

# Catalyst

  
CENTER FOR  
TRANSPORTATION STUDIES  
UNIVERSITY OF MINNESOTA

June 2022

## Bending the curve: Addressing the troubling trends in Minnesota traffic fatalities

Over the last 20 years, Minnesota has made significant progress in reducing traffic fatalities. Progress has stalled, however, and fatalities are now increasing year-over-year—especially since the beginning of the pandemic. On May 9, the CTS Councils convened a panel of transportation experts to frame the challenges behind the numbers and discuss what the solutions could be.



Photo: Adobe Stock

## Distance-based user fees show promise for use in shared mobility fleets

Vehicles that use little to no gasoline are becoming more common, making it harder to rely on the fuel tax for transportation funding. One way to backfill this lost revenue is a distance-based user fee, but concerns about data privacy and other issues are slowing its adoption. MnDOT recently conducted a demonstration to see how the approach could work for shared mobility fleet operators. As part of the project, U researchers evaluated the demonstration and looked at implications for privacy and equity.



Photo: Adobe Stock

## Improved tool to help MnDOT make freeway travel time more reliable

Reliable, consistent freeway travel times are crucial to the quality of life and economic health in busy metro areas such as the Twin Cities. For traffic managers to achieve travel time reliability, information is essential. An innovative tool



developed by University of Minnesota Duluth researchers is providing new insights—helping MnDOT traffic managers effectively and efficiently manage traffic congestion and incidents.



Photo: Shutterstock

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## Leaders, students recognized at CTS awards ceremony

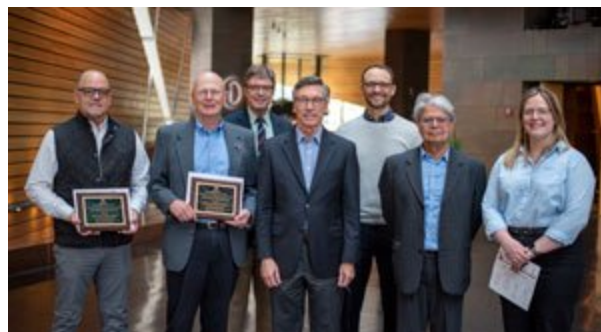
CTS presented awards to distinguished leaders and students during our Annual Meeting and Awards Luncheon on May 9. Congratulations to this year's recipients!



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## Distance-based user fee project receives Research Partnership Award

A pilot demonstration of distance-based user fees in shared mobility fleets received this year's Robert C. Johns Research Partnership Award. The team included representatives from the University, MnDOT, and HOURCAR and Zipcar.



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## A \$10 plasma igniter produces zero emissions and doubles fuel economy

An experimental energy researcher at the U of M has developed an inexpensive low-temperature plasma igniter that can replace conventional spark plugs. While traditional spark plugs produce a high-temperature spark, a low-temperature plasma igniter deposits a smaller and more precise amount of energy for ignition. Moreover, plasma igniters can immediately be dropped into the existing engines. This roughly \$10 addition to an engine could lead to hundreds of dollars in fuel savings while potentially producing zero emissions and leaving no carbon footprint.

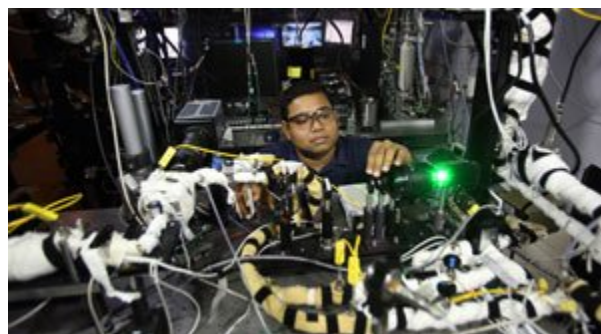


Photo: Dino Vournas/Sandia National Labs

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The Minnesota Department of Public Safety reports around 2,000 deer-vehicle collisions across the state annually. But State Farm Insurance, which gathers its own data based on insurance claims filed, estimates the number of animal-driver collisions at over 40,000 in Minnesota last year, most of which involve deer. With funding from MnDOT, a wildlife biologist at the University of Minnesota Duluth is taking part in a pilot study to better understand where deer-vehicle collisions happen, document their frequency, and develop recommendations to reduce these incidents.



Photo: June Breneman

## Save the date: 2022 CTS Transportation Research Conference

Join us for a day of discovery and innovation at this year's Transportation Research Conference, scheduled for November 3, 2022, at the Graduate Minneapolis Hotel. The annual event will convene researchers and practitioners to explore the latest innovations in transportation research, implementation efforts, and engagement activities.



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*UMD News*, June 24, 2022
- [What would a gas tax holiday mean for Minnesotans?](#)  
*MinnPost*, June 22, 2022

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## Bending the curve: Addressing the troubling trends in Minnesota traffic fatalities

June 14, 2022



Over the last 20 years, Minnesota has made significant progress in reducing traffic fatalities. Progress has stalled, however, and fatalities are now increasing year-over-year—especially since the beginning of the pandemic. On May 9, the [CTS Councils](#) convened a panel of transportation experts to frame the challenges behind the numbers and discuss what the solutions could be.



Photo: Adobe Stock

### Traffic gone wild

“Mayhem in Minnesota—Traffic Gone Wild” was the unflinching title of keynote speaker Mark Kinde’s talk. Kinde, manager of the Injury and Violence Prevention Section of the Minnesota Department of Health, traced the history of Minnesota’s Toward Zero Deaths program. Before its launch, “We were killing, on average, between 600 and 650 people a year on Minnesota’s roads,” he said. Through collective action, Minnesota’s death rates fell significantly—down to 361 fatalities in 2014.

“Then we get to 2020, and things went bad,” Kinde continued. The first few months of the pandemic brought a steep rise in remote work and plummeting traffic volumes, “but soon we were seeing that something’s not right,” he said. “Our overall crashes were down, but severe injuries and deaths were already in 2020 starting to escalate.”

Preliminary fatalities for 2021 now stand at 488, a 26 percent increase over 2020 (the highest one-year percentage increase since 1943–1944) and a 37 percent increase over 2019. Speed was a factor in one third of fatal crashes in 2021; citations for people speeding at 100 miles per hour or more were three times higher in 2021 than in 2018.

Over these two years, Kinde said, there was much less appetite and support for citations. “When you take off checks and balances in operating together in society...people are inclined to do what they want. People are born selfish by nature,” he said. “When we want what we want, when we want it, and we start using an engine that can go 100 mph...it’s a prescription for problems.”

Minnesota’s **488 traffic deaths** in 2021 marked a **26% increase** over 2020 and a **37% increase** over 2019.

Captain Matt Markham of the Columbia Heights Police Department expanded on the challenges for law enforcement. When the pandemic began, departments tried to maintain baseline service by mitigating COVID exposure. This led to a reduction in traffic enforcement—and without enforcement, “you’re going to see people violate the law,” he said. “Then we started to see those high-flyers—those people driving over 100 miles an hour.”

The killing of George Floyd and the related civil unrest compounded the challenges. “This incident diminished trust and legitimacy within the community,” Markham said. “Law enforcement can’t do their job without the cooperation of the public.” Many officers took early retirement and others didn’t feel comfortable making traffic stops. Faced with staffing shortages, he said, officers become reactive instead of proactive.

One example of the impacts: In both 2018 and 2019, 8 drivers fled from Columbia Heights police in a motor vehicle. That number rose to 24 in 2020 and 32 in 2021, Markham said.

## **Solutions: Infrastructure, safe systems, and technology**

Three speakers offered ideas for countering these troubling trends. Will Stein, safety engineer with the Federal Highway Administration’s Minnesota Division, said significant new investment in the federal Bipartisan Infrastructure Law could be leveraged to address safety. Funding in the Highway Safety Improvement Program alone will increase 34 percent.

“That’ll help us get some more good infrastructure projects out on Minnesota roads,” he said.

Brian Sorenson, director of MnDOT’s Office of Traffic Engineering, discussed growing interest worldwide in the Safe System approach. This holistic approach works by building and reinforcing multiple layers of protection—including safe roads, safe speeds, and post-crash care—to prevent crashes from happening and minimize harm when they do occur. A critical principle is redundancy. Humans inevitably make mistakes, he said, but the layers of protection—“like overlapping layers of Swiss cheese”—can reduce the chance of a fatality or serious injury crash finding its way through the holes.



Graphic: FHWA ([click here to enlarge](#))

Sorenson also emphasized the role of public acceptance and politics in traffic safety. “It is staggering to me that in our country, 40,000 deaths on our system [are] just accepted,” he declared. “A lot of times we know what the solutions are, and we have a hard time getting them implemented because the public’s not on board.”

Safe vehicles—another element of Safe Systems—are much less difficult and costly to upgrade than roadways, said Nichole Morris, director of the HumanFIRST Laboratory in the U’s Department of Mechanical Engineering. The vehicle fleet turns over about every 12 years, making safety improvements possible much faster.

“Speed limiters are a technology we have capability for today,” Morris said. “Your car can know what the speed limit of the roadway is, and there’s absolutely no reason why your car should assist you in breaking the law.” Speed limiters could also address the exponential growth in police pursuits in Minnesota and nationwide, she added.

HumanFIRST researchers are studying how to boost public acceptance of speed limiters. “If the public demanded it, original equipment manufacturers could flip a switch tomorrow and start to roll out this technology,” Morris said. Automated warnings—similar to today’s seatbelt alerts—could be an alternative.

Morris also criticized the limited rollout of automated emergency braking systems. Vehicle manufacturers had committed to making these systems widespread by 2022, but only

about 60 percent offer them—mainly on more expensive models. “We could have shrunk our fatal crash rates by 30 percent if we would have gotten automated emergency braking standard,” she said. “We’ve got a huge equity issue—you have to have the means to buy safety.”

As vehicle automation becomes more common, control of most lateral and longitudinal movements will shift to the vehicle. This could prompt questions about manufacturers’ responsibility for reckless driving, she said.

Reinforcing previous speakers, Morris called for a multidisciplinary approach encompassing engineering, education, and enforcement. “You have a very weak lever when you try to pull on any one of these things in isolation.”

The webinar was sponsored by the four CTS Research Councils and the CTS Education and Engagement Council.

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## Distance-based user fees show promise for use in shared mobility fleets

June 7, 2022



Dependence on the motor fuel tax as a revenue source will become increasingly difficult for transportation agencies in the coming years, as the number of vehicles on the road that use little to no gasoline—including electric vehicles—is expected to grow quickly.



Photo: Adobe Stock

To continue providing a strong transportation system, transportation agencies will need new financing tools to supplement shrinking revenue. A logical way to backfill this lost revenue is a distance-based user fee (DBUF)—a fee calculated based on distance driven rather than fuel burned.

The Minnesota Department of Transportation (MnDOT) recently partnered with shared mobility\* fleet operators to conduct a demonstration of distance-based user fees. During the 12-month demonstration, MnDOT used existing technologies embedded within these vehicles to automatically calculate the distance-based fees. The factory-installed “telematics” capabilities enabled reporting of the distance traveled and the time the travel occurred, the core data needed for distance-based fee calculations.

As part of the project, researchers at the Humphrey School of Public Affairs evaluated the demonstration based on its feasibility,

"Vehicles that don't use gasoline still contribute to the deterioration

efficiency, adequacy, and equity. Work included policy research, financial analysis, and outreach and education efforts. Specifically, the team looked at the implications of distance-based user fees on privacy, equity, and administration costs—all of which are often raised as obstacles to distance-based fees.

The evaluation found that the shared-mobility approach has several important advantages:

- **Privacy is possible:** Privacy concerns were essentially nonexistent; personal data was collected in ways that customers consented to when they enrolled, and the only data reported to state tax collectors was aggregate distance traveled by the overall fleet.
- **Hassle-free for drivers:** With this method, drivers do not have to buy or install new equipment or report distance traveled to tax collectors. In fact, they don't have to do anything differently.
- **System security:** Using the shared-vehicle approach, it is much more difficult for typical users to avoid fees by altering embedded telematics equipment. This is essential to system integrity and revenue collection.
- **Streamlined collection:** A fleet focus allows the government to collect from a relative handful of fleet operators who already have the imbedded telematics needed for data collection, not from millions of individual vehicle owners.

While this project looked at shared-mobility fleets, many other types of fleets could use this approach, says Frank Douma, the principal investigator of the research component. These include government vehicles, ride-sharing companies, food-delivery services, package delivery companies, and freight haulers.

The research team included Douma, Jerry Zhao, Camila Fonseca, Raihana Zeerak, Adeel Lari, Lee Munnich, and Meredith Benesh of the Humphrey School and Joe Loveland of Loveland Communications.

of roads and bridges. Distance-based user fees can be applied to any type of vehicle regardless of its fuel source and maintain the foundational “user-pays” principle of road financing.”

— *Minnesota User Based Fee Demonstration (CTS, Dec. 2021)*



Photo: Adobe Stock

The research was made possible through a federal Surface Transportation System Funding Alternatives grant to MnDOT. The work itself was funded in equal parts by the federal grant and matching funds from MnDOT.

The project received the 2022 Robert C. Johns Research Partnership Award ([see related article](#)).

**\*Shared Mobility Vehicles:** *The team's definition includes carpooling and vanpooling, ride-sourcing services provided by transportation network companies such as Uber and Lyft, and carsharing services that provide their customers either one-way trips or two-way trips (e.g., Zipcar and HOURCAR). With shared mobility services, customers essentially rent the use of vehicles for a relatively short amount of time—perhaps for a few hours.*

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## Improved tool to help MnDOT make freeway travel time more reliable

June 27, 2022



Reliable, consistent freeway travel times are crucial to the quality of life and economic health in busy metro areas such as the Twin Cities. For Twin Cities traffic managers to achieve travel time reliability, information is essential:

- Where, when, and why is congestion happening?
- Is congestion improving or worsening?
- What effect will heavy rain or snow have on traffic?
- How will a work zone or a major sporting event affect congestion?
- What impact did the pandemic have on freeway congestion?



Photo: Shutterstock

An innovative tool developed by University of Minnesota Duluth (UMD) researchers is providing new insights into questions like these—helping Minnesota Department of Transportation (MnDOT) traffic managers effectively and efficiently manage traffic congestion and incidents. Additionally, the tool supports the agency in identifying and prioritizing future freeway improvement projects.

“The system we developed can very efficiently calculate travel-time reliability for any given corridor,” says Eil Kwon, a professor with the UMD Department of Civil Engineering and the

project's principal investigator.

This project's aim was expanding an earlier version of the Travel-Time Reliability Estimation System (TeTRES). The goal was to broaden its usefulness and create a comprehensive system for MnDOT traffic managers and planners to use for assessing the reliability and traffic flow performance of freeway corridors. The original TeTRES (developed in a previous MnDOT-funded project) integrated data from multiple sources to estimate reliability measures for specific corridors under various operating conditions.

With TeTRES as a starting point, investigators added a new module to calculate how well traffic is flowing at a given time (traffic flow effectiveness). Next, they added historical traffic flow, weather, work zone, and special event data to the TeTRES database; this allowed them to calculate historical travel times on more than 100 routes at five-minute intervals and link them to conditions such as weather or incidents. Researchers also analyzed travel-time reliability trends for numerous routes and created a new measure called the vulnerability index, which indicates the combined level of reliability and congestion.

Finally, investigators explored a method to quantify the ability of a corridor to adapt and recover from congestion-causing disturbances—a measure known as operational resilience. They tested their model on three freeway segments and were able to identify a clear relationship between operational resilience and geometric factors such as the number of weaving sections (where merging and exiting lanes intersect) and the number of entrance and exit ramps on a given corridor.

The project produced a new software system that efficiently calculates travel-time reliability and analyzes key operational measures for any corridor in the Twin Cities metro area. It can also be used for applications such as identifying and prioritizing bottlenecks.

"These tools will help us identify not only the most problematic corridors for traffic congestion in the metro area, but the factors causing the problems," says Brian Kary, director of MnDOT's Regional Transportation Management Center. "The data will be invaluable for our business and planning processes."

MnDOT has already begun using the data produced from this study in planning future projects. The agency will also develop staff expertise and process protocols to make the software more easily available to traffic planners and managers.

*Writer: Megan Tsai*

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## Leaders, students recognized at CTS awards ceremony

June 2, 2022



CTS presented the following awards during our Annual Meeting and Awards Luncheon in May. Congratulations to this year's recipients!

### Richard P. Braun Distinguished Service Award

This award, which recognizes outstanding leadership in research and innovation, was presented to Laurie McGinnis, director of CTS from 2010 to 2021.

McGinnis led the Center in identifying program opportunities, securing funding, directing programs, and establishing future directions in transportation research, education, and outreach with the involvement of faculty and research staff from 33 departments.



Laurie McGinnis

McGinnis's longtime colleague and MnDOT assistant commissioner Tim Henkel shared a few words about her role as a research champion and innovator: "While examples are many, one of Laurie's most important and recent contributions is the Accessibility Observatory. All travel is driven by the need to reach a destination. How well individuals are able to meet that goal depends on how fast they can travel, where they are, and the location of their destination."

Henkel noted, "Innovators listen and take action. Laurie did just that by bringing together expertise from across the country to establish the Accessibility Observatory, which works to change the way we understand end-to-end transportation."

## Distinguished Public Leadership Award

Margaret Anderson Kelliher, director of the Minneapolis Department of Public Works, received this award, which recognizes public leaders who have influenced innovative transportation policy directions.

Kelliher previously served as MnDOT commissioner, where she oversaw investments to build safer roads and bridges and improve mobility for people walking and biking statewide. She is also a former member of the Minnesota House of Representatives and served as Speaker from 2007 to 2011.



*Margaret  
Anderson Kelliher*

Colleague, friend, constituent, and former MnDOT Commissioner Charles Zelle shared: “Margaret’s quick grasp of technical details—along with a nuanced understanding of competing interests—gives her the distinct ability to manage challenging situations to positive results. From orchestrating the legislative veto override that saved Minnesota transportation to leading MnDOT during COVID and increased infrastructure investment, we have much to appreciate.”

## Ray L. Lappegaard Distinguished Service Award

This award, which honors outstanding leadership, mentorship, and support for the transportation profession, was presented to Dave Montebello, SRF Consulting Group’s board chairman.

Montebello also worked for MnDOT and Wright County during his 43-year career. He has developed transportation policy and performance-based plans for MnDOT, the Met Council, and many local governments.



*Dave Montebello*

“Dave is an outstanding professional who has brought a great deal of integrity and leadership to our industry,” said Todd Polum, president and CEO of SRF Consulting Group. “He’s provided keen insights to the development of many local, regional, and state initiatives, allowing for more informed and strategic investments for both our communities and transportation systems. Dave has also been a valuable mentor to many, willing to share his own experiences and perspectives.”

## William K. Smith Distinguished Service Award

Michael Loney, a senior logistics manager with Medtronic, received this award in recognition of his leadership, mentorship, and education of future leaders in private-sector freight transportation.

With more than 20 years of supply chain experience, Loney's primary focus is sourcing a global multimodal transportation management system. He has also worked in carrier operations, distribution management, operations management, and corporate transportation roles.



*Michael Loney*

Bill Goins, a longtime member of the Minnesota Freight Advisory Committee (MFAC), said: "From Michael's days in transportation with UPS, his management responsibilities at Medtronic, and his experience in several supply chain functions, he has built a solid industry background. Michael is always willing to share his knowledge and experience with others by participating in interviews for research studies, supporting MFAC, and participating in educational events, conferences, and public-private academic efforts."

## Matthew J. Huber Student Award

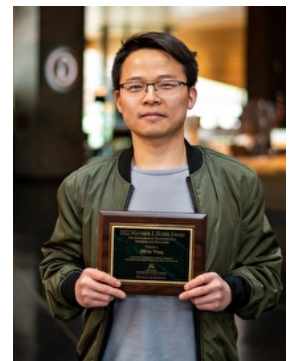
This award, named in honor of the late Professor Emeritus Matthew J. Huber, is presented to University of Minnesota graduate students demonstrating outstanding academic achievement in engineering, science, and technology fields. Kathryn Kramarczuk, a master's student in water resources science, and Shi'an Wang, a doctoral candidate in civil engineering, received this year's awards

Andy Erickson, research manager at the U's St. Anthony Falls Laboratory, has worked with Kramarczuk for more than two years.

"Kathryn's research will contribute a 'ready-to-install' treatment practice that can help local, state, and national transportation agencies remove pollutants from road runoff," Erickson said. "She is passionate about wanting clean water for everyone, and I know she'll carry that passion forward in whatever she does."



*Kathryn  
Kramarczuk*



*Shi'an Wang*

Michael Levin, assistant professor in the Department of Civil, Environmental, and Geo-Engineering (CEGE) and Wang's advisor, has worked with Wang for nearly three years. "Shi'an is by far the most independent PhD student I know," Levin said. "He problem-solves and finds novel ways to apply interdisciplinary methodologies in the transportation field, including the areas we've been working on: automated vehicles, parking infrastructure, and where and when to give incentives."

Kramarczuk and Wang's nominators also recognized them for their perseverance in overcoming challenges brought on by the pandemic.

## **Richard P. Braun Transportation Scholarship**

Noah Gallagher, an undergraduate student in environmental engineering, received this year's scholarship. It is awarded to University of Minnesota undergraduate students pursuing degrees related to transportation who have demonstrated academic merit and leadership skills.

Co-advisors Andy Erickson and John Gulliver, CEGE professor emeritus, have worked with Gallagher for just over a year. "While working on stormwater treatment projects, Noah has proven himself in the laboratory, in the field, and in using theory to analyze results," they wrote in his nomination letter. "He is persistent and goes the extra distance to finish a task, displaying his leadership skills when called for."

Gallagher's nominators also noted his willingness to work through obstacles caused by the pandemic.

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## Distance-based user fee project receives Research Partnership Award

June 7, 2022



A pilot demonstration of distance-based user fees in shared mobility fleets received this year's Robert C. Johns Research Partnership Award. As vehicles switch from gas-fueled to electric and revenues from the fuel tax begin to decline, the transportation industry is looking for alternative ways to fund roadways—and these fees have been gaining traction as a possibility.

During the 12-month demonstration, MnDOT used existing technologies embedded within shared mobility vehicles to automatically calculate the distance-based fees. As part of the project, researchers in the Humphrey School of Public Affairs evaluated the demonstration based on its feasibility, efficiency, adequacy, and equity. [Read more about the project.](#)

When the team first started working on the project several years ago, members saw that shared mobility and its technologies were becoming very important and influencing how the transportation system works. "We had a chance to meet with Zipcar and HOURCAR, and after that we realized we could leverage the markets and the tools of these companies to address equity and other issues—including privacy concerns—this way," says Frank Douma, a Humphrey School researcher and the principal investigator of the research component.



*Left to right: Phil Magney, Ken Buckeye, Frank Douma, Bob Johns, Chris Berrens, Adeel Lari, Meredith Benesh*

The Research Partnership Award is named in honor of former CTS director Robert Johns. The award is presented annually to a team of individuals who have collaboratively drawn on their diverse expertise to achieve significant impacts on transportation.

## Project team

- University of Minnesota: Frank Douma (PI), Meredith Benesh, Camila Fonseca-Sarmiento, Adeel Lari, Lee Munnich, Jerry Zhao, Raihana Zeerak
  - Federal Highway Administration: Andrew Emanuele, Jim McCarthy
  - HOURCAR: Paul Schroeder, Riley Haberland, Jennifer Crandall
  - Loveland Communications: Joe Loveland
  - Minnesota Department of Revenue: Glen Kleven, Jeremy Neeck
  - Minnesota Department of Transportation: Jeanne Aamodt, Chris Berrens, Ken Buckeye, Serge Phillips, Lynn Poirier, Erik Rudeen, Ray Starr
  - VSI Labs: Phil Magney, Matthew Linder, Anas Al Badi, Mayura Gunarathne
  - WSP: Trey Baker, Markell Moffat, David Ungemah, Mike Warren
  - Zipcar: Sabrina Sussma
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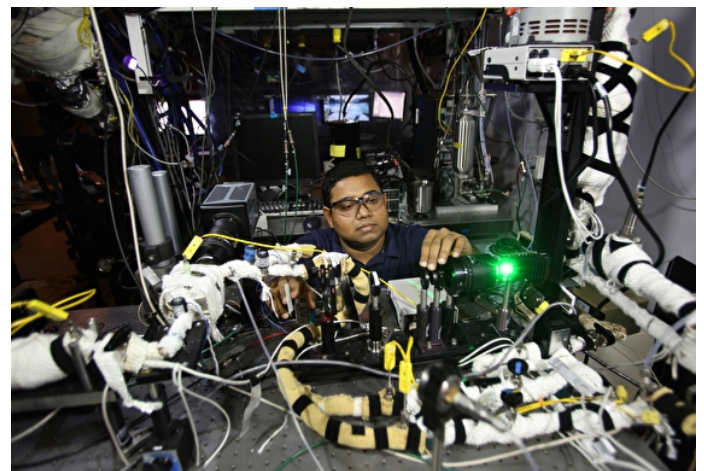


## A \$10 plasma igniter produces zero emissions and doubles fuel economy

June 21, 2022



Transportation is responsible for nearly one-third of the world's greenhouse gas emissions and is a major contributor to global warming and climate change. While electric transportation can offset a fraction of toxic greenhouse emissions, batteries charging solely on clean electricity and environment-friendly battery recycling technology will take decades to mature. To cut down greenhouse emissions, we need sustainable and scalable technologies that can be deployed in the next few years to enable the clean burning of fuels.



*Sayan Biswas makes a critical adjustment to the plasma igniter controller. The controller module optimizes different plasma parameters to improve combustion efficacy.*

Sayan Biswas, PhD, the Benjamin Mayhugh Assistant Professor of Mechanical Engineering in the College of Science and Engineering at the University of Minnesota, is an experimental energy researcher who is deeply motivated by the fact that our current overreliance on fossil fuels results in an alarming one-way downslope.

“That dangerous trajectory could take us to the point of no return as we’re adding more greenhouse gases and the planet is warming up,” Biswas explained. “There is a simple solution to this problem—adopt technologies that produce fewer or zero greenhouse

gases. The question is: How do we develop clean energy technologies that can scale up to match our current gigantic energy demand?”

That’s where plasma comes in. Plasma—the fourth state of matter after solids, liquids, and gases—is an ionized gas consisting of ions, electrons, and excited particles. One of Biswas’s solutions: an inexpensive low-temperature plasma igniter that can replace conventional spark plugs. While traditional spark plugs produce a high-temperature spark, a low-temperature plasma igniter deposits a smaller and more precise amount of energy for ignition. Moreover, plasma igniters can immediately be dropped into existing engines. This roughly \$10 addition to an engine could lead to hundreds of dollars in fuel savings while potentially producing zero emissions and leaving no carbon footprint.

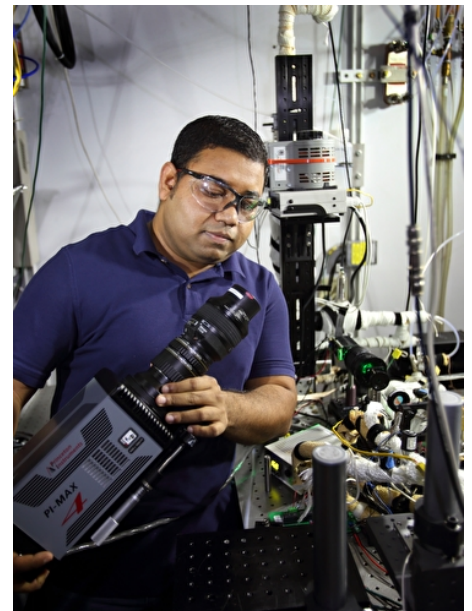
## Technology catches up

The fact that plasma could be a powerful ignition source has been known for a while. Low-temperature plasma discharges generate ozone, excited gas molecules, and ions, which can change fuel chemistry so that it can burn leaner and faster at a lower temperature, resulting in nearly zero emissions and doubling fuel economy.

It took a while for the plasma technology to become viable for use in engines. Twenty years ago, plasma generators were the size of a room. Now they’re the size of a lunchbox, making it practical to install them in a typical engine. Biswas collaborated with material scientists and electrical engineers from Sandia and Argonne National Laboratories to create a prototype plasma igniter. Because the original prototype cost \$10,000, Biswas then worked with manufacturing experts to figure out ways to make the technology cost-effective.

Thanks to these collaborations and advancements in manufacturing and power electronics, Biswas and his colleagues were able to put a plasma igniter in an engine and demonstrate its efficacy.

“We measured the emissions and saw that nitrogen oxide emission, a significant contributor to greenhouse gases, is basically taken out of the picture because the engine is



*Biswas installs the high-speed camera to image plasma physics and ignition behavior. Photos: Dino Vournas/Sandia National Labs*

burning fuel at such a low temperature that it does not break nitrogen-nitrogen triple bonds, one of the strongest known chemical bonds,” Biswas said.

Through a series of lab-based engine experiments for a range of operating conditions, they found that plasma technology also dramatically improves fuel economy. An engine delivering 35 miles per gallon might achieve 60 to 70 miles per gallon with negligible pollutant emissions.

## What’s next?

While the technology has been proven, Biswas and his team still need to know how durable it is before they begin installing plasma igniters in production engines. They are working with several engine manufacturers to conduct reliability and longevity testing of plasma igniters in their four- and six-cylinder engines. If all goes well, Biswas envisions this technology could begin to be included in all gas engines that use an igniter.

With a goal of cutting down greenhouse gas emissions by more than 30 percent before 2030 to achieve net-zero emissions by 2050, Biswas and his research team continue to investigate technologies that can make near-term energy production and use cleaner and more efficient. They are developing synthetic carbon-neutral and carbon-negative fuels to replace fossil fuels. They’re also exploring new research directions with plasma, such as plasma technologies in supersonic flights and plasma for renewable energy harvesting.

Biswas believes we can have a significant impact on climate change by making steady and sustained technological changes starting now.

“We have to make small changes on a regular basis,” Biswas said. “We have to work together, and we must act now. I am motivated to give people technologies they can incorporate into their lifestyles. It is not too late to limit some of the worst effects of climate change.”

*Originally published by Office of the Vice President for Research, April 19, 2022. [Read the original version.](#)*

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## Study underway to reduce deer-vehicle collisions

June 9, 2022



How often do you see a deer crossing where there's a deer crossing sign? Those yellow warnings are supposed to make drivers slow down and watch for deer to reduce collisions. But do they work? Because drivers tend to ignore the signs, the Minnesota Department of Transportation (MnDOT) has removed most of them on state highways and stopped putting them up.



Photo: June Breneman

So the problem continues. Annually, the Minnesota Department of Public Safety (DPS) reports around 2,000 deer-vehicle collisions across the state. But State Farm Insurance, which gathers its own data based on insurance claims filed, estimates the number of animal-driver collisions at over 40,000 in Minnesota last year, most of which involve deer.

According to Ron Moen, wildlife biologist with the Natural Resources Research Institute (NRRI) at the University of Minnesota Duluth, the State Farm estimate is closer to the actual number of deer-vehicle collisions, in part because the number reported to the state is not intended to be a complete count. And insurance companies only get notified when the damage is severe enough to warrant expensive auto repairs, so the State Farm number may even be an underestimate.

With funding from MnDOT, Moen is taking part in a pilot study to better understand where

deer-vehicle collisions happen, document their frequency, and develop recommendations to reduce these incidents.

"The base economic cost is \$20 million per year for reported accidents, much more when considering unreported collisions," Moen said. "Deer-vehicle collisions are costly, in terms of both dollars and injury. So that's the motivation and why MnDOT is interested in this."

## Deer data

Moen is working with Raphael Stern, assistant professor in the Department of Civil, Environmental, and Geo- Engineering, on the project. Stern is the pilot project's principal investigator and will do the statistical analysis of the data collected.

To get the required data, Moen needs to visit and document as many road-killed deer as possible. He uses his smartphone to take pictures of the deer where it fell on the roadside and notes which direction the vehicle was headed as well as the deer's gender and rough age (fawn or adult).

The effort is creating a new database that can be compared with what is reported to DPS. This new database shows where the deer-vehicle collision hot spots are and what might be contributing to these collisions—road characteristics, habitat, amount of traffic, and speed limits.

"If we can reduce these collisions by just one-half of a percent, this \$200,000 pilot study has the potential to deliver a million dollar return on investment," Moen said. "Minnesotans seem to know, it's not *if* you'll hit a deer, but *when*. We understand [the] cost of human injuries, car repairs, lost work time, not to mention the emotional toll of a car accident."

## Road work

Moen's smartphone not only captures images of the deer, but also the GPS coordinates of the collision site. On a Wednesday in late March, Moen was on a stretch of County Highway 53 in rural Duluth gathering data. Back at the office, he adds the coordinates to the database and maps the incidents.

His takeaway from just that eight-mile stretch of Highway 53 is the documentation of 25 deer-vehicle collisions since May 2021.

“That is surprising to me, and among the highest rate I’ve seen on roads I’ve driven,” Moen said. “Twenty-five accidents in less than a year on just this eight-mile stretch of roadway.”

The study is also gathering deer-vehicle collision data on about 500 miles of other roads in the Duluth area, including Interstate 35, Highway 33, Highway 2, and some smaller roads in rural Duluth. On some roads over the past winter, Moen recorded as many as one deer-vehicle collision every three to four miles.

“When you hit a deer you lose work time, you have to call your insurance agent, get your car fixed, and might have injuries,” Moen said. “It’s often fatal to the deer but could also be to the humans involved. I hope this study succeeds in reducing these collisions.”

## Next steps

Moen is halfway through the first year of data collection and already has concrete results. He’ll continue collecting data for a full year. The next step is to use the data to figure out how to reduce these collisions.

“Maybe we can identify strategies to reduce collisions—maybe dynamic signage with motion detectors—in more strategically placed locations that would make a difference,” Moen said. “Other potential solutions include deer fencing paired with under- or overpasses.”

*This article was written by June Breneman and originally published by the Natural Resources Research Institute on May 5, 2022. [Read the original version.](#)*

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## Save the date: 2022 CTS Transportation Research Conference

June 16, 2022



Join us for a day of discovery and innovation at this year's Transportation Research Conference, scheduled for November 3, 2022, at the Graduate Minneapolis Hotel. The annual event will convene researchers and practitioners to explore the latest innovations in transportation research, implementation efforts, and engagement activities.



At this time, we are planning to offer the conference **in person only**, and we're looking forward to welcoming you back to campus!

More information, including registration and program details, will be available on the [conference web page](#) in late summer.

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