Catalyst

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Could remote drivers be the future of ride-hailing?

A new technology combining nearly autonomous vehicles with remote “tele-operators” has the potential to overcome both the technological and societal hurdles posed by driverless vehicles. Ride-hailing providers will be an important application for remote-driving technology, and U of M researchers say it offers clear advantages for companies and their customers.

Funding for maintaining Minnesota’s roads is billions short. Researchers offer ideas to fill the gap

Most of Minnesota’s pavements are aging and need significant maintenance or reconstruction—but the money to fix them isn’t there. In a recent project, researchers sought to understand the causes and impacts of deferred maintenance at the local-agency level. The goal was to create strategies to help local governments secure the funding they need and promote a common understanding among elected officials and the public about the risks of delaying road repair.

Automated vehicles could increase accessibility for Twin Cities east metro

Planners and policymakers need to prepare for the mainstreaming of connected and automated vehicle (CAV) technology and the evolution of the current transportation system—all while ensuring that transportation equity has a seat in the vehicle. In recent years, researchers have gathered information from community members and stakeholders across the state to understand the needs of transportation-disadvantaged communities. In their most recent work, they found a potential for CAVs to fill a

constructive role in the east metro of the Twin Cities.

Treating stormwater with local by-products reduces road construction costs, minimizes waste

Ongoing research is looking into the possibility of using local industrial waste for roadside stormwater construction projects. This would help reduce material and transportation costs and put otherwise wasted materials to use. Researchers' most recent work tested materials ranging from peat by-products to street sweepings.

Teen students receive immersive transportation education at NSTI camp

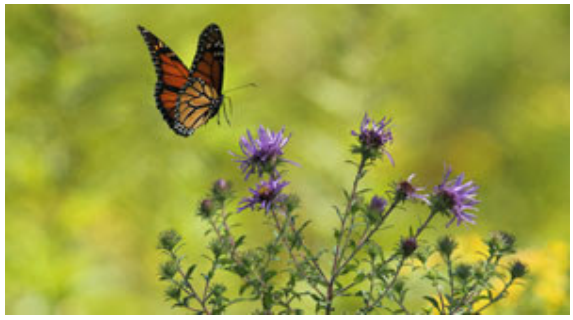
Ever wanted to build a model bridge with popsicle sticks, program a mobile mini-robot, or make an "asphalt" cookie? A cohort of 27 middle school and high school students did just that and more through a wide range of hands-on STEM-based activities at our seventh annual National Summer Transportation Institute (NSTI) in July. The free program attracts a diverse range of students entering grades 7–9 and provides interactive educational experiences for potential careers in transportation, engineering, and related fields.

Register for the 2022 CTS Transportation Research Conference

Register to join us at the annual CTS Transportation Research Conference, scheduled for November 3, 2022, at the Graduate Minneapolis Hotel on the U of M's Twin Cities campus. You'll hear from transportation thought leaders, researchers, and practitioners about their latest research findings, implementation efforts, and engagement activities.

Roadside habitats for pollinators

Pollinators and insects provide crucial support for 70 percent of our country's crops and are an important part of our ecosystem, yet many are declining due to factors such as habitat loss. To counteract this decline, many are looking toward investing in roadsides. A U of M researcher has overseen three projects in Minnesota to determine the benefits and the risks of developing roadside habitats for native plants and pollinators.



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Catalyst Editors: Pamela Snopl, Christine Anderson
Contributing Editors: Amy Friebe, Michael McCarthy, Maggie Biever
Designer: Angela Kronebusch
Freelance Writers: Megan Tsai, Sophie Koch

Could remote drivers be the future of ride-hailing?

August 24, 2022

A new technology combining nearly autonomous vehicles with remote "tele-operators" has the potential to overcome both the technological and societal hurdles posed by driverless vehicles. Ride-hailing providers will be an important application for remote-driving technology, and U of M researchers found it offers clear advantages for companies and their customers.

Photo: Lyft

"Fully autonomous vehicles may take longer than initially expected to become a reality because of technological challenges, public acceptance, and safety concerns," says Saif Benjaafar, Distinguished McKnight University Professor in the Department of Industrial and Systems Engineering. "Tele-operated vehicles could provide the efficiency and flexibility of autonomous vehicles while keeping humans in the loop and ultimately responsible for driving decisions."

Tele-operated vehicles would offer several advantages for providers. Perhaps the most important is that remote drivers would be a common resource interchangeably assigned to fulfill trips regardless of a trip's origin or destination. A remote driver would not be dedicated to a single vehicle, so the service could operate with more vehicles than drivers. This would reduce the inefficiencies evident in today's service when drivers move from low-demand to high-demand locations—repositioning that can cost providers and drivers time and money. Tele-driving would also be important in places where drivers are costly or in short supply.

In this study, Benjaafar's research team examined efficiencies that could be gained by operating a ride-hailing service with remote drivers in a region such as the Twin Cities metro. Here's how it would work:

- The service operator at a central command center matches a vehicle and remote driver to a customer.
- The remote driver takes control of the vehicle, drives it to the customer (similar to a drone operator), picks up the customer, and drives them to their destination.
- Once the trip is complete, the remote driver and vehicle are unpaired and become independently available for future requests.

Remote ride-hailing drivers could steer vehicles the way operators control drones. Photo: Adobe Stock

The researchers studied the impact of operating with more vehicles than drivers —specifically, the extent to which the number of drivers relative to the number of vehicles can be reduced without reducing the quality of the service to customers. They considered two scenarios: one where customers are impatient and leave the system if they cannot be immediately matched with a vehicle and driver, and one where they are patient and willing to wait to be matched. The researchers modeled the dynamics of these two scenarios with a multi-server queueing model.

The models showed that whether customers are patient or not, a system with more vehicles than drivers can maintain or even improve the amount of demand that can be served and the corresponding quality of service (i.e., delay experienced by customers).

Benjaafar says the results, which may seem counterintuitive, can be explained as tradeoffs between faster service times and more drivers, with three key factors at work: the number of idle vehicles, where vehicles are located (distant or close to pick-up sites), and pick-up wait times.

Other benefits are possible. Teledriving would eliminate the discriminatory behavior of onboard drivers who avoid locations they perceive to be unsafe, and personal safety would no longer be a concern for drivers and riders. Tele-drivers wouldn't need to own a vehicle, broadening labor participation. And policymakers could set access and pricing regulations.

The researchers note that several pilot projects are demonstrating the commercial viability of teledriving, including one by Vay, a German TNC, and several involving remotely controlled robots for food delivery.

This research was funded as part of a National Science Foundation (NSF) Smart and Connected Communities grant (award no. CMMI-1831140)—Leveraging Autonomous Shared Vehicles for Greater Community Health, Equity, Livability, and Prosperity (HELP).

Writer: Megan Tsai

Funding for maintaining Minnesota's roads is billions short. Researchers offer ideas to fill the gap

August 9, 2022

Most of Minnesota's pavements are aging and need significant maintenance or reconstruction—but the money to fix them isn't there.

Graphic: Adobe Stock

"While maintenance spending has increased slowly in recent years, that modest increase is nowhere near enough to address the deferred maintenance of Minnesota's pavements," says Camila Fonseca-Sarmiento, director of fiscal research at the Institute for Urban and Regional Infrastructure Finance (IURIF) in the Humphrey School of Public Affairs.

In a project funded by the Minnesota Local Road Research Board, researchers sought to understand the causes and impacts of deferred maintenance at the local-agency level. The team examined how local governments make maintenance expenditure decisions and the primary factors influencing those decisions. The goal was to create strategies to help local governments secure the funding they need and promote a common understanding among elected officials and the public about the risks of delaying road repair.

"Failing to keep up with pavement maintenance shortens asset life and increases future maintenance costs," says Fonseca-Sarmiento, the study's principal investigator. "And it

threatens the safety and health of the people using the system."

The researchers used a multifaceted approach, including a spatial analysis of maintenance spending in the state's cities, counties, and townships. They explored local public finance data from the Minnesota Transportation Finance Database and road condition data from MnDOT to identify trends or patterns. They then conducted nine case studies (four counties and five cities representing diverse areas) for in-depth analysis, followed by a survey to local Minnesota governments.

The team found that many Minnesota counties, cities, and townships face significant funding shortages. "Some local agencies report millions in deferred maintenance backlog," she says.

Maintenance spending at all levels of government (including state and federal funds) increased slightly between 2006 and 2018. At the county, city, and township levels, maintenance spending per lane mile increased slightly from 2006–2010 to 2014–2018. However, costs also rose, and many localities reported significant funding gaps. "To maintain pavements at an acceptable level, localities' annual maintenance needs ranged from $250,000 up to $22 million," Fonseca-Sarmiento says.

Several factors affect funding availability. Local road repair is generally funded through local revenues or general funds and state funding, depending on the type of system. However, funding capacity from local communities is limited, and state-aid support has decreased. The pandemic also worsened funding shortfalls through reductions in local revenues and state support.

Photo: Adobe Stock

At the county level, researchers found that an increase in the share of federal and state grants (in total revenues) decreases the share of total roadway expenditures spent on maintenance. "This finding suggests that additional intergovernmental funding is invested in transportation projects other than maintenance, such as construction," Fonseca-Sarmiento says.

Cities and counties are trying to close the gaps. Some are using new funding sources such as wheelage taxes, while others are completing more work in-house and performing more preventive maintenance. "Our case studies demonstrate how some of these approaches are

making an impact," she says.

Researchers documented several reasons for maintenance delays. On the fiscal side, continued improvements in vehicle fuel efficiency are reducing fuel-tax revenues. Politically, officials and policymakers typically prioritize more popular and visible needs—especially new infrastructure—based on public perceptions. In addition, some local agencies lack management capacity and staff expertise to consider all the necessary information for making maintenance investments.

Based on their findings, researchers made seven recommendations to help local transportation agencies secure and maintain adequate funding to meet their road maintenance needs:

- Adopt a standard definition of deferred maintenance.
- Identify acceptable pavement and bridge condition targets.
- Estimate funding needed to achieve targets.
- Monitor the achievement of targets.
- Report pavement and bridge conditions, trends, and target achievement.
- Plan and coordinate maintenance activities with other stakeholders.
- Maintain a consistent funding stream for roadway maintenance activities.

The final report will serve as a reference tool for local public works directors and engineers who are responsible for budgets and who work with elected officials to secure adequate maintenance budgets.

"This project really illustrated that the longer maintenance is put off, the more difficult it is to catch up," says Paul Oehme, City of Lakeville public works director and the project's technical liaison. "Maintaining an appropriate and stable level of maintenance funding is most cost-effective in the long term. We can now better communicate that information to decision makers."

Others on the research team were Raihana Zeerak (IURIF research associate), Jerry Zhao (IURIF founder and advisor), and Haiyue Jiang (Humphrey School doctoral candidate).

Writer: Megan Tsai

Automated vehicles could increase accessibility for Twin Cities east metro

August 4, 2022

Autonomous snowplows—like the one shown in this 2020 competition—could clear sidewalks and bus stops more quickly, making infrastructure more accessible year-round for pedestrians and transit riders. Photo: Dunwoody College of Technology

Connected and automated vehicle (CAV) technology is moving forward, with three pilot shuttle projects on tap in Minnesota this year alone. Rapid developments are leaving little time for planners and policymakers to prepare for the mainstreaming of technology and the evolution of the current transportation system—all while ensuring that transportation equity has a seat in the vehicle.

In the past several years, U of M researchers have gathered information from community members and stakeholders across the state to understand the needs of transportation-disadvantaged communities. These populations have limited access to transportation because of their level of income or ability or the extent of service in an area.

In their most recent work, the researchers focused on communities in the east metro of the Twin Cities, particularly the East Side, downtown, and Frogtown areas of St. Paul. They documented mobility challenges and explored how CAVs could change the landscape of transportation options and accessibility.

“We found a potential for CAVs to fill a constructive role,” says Frank Douma, director of state

and local policy and outreach with the Institute for Urban and Regional Infrastructure Finance (IURIF) in the Humphrey School of Public Affairs and the project's principal investigator.

Two ideas stand out as tangible ways CAVs can solve issues: by closing existing transportation gaps and by facilitating non-passenger uses.

"Study participants emphasized that compared to other parts of the Twin Cities area, there is a relative lack of transit accessibility in the east metro," says Adeel Lari, IURIF director and the project's co-investigator. While transit access is generally concentrated in downtown St. Paul, job growth has occurred further and further out from the urban core, causing long commutes that are not well served by transit.

One case that typifies this spatial mismatch is the limited access between the Sun Ray transit center and the Woodwinds Health campus. The area has been talked about as a CAV pilot opportunity.

Photo: Metro Transit

"CAVs could supplement the existing transportation system to close such gaps, but it will be crucial to build in accessibility for all users," Lari says. Strategies could include requiring an attendant on board to assist riders, ensuring that technology supports multiple languages and is visually and audibly accessible, and offering technological support for unbanked riders and riders without a smartphone.

CAVs could also be a constructive tool for non-passenger uses in the east metro. "Study participants specifically noted the use of CAV technology for maintenance and delivery as a way to increase accessibility," Lari says.

One example is the potential for automated snowplows to clear sidewalks and bus stops. "Using CAV technology for maintenance would have tremendous potential for making multimodal infrastructure more accessible, especially during the winter months," says study team member Kim Napoline, a former Humphrey School graduate research assistant.

Efforts to automate snow removal tools are already underway. Dunwoody College in Minneapolis hosts an annual autonomous snowplow competition that demonstrates this potential use.

Delivery service, which took on increasing importance during the pandemic, is another opportunity for CAVs in the east metro. The researchers say it will be important to focus not only on younger people adept at using today's common apps but also on seniors and others who need groceries and prescriptions brought to their homes.

"A marketplace for essential deliveries could be formed in the east metro, building on mobility services such as Mobility4All that seniors are already using," Lari says. Another mobility provider, NewTrax, transitioned to food distribution during the pandemic, partnering with Washington and Ramsey Counties to provide food to people in need.

Overall, the researchers say there is significant potential for CAVs to connect underserved areas to the broader metro-wide transit system, which could prove beneficial for communities and transit systems alike. They note, however, that the cost of using CAV technology is a major factor: Planners may need to consider establishing partnerships or policy interventions to avoid inequitable "tiers of access" from emerging in a CAV system.

One of the most prominent themes that surfaced in the study was the potential for CAVs to reiterate existing transportation disparities. Participants raised concerns about private manufacturers driving CAV development and emphasized that public policy must be created to encourage—or force—manufacturers to address equity issues. "Perhaps the most notable takeaway is that policy needs to take a stronger role in guiding private development to address equity issues as CAV technology develops," Douma says.

The research will be published in the University of Michigan's *Journal of Law and Mobility*. Erika Shepard, another former Humphrey School research assistant and study team member, is the lead author of the paper. She is now a multimodal planner with the Wisconsin Department of Transportation.

The research was sponsored under the Transportation Policy and Economic Competitiveness (TPEC) Program. TPEC is a joint program of IURIF and CTS.

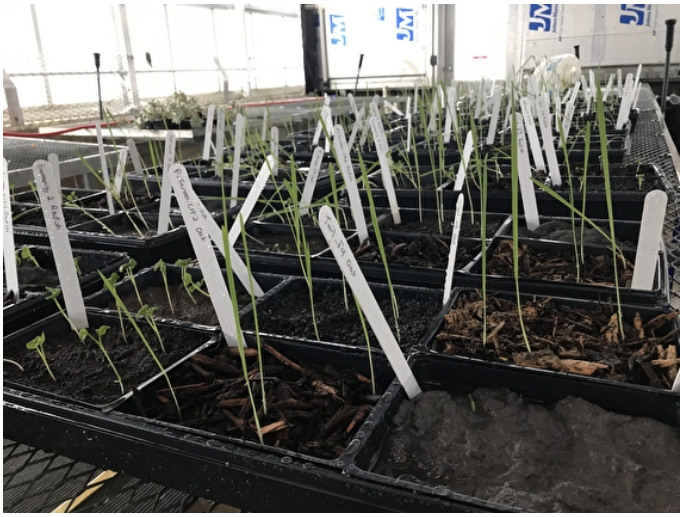
TPEC progress report highlights automated vehicle, supply chain activities

The 2020–2022 progress report of the Transportation Policy and Economic Competitiveness Program is now available. The report showcases TPEC work in the areas of connected and automated vehicles, medical supply chains, telecommuting, and more.

Treating stormwater with local by-products reduces road construction costs, minimizes waste

August 29, 2022

Ongoing research is looking into the possibility of using local industrial waste for roadside stormwater construction projects. This would help reduce material and transportation costs and put otherwise wasted materials to use.



Tests of the individual and blended biofilter materials were conducted on greenhouse-grown plants.

Managing stormwater runoff and the pollutants it can carry is a huge priority for highway departments. The Minnesota Pollution Control Agency requires stormwater installations for new construction projects, and these installations need to be capable of capturing the first inch of rainfall in a given storm event.

Researchers from the University of Minnesota Duluth (UMD) and the Natural Resources Research Institute (NRRI) have been partnering with MnDOT in a series of projects that aim to find viable construction materials that are closer to construction sites. Their most recent work tested a wider range of materials.

Bioslopes and bioswales (shallow ditches along roads that catch and filter runoff) are a recommended tactic. However, these biofilters have traditionally involved hauling materials such as compost, peat, and sand from other areas, which costs fuel and money.

“By-products and waste materials generated by mineral, forestry, agricultural, and industrial sectors have the potential to be recycled, reused, or combined with traditional materials to create a sustainable source of value-added soil or soil amendments,” says David Saftner, principal investigator for the 2022 project and associate professor in the UMD Department of Civil Engineering.

Previous studies published in 2019 and 2021 laid the groundwork; researchers identified properties that a successful biofilter material needs, such as good water retention, high infiltration capacity, contaminant-filtering effectiveness, and an ability to grow and support vegetation.

Preliminary studies at test plots found that peat and compost mixed with taconite tailings show promise. Long-term monitoring found that these experimental biofilters are capable of capturing the required first inch of rainfall.

Continued research in 2022 tested the viability of additional by-products and waste materials. Researchers found and tested 11 potential candidates local to northeastern Minnesota, including:

- Peat by-products (often generated during land use and industry processes)
- Tree bark (timber/forestry residuals)
- Harbor dredge sediment (from Duluth’s shipping channel)
- Coarse and fine taconite tailings (by-product of taconite mining)
- Street sweepings (from public works departments)

Street sweepings, such as this stockpile in Duluth, can work well in soil blends. Photos: Meijun Cai

Analysis of the environmental and civil engineering characteristics of the different materials found, overall, that peat by-products continue to show a lot of promise, says NRRI environmental engineer Meijun Cai. Peat by-products proved the most effective at removing metals from runoff, and they provide phosphorous for plant growth. Since peat by-products tend to turn stormwater acidic, however, the researchers recommend mixing them with inorganic materials such as coarse taconite tailings, street sweepings, or dredge sediment.

Biological and chemical tests found that none of the proposed materials are hazardous, and life-cycle studies confirmed that locally sourced materials have lower environmental impacts.

“This conclusion reinforces the importance of the current research,” Cai says.

Future work will involve testing the in-situ performance of the different materials in biofilter systems (the 2022 study was done purely in a lab). The effectiveness of the materials will also be studied over a longer period of time, Saftner says.

In addition, a wider variety of materials will also be studied on a statewide basis. The researchers plan to produce an implementation guide to help MnDOT and county engineers with factors such as mixing ratios and technology, design and construction specifications, and monitoring requirements.

“The sustainable soil design practices identified in this project have multiple benefits: Financial savings for us, the counties, and the material producers; water quality protection; a reduction in solid waste and carbon into the atmosphere; and aesthetics,” says Dwayne Stenlund, erosion control specialist with the MnDOT Office of Environmental Stewardship. “We’d like to explore similar opportunities throughout the state.”

Writer: Sophie Koch

Teen students receive immersive transportation education at NSTI camp

August 18, 2022

Ever wanted to build a model bridge with popsicle sticks, program a mobile mini-robot, or make an "asphalt" cookie? A cohort of 27 middle school and high school students did just that and more through a wide range of hands-on STEM-based activities related to the transportation field at the U of M this summer.

CTS sponsored the seventh annual National Summer Transportation Institute (NSTI) from July 18-29, 2022. The free program attracts a diverse range of students entering grades 7–9 and provides interactive educational experiences for potential careers in transportation, engineering, and related fields. The 2022 cohort included students from across the Twin Cities, but also those visiting from as far away as Duluth and New Jersey.

Activities included a connected and automated vehicles showcase organized by The PLUM Catalyst; a visit with Great Plains Institute and ISD 112 staff about electric vehicles, including an all-electric school bus; a campus tour including the University Bike Center; and virtual experiences with a tour of an Amazon Fulfillment Center and a traffic control game. Students visited with—and learned from—faculty, graduate students, research fellows, engineers, and other professionals in an immersive campus experience at several University buildings and facilities.

Campers were also busy off-campus with interactive field trips at:

- MSP International Airport
- Metro Transit
- MnDOT Materials Lab
- HDR Engineering
- Third Avenue Bridge (Minneapolis)

- St. Anthony Falls Laboratory

NSTI students kicked off the 2022 camp on July 18 by programming Ozobots.

NSTI is funded by the Federal Highway Administration and CTS and administered by the Minnesota Department of Transportation (MnDOT). In addition, this year's camp received a gift from Minnesota's Transportation Conference to help offset expenses and also ensure that campers could attend the camp at no cost.

Registration and July dates for 2023 NTSI camp will be announced in early 2023. Contact Program Coordinator Rachel Brodeur for more information.

Thank you for an amazing camp experience! Our family is so grateful for this opportunity and the enthusiasm and skill of all adults involved. We could not ask for a more enriching or meaningful camp. It was a safe and challenging environment where my son explored his passions and learned.

—2022 NSTI camp family

Register for the 2022 CTS Transportation Research Conference

August 16, 2022

Register to join us at the annual CTS Transportation Research Conference, scheduled for November 3, 2022, at the Graduate Minneapolis Hotel on the east bank of the U of M's Twin Cities campus in Minneapolis.

The opening session and luncheon presentations are described below. Concurrent sessions will explore transportation equity, environmental resilience, driver behavior, infrastructure, planning, technology, and more. See complete details in the preliminary conference program (PDF).

This year's conference will be held in person only; we hope to see you there!

Opening Session: The Transport Transformation Can't Wait for Technofuturistic Utopia

"Pay no attention to the man behind the curtain," the Wizard of Oz told the adventurers. The wizard feared they would discover his deception. This, according to Peter Norton, is our dilemma.

We have all the technology we need for the transport transformation, Norton says, but tech companies, automakers, and others want to convince us that we need unlimited futuristic tech. For 90 years, they have been selling us impossible futures, always on the promise that

amazing technology will finally deliver a city in which everyone can drive anywhere at any time without delay. When the promises fail, they invoke the next generation of amazing technology to restore their lost credibility. But amazing technology does not make car dependency work. The promoters' goal has never been transport sufficiency; they sell transport consumerism.

In this presentation, Norton will pull back the curtain, expose the high-tech distraction, and demonstrate that we already have everything we need for the affordable, healthful, inclusive, and sustainable transport future we seek.

Norton is an associate professor of history in the Department of Engineering and Society at the University of Virginia, where he teaches the history of technology, social dimensions of engineering, research, and professional ethics.

Following the presentation, Minnesota experts on connected and automated vehicles will discuss Norton's ideas and explore how academic researchers, agencies, and industry partners can work together to build effective, safe, and innovative transportation technologies.

Luncheon: Equity and Electrification

In this presentation, Shelley Francis will discuss the challenges we face in ensuring that the transition to electrified transportation is both equitable and effective.

Francis is the co-founder and managing partner of EVNoire and EVHybridNoire. Her work has focused on helping policymakers and diverse communities navigate electrification and build a transportation system that works for all.

Roadside habitats for pollinators

August 2, 2022

Pollinators and insects provide crucial support for 70 percent of our country's crops and are an important part of our ecosystem, yet many are declining due to factors such as habitat loss. To counteract this decline, many are looking toward investing in roadsides.

Emilie Snell-Rood, associate professor of ecology, evolution, and behavior at the College of Biological Sciences, has overseen three projects and more than 400 roadside site surveys in Minnesota to determine the benefits and the risks of developing roadside habitats for native plants and pollinators.

Her research has explored the potential of roadside habitats for monarch butterflies, the toxicity of roadsides, and roadside restoration methods. Snell-Rood is using the results of her work to help with conservation efforts by providing data-driven guidance to roadside managers.

Snell-Rood's research was also recently recognized by the U's Office of the Vice President for Research (OVPR). Her work received an honorable mention in OVPR's inaugural Innovation Impact Case Award, which highlights research that has had a significant impact outside of academia and made a meaningful difference in our communities.

Read more about Snell-Rood's research in the full story from OVPR.