The last twenty years have been exciting for Schwarz. While he earned his PhD in electrical engineering from the UI, this NADS founder has taught himself a lot along the way, too. "I've taken AI classes and courses on programming robotic cars, but mostly I learn by doing. I've taught myself Python, MATLAB, data analysis, machine learning, and aspects of human factors engineering, as well as a variety of other things. Learning new tools and approaches is my favorite part of the job."

The Engineering & Modeling Division seeks to enable cutting edge research in advanced vehicle technologies through research and development in modeling and simulation. The division leads, coordinates, and enables the advancement of modeling and simulation capabilities and provides new opportunities for research, education, and collaboration.

For more than 20 years, Dr. Chris Schwarz has served as a NADS Associate Research Engineer. His research has involved all types of advanced driver assistance systems, connected vehicles, warning systems, automated vehicles, and driver impairment modeling. Schwarz's current research interests include vehicle automation.



Schwarz perfects simulations with Transportation Visualization Program Manager Shawn Allen

Developing Connected Simulation:

Studying the Interactions between Drivers, Pedestrians, and Bicyclists

Capturing motion: A student runs in place in Dr. Stephen Baek's Visual Intelligence Laboratory's 4D scanning system. This 19-foot diameter geodesic dome structure has 100 DSLR cameras precisely synchronized and controlled via an opto-isolated control circuit developed in-house. The cameras are linked to a network of computers such that the high resolution videos recorded by the cameras are efficiently processed in parallel.

Imagine tackling a project labeled "longer term and higher risk." To most, this would be more than a little intimidating. But then consider that it's also described as breakthrough research with the potential for transformational improvements to plan, build, renew, and operate safe, congestion free, and environmentally sound transportation systems. Sounds exciting, doesn't it?

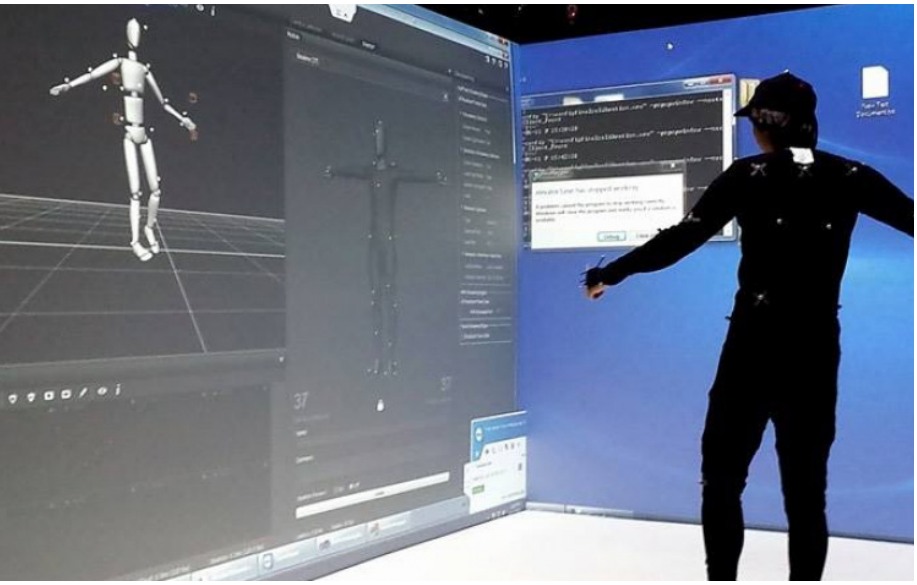
This is how the Federal Highway Administration (FHWA) describes its Exploratory Advanced Research program, intended to spur innovation and focus on higher risk and higher pay-off research. Projects funded under this program could lead to transformational changes and revolutionary advances in US transportation.

In 2017, a collaborative team of researchers from the University of Iowa won a $1.8 million grant under this program. The team is comprised of researchers from the National Advanced Driving Simulator (Dr. Daniel McGehee and Dr. Chris Schwarz), Hank Virtual Environments Laboratory (Dr. Joseph Kearney and Dr. Jodie Plumert), and Visual Intelligence Laboratory (Dr. Stephen Baek). Their project seeks to connect driving, bicycling, and pedestrian simulators in order to study participant interactions. While the concept of connected simulators isn't new, the team has proposed innovative ideas to advance new methods in simulation.

Today, in almost all simulation research, it's just one participant driving, walking, or riding a bike in a computer-controlled environment. But think about it—all sorts of gestures are used to communicate, like waving people on through a four-way intersection or making eye contact to safely cross the street. Driver, bicyclist, and pedestrian expectations, anticipations, and responses to the behavior of other road users are critical to road safety.

So how can gestures be incorporated into simulated environments to increase realism? That's what the UI's team is investigating. The team is working to not only connect their simulators, located across campus, but also to develop avatar technology to visually represent participant glances and movements. Currently, the team is approaching the end of their first year in the project, with a demonstration on avatars in the simulations coming soon. Next steps of this significant undertaking include developing scenarios and determining how to get the participants/avatars to interact when they can move freely within this virtual world.

Hank Virtual Environments Lab:
psychology.uiowa.edu/hank-virtual-environments-lab
Visual Intelligence Lab: **www.stephenbaek.com/lab**



> "Having a networked environment of simulators will be revolutionary. While using connected simulators to study road safety issues is rare right now, we're working to move beyond demonstrations to studying interactions among multiple roadway users."
>
> *- Chris Schwarz, Co-Principal Investigator*

Top: A roadway in NADS' Springfield, a 285 square mile virtual proving ground
Middle Left: Full body tracking at the Hank Virtual Environments Laboratory
Bottom Left: Dr. Jodie Plumert, Professor and Chair of the UI Department of Psychology, demonstrating the Hank Virtual Environments Laboratory pedestrian simulator
Bottom Right: Behind the wheel of the NADS-1 simulator

ABOVE THE INFLUENCE

Dr. Tim Brown talking about the dangers of drugged driving with the Premier of Manitoba, Brian Pallister

The Drugged Driving Division is a multidisciplinary team of dedicated researchers working collaboratively to reduce drug-impaired crashes and fatalities by researching the impact of drugs on driving performance and safety.

Leading them is Dr. Timothy Brown, who has been with the National Advanced Driving Simulator since its beginning. Brown is an expert in human factors and transportation safety and has extensive experience in the design, development, conduct, and analysis of driving research studies. His academic and research career has focused on in-vehicle systems, warning systems, medical considerations in driving, and modeling driver performance. Recent work has focused on evaluating vehicle systems to better understand potential safety benefits.

In his free time, Dr. Timothy Brown is an avid Boy Scout leader and president of a local school board. He runs the scoreboard at high school basketball games. An upstanding citizen and a self-proclaimed rule follower, he's not the kind of person you'd expect to be involved with drugs. But he is, in fact. These days, primarily marijuana and opiates. At least, those are the drugs that have consumed his work-life focus over nearly the last decade.

An easy-going, talkative professional who's been conducting driving research for more than 20 years, Brown chuckles as he talks about the direction his career path has taken. "Did I ever imagine I'd be doing this for a living? No way," he says. "Noooooo way."

According to the National Survey on Drug Use and Health, in 2016 20.7 million people aged 16 or older drove under the influence of alcohol and 11.8 million drove under the influence of illicit drugs. Even more drive while using combinations of prescription and over-the-counter medications.

EVOLUTION

Brown's career didn't begin in drugged driving research. As a University of Iowa undergrad in 1993, Brown worked at the Iowa Driving Simulator, predecessor to NADS. At first, his research covered a variety of topics, like crash avoidance systems and forward collision warnings. When he made the move to the new NADS facility, one of his first projects was an alcohol-impaired driving study.

So was alcohol Brown's gateway into drugged driving? "I kind of just fell into it, really. Well, I fell into it, or it was thrust upon me," Brown jokes.

Over the years there's been a shift in impaired driving research, one that Brown has been a part of as he's worked his way up to the position of senior researcher. Research on driving under the influence of alcohol became more about looking at impairment in general, which then evolved into studying drugged driving. Brown's increasing experience meant that he was often tasked with projects that didn't fit well with other researchers' expertise.

But Brown would have delved into anything that was thrown his way, he says. "I don't really care that much what my study topic is. My favorite thing to do is to just dig into the data and find the answers."

FINDING THE ANSWERS

When you meet with Brown in his office, it never fails that there are always students just around the corner, looking for answers of their own. "Come on in," Brown tells them, regardless of what he's doing. He never makes them feel as if they're interrupting. Because, no matter how busy he is, Brown almost never turns a student away.

Sometimes it's undergraduates that are working on a project. Over the summers, it's members of the Secondary Student Training Program: high school students coming to the UI for a summer class where they get the opportunity to work on research. Brown is enthusiastically dedicated to helping the next generation of transportation researchers get their start.

"I like working with students of any age," he says. "They come in with fresh perspectives. They're not tainted by the 'we've always done it this way' thinking. They ask a lot of questions and it keeps your mind agile."

EXPERTISE

Of course, it's not just students that seek Brown out for his answers. People the world over contact him for his expertise. This year, Canada passed a bill legalizing marijuana for recreational use. However, while recreational marijuana will now be legal in the country, it is up to the individual provinces to set specific rules and restrictions for the substance's use and sale.

This March, the Premier of Manitoba met with Brown and other NADS and University of Iowa staff to gain more knowledge about how marijuana impacts driving abilities. Since then, Brown has fielded additional phone calls from Canadian leaders as well, asking for his expertise in the subject area.

Brown works with two students from the Secondary Student Training Program reviewing a miniSim scenario

Brown is looking forward to further growing the drugged driving research done at NADS. "We are ready. We have the facilities and licenses required to house marijuana and other drugs. Our staff is well-qualified with the necessary expertise and certifications in handling these types of drugs. Our program is ready."

So what does Brown hope will come from his very specific line of work? "We all try to make an impact and increase the body of knowledge. I would like to be able to look back and know that I had some impact in reducing fatalities, in saving lives."

Drug-Impaired Driving

A growing concern in the area of traffic safety is the increasing prevalence of operating a motor vehicle under the influence of controlled substances and illicit drugs. Recent estimates indicate that almost half of the US population has used at least one prescription drug in the past month and over 20% have used at least three. The most recent roadside survey shows that, while the number of drivers with alcohol in their system has been declining, the proportion of drivers with a drug in their system has increased.

Drugged driving research has been a key component of work at National Advanced Driving Simulator since the first National Highway Traffic Safety Administration (NHTSA)-funded studies in 1993. The UI has been at the forefront of studying how individual drugs impact driving performance. This began with research showing that second generation antihistamines (i.e., Allegra) are safer to use while driving compared to older, first generation antihistamines (i.e., Benadryl).

To comprehensively study how drugs impact a number of driving behaviors and decision-making, NADS has developed a Standardized Scenario, intended to replicate a generic drive from an urban area to a rural home, that includes challenges such as a yellow-light dilemma, turning across traffic, merging interstate traffic, and negotiating curves. This scenario has three equivalent versions and has been used to study alcohol impairment, drowsiness, distraction, and drugged driving.

More recently, NADS collaborated with NHTSA and the National Institute on Drug Abuse (NIDA) to examine how alcohol and cannabis alone and in combination affect driver performance. This study showed a linkage between increased levels of cannabis and decreased lateral control, as well as slower driving while under the influence of cannabis.

Although NADS' cannabis study provides a good starting point, more research is needed to better understand how different frequencies of users are affected, how various strains of cannabis change the impacts, how edibles affect performance, and how changes in performance relate to crashes. Research into the effects of drugs such as cannabis, opioids, depressants, and other prescription and over-the-counter medications is essential to reducing crashes and fatalities.

To learn more about drugged driving, visit:
www.nads-sc.uiowa.edu

The Volcano cannabis distribution system

48%

or at least 100 million of the 210 million American drivers are on at least one prescription medication

Around 5%

or more than 5 million American drivers have used a medication for a non-medical purpose in the last month

In studies conducted at the National Advanced Driving Simulator, cannabis use was associated with:

- An increased tendency to drive below the speed limit
- Increased following distance
- Lane weaving

It's not always drowsiness.

In studies with NADS miniSims, prescription and non-prescription drugs had different effects on drivers. Combinations, such as using both opioids and caffeine, also resulted in unpredictable effects.

Saving Lives After Crashes Happen: TRAUMAHAWK

What can your smartphone do: Check email? Play music? Post pictures to social media? Save...lives?

Saving lives is what TraumaHawk is all about. Funded by the Iowa DOT, this smartphone app was developed by the University of Iowa to connect law enforcement to hospital trauma teams by showing the crush patterns of severe crashes. These data provide critical information that allows for better preparation of trauma resources.

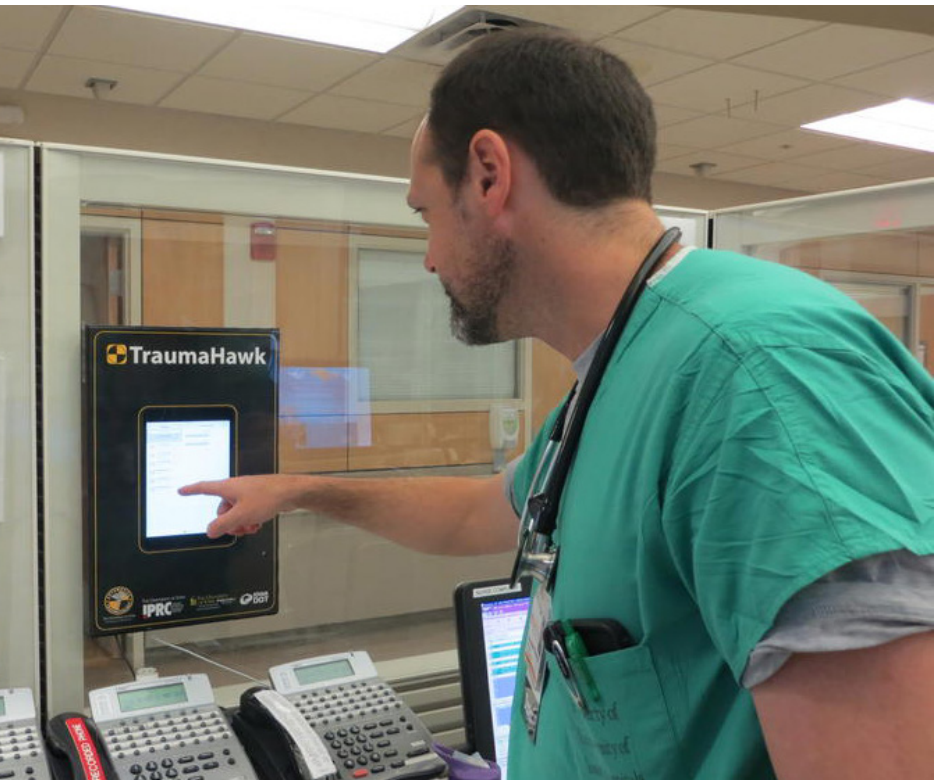
A few years ago, researchers at the UI were disturbed to find that, on average, staff at the UI Hospitals and Clinics only had seven to eight minutes of notice before an ambulance arrived with a crash victim. TraumaHawk set out to change that, finding a way to provide emergency department staff more time to prepare for crash victims.

How does this happen? At the scene of a motor vehicle crash, state patrol troopers can use TraumaHawk to quickly generate a report that includes vital collision information along with photographs of the vehicle damage. This report is then transmitted to the hospital emergency department, providing critical additional minutes for preparation. With these images and information, trained professionals are able to assess patterns of injury based on crush and intrusion patterns of the damaged vehicle.

The benefits are clear. With more time to prepare for the arrival of trauma patients, emergency department staff are better able to plan how many and what kinds of staff members and supplies are needed. They can also better anticipate the types of injuries. This results in a better diagnosis of injuries and utilization of hospital resources. Advance notice of crash severity and location can help save lives.

Today, TraumaHawk continues to develop. Researchers are currently working to expand use of the TraumaHawk app with Iowa State Patrol troopers in east-central Iowa and other parts of the state.

IN 75% OF CASES WHERE TRAUMAHAWK HAS BEEN UTILIZED, ALERTS HAVE INCREASED THE AVERAGE ADVANCE NOTICE TIME FROM 9-29 MINUTES. THE MAXIMUM AMOUNT OF TIME A TRAUMAHAWK ALERT PROVIDED ADVANCE NOTICE WAS 90 MINUTES.



Top: TraumaHawk image of a vehicle
Left: Dr. Chris Buresh demonstrates the TraumaHawk MODULE at the UI Hospitals and Clinics Emergency Department

The Human Factor

The Human Factors & Behavioral Sciences Division at NADS seeks to reduce vehicle crashes by applying rigorous research techniques to understand the evolving relationship between humans and vehicle technology. The division utilizes its research expertise, domain knowledge, and unique combination of research tools to address critical questions in the field of transportation human factors.

Leading the division is Assistant Research Scientist Dr. John Gaspar. In the last few years with NADS, Gaspar has led studies investigating drowsy driving, driver reactions to events like unintended acceleration, and vehicle automation. Gaspar's areas of expertise include human factors and human performance, cognition and attention, vehicle automation, driving simulation, and cognitive aging. Gaspar holds a PhD in Human Performance and Engineering Psychology, with minors in Neuroscience and Statistics.

Left: Dr. John Gaspar downloads data from one of NADS' on-road research vehicles after a participant drive
Right: Drowsy driving study night drive in the NADS-1

Like most university buildings late at night, NADS is dim and eerily quiet. Sometimes you'll catch a student hunkered down behind a computer, working on programming into the wee hours of the morning. Usually there's a lone janitor wearing headphones while emptying bins and wiping down tables. However, there was a time this year when, long after the rest of the world was (or should have been) sleeping, you could find the lights on and the NADS-1 simulator gliding across the bay.

As part of a recent drowsy driving study for Aisin Technical Center of America, Dr. John Gaspar and a skeleton crew of NADS staffers studied control room monitors until well after two o'clock in the morning. They watched as participants drove four-hour, 50-mile interstate loops, the longest ever done in the NADS-1. These lengthy drives were conducted to identify the range of drowsiness detectable by a production driver monitoring system. At the beginning of their drives, participants had been awake for 14-18 hours in order to capture the full range of the drowsiness spectrum, from fully awake to very drowsy. But, by the end of the night, they weren't the only ones yawning or bobbing their heads.

"It was difficult for staff not to be a little drowsy ourselves. But when one participant fell asleep, drifted across the median, and woke up in the oncoming lane of traffic, that was definitely an eye opener," Gaspar says.

This Aisin study is one of a few drowsy driving research projects Gaspar has overseen during his career. And it's just one of the many varied human factors projects taking place at NADS. "Being able to work in different platforms—in the simulator or on-road—and to research different topics is a unique combination. The variety of possibilities for our research at NADS is exciting."

SIMULATION TO AUTOMATION

To say that NADS human factors research projects are varied might be an understatement. This year, Gaspar and NADS Senior Research Associate Cher Carney moved from simulation to on-road, undertaking an intensive study that looks at the extended interactions drivers have with a partially automated vehicle.

As the world moves into the future of automated vehicles, it's essential to better understand the interaction between drivers and advanced technologies. For the study, participants were given a one-week experience with a partially-automated NADS vehicle. During their daily commutes, drivers were told that they could use the automation as much as they felt comfortable. As they drove, five cameras installed on the interior and exterior recorded views from several angles. These recordings resulted in approximately 150,000 seconds of data, or 4.5 million frames.

After each drive, NADS staff and students worked around the clock to code each glance and behavior of the participant, as well as record vehicle measures like speed, lane position, and pedal input. At 700 glances per drive, it takes the majority of the day for staff to code just twenty minutes of video. "This is my first naturalistic study," Gaspar says. "But our research team leading the coding efforts have years of experience in this field. It's a taxing job, and we couldn't do it without them."

The staff's coding expertise will be required through the next phase of this project as well. Over two years, NADS will execute controlled driving studies on a closed course, looking at how drivers handle taking over an automated vehicle in well-defined situations.

WHAT'S NEXT?

Going from simulator to on-road to test track research, it's clear that you can never really be sure what's next for this division. Sometimes you even get to have a little fun, like this past year when British Science YouTuber Tom Scott shot a video segment in the NADS-1 on the distraction of vlogging while driving. Gaspar prepared a few standard driving scenarios for this visit, while also using one from a recent study on unintended acceleration. This scenario mimicked an unexpected stuck gas pedal, catapulting the NADS-1 simulator across the bay while the driver attempted to gain control. As one might expect, Scott's inattentional blindness as he recorded video resulted in speeding, swerving, and missing a stop sign. Currently, the video is at more than 415,000 views on Scott's YouTube channel.

While Gaspar can't always be sure what the next project will be, there are a few slated for the near future that he's excited about. One SAFER-SIM study looks at how to provide warnings to autonomous vehicle drivers using Aisin's driver monitoring system and the NADS-1. Another will examine how to convey information on the state of the automation to the driver, to help them understand how it's performing. "We study problems that are difficult to address in transportation," Gaspar says. "But we have a team of people here who are really good at running challenging studies."

There's another drowsy driving study slated soon, too, this one for NHTSA. When asked if he's hoping for even more overnight studies in the future, Gaspar laughed. "It seems like I'm always hoping that this one will be the last, and then another one comes along. It's tiring, but then you see the participants' slowed reaction times or crashes in the simulator and remember just how important our work is."

Top: Engineer Alec LaVelle wears occlusion goggles in testing interfaces against NHTSA visual manual guidelines standards while Research Associate Cherie Roe looks on
Left: miniSim Program Coordinator Joe Meidlinger works with a student wearing eye tracking headmount system
Center: Quad camera view of driver nodding off during a drowsy driving study in the NADS-1 simulator
Right: Undergraduate Research Assistant Kaycee Davis tests a novice driver training program

BUILDING ON EXPERIENCE

Creating a solid foundation for NADS Human Factors Research

It takes a solid foundation to build a high-quality research program. While the National Advanced Driving Simulator facility is celebrating its 20th anniversary this year, driving safety research has been taking place at the University of Iowa for decades, making it one of the top research institutions in the nation.

Human factors research is the cornerstone NADS was built on. For the last few decades, the NADS team of experts has contributed to a better understanding of how humans interact with vehicles. Many of the technologies in today's vehicles came through the UI as part of their research and development and safety testing. For instance, in the mid-2000s, experts at NADS were tasked with studying Electronic Stability Control (ESC). The decision for the federal government to ultimately require ESC to be standard on all US vehicles by 2012 was solidified by a major study at NADS during this time.

At NADS, we rely on our strong foundation of experts, many of whom built their careers here. Others came to us from universities across the nation or industry partners, assembling a wide range of experience. For instance, we have an in-house expert, Senior Associate Researcher Cher Carney, that spent years writing the standard on Advanced Traveler Information Systems that the Federal Highway Administration (FHWA) says it still uses today. And our director, Dr. Daniel McGehee, has more than a million miles of naturalistic and on-road data human factors and driver behavior testing experience.

A few of the technologies now on American roadways that have been studied at the University of Iowa and National Advanced Driving Simulator:

Forward Collision Warning
Anti-lock Braking System
Lane Departure Warning
Electronic Stability Control
Adaptive Cruise Control
Adaptive Headlights

Today, our human factors experts are carrying out a wide array of work, including naturalistic driving studies, surveys, and simulation experiments. We are focusing resources on critically important work, such as studying distracted and drug impaired driving. We are testing vehicles and their technologies to industry standards. For the fifth year, we are working with an auto manufacturer to test interfaces to the NHTSA visual manual standards and provide feedback on how systems can be improved to reduce distraction. A number of our researchers' findings have been used to redesign these systems to make them less distracting. We're also helping industry leaders make roadways safer by testing adaptive headlights. We're lending our expertise to help local, state, and national leaders craft policy.

All of this results in one of the top human factors research institutions in the nation. We're proud of what we've built, and looking forward to expanding on this success in the future.

As a result of a study conducted by NADS, Electronic Stability Control (ESC) was required to be included standard on all new cars by 2012. According to NHTSA, ESC has led to a 60% reduction in fatal rollover crashes and is estimated to have saved 7,000 lives between 2011-2015 in the US alone.

Cultivating Safer Iowa Roads

NADS' Commitment to Farmers and Young Drivers Across the State and US

There's no question that NADS researchers are dedicated to safety. The mission statement says it all: Improving safety by researching the connection between drivers, motor vehicles, and road users.

But it's about more than just doing a job. Many of the NADS researchers were born here. All are proud Iowans with a dedication to their families, neighbors, and friends who live and work here. So what have we been doing to make our many Iowa roadways safer?

Top: SaferTrek devices prepped and ready for deployment. SaferTrek systems are attached to farm equipment using strong magnets. Bottom: Research Associate Michelle Reyes switches the magnets of a newly attached SaferTrek device on a local farmer's combine. SaferTrek devices video record vehicles as they approach, follow, and begin to pass the farm equipment.

Instrumented Farm Vehicle Roadway Study

According to NHTSA, while only 19% of the US population lives in rural America, nearly half of traffic fatalities typically occur in rural areas. Crash fatality and injury rates are higher on rural roadways than other roadway types, with rural fatality rates being more than twice as high as urban rates for a wide variety of injuries. Rural roadway crashes are more frequent, severe, and likely to result in death.

The presence of farm equipment is another characteristic of rural roadways that can contribute to crashes and injuries. Farm equipment crashes, which often involve a vehicle rear-ending or passing the farm equipment, are much more likely to occur on high-speed roads (over 50 mph speed limits), roads with high traffic density, farm-to-market routes, and smaller lane widths. Collisions involving farm equipment are about five times more likely to result in a fatality.

The Instrumented Farm Vehicle Roadway Study seeks to objectively observe vehicles as they approach farm equipment, with two project aims for the project. The first is to measure farm equipment exposure to the roadway (e.g., miles traveled, location) and frequency with which cars approach the equipment. Second, the project seeks to identify behavior of vehicle drivers as they approach farm equipment from behind. Behaviors to be examined include speed, deceleration while approaching the farm equipment, following distance, number of passing attempts, and passing.

To obtain data, the research team, which includes electrical engineering researchers and students at IIHR - Hydroscience and Engineering, developed an innovative GPS/video integrated data system, a device called SaferTrek. SaferTrek records farm equipment roadway exposure and behavior of vehicle drivers approaching from behind. Farm equipment operators volunteer to have a SaferTrek system attached to their equipment during periods of frequent roadway use.

The research team has been busy conducting pilot tests of the technology in Johnson County and reaching out to farm equipment operators in other areas of Iowa for the testing phase. After data collection is complete, during the second phase of the project the research team will develop, implement, and evaluate a community-level intervention to increase driver awareness and reduce driving errors in order to protect farm equipment operators.

Over the last year, NADS Research Associate Michelle Reyes has served as the project's study coordinator. "Michelle has played an important role in the development and implementation of the SaferTrek equipment. She's helping us reach out to local farming communities to understand how we can install SaferTrek on different types of farm equipment, and building relationships with operators who are providing their expertise," says Cara Hamann, Faculty Associate in the Department of Epidemiology and the study's Principal Investigator.

The project involves collaboration between three leading UI research groups: the UI Injury Prevention Research Center, Great Plains Center for Agricultural Health, and NADS.

The Instrumented Farm Vehicle Roadway Study is funded by the CDC/NIOSH through the UI's Great Plains Center for Agricultural Health. To learn more about this and other projects, visit: **www.public-health.uiowa.edu/gpcah**

Novice Teen Drivers

Newly licensed teen drivers are at high risk for car crashes. Teen drivers 16-19 years old have crash rates that exceed those of any other age group, with 16-year-olds having the highest crash rates.

Motor vehicle crashes are a leading cause of death for 15- to 20-year-olds. In 2016, 1,908 YOUNG DRIVERS DIED in motor vehicle crashes, with an estimated 195,000 INJURED.

- NHTSA Traffic Safety Facts, 2015/2016 Data

NADS researchers are committed to studying novice driver behaviors and are playing an active role in reducing teen driver crashes. Teen driver research conducted at the UI and NADS has included naturalistic studies that investigate distraction and driver training, as well as analyses of crash rates, licensing trends, and changes in younger driver policies.

In five studies conducted from 2006-2015, novice teen drivers' cars were equipped with event-triggered video devices that recorded when high g-forces were experienced in the vehicle. Pairing this new technology with parental feedback in the form of video review and weekly graphical report cards, researchers extended the parents' ability to teach their children, even after the teens began driving independently. Overall, video feedback and parental mentoring intervention resulted in a significant decrease in participants' rates of safety-relevant events. Teens with the highest rates during baseline benefited the most from the intervention, dropping their incident rates significantly.

"It was so successful that we continue to field calls from parents of former subjects today, asking if we're still conducting the study and wondering if their younger children can also participate," says Cher Carney, NADS Senior Research Associate.

In 2018, Cher Carney and Michelle Reyes received the Iowa Commissioner of Public Safety's Special Award for Excellence in Traffic Safety, in recognition of their work in teen driving safety.

A Passion for People

SAFETY RESEARCH USING SIMULATION
UNIVERSITY TRANSPORTATION CENTER

SAFER-SIM Director Dawn Marshall talks with Harding Middle Schoolers about careers, as well as brainstorming problems simulation could solve and planning experiments based on their problems

Whether it's presenting to a crowded room or just talking one-on-one in her office, when Dawn Marshall discusses the work she does, you can tell it comes from a place of true passion and excitement. Her eyes light up and hands begin to flutter as she describes the latest SAFER-SIM University Transportation Center (UTC) success story or one of her research projects.

Marshall didn't always know she'd discover her career passion in transportation safety research. In fact, she got her first undergraduate degree in finance before exploring industrial engineering almost a decade later.

"As an undergraduate research assistant, I learned I could help people become safer drivers through my work in this field. Instantly, I was hooked. I went to graduate school to do exactly what I'm doing today and I still absolutely love what I do."

- Dawn Marshall, SAFER-SIM Director

SAFER-SIM

Currently, one of Marshall's biggest passions is serving as Director for the SAFER-SIM UTC. As the SAFER-SIM Director, Marshall works with consortium site directors and research study principal investigators to successfully accomplish SAFER-SIM's goals. "We have a very multidisciplinary team. Our researchers range in specialty from psychology and brain science, to various engineering disciplines, to medicine and pharmacology, to orthopedics, and much more. Some of our projects have even included kinesiologists and physical therapists. And, yet, through all these varied collaborations, our focus is always clearly on transportation safety."

Marshall is careful with the way she phrases her thoughts—her love for her work is so strong, it's clear that she wants it all to come out exactly perfect. But there's one thing she can answer without hesitation: what is SAFER-SIM's greatest strength? "The diversity," she says. "Our collaboration across many disciplines really brings us out of the silos that are often present in transportation safety work."

Because of her dedication, these collaborations will continue. Last year, SAFER-SIM received funding for another grant to continue the program. The grant provides $1.4 million in the first year, with up to $7 million in funding over five years. Marshall's voice quickens as she talks about the upcoming research projects starting under the new grant. She describes a shift in focus to research areas that allow SAFER-SIM to examine interactions between different road users, not just drivers. An initial project investigates distributed simulation:

SAFER-SIM Director Dawn Marshall and Research Support Coordinator Jacob Heiden discuss an upcoming SAFER-SIM webinar

connecting pedestrian, bicycle, and driving simulators in order to study interactions between people. Glances, head nods, and hand waves are all important; thus, a key part of this effort is building realistic and believable avatars that can do these things in real-time, something a student in the UI Visual Intelligence Laboratory is currently working on.

NEW HORIZONS

This year, with the expansion of the UI College of Engineering building, SAFER-SIM opened the Driving Research and Innovation in Virtual Environments (DRIVE) Laboratory. The first dedicated space on campus for the SAFER-SIM program, the DRIVE Lab supports projects that come through NADS, while also making resources more accessible to students. Marshall hopes that the DRIVE Lab not only brings driving simulators to campus for students that already want to work in this field, but that it also introduces transportation safety research to a whole new audience.

While computer scientists and engineers are obviously needed for transportation safety research, Marshall emphasizes that it takes a wide range of people with different skillsets to run a research facility as sophisticated as NADS. It requires engineers, artists, business people, and finance experts. It takes people who specialize in collecting data and creating a good experience for volunteer research participants. "Even just amongst engineers there's a huge variety of people we need," Marshall says. "It's not just human factors engineers, but we also need software and hardware engineers. We need people with engineering experience to do maintenance and upkeep on the simulators. We need all kinds of people to be successful in our work."

For Marshall, it's all about the people. It's the reason why she loves what she does. And she hopes that SAFER-SIM and many the efforts they're undertaking with the DRIVE Lab will reach people with all sorts of interests to improve transportation safety research.

"A lot of people come to this field through a love of vehicles or technology. I came to it through an interest in the people who drive the cars. In our research, having a variety of people with different interests and passions creates a great balance and innovative interactions, allowing us to look at issues from all sides of the equation."

To learn more about SAFER-SIM, visit: **safersim.nads-sc.uiowa.edu**

The SAFER-SIM program employs simulation techniques to address safety issues prioritized by the US DOT. SAFER-SIM sponsors research, STEM outreach activities, and workforce development efforts across its five consortium sites. SAFER-SIM fully engages students at all levels of research and disseminates findings and techniques to the research community, safety professionals, and the public.

Beyond serving as the SAFER-SIM Director, Dawn Marshall's research with NADS has spanned several topics involving simulation, including projects evaluating in-vehicle systems such as adaptive cruise control, lane departure warning, forward collision warning, intersection violation warning, and development and evaluation of situational awareness measures within a connected vehicles context. Her experience also includes the effectiveness of warning systems for older drivers, teen driving behavior near licensure, and integrated control heads for law enforcement.


grow
JOHNSON COUNTY
good food is a human right

Promoting STEM Across Iowa

During a tour of the National Advanced Driving Simulator, squeals and eruptions of laughter are often heard throughout the building as kids try—and fail—at texting while driving a miniSim. Sometimes, observers will let out a few good screams as drivers, their eyes off the road, drift into an oncoming lane or the shoulder, gravel rumbling beneath the virtual tires. While it's funny to see friends fail at this task, Jacob Heiden knows that the exercise carries a powerful message. He relays that message to kids as he debriefs them after each drive.

"It's really rewarding to see kids understand the impact that their actions can have while driving. I know I'm giving kids a fun learning experience, but also teaching them something that could save a life someday."

- Jacob Heiden, SAFER-SIM Research Support Coordinator

Heiden, an Iowa native, works hard to introduce kids and adults of all ages to transportation safety. Not only is SAFER-SIM outreach important for creating better drivers and safer roadways, but it also helps build the transportation workforce of tomorrow. Introducing transportation safety research to new audiences may lead to advanced innovations and improved safety.

For years, the SAFER-SIM program has been taking important messages like this one to people of all ages across Iowa and beyond. Since 2013, SAFER-SIM has interacted with 44,552 students. Across Iowa alone, the outreach is impressive, impacting kids and adults from nearly every town. These interactions will lead to safer roadways and enhance Iowa's position as a national leader in transportation safety.

One of Heiden's proudest moments to date includes organizing the First Annual STEM Festival at the Johnson County 4-H and FFA Fair in 2017. "It introduced STEM to a whole new audience and hopefully, through our marketing efforts, brought a whole new group of kids and families to the fair. This is a great collaboration that's just going to grow year after year."

Since 2013, SAFER-SIM has:

Funded

68

individual and collaborative

RESEARCH PROJECTS

Sponsored monthly webinars relating to SAFER-SIM research projects. To date,

40

WEBINARS

are posted to the YouTube channel with more than

2,700

VIEWS

Interacted with

44,552

STUDENTS

at STEM fests, career fairs, tours, and schools

Opposite: SAFER-SIM Research Support Coordinator Jacob Heiden mans the table at the Annual STEM Festival at the Johnson County Fair
Left: Students react as a classmate crashes during a miniSim driving demonstration

LIKE A WELL-OILED MACHINE

miniSim Program Manager Andrew Veit works with student Greg Beaver on miniSim programming

miniSim™

The NADS miniSim™ is high-performance driving simulator software designed for research, development, clinical, and training applications. Recognized as a world leader and based on decades of research, the miniSim is modern, sophisticated, and effectively-priced. The NADS miniSim program provides the functionality and support to both external and internal miniSim users so that they can fulfill their research and development goals, while keeping the miniSim an affordable and accessible solution.

Andrew Veit has served as the miniSim Program Manager for nearly a decade. In this role, he is responsible for proposals, product management, and system design. To date, he has led more than 100 miniSim projects.

A tremendous amount of top-notch machinery is essential to keeping the NADS facility operating at the high standard of performance that it does today. There's the thousands of mechanical components that make up the simulators and miniSims. There's the computer hardware in the control room. There's the instrumentation systems in the on-road vehicles.

And then there's Andrew Veit, a vital cog in the NADS organization.

Veit runs like a well-oiled machine, always moving, always working. Effortlessly, he shifts from one task to the next. He's a self-proclaimed tinkerer who loves sharing his passion for making things that get used. He travels at least one week a month (if not more) to install and upgrade miniSims across the country. He's so productive, some co-workers question if he actually sleeps. "I've forced

myself to slow down a little, but the deadlines will always be there" Veit says. "But it's what I enjoy. I'm proud of the quality of work we do here."

Helping NADS to run since 2005, Veit was originally hired as a quality engineer, working on the NADS-1 simulator's motion system. During this time, software was developed at NADS for staff to run and test scenarios at their own workstations. It was soon realized, however, that this development could serve a much bigger purpose. When Veit designed and developed hardware to supply to researchers outside NADS, the miniSim was born.

A PRODUCTIVE YEAR

Over the course of a decade, the miniSim program has become recognized as a world leader in modern, sophisticated, and effectively-priced driving simulators for research, development, clinical, and training applications. 2018 was busier than ever for miniSim, with more individual projects shipped out in the spring than all of the previous year. Three quarter cab systems were completed, one each for the SAFER-SIM program, UC Denver, and SUNY Buffalo. A simplified cab system was developed for a company in China. Major upgrades were also conducted for a quarter-cab research simulator and the National Highway Traffic Safety Administration's miniSim, located at the Turner-Fairbank Highway Research Center, and for a simulator at Battelle.

The miniSim software also received major upgrades this year. In addition to previously available enhanced vehicle automation technologies, miniSims can now be programmed with lane keeping assist and have a haptic seat option. A new version of the steering loader was also released. The steering loader provides the right steering wheel feel in normal driving situations, provides torque cues for ADAS systems like lane keeping assist, and will turn the wheel when the vehicle is under autonomous control. The mechanism for this system was designed by Engineering Associate and former NADS student employee, Jacob Ohrt.

"Jacob was the engineer on the steering loader improvements. I consulted, but he did all the work and he did a fantastic job with it," Veit says.

Custom half-cab miniSim with a two-projector display system built for Yale University's Developmental Neurocognitive Driving Simulation Research Center

"The miniSim has been essential to our research on cannabis impaired driving. The NADS miniSim team was critical in helping us get the simulator data collection running quickly."

- Ashley Brooks-Russell, PhD, MPH
Assistant Professor
Colorado School of Public Health, UC Denver

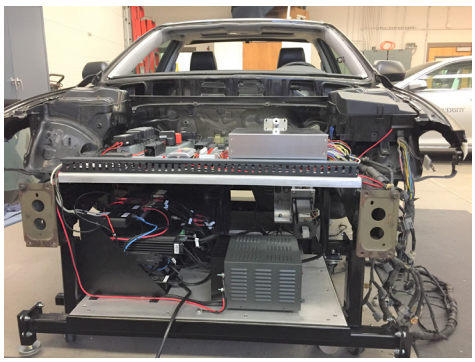
PART OF A SYSTEM

While Veit is a machine, he can't handle the miniSim program alone. Program Coordinator Joe Meidlinger has not only been managing the builds of standard miniSims and handling routine customer contacts, but over the last year he has created training videos, providing users with new ways to learn more about the miniSim's capabilities.

Students are also a vital mechanism in ensuring the miniSim's success. An indispensable part of the team, the work students do is varied. Typically, they help in assembling simulators and perform the hands-on work like mechanical assembly, wiring, and soldering. Veit likes to have them design and make things. "Students here really do value the learning experience, to be handed something and expect it to be completed. To work on and maybe struggle with a problem—it's an important thing for all engineers to do!"

And assembling a productive team as well as a successful program—it's what Veit does.

To learn more about miniSims visit:
www.nads-sc.uiowa.edu/minisim



Front end of the Yale University Developmental Neurocognitivbe Driving Simulation research Center half-cab miniSim under construction at NADS

A Simplified miniSim completed for the SAFER-SIM's new DRIVE Lab at the University of Iowa. This miniSim will be used for tours, education, and UI undergraduate and graduate research.

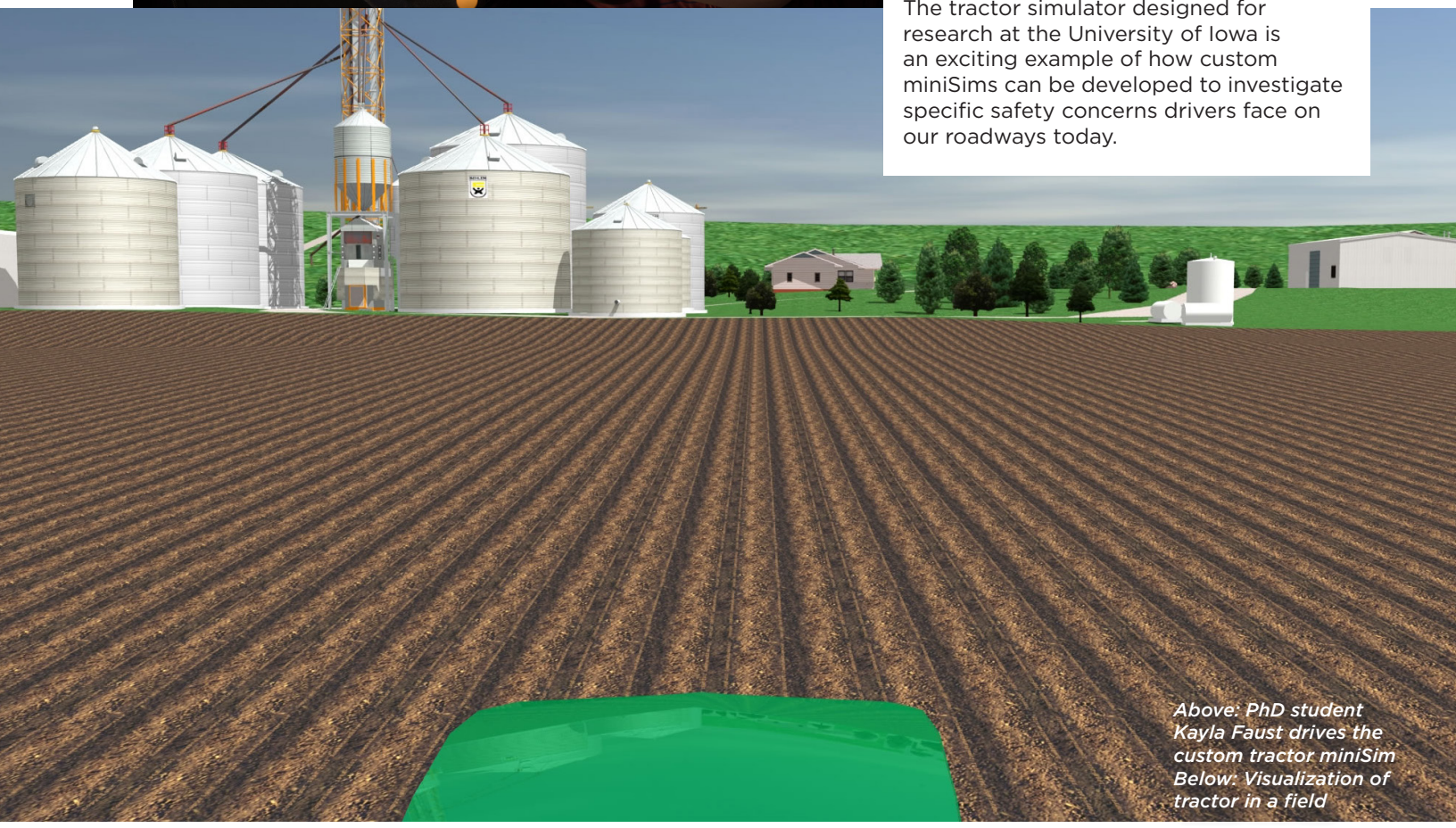
Focus on Ag Safety

The Custom Tractor miniSim

The miniSim is high-performance driving simulator software designed for research, development, clinical, and training applications. Recognized as a world leader in modern, sophisticated, and effectively-priced driving simulators, the miniSim is based on decades of research and development at NADS.

While there are a number of standard miniSims available (desktop, simplified, quarter, and half cab), miniSims can also be engineered to meet specific requirements. This includes customizing specialty cabs, driving environments, geospecific locations, scenario models, user interfaces, active safety subsystems, and more.

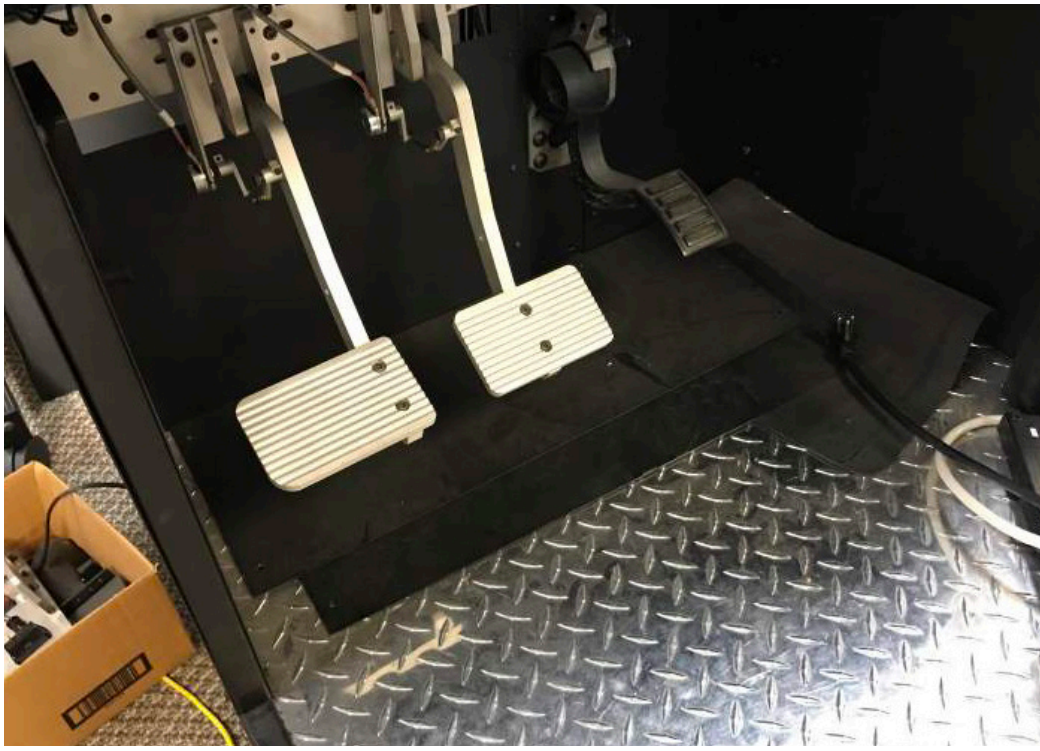
The tractor simulator designed for research at the University of Iowa is an exciting example of how custom miniSims can be developed to investigate specific safety concerns drivers face on our roadways today.



Above: PhD student Kayla Faust drives the custom tractor miniSim
Below: Visualization of tractor in a field

About 100 agricultural workers suffer a lost-time work injury every day, and the workplace mortality rate for farm workers is 19 per 100,000, far above the 3.6 per 100,000 injury rate overall.

We're helping to change that.



Tractor Custom miniSim

The west wall of the NADS conference room begins to vibrate, but none of the staff inside appear concerned. As the low rumble grows, curious visitors ask about the noise. Casually, staff informs them that it's just the tractor miniSim in the room next door, running yet another subject.

"It's pretty loud, I know. But that's what makes it so realistic," says project lead Kayla Faust.

Faust is a second year a PhD student with the UI College of Public Health. She's studying occupational injury prevention with a focus on transportation safety and making rural roads safer for drivers of both farm and non-farm vehicles. In 2017, Faust obtained funding to work with Iowa farmers to examine tractor driving performance. But, like what most PhD students face, Faust's funding was limited. However, NADS miniSim staff were able to work within her budget constraints to develop a realistic desktop tractor driving simulator.

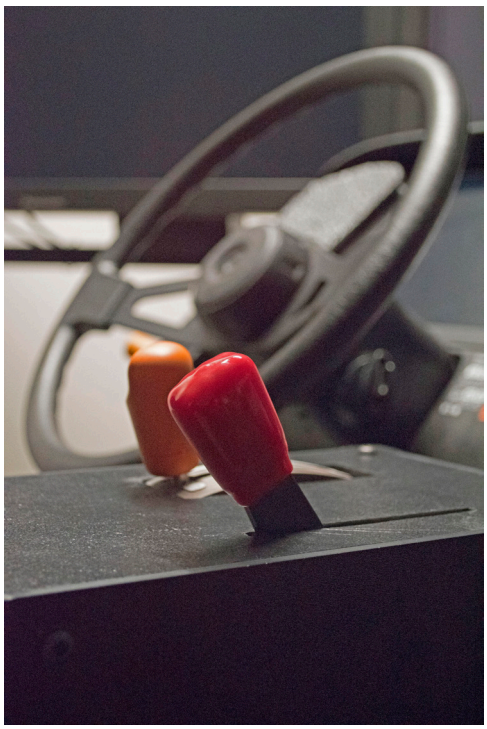
Creating a simulator that mimics the appearance and feel of the vehicle type being studied is critical when conducting driving simulation research. A tractor's dynamic characteristics like braking response, center of gravity, steering geometry, seating position, and field-of-view are considerably different from personal vehicles due to their functional requirements.

To approximate a realistic cab at reasonable cost, the miniSim team repurposed a heavy truck cab already on-hand. NADS miniSim students then researched tractor control mechanisms, designed and built an armrest with transmission and throttle hand controls, and installed a suspension seat, directional control lever (reverser), and turn signal. These new controls were integrated with the simulator's USB cab interface electronics and calibrated to work with miniSim software.

A driver in the loop simulation requires that the driver have a cab to interface with, but a mathematical model of the vehicle being driven is also needed to calculate the correct responses to the driver inputs. A vehicle dynamic model of a John Deere 7820 incorporating powertrain, tire, and multi-body chassis models had previously been developed for use on the NADS-1, and this model was adapted to the miniSim by NADS Associate Research Engineer Chris Schwarz. The visual model of the cab was adapted from the model used on the NADS-1 by NADS Transportation Visualization Program Manager Shawn Allen, along with refinements including a new instrument panel display.

Today, Faust has completed her data collection efforts. In the future, data from Faust's studies can be used to make design changes to farm vehicles or roadways, improving safety for everyone.

"It was so easy to work with the miniSim team," Faust says. "They did a fantastic job putting my custom tractor miniSim together. I've gotten a lot of great comments from study participants on how realistic it is."



A look at the details of the custom tractor miniSim. Top: The pedals under development. Bottom: Hand controls mimic those in a real tractor

From A to V Alphabet Soup

The Automated Driving Systems Division strives to improve driving safety by researching the impact of advanced vehicle technologies and automated driving systems on our roadways. The division seeks to lead, coordinate, and enable the advancement of automated driving systems in Iowa and provide an ongoing forum for research, education, and collaboration.

Ashley McDonald has served as a project or program manager for more than six years with projects that represent a variety of goals, stakeholders, size, scale, and complexity, within all phases of project management. McDonald managed and coordinated all components of the MyCarDoesWhat national education campaign, including survey sampling design, data collection protocol development and management, quality control, and preliminary data analysis preparation. McDonald managed the National Consumer Survey of Driving Safety Technologies, as well as coordination of several other data collection studies. In 2016, she served as the project manager on the UI's Technology Demonstration Study.

Ashley McDonald is a **PMP** (Project Management Professional©) with a focus in **AV** (automated vehicles) and **ADAS** (advanced driver assistance systems). She's led surveys and studies delving into vehicle safety features like **ACC** (adaptive cruise control), **BSM** (blind spot monitoring), **LKA** (lane keeping assist), **LDW** (lane departure warning), **RCTA** (rear cross traffic alert), **AEB** (automatic emergency braking), and much more. Last year, she helped get the area named as one of just 10 US DOT-designated **AVPG**s (Automated Vehicle Proving Grounds). Her work with the Iowa **DOT** has branched out into separate projects with titles like Amendments **4A-4F**.

So much of McDonald's work is acronyms and abbreviations that, at times, it's difficult for coworkers to keep track of her projects. "We joke about how I've got an alphabet soup going on in the Automated Driving Systems division. Some days it really does feel like I'm talking in a different language," McDonald says.

To be clear, this language describes technologies that are in-production today by automakers and actively being used on our roadways. While fully automated, self-driving cars are a long ways off, most vehicles on our roadways now have some sort of automation, ranging from basics like anti-lock braking systems (**ABS**) and cruise control to the newer technologies

McDonald and her team are studying, like self and assisted parking and lane keeping assistance. So how is McDonald's division balancing the task of preparing for the future, while researching the technologies on our roads right now?

SPELLING SUCCESS

A big part of preparing for advanced vehicle technologies is collaborating with others throughout the US to share ideas and hear different points of view. Within the Midwest, McDonald and NADS staff are hosting quarterly Connected and Automated Vehicle (**CAV**) calls with other **AVPG**s, state **DOT**s, and universities to discuss ideas, mitigate patchwork, and ensure people and goods can move freely and efficiently in our region.

Nationally, McDonald has been participating in a series of meetings held across the country by the Federal Highway Administration (**FHWA**). These National Dialogue on Highway Automation meetings are designed to facilitate information sharing, identify key issues, and support the transportation community to safely and efficiently integrate automated vehicles into the road network. Input from these meetings will help inform **FHWA** research, policies, and programs.

One National Dialogue meeting focusing on digital infrastructure and data—what it is and who's responsible for it—was of particular interest to McDonald. The **FHWA** defines digital infrastructure as the static and dynamic representation of the physical world with which automated vehicles will interact to operate.

"The National Dialogue on Highway Automation meetings are fantastic," McDonald says. "But one thing I've noticed missing from the conversation is that, once we have a digital infrastructure, what does it mean when it comes into the vehicle?"

That's what McDonald and the Automated Driving Systems Division is focusing on right now in its partnership with the Iowa **DOT** and Iowa State University.

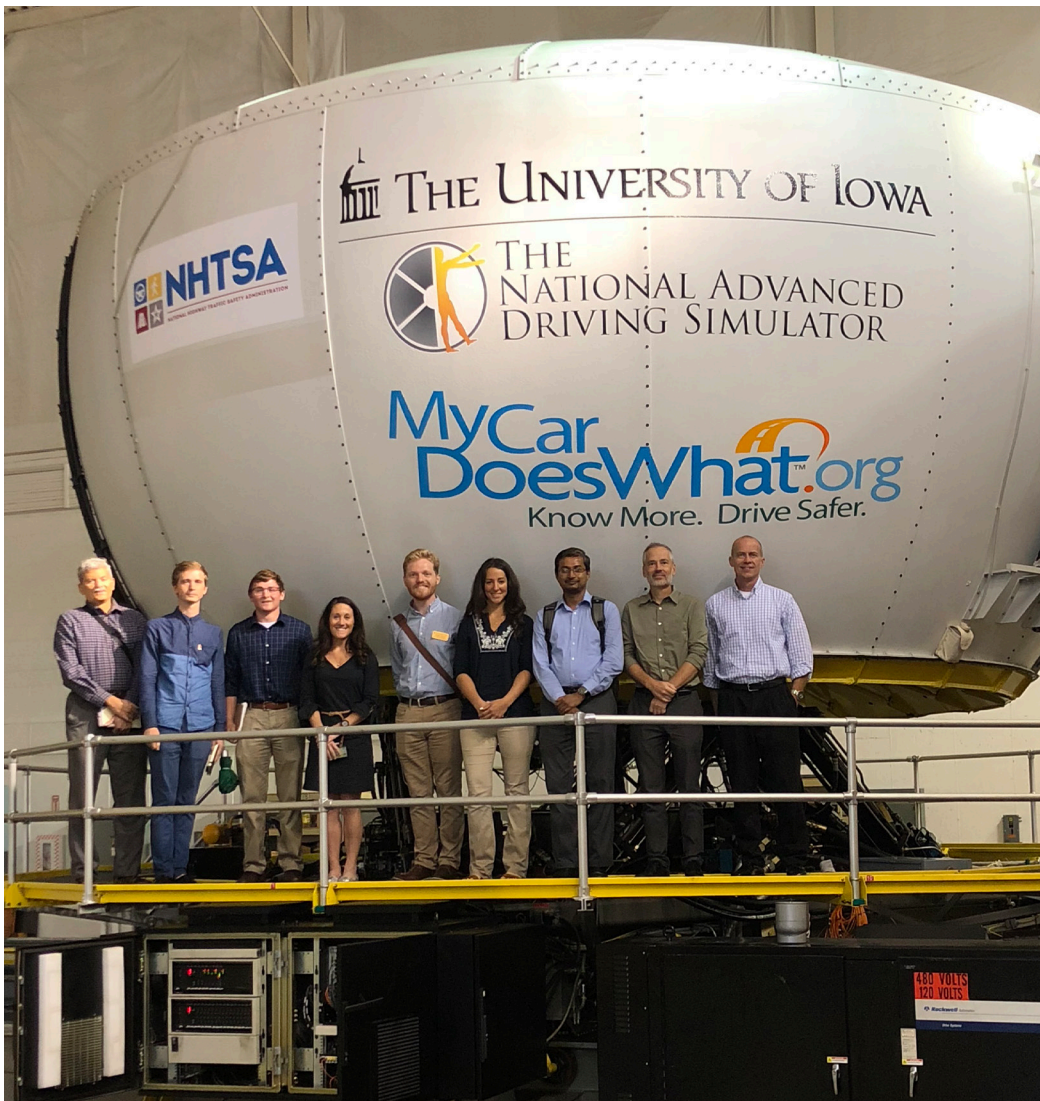
I IS FOR IOWA

The initial focus of automated vehicle development has largely been on vehicle-based solutions, such as the addition of sensors and software. However, while sensors can help detect the driving environment around the vehicle, additional driving environment data from external sources can add significant value in helping vehicles understand and anticipate driving conditions. This external information allows vehicles to "see" further ahead in all conditions and serves as an additional set of input data for **AV** control functions, adding to the safety and comfort.

Over the past few years, McDonald and staff at NADS have partnered with the Iowa **DOT** on its **AV** Technologies Project. This project is deploying a set of key capabilities to the driving public in Iowa, centering around providing automotive-grade information, including: hazard alerting, predictive travel condition datafeeds, **AV**-ready datafeeds, and driving environment data. The **AV** Technologies Project partnership is working to get a high-definition (**HD**) digital mapping structure in place. This **HD** map, created with high-quality, high-accuracy data, will not serve as a replacement for cameras and sensors in automated vehicles, but will provide redundancy to improve safety.

Recently, McDonald and her team have been conducting pilot demonstrations that feature connection to the Iowa DOT's digital infrastructure. One demonstration utilizes the NADS' Lincoln MKZ, which has sophisticated software developed by AutonomouStuff to operate the vehicle autonomously with the vehicle's sensors, cameras, and Iowa's HD map. These demonstrations will help the industry better understand elements of data quality and standards necessary and sufficient when informing vehicle control.

Left: McDonald and Research Associate Cherie Roe work to program the NADS' new Lincoln MKZ.
Below: McDonald with UI Urban and Regional Planning students who are helping to prepare for the anticipated impacts of automated vehicles on the built environment and community. Final documents from their work will provide policy guidance to Iowa City in public transportation services, parking, street design, and land use.



Iowa's Automated Vehicle Proving Grounds

Right: The NADS Lincoln MKZ near a cell tower along rural roadways in the Iowa AVPG.
Top Left: The Volvo XC90 on-road
Bottom Left: Springfield, NADS' 285 square mile virtual proving ground

In 2017, the US DOT named the Iowa City/Cedar Rapids Corridor as one of the nation's ten designated Automated Vehicle Proving Grounds. Today, the Iowa AVPG focuses on the diversity of automated vehicle testing environments that Iowa has to offer, including both physical roads and virtual simulation environments. The Iowa City/Cedar Rapids Corridor also features variety in climate, road users, and roadway landscapes.

So what is the Iowa AVPG doing today?

Today we are working to refine the AVPG. Consumer education is a big component for the future of automated vehicles and their technologies. Our past research has shown that most drivers have exposure to advanced vehicle technologies, but many do not fully understand how to operate them. Additionally, our research has demonstrated that initial exposure impacts driver trust, perceptions, and attitudes toward the technologies. In the next year, NADS researchers will conduct a series of AV focus groups to better understand what Iowans know and their perceptions of these technologies.

We're also collaborating frequently with other AVPGs and universities through meetings, calls, and projects to share ideas, discuss policy, keep each other informed, and ensure we're at the forefront of technology.

Finally, we're working to temper the idea that automated, self-driving vehicles are here today. Much of what is covered in headlines and on social media is technology that's being tested by the industry and isn't consumer-ready. Technology that most consumers have in their vehicles is vastly different. Drivers are definitely still in control.

IOWA ADVISORY COUNCIL ON AUTOMATED TRANSPORTATION

This year, the Iowa Advisory Council on Automated Transportation was formed. This group, led and governed by the Iowa DOT, seeks to create an automated vehicle ready driving environment for the safe movement of people and freight for a thriving Iowa economy. The council will function as a catalyst and forum for automated vehicle technologies, discussing policy and strategy to further safe, effective, and successful research, development, testing, operation, and implementation in Iowa. The council will provide coordinated feedback to both public and private entities, as well as education and outreach.

Subcommittees will provide input on topics related to economic development, energy, commerce and freight, public safety, insurance, infrastructure, local government, agricultural and rural issues, and communications.

The UI/NADS co-chairs management and logistics of the council, also providing expertise in vehicle safety, policy, and education around automated vehicle technologies. Additionally, Iowa State University will provide its expertise on transportation infrastructure and operations.

AVPG at a Glance:

3,226
miles of HD mapped interstate

230
miles of road in the NADS-developed Springfield simulated road network virtual proving ground

TEN
AVPGs nationwide

Greg Wagner, NADS Senior Engineering Associate, explains the features of the new Lincoln MKZ to Iowa City Mayor, Jim Throgmorton, and City staff as they tour NADS to gain greater knowledge on autonomous vehicles and policy

SAVE THE DATES

The University of Iowa and the National Advanced Driving Simulator are hosting two international conferences in 2019. Save the dates and join us!

10th International Driving Symposium on Human Factors in Driver Assessment, Training, and Vehicle Design

June 24-27, 2019
Santa Fe, New Mexico

This symposium, founded and run by the University of Iowa, is focused on providing an interdisciplinary forum for scientific exchange between users of driving assessment tools, applications and technology. Attendees will include researchers and practitioners working on applications of driving assessment from the perspective of engineering, psychology, medicine, and public health.

www.driving-assessment.org

Road Safety & Simulation Conference

October 14-17, 2019
Iowa City, Iowa

The Road Safety and Simulation Conference series was established in Rome in 2007 and since then has provided a bi-annual platform for researchers and professionals from various disciplines to share expertise and the latest insights in the field of road safety and simulation.

www.rss2019.org

Directors Past & Present

As we celebrate the National Advanced Driving Simulator's 20th anniversary this year, we'd like to take a look back at those that have paved the way to help us become a world leader in driving safety research. Thank you to all of the NADS directors over the past two decades. Your tremendous contributions to our success are appreciated every day!

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