NATIONAL ADVANCED DRIVING SIMULATOR

2021 ANNUAL REPORT

INSIDE

ADS for Rural America now on the roads in rural Iowa
# CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>From Our Director</td>
<td>4</td>
</tr>
<tr>
<td>National Advanced Driving Simulator (NADS) Overview</td>
<td>6</td>
</tr>
<tr>
<td>ADS for Rural America: Now on the Roads in Rural Iowa</td>
<td>8</td>
</tr>
<tr>
<td>Driving Drowsy</td>
<td>12</td>
</tr>
<tr>
<td>Human to Machine, Machine to Human</td>
<td>14</td>
</tr>
<tr>
<td>Understanding Adaptive Cruise Control</td>
<td>15</td>
</tr>
<tr>
<td>Does Regenerative Braking Have Safety Benefits?</td>
<td>16</td>
</tr>
<tr>
<td>Heartbeat Detection with Radar</td>
<td>17</td>
</tr>
<tr>
<td>Cannabis and Driving</td>
<td>18</td>
</tr>
<tr>
<td>Drug Use in Crashes Higher During COVID-19 Pandemic</td>
<td>20</td>
</tr>
<tr>
<td>Our Students</td>
<td>21</td>
</tr>
<tr>
<td>Students Build miniSims, Gain Experience</td>
<td>22</td>
</tr>
<tr>
<td>Evaluation of Novice Driver Training Programs</td>
<td>24</td>
</tr>
<tr>
<td>SaferTrek: Sharing the Road</td>
<td>25</td>
</tr>
<tr>
<td>New Features in Our Virtual Worlds</td>
<td>26</td>
</tr>
<tr>
<td>SAFER-SIM: Educating for Safety</td>
<td>28</td>
</tr>
<tr>
<td>‘Driving Science’ Free STEM Education Program</td>
<td>29</td>
</tr>
<tr>
<td>News Briefs</td>
<td>30</td>
</tr>
<tr>
<td>Our Partners</td>
<td>34</td>
</tr>
</tbody>
</table>

# CONTACT US

**NADS.UIOWA.EDU**

- nads-contacts@uiowa.edu
- @NationalAdvancedDrivingSimulator
- @DrivingSim
Our faculty and staff

We have some of the most dedicated and longest-serving faculty and staff in the industry. At a glance:

- **26** Full-time faculty and staff
- **400+ years** of experience in driving research and support at the University of Iowa
- **16** national and international committees

The NADS Subject Registry

Individuals in our subject registry get notified about our research studies that are recruiting participants. The number of active individuals in our registry is shown below.

To see our studies currently recruiting subjects, visit:

→ DRIVINGSTUDIES.COM
Our staff has done a wonderful job in returning to the new COVID normal in our research operations. This past year has been filled with challenges that our dedicated staff has risen to and met with the full gusto and grit to continue our high quality and impactful research. While the COVID-19 era appears far from over, we have adapted our operation so we can continue to operate in a safe and efficient manner. Our international leadership in conducting driving research has paid off not only here in Iowa, but also to many of our international colleagues who have adapted our safety recommendations.

There are several notable highlights for this year. One of the largest is getting our ADS for Rural America project off the ground, building the vehicle with AutonomouStuff, and getting on the road and collecting the vital data we need. There are so many of our talented staff to congratulate. This is truly historic to get an automated vehicle operating in rural environments with roadways that may lack painted lane markings or even pavement.

Our cannabis research continues to lead the field, as we were awarded the “Best Scientific Paper Award” at the AAAM Annual Scientific Conference. We continue to excel in human factors research, this year focusing on drowsy driving and transition of control in automated vehicles. We are pushing the boundaries of connected simulation with our partners at University of Wisconsin–Madison. And the pandemic certainly hasn’t slowed down our outreach activities, as the SAFER-SIM team continues to host webinars, internships, and more.

Finally, our students continue to thrive and continue our leadership tradition. Zach Noonan, PhD, one of our recent graduate alumni, is now at MIT under a prestigious post-doctoral fellowship.

Have a look in these pages at our many accomplishments from the past year!

Daniel V. McGehee
Director, National Advanced Driving Simulator
Associate Professor
Industrial & Systems Engineering
Emergency Medicine
Public Health
Public Policy
Left to right: NADS Director Dan McGehee, University of Iowa President Barbara Wilson, and College of Engineering Dean Harriet Nembhard.

Wilson became president of the University of Iowa in July 2021.
TOUR OUR TECH

See our new 360° virtual tour at

BIT.LY/NADS-TOUR
Our Mission
Making our roads safer by researching the connection between humans and vehicles

Our Research
We conduct research with simulators and on-road vehicles. Funded by government and industry partners, our expertise includes

- Human factors
- Distracted driving
- Drowsy driving
- Drugged driving
- Connected and automated vehicles
- Mobility
- At-risk populations (older and novice drivers)
- Simulation science
- Crash biomechanics
- Safety and crash data analysis

Our Simulators
NADS-1 simulator: One of the world’s most realistic driving simulators
NADS-2 simulator: A fixed-base simulator with high-resolution graphics
NADS miniSim™: A low-cost PC-based portable simulator available for purchase

Our On-road Vehicles
- Tesla Model S75D
- Ford Transit shuttle bus
- Lincoln MKZ
- Volvo XC90
- Toyota Camry XLE
NOW ON THE ROADS IN RURAL IOWA

A project for safer and more accessible rural roads with the use of automated driving systems (ADS)

Thanks to a $7 million grant from the U.S. Department of Transportation and officially launched in October 2021, this demonstration project uses a custom, partially-automated Ford Transit shuttle bus on rural roads.

We are now driving a 47-mile route and collecting data on automation performance, weather and surface data, and data from our riders on their trust and acceptance of the technology. In the fall of 2021, we completed the first phase of data collection. A total of 80 drives will take place over the next two years. During each phase, the automation will be enhanced to become more sophisticated and add more functionality.

Equipment

1. DSRC antenna
2. GPS antenna
3. HD cameras
4. Lidar sensors (front and rear)
5. Webcam (front and rear)
6. Mobileye collision avoidance system
7. Vaisala mobile detector: surface and weather data
8. Long range radars (front and rear)
Show how ADS can **broaden mobility** and improve quality of life, especially in areas with little to no public transportation. We are recruiting people 65 and older or people 25 and older who have a disability or visual impairment.

**Provide data** to the U.S. DOT for rule-making and the safe implementation of ADS on all our roads. Data will be publicly available at ADSforRuralAmerica.uiowa.edu starting in early 2022 and added to throughout the project.

**Improve safety** on our nation’s roadways with the integration of automated driving systems. What can and can’t automated technology handle at this point and why?

**Represent rural roadways** and their unique characteristics in ADS research, including slow moving vehicles on the road, sharp curves, varying surface types, unmarked roads, and changing weather conditions.
Data lead Steve Cable (pictured) designed and configured the user interfaces inside and outside the vehicle. Cheryl Roe (driver’s seat) is the safety lead and one of the specially-trained safety drivers.

Custom displays developed for the vehicle include interfaces for the central passenger display (pictured above), safety driver, co-pilot, passenger tablets, and remote monitor view.

Passengers use the tablets to rate their current level of anxiety at nine predefined spots along the route. They also take pre- and post-drive questionnaires and wear wrist devices that collect biometric data.
Our project partners

In addition to working closely with the U.S. DOT and Iowa DOT on this project, our primary technology partners are Hexagon | AutonomouStuff and Mandli Communications.

Hexagon | AutonomouStuff turned our Ford Transit shuttle bus into a custom automated vehicle. With their expertise, they outfitted the vehicle with a suite of hardware and software which enable autonomous operation in live traffic.

The team at NADS continues to work with AutonomouStuff through each of the project’s phases. For each phase, they enhance the automation to make it more sophisticated and add more functionality. Phase 1, for example, focused primarily on autonomous operation on divided highways. In later phases, the team will be adding functionality to allow the vehicle to drive through towns, navigate parking areas, explore unmarked gravel roads, and more, all under full automation.

About: AutonomouStuff—based in Morton, Illinois—is part of Hexagon’s Autonomy & Positioning division. Hexagon is a global leader in sensor, software, and autonomous solutions.

Webinar

Watch a Hexagon | AutonomouStuff webinar about our project (from May 2021) at bit.ly/UI-ADS-webinar.

Mandli Communications created the high-definition (HD) map of our 47-mile route. The HD map has been installed as part of the brain of our shuttle bus, which allows the vehicle to identify where it is on the road within 10 cm. It will be updated during the project as needed to reflect changes due to construction along the route.

To create an HD map, the Mandli team used a van (pictured right) that is outfitted with nine cameras, two Lidar sensors, pavement scanners (the two silver boxes), and a GPS antenna. The Lidar sensors create a real-world 3D view of the scanned area, and the pavement scanners can detail cracks in the pavement as small as 5 mm wide.

About: Based out of Madison, Wisconsin, Mandli specializes in pavement mapping for state DOTs and creating HD maps for automated vehicles, as well as other types of imaging and 3D profiling of roads and pavement, positional data, and mapping roadway lane assets.

Learn more and subscribe to our newsletter at ADSforRuralAmerica.uiowa.edu
DRIVING DROWSY
Eye-tracking software used to detect levels of drowsiness, among other measures

Drowsiness alerts: Do they work?

A recent study sponsored by the National Highway Traffic Safety Administration (NHTSA) looked at drowsiness during overnight drives of four hours in the NADS-1 simulator. The goal was to look at how drowsiness mitigation tactics—such as a coffee cup alert when the vehicle detects drowsiness in the driver— influence driver decision-making and performance over long drives and the interface design implications of these findings.

Simulation drives were held between 2 and 6 a.m., and drivers were given the option to stop and take breaks. Results are being analyzed and prepared for publication.
Drowsy driver decision-making

In a similar upcoming study, NADS researchers are looking to gain a deeper understanding of drowsy driver decision-making over longer drives and how aware drivers are of their own level of drowsiness.

This study is sponsored by the AAA Foundation for Traffic Safety, with partners from NORC at the University of Chicago.

Subjects will be required to
1. Wake up 16 hours before the study visit and stay awake all day
2. Sit for a while upon arrival to induce boredom and drowsiness
3. Drive in a simulator along an interstate loop for four hours, overnight

They will be given opportunities to stop at rest areas, get out of the simulator, eat, get caffeine, and take a nap if desired. The team is looking at the frequency and duration of breaks, head bobbing, and eye-tracking data.

Three measures will be analyzed:
1. Subjective: How much they think they were drowsy
2. Performance: Frequency of lane departures
3. Objective: Percent of time eyes were closed (based on eye-tracking software)

Data collection and analysis will be completed in early 2022.
HUMAN TO MACHINE, MACHINE TO HUMAN

NHTSA has funded a series of studies with NADS involving transition of control between automated and manual driving. Here are two of the most recent.

Transition of Control (TOC)

How does the timing and sequence of interface design influence the transition from automated to manual driving? What’s an effective interface and alert design for a safe transition? These are the questions NADS researchers aim to answer in this study’s second year.

Led by Director of Human Factors Research John Gaspar, PhD, this project is one of the first to look at driver behavior during automation in a traffic jam simulation. The system—called Traffic Jam Auto Drive (pictured)—was developed in-house and controls the vehicle during low-speed congested driving conditions. Researchers identified when the driver was able to take manual control and rated the quality of those takeovers.

“We have the perfect toolkit with the NADS-1 simulator to do this study,” says Gaspar. “Its motion base allows us to study the complete transition of control from the automated system back to the human driver, and it also allows us to rate the quality of those takeovers.”

The study has completed its first round of data collection with 120 participants. Follow-on phases will examine additional components of requests to intervene, such as modality and feedback.

Temporal Components of Warning (TCW)

What is the minimum amount of time needed to safely transition back to manual driving after being in automated driving? What happens if the transition time is too short?

For this study, first, the vehicle alerts the driver when it is safe to activate automation. While the vehicle is under automation, the driver is reading and responding to emails on a cell phone. The vehicle then alerts the driver that the automation will be ending soon, and the driver is given a short amount of time to regain situational awareness. The driver then starts driving manually again.

Design engineer Alec La Velle worked on the scenario and route development. He programmed it to give the driver a 3- to 8-second window of time to transition back to control, and if they responded correctly, their window of time got progressively shorter for each transition (down to a 3.35 second minimum).

“We already do the most complex traffic jam and construction zone simulations, but this is the first time we’ve done something adaptive based on the subject’s actions,” La Velle says. “So this was a really interesting project from a development standpoint.”
UNDERSTANDING ADAPTIVE CRUISE CONTROL

Mapping the Quality of Drivers’ Mental Models to Safety and Performance: Year 2

During the first year of this AAA Foundation for Traffic Safety–sponsored study, subjects were grouped based on the strength of their understanding of adaptive cruise control (ACC), and then their simulator driving performance was compared to their level of understanding. Researchers found that subjects with a strong understanding of ACC responded earlier when the system failed to detect an object ahead.

Now in the second year of this study, the team is tracking new owners of vehicles equipped with ACC—drivers who have never used ACC before—to explore how their understanding changes over the first six months of interacting with the technology. Questionnaires were given monthly over those six months, and then subjects drove the NADS-1 simulator. This allowed researchers to look at driving performance and determine how well it matched the subject’s mental models, or understanding, of ACC.

Results for Year 2 are being analyzed. To learn more about the results from Year 1 of this study, watch the SAFER-SIM webinar at bit.ly/3plkvdK.
DOES REGENERATIVE BRAKING HAVE SAFETY BENEFITS?

If you’ve driven an electric vehicle, you’ve likely used regenerative braking. This feature causes the vehicle to decelerate as soon as the foot is lifted off the accelerator pedal and continues to actively brake if neither pedal is depressed. This essentially turns the motor into a generator and charges the vehicle’s battery.

But is there a safety benefit to this feature? Funded by SAFER-SIM, this is the first study we know of looking at the safety implications of regenerative braking. “You basically get a head start on the braking so that the stopping distance is reduced,” explained Chris Schwarz, PhD, principal investigator.

Schwarz modeled the deceleration of the NADS’ Tesla and replicated that in the NADS-1 simulator. Graduate student Christopher R. M. Rundus designed the experiment and simulator scenario, helped run subjects, and was first author on the paper published in *Ergonomics* in 2021. Schwarz and Rundus were able to identify and quantify the deceleration advantage—measuring how far the vehicle traveled from the time the foot is lifted off the accelerator pedal to the time the brake pedal is depressed.

“In this first paper, we determined that there is a braking advantage, so now we can dive into how this affects the driver’s braking behavior, which is the goal of my next paper (in progress),” said Rundus.

Since the vehicle actively decelerates when neither pedal is depressed, they hypothesized that this would result in a difference in driver foot behavior. They did find a notable difference in foot behavior after the accelerator pedal is released until the brake is pressed. They also found drivers engaging more often in foot behavior indicating uncertainty—i.e., a greater prevalence of the foot moving back and forth, or “wagging foot.”
The same type of millimeter wave radar used on the outside of vehicles can be put inside pointed at the driver to detect occupancy, movement, respiration, and heartbeat. This technology has been used in medical applications to measure vital signs, but using it in a vehicle introduces noise from vehicle vibration and makes measurements less accurate.

Chris Schwarz and team, however, found that the NADS-1 simulator is an accurate platform to further test the technology in vehicles. When collecting heartbeat data in the simulator versus in an on-road vehicle, the results were comparable.

In an upcoming study, the radar will be tested to see if it can be used to detect or predict drowsiness, compared to using a camera.
CANNABIS AND DRIVING

Researchers identify brain markers that signify cannabis impairment, win ‘top paper’ award

In an important step toward identifying who is too impaired to drive due to cannabis use, a team of researchers from the University of Iowa and Advanced Brain Monitoring (Carlsbad, California) found there are specific markers in brain activity linked to cannabis intoxication that consistently and negatively impact driving performance.

The study, funded by the National Institutes of Health, involved collecting EEG data on subjects while they underwent a series of cognitive tasks and a simulated driving task. The researchers were able to identify those whose driving was negatively impacted due to cannabis use by looking at the EEG data.

These findings provide better understanding to how drugs impact brain activity in the context of driving impairment. The team hopes to dive deeper into the cognitive processes and better understand the root causes to changes in driving performance while under the influence of cannabis.

This fall, the paper summarizing these findings—“EEG Biomarkers Acquired During a Short, Straight-line Simulated Drive Predict Impairment from Cannabis Intoxication,” published in Traffic Injury Prevention—was awarded the “Best Scientific Paper Award” at the Association for the Advancement of Automotive Medicine’s (AAAM) Annual Scientific Conference.

“We’re honored that our colleagues in the field found so much value in our work in this area. I look forward to continuing our efforts to expand this research,” says Tim Brown, PhD, lead author and director of drugged driving research at NADS.
Might different strains of cannabis alter driving in different ways?

Another publication using this data reported that differences in perceived effects—or types of high felt from cannabis—are related to the impairing effects on driving. University of Iowa graduate student Thomas Burt is lead author on the paper published in Traffic Injury Prevention.

While the study itself used the same strain of cannabis, the perceived effects felt from that strain differed among subjects. This lends support to the notion that different types of high—which often come from different strains of cannabis—may affect driving performance in different ways. Specifically, when drivers had a perceived effect that produced more stimulation, there was less impact on driving, while a more stoned or high feeling produced a greater negative effect on driving.

Cannabis users in Iowa

Advanced Brain Monitoring will be using data collected at NADS in the development of an app and mobile EEG system to detect levels of impairment due to cannabis use in drivers. Data collection involved testing subjects in their reactions to stimuli; physiologic responses such as blood pressure, heart rate, and where the eyes were focused; and reaction times while braking or accelerating.

The project also involved a survey of 842 Iowa respondents, the results of which allowed the team to create a profile of what a cannabis user in Iowa looks like as it relates to driving. Overall, more frequent users were more likely to drive within two hours of cannabis use. If they planned to drive, only 10% of the most frequent users reported not using cannabis compared to almost 53% of the least frequent users. Similarly, the proportion who drove following the use of both cannabis and alcohol also increased with frequency of cannabis use.

While the majority reported that cannabis use did not affect their driving regardless of frequency of use, those who had used at least 21 of the last 30 days were most likely to report no difference in their driving.

Nursing student Tannah Tedesco prepares to draw blood to determine the level of THC in a subject's system.

About 500 mg (one dose) of ground cannabis, with a Volcano device used to fill an inhalation balloon.
DRUG USE IN CRASHES HIGHER DURING COVID-19 PANDEMIC

With the exception of alcohol, relatively little is known about drugged driving prevalence and the relationship of drugs to crash risk. Dunlap and Associates, Inc., selected the University of Iowa as one of the data collection sites to examine the prevalence of alcohol and drugs from several categories, which includes over-the-counter, prescription, and illicit drugs, in motor vehicle crashes.

The data from this project will lead to a better understanding of the prevalence of drug use among injured drivers and other highway system users (e.g., pedestrians, bicyclists, motorcycle riders). Sponsored by NHTSA, the project is collecting data from a large sample of seriously- and fatally-injured drivers and victims of other traumas who report to an emergency room.

After an initial phase of the project (prior to the University of Iowa getting involved), NHTSA reported: “Drivers in particular showed significantly higher overall drug prevalence during the pandemic, with 64.7% testing positive for at least one active drug, compared to 50.8% before. [...] The observed cannabis and opioid prevalence rates before and during the public health emergency could be indicative of a growing problem.” More recent data is now under analysis.

To gather this data, NADS researchers Tim Brown, PhD, and Michelle Reyes collaborated with partners at University of Iowa Hospitals & Clinics. The NADS team was able to link about 300 individuals treated in the Emergency Department for motor vehicle crash injuries to data from police-reported crashes. The NADS team extracted the data specified by Dunlap, verified its accuracy, and entered it into an online data portal. In addition, they worked with the Iowa DOT to obtain the crash diagrams and created crash reports without personally identifiable information.
We work with students in all phases of their college careers. A few of our graduate students are highlighted here.

**Thomas Burt**

*Research interest: modeling impaired driving performance*

Thomas’s first publication was a literature review to identify gaps in research, understand the implications for modeling driving performance, and describe future research needs. The results from his second paper are summarized on page 19.

**Joy (Jimin) Kim**

*Research interest: transfer of learning*

As the technology in a vehicle develops, the safety concern about it is increasing as well. When the driver changes their car or when the system is updated, safety issues arise because of the knowledge gap between the old and new systems. By researching the transfer of training, Joy expects to mitigate drivers’ confusion and use the systems safely.

**Christopher R. M. Rundus**

*Research interest: electric vehicles and regenerative braking*

Christopher’s dissertation focuses on regenerative braking, how human drivers interact with the new braking system, and how to leverage regenerative braking to provide a braking advantage. His first two papers are summarized on page 16. His current research is focusing on making regenerative braking dynamic, so the kinematic deceleration advantage can adjust based on the environment in front of the user vehicle.

**Emily Shull**

*Research interest: transition of control in automated vehicles*

Emily’s primary interest is understanding how we can effectively facilitate the transition of control from partial automation back to the driver. This includes identifying the minimum amount of time needed for the driver to safely take control, maintaining the driver’s situational awareness both before and during the transition of control, and finally, aiding the driver’s attentional shift back to the roadway.
Students Build Minisims, Gain Experience

Ben Berhow and Wil Comer—two seniors majoring in mechanical engineering at the University of Iowa—both landed part-time jobs with the miniSim team at the National Advanced Driving Simulator this past year, giving them valuable on-the-job experience.

They assemble new miniSims and upgrade existing ones, following the customer’s specifications and under the supervision of miniSim Director Andrew Veit. They order the necessary parts and have become adept both at designing new in-house solutions, such as designing a new steering loader, and at adapting existing products to fit their needs.

For example, the steering wheels that the team were previously using are no longer manufactured, and the new model didn’t have the inputs needed. They collaborated with Veit and the miniSim software developers to come up with a solution.

“That project was a perfect example of how fortunate we are to work on a smaller team,” said Comer. “We can freely share our ideas and progress and work alongside professionals to problem-solve, which has definitely strengthened my communication skills in a professional setting.”

He pointed out that some of their classmates are on teams of 50 or more interns at larger companies who don’t get the same attention and development that Comer and Berhow get at NADS.

While working on a miniSim, they follow documentation instructions in existing manuals, while also looking for ways to improve the manuals as they go. “I’ve really learned to be adaptable and roll with the punches,” said Berhow. “You go into a project thinking you’ll be able to follow the manual, but you often need to problem solve and figure out new solutions as you go.”

What’s next for the two? After graduation, Comer will be looking for a research and development job with a focus on design and materials, while Berhow will attend graduate school at the University of Iowa in mechanical engineering.

“Working under Andy [Veit] has been phenomenal,” added Berhow. “He really takes the time to teach, so it’s been an amazing learning opportunity.”
MINISIM YEAR IN REVIEW

The past year for the miniSim team involved completing a number of behind-the-scenes projects such as migrating to a new software development environment (newer version of Visual Studio), bug fixes, updates to the steering wheels, and beginning design of a new steering loader.

80+

MINISIMS IN USE WORLDWIDE

FY21 MINISIM PARTNERS

- Leidos, Inc.
- Hyundai
- U.S. Department of Homeland Security
- Acclaro Research Solutions, Inc.
- Booz Allen Hamilton, Inc.
- American University of Sharjah
- Georgia Institute of Technology
- A.T. Still University of Health Sciences
- Cognitive Research Corporation
- Michigan Technological University

Customize a new or upgrade your existing miniSim at:

→ NADS-SC.UIOWA.EDU/MINISIM
EVALUATION OF NOVICE DRIVER TRAINING PROGRAMS

Michelle Reyes, senior research associate, and Elizabeth O’Neal, PhD, postdoctoral research scholar, recently wrapped up a project with SAFER-SIM and the AAA Foundation for Traffic Safety that evaluated the PALM and ACCEL novice driver training programs and their effectiveness in improving hazard anticipation skills.

The NADS-2 driving simulator was used to assess novice teen drivers’ glances and driving performance in response to potential hazards. Subjects were ages 15 and 16 and began the study within two weeks of obtaining a license allowing them to drive independently. Subjects completed three hazard-laden study drives over a six-month period.

Results

Analyses of a subset of the hazards encountered during the drive did not yield strong results.

However, when accessing the highest level of situational awareness (SA) for a parallel parked car preparing to pull out into the driving lane, both PALM and ACCEL training programs were associated with higher SA relative to controls six weeks after training (Visit 2 as shown in the graph below). But all conditions achieved similar levels of SA at Visit 3 about six months after training.

Webinar

Learn more about these findings from a recorded SAFER-SIM webinar at bit.ly/novice-drivers-webinar.
In a multi-year project nearing completion, SaferTrek GPS/video data devices—shown above—were installed on Iowa farm equipment that collected data and recorded vehicles as they approached, followed, and began to pass farm equipment. Data were collected for three fall harvest seasons and one spring/summer season.

The project’s aims were 1) to measure farm equipment exposure to the roadway (e.g., miles traveled, location) and frequency with which cars approached the equipment, and 2) to identify behavior of vehicle drivers as they approached farm equipment from behind. Behaviors examined included speed, deceleration while approaching, following distance, number of passing attempts, and passing.

The four data collections—which comprised more than 3,100 farm vehicle days—yielded more than 2,000 video recordings of vehicle interactions and an estimated 13,500 candidate trips where the farm equipment was traveling more than 8 mph. Processing of the trip data and vehicle recordings are in progress.

Other related projects in final review

- Development of a crash data dictionary to better understand what really happened during a crash. What do the coded numbers from crash reports really mean?
- What are the impacts of road conversions from four- to three-lane street configurations on businesses and emergency response in Iowa communities?
NEW FEATURES IN OUR VIRTUAL WORLDS

Our staff members are constantly developing new features and adding more options to our virtual environments for various clients. Here are a few highlights from the past year.

**University of Central Florida**

Engineering Coordinator Shawn Allen created three new multi-lane urban intersection tiles for the University of Central Florida. Each tile contains a complex traffic pattern with multiple roadway elements consistent with the complexity of a highway interchange. Included with this project are new lane context navigation and additional new roadway signs.

**Leidos**

In a project with Leidos, Allen created new scenarios to support the driver cutting into a platoon between trucks that were driving under automation, and then restoring the platoon condition when the driver exited the formation. The project included new three-lane tiles (a diamond interchange and two straights), new signage, and also used audio navigation cues.
University of Kansas

In one of the largest tiles NADS has developed, Allen built a new environment with 18 merge events, 88 road paths, and 36 unique four-way intersections. Programs were created to support this project, as each intersection could not be copied but had to be unique. Each intersection is signal-controlled with dedicated left-turn and protected right-turn lanes. A scenario was also developed to test merge events following turns to the right.

NADS for TCW project

A new interchange, hill, curve, and straights were developed to support this project, including large filler tiles with structures for urban/developed area use. Read a summary of this NHTSA-sponsored project on page 14.
Safety Research Using Simulation (SAFER-SIM) is a grant-funded Tier 1 University Transportation Center that shares its researchers’ expertise with both students and seasoned researchers alike.

Led by the University of Iowa, SAFER-SIM is comprised of a multidisciplinary team of researchers across four additional consortium sites: University of Massachusetts–Amherst, University of Central Florida, University of Wisconsin–Madison, and University of Puerto Rico–Mayagüez.

SAFER-SIM webinar spotlight

“Interfacing Synchrono and NADS for Virtual Simulation of Conventional, Connected, and Autonomous Vehicles”

This project, funded by SAFER-SIM, enabled the NADS-1 simulator in Iowa to interface in the same virtual environment with a Chrono simulation running at the University of Wisconsin–Madison. This setup allows for the study of human-driven vehicles interacting with automated vehicles, convoys of automated vehicles, and could be used for more complex traffic scenarios in the future.

These two vehicles are controlled by two different human drivers: one in Iowa and one in Wisconsin.
Scouting badges

SAFER-SIM and NADS have created a resource that gives Scouts across the country the chance to earn the following merit badges online. Scouts can watch the videos on our YouTube channel, which guide them through the process.

Visit bit.ly/SAFER-SIM-badges to learn more.

Traffic Safety Merit Badge

Gives Scouts crucial tools to stay safer in traffic when driving a car on a highway, riding a bike across town, or jogging across a busy street.

Engineering Merit Badge

Gives Scouts a better understanding of how engineers work and how to apply the engineering process to daily problems.

181 SCOUTS COMPLETED
13,600 YOUTUBE VIEWS

91 SCOUTS COMPLETED
5,300 YOUTUBE VIEWS

‘DRIVING SCIENCE’ FREE STEM PROGRAM

We are partnering with Iowa junior highs, high schools, and other educational groups to give custom, complementary lessons around applied math and science related to driving and teach them about driving research, automated vehicles, and more. For example:

Time to collision (TTC) = (-distance between two vehicles) / (lead car velocity − follow car velocity)

TTC = (-800) / (20 − 100) = 10 seconds to collision

To learn more, email nads-contacts@uiowa.edu.

181
13,600
91
5,300

SCOUTS COMPLETED
YOUTUBE VIEWS
SCOUTS COMPLETED
YOUTUBE VIEWS
Three local high school students participated in an internship at NADS this past summer, during which they created a robotic vehicle platform that demonstrates automated vehicle (AV) concepts. The aim of the project was to recreate the AV testing paradigm in miniature using both a physical vehicle as well as a simulation environment. The students were able to make progress on both fronts and would like to continue to work on the project in their spare time.

With a vehicle and simulation, they used AI deep learning concepts to train the vehicle to drive on a road in simulation, then transferred the control over to the real car. A future extension to the car could be to add a trailer and train it to back up—a problem common to heavy tractortrailers.

“Workplace Learning Connection offers high school students amazing opportunities to explore their career interests,” said Chris Schwarz, PhD, director of engineering and modeling research. “These interns were bright, enthusiastic, and eager to dive into this project.”
Other outreach

Summer 2021 marked a gradual return to in-person events for both SAFER-SIM and NADS outreach activities.

- Johnson County Fair, July 2021
- University of Iowa Homecoming Parade, October 2021
- TrekFest in Riverside, Iowa (the future birthplace of Captain James T. Kirk), June 2021
Another successful International Driving Assessment conference was held in June 2021 as a virtual event—with two engaging keynote speakers, some networking time on a unique video-game-like virtual platform called Gather, and a Honda student session with 15 talented student presenters.

A competition was included in the student session with cash prizes awarded to three top student poster presenters. Congratulations to the three winners, listed below.

Winning abstract:
- Linda Pipkorn, Chalmers University of Technology, “Driver visual attention before and after take-over requests in conditional automation: a public road study”

Runners-up:
- Erika Ziraldo, University of Guelph, “Vehicle Control and Driver Workload During Simulated Driving: Can Cue Substitution Compensate for Lower Simulator Feature Fidelity?”
- Katelyn Schwieters, University of Minnesota, “Exploring Gender Differences in the Perception of Levels of Automation and Comfort with Autonomous Vehicles”

Keynote speakers:
- Trent Victor, PhD, director of safety research and best practices at Waymo, who presented: “Safety Assessment of the Waymo Driver”
- Marieke Martens, PhD, MSc, Eindhoven University of Technology, who presented: “Automated vehicles and road safety: So what about ethics?”

Our next Driving Assessment Conference is yet to be determined. Find updates at drivingassessment.uiowa.edu or email NADS-DA21@uiowa.edu.
NADS launches new website

Check out our new website, launched in early 2021.

Find more information on our latest research, tech resources, our people, outreach, and more.

→ NADS.UIOWA.EDU

FOLLOW US

Facebook @NationalAdvancedDrivingSimulator
Twitter @DrivingSim

Or email:
Email nads-contacts@uiowa.edu
OUR PARTNERS

NADS Advisory Board members

Linda Angell  
President and Principal Scientist  
Touchstone Evaluations, Inc.

Stacy Balk  
U.S. Department of Transportation  
National Highway Traffic Safety Administration (NHTSA)

Tom Banta  
Vice President, Director Strategic Growth  
Iowa City Area Development Group

Pujitha Gunaratne  
Senior Executive Engineer  
Toyota Collaborative Safety Research Center

Terry Johnson  
Chief Financial Officer and Treasurer  
University of Iowa

Gary Kay  
President  
Cognitive Research Corporation

Scott Marler  
Director  
Iowa Department of Transportation

Brian Philips  
Senior Research Psychologist  
NHTSA, Turner-Fairbank Highway Research Center

Ann Ricketts  
Associate Vice President for Research  
University of Iowa

Trent Victor  
Director of Safety  
Waymo

C.Y. David Yang  
Executive Director  
AAA Foundation for Traffic Safety

University of Iowa faculty partners

Ned Bowden  
College of Liberal Arts and Sciences  
Chemistry

Venanzio Cichella  
College of Engineering  
Mechanical Engineering

Alejandro Comellas Freymond  
Carver College of Medicine  
Internal Medicine – Pulmonary, Critical Care, and Occupational Medicine

Soura Dasgupta  
College of Engineering  
Electrical and Computer Engineering

Jeffrey Dawson  
College of Public Health  
Biostatistics

Gary Gaffney  
Carver College of Medicine  
Psychiatry

Amanda Haes  
College of Liberal Arts and Sciences  
Chemistry

Cara Hamann  
College of Public Health  
Epidemiology  
Injury Prevention Research Center

Loreen Herwaldt  
Carver College of Medicine  
Internal Medicine – Infectious Diseases

Karim Hoth  
Carver College of Medicine  
Psychiatry

Joseph Kearney  
College of Liberal Arts and Sciences  
Computer Science  
Hank Virtual Environments Laboratory

Gary Milavetz  
College of Pharmacy  
Pharmacy Practice and Science

Nicholas Mohr  
Carver College of Medicine  
Emergency Medicine

Corinne Peek-Asa  
College of Public Health  
Occupational and Environmental Health Injury Prevention Research Center

Jodie Plumert  
Carver College of Medicine  
Psychological and Brain Sciences  
Hank Virtual Environments Laboratory

Kyle Rector  
College of Liberal Arts and Sciences  
Computer Science

Thomas Schnell  
College of Engineering  
Industrial and Systems Engineering  
Operator Performance Laboratory

Gregory H. Shill  
College of Law  
Corporate Governance and Control

Ergun Uc  
Carver College of Medicine  
Neurology

Shaun Vecera  
College of Liberal Arts and Sciences  
Psychological and Brain Sciences

Chao Wang  
College of Engineering  
Industrial and Systems Engineering

Mark Wilkinson  
Carver College of Medicine  
Ophthalmology

Xun Zhou  
Tippie College of Business  
Management Science
External faculty partners

Oregon State University
David Hurwitz

University of Central Florida
Mohamed Abdel-Aty
Naveen Eluru
Zhaomiao (Walter) Guo
Samiul Hasan
Amr Oloufa
Omer Tatari
Yina Wu
Lishengsa Yue
Mohamed Zaki

University of Colorado Anschutz Medical Campus
Ashley Brooks-Russell
Michael Kosnett

University of Leeds
Natasha Merat
Richard Romano

University of Massachusetts–Amherst
Chengbo Ai
Eleni Christofa
Cole Fitzpatrick
Michael Knodler
Anuj Pradhan
Shannon Roberts

University of Puerto Rico–Mayagüez
Carla López
Alberto M. Figueroa Medina
Benjamin Colucci-Rios
Didier Valdés

University of Washington
Linda Ng Boyle

University of Wisconsin–Madison
Madhav Chitturi
John D. Lee
Dan Negrut
David Noyce
Jon Riehl
Kelvin R. Santiago
Radu Serban

Volpe National Transportation Systems Center
Donald Fisher

Xavier University
Ryan Miller

Yale University
Barbara Banz
Federico Vaca

Additional external partners and sponsors

AAA Foundation for Traffic Safety
Acclaro Research Solutions, Inc.
Advanced Brain Monitoring
Aisin Technical Center of America, Inc.
American University of Sharjah
A.T. Still University of Health Sciences
Battelle Memorial Institute
Booz Allen Hamilton, Inc.
Charles River Associates
Cognitive Research Corporation
Colorado Department of Public Health and Environment
Colorado State University
Dunlap and Associates, Inc.
Exponent
Federal Law Enforcement Training Centers
Federal Transit Administration
Federal Highway Administration
General Motors Corporation
Georgia Institute of Technology
Governor’s Traffic Safety Bureau
Hexagon | AutonomouStuff
Hyundai America Technical Center, Inc.
Iowa City Area Development Group
Iowa Department of Transportation
Iowa Governor’s Traffic Safety Bureau
Iowa State University
Leidos, Inc.
Lenstec, Inc.
Loyola Marymount University
Mandli Communications
Massachusetts Department of Transportation
Massachusetts Institute of Technology
MetroPlan Orlando
Michigan Technological University
National Highway Traffic Safety Administration
National Institute on Drug Abuse
Oakland University
Office of the Assistant Secretary for Research and Technology
Purdue University
State Farm
Swinburne University of Technology
Tongji University
toXcel
Toyota Collaborative Safety Research Center
University of Kansas
University of New Hampshire
University of Windsor
U.S. Department of Transportation
U.S. Department of Homeland Security
Veterans Affairs
Volpe National Transportation Systems Center
Wisconsin Department of Transportation
Westat
The University of Iowa prohibits discrimination in employment, educational programs, and activities on the basis of race, creed, color, religion, national origin, age, sex, pregnancy, disability, genetic information, status as a U.S. veteran, service in the U.S. military, sexual orientation, gender identity, associational preferences, or any other classification that deprives the person of consideration as an individual. The university also affirms its commitment to providing equal opportunities and equal access to university facilities. For additional information on nondiscrimination policies, contact the Director, Office of Institutional Equity, the University of Iowa, 202 Jessup Hall, Iowa City, IA 52242-1316, 319-335-0705, oie-ui@uiowa.edu.