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CE IMPACT

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PURDUE UNIVERSITY

Lyles School of Civil Engineering

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MESSAGE FROM THE HEAD

Not since when I first became an educator had I looked more forward to the beginning of a semester.

The fall semester is well upon us, and the infusion of life back on campus is certainly a welcome one. Students, faculty and staff have returned. Classrooms, laboratories and offices are buzzing with activity. While the pandemic remains at the forefront of our safety concern, the grace and maturity everyone exemplified has been encouraging and admirable. Our Boilermakers continue to demonstrate incredible focus and determination to Protect Purdue — and it fills me with a sense of optimism as we move forward, together.

Of course, this past year-and-a-half has not been just about waiting and holding on. It has been about perseverance, adaptability and innovation. Despite the pandemic, the Lyles School of Civil Engineering continued to provide its students with the same world-renowned education that has come to be expected for more than a century. Our cutting-edge research continued and progressed to new heights. We greatly expanded upon our online education opportunities — and we intend to progress even further in all of these aspects in the semesters to come.

Civil engineers have shaped the world to how we know it today and they are the ones who will determine its future. No matter the state of the world, we are always looking ahead in search of new ways to improve the lives of our fellow humans and to preserve this planet we all share.

In this edition of *IMPACT*, you will learn about the continued excellence our students, faculty and staff have achieved and their goals moving forward — particularly, in the realm of infrastructure. Stories include research into generating greater access and use of public transportation, development of smart intersections, using unmanned aerial vehicles to map out challenging environments, the creation of lower-cost commercial sensors to monitor soil conditions and innovations in 3D printing for structural applications and shape-memory alloys.

The world is moving forward and civil engineers must continue to look even further ahead as we strive to not only educate and improve the lives of others today, but prepare the engineers of tomorrow and create a future where they can take humanity to even greater heights.

All the best,

Rao S. Govindaraju
Bowen Engineering Head of Civil Engineering
and Christopher B. and Susan S. Burke Professor of Civil Engineering

IN THIS ISSUE:

ON THE COVER

Purdue University is a partner in a $9.95M U.S. Department of Transportation project aimed at demonstrating the safety and mobility potentials of a next-generation traffic control system. Called "smart intersections," the technology is capable of gathering and transmitting information in real time to connected and automated vehicles (CAVs).

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NEWS & EVENTS

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CIVIL ENGINEERING
GRADUATE PROGRAM IN THE U.S.

#2
CIVIL ENGINEERING
ONLINE MASTER'S PROGRAM

The Lyles School of Civil Engineering's Christopher B. and Susan S. Burke Graduate Program in Civil Engineering has been recognized — once again — as a top 10 graduate program in the country.

U.S. News & World Report has released its national rankings of graduate programs for 2022 with Purdue Civil Engineering ranked No. 6 in the nation. The graduate rankings are computed from the responses to a survey sent to deans, heads and selected senior faculty.

The Burke Graduate Program has been consistently ranked in the top 10 by *U.S. News & World Report* for over a decade. Overall, Purdue's College of Engineering graduate program was ranked No. 4 in the nation.

The Lyles School of Civil Engineering's Online Master's Program has been recognized as No. 2 in the nation.

U.S. News & World Report has released its national rankings of Best Online Graduate Programs for 2021 with Purdue Civil Engineering ranked No. 2 overall. The rankings are based on engagement, faculty credentials and training, expert opinion, services and technologies and student excellence.

The Online Master's Program joins the school's graduate (No. 6) and undergraduate (No. 3) programs as top 10 programs in the nation by *U.S. News & World Report* rankings. Purdue University's Online Master's in Engineering Program was ranked No. 3 in the nation.

Congratulations to the 150 graduate and undergraduate students who earned their civil engineering degrees in May!

Due to COVID-19 restrictions in place, we held separate outdoor celebrations for our graduate and undergraduate students at Hampton Hall. However, the festive atmosphere remained as we welcomed our newest alumni.

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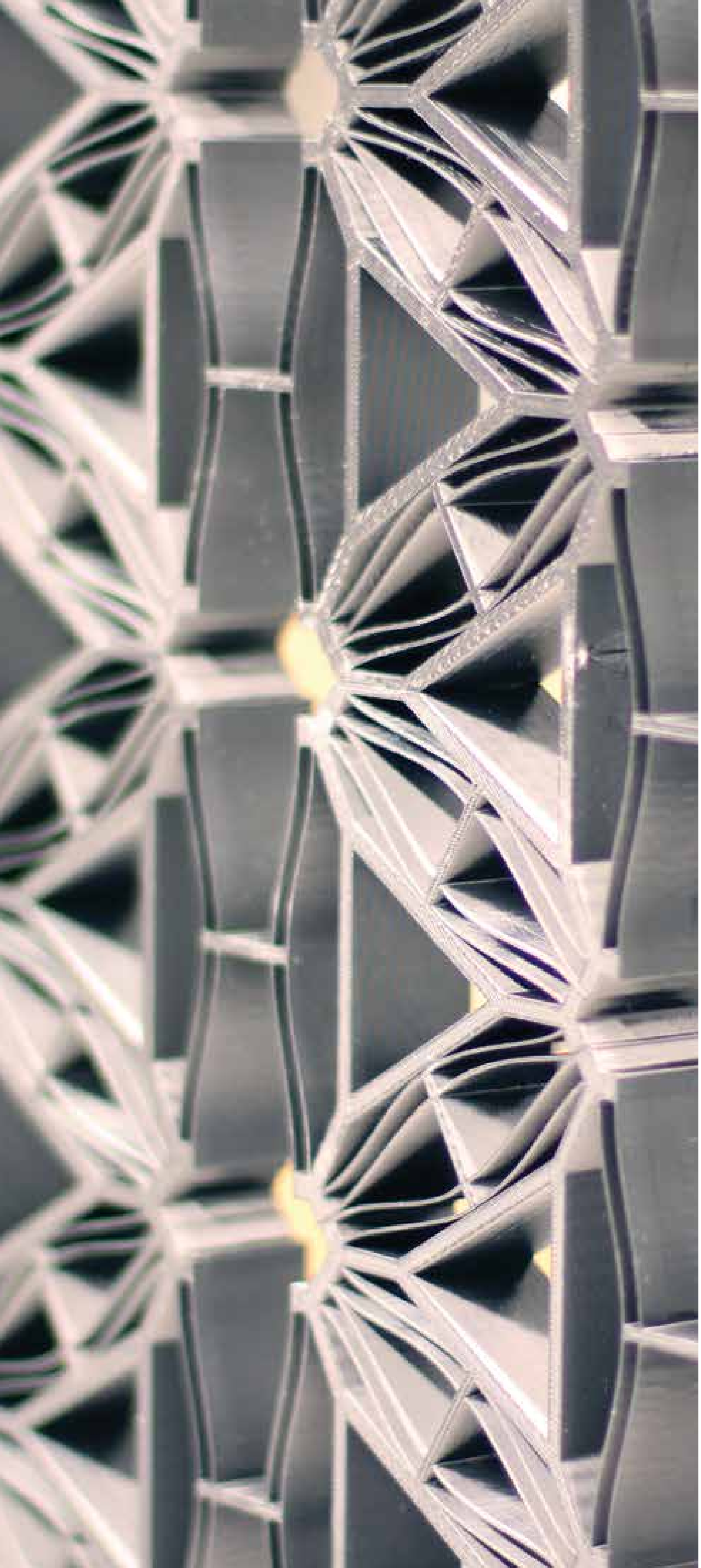


BUILDING *TOMORROW*

3D-PRINTED CONCRETE IS SPEEDING UP THE CONSTRUCTION INDUSTRY

Purdue researchers are utilizing 3D concrete printing to potentially improve the stability of structures, reduce their construction time and overall cost and to enable new functionalities.

Pablo Zavattieri, the Jerry M. and Lynda T. Engelhardt Professor in Civil Engineering, is involved in a pair of research teams that are studying new uses for 3D printing that could have a wide impact in materials, architectural and structural engineering. One team is researching reinforced concrete structures and another is researching how new, architected materials can mimic modern shape-memory alloy.

“With 3D concrete printing, research conducted over the last few years has taken giant leaps into a new era of building homes and other civil structures,” Zavattieri said. “This emerging technology allows for the creation of more complex structures and has shown to be both more cost-effective and faster to build.”

The Purdue concrete 3D printing research team, led by Jan Olek, the James H. and Carol H. Cure Professor in Civil Engineering; Jeffrey Youngblood, professor of materials engineering; Zavattieri; and PhD students Fabian Rodriguez, Reza Moini and Yu Wang; has partnered with the Lyles School of Civil Engineering's Robert L. and Terry L. Bowen Laboratory for large-scale civil engineering research. At Bowen Lab, the research team, in collaboration with Amit Varma, the Karl H. Kettelhut Professor of Civil Engineering; Christopher Williams, assistant professor of civil engineering; and graduate student Shubham Agrawal; has been producing prototypes of reinforced 3D-printed structural elements and comparing the mechanical performance with conventional cast concrete.

"We started working in small-scale 3D printing of cement and mortar and have spent the past few years understanding the materials used and developing the process to make it more efficient," Rodriguez said. "We are now ready to apply what we have learned, into a large-scale process that, we hope, will make a giant impact on structural engineering."

Zavattieri said that the 3D printing of cement-based materials is being intensively explored as a time and cost-effective alternative to conventional cast concrete in the construction industry. Its development relies on the successful integration of structural engineering, material design, the extrusion system, testing procedures and, more recently, the use of techniques to incorporate reinforcing components as an important step to develop viable alternatives for large-scale construction with the aim to satisfy the performance requirements of conventional methods.

The research team has created cement-based mixtures to be used in 3D printing systems at different size scales using controlled architectures that significantly influence the performance of the material. Simultaneously, the team has developed a reinforcing alternative that allows an enhanced mechanical response of 3D-printed cement-based materials by using a 3D-printed steel plate to promote composite action between the reinforcement and cementitious matrix.

"We are looking to produce larger elements with a size-scale closer to structural applications to replicate what the team has learned so far at the prototype scale and demonstrate the advantages not only from a mechanical point of view but also from the efficiency and economy of the use of this technology," Zavattieri said.

PhD student Fabian Rodriguez monitors the progress of the latest 3D printing.

ARCHITECTED MATERIALS CAN MIMIC SHAPE-MEMORY ALLOY

In the realm of architected materials, Zavattieri's team is researching shape-memory alloy that could potentially be used in a wide variety of fields, including civil engineering materials and structures.

What, exactly, is shape-memory alloy? As the name suggests, shape-memory alloy (SMA) is a material that can be deformed and returned to its original shape when heat is applied. Stents that are inserted and then expanded in arteries are made of shape-memory alloy.

Shape-memory alloy is made from nitinol — a mix of nickel and titanium — and is both expensive to buy and produce. Zavattieri's research into 3D materials with nitinol's properties, however, could lead to a dramatic reduction in cost for both producers and consumers, and even enable new properties and applications that were not possible before with nitinol.

"Currently, shape-memory alloy is very expensive and would make using it for any large-scale project almost impossible through cost alone," Zavattieri said. "So, what we are doing is playing with the geometry of 3D-printed materials to mimic the behavior. With this we can use these materials for larger projects such as adding them to buildings and bridges to make them more earthquake resistant."

Additionally, these architected materials can be made from a wide variety of polymers, made by many different low-cost production processes as well as 3D printing, and are designed to respond to various stimuli such as heat, magnetic fields and solvent absorption. These architected materials offer a lower-cost alternative that can expand the design space for SMA-like material behavior to include larger-scale (e.g., self-compacting dunnage) or lower-cost applications (e.g., medical implants).

Postdoctoral researcher Yunlan Zhang said that the applications for the research are as flexible as the material itself.

"This is truly cutting-edge research being done," Zhang said. "We're already exploring its effectiveness in protective equipment for both land-based vehicles and in aerospace vehicles."

Civil engineering PhD student Kristiaan Hector echoed Zhang, adding their work is surely just the beginning and will lead to even greater leaps in the near future.

"With the structure of these materials, energy can be absorbed and dissipated in a way that it can protect a person or object without sacrificing itself," Hector said. "Research into this has only really just begun, but — in a few years — you'll probably see this cause a major shift in architectural and structural applications."

ADVANCING AGRICULTURAL TECHNOLOGY *WITH ARTIFICIAL INTELLIGENCE*

RESEARCHERS DEVELOPING LOWER-COST COMMERCIAL SENSORS TO MONITOR SOIL CONDITIONS

A multi-disciplinary effort between the Lyles School of Civil Engineering and Purdue's School of Electrical and Computer Engineering is working toward developing low-cost, reliable soil sensors that could reduce their price from several hundred dollars to just a few cents each. This effort is through Scalable Manufacturing of Aware & Responsive Thin (SMART) Films Consortium that aims at making Internet of Things (IoT) sensor technology so affordable that it can be produced in bulk and deployed over large areas.

Through the use of 3D-printing technology, Purdue researchers are developing a soil sensor that can be quickly and inexpensively produced. These small devices can be used to test the nitrate levels in soil — a vital piece of information for both farmers and environmental researchers.

Materials engineering master's student Jose Waimin and electrical and computer engineering postdoctoral researcher Hongjie Jiang set up a soil sensor.

"Once you identify the nitrate levels, you can adjust the setting of fertilizers," said Mohammad Jahanshahi, associate professor of civil engineering. "For both farmers and environmental engineers, these sensors are necessary for their work — but they're fairly expensive, currently."

The sensors measure the difference of the potential voltage between the sensor electrode and the reference electrode, and this voltage reading is converted into the concentration of the nitrates.

"Similar printed electrochemical sensors can be used to measure nutrients, pesticides, bacteria or viruses. Applications are in digital health (wearable devices), food safety/freshness and environmental monitoring," said Ali Shakouri, professor of electrical and computer engineering and the Mary Jo and Robert L. Kirk Director of the Birck Nanotechnology Center.

Jahanshahi said commercial soil sensors typically cost around $800. However, Purdue uses roll-to-roll printing and coating machines, which can produce sensors for as little as 10 cents.

"Depending on what you wanted these sensors to test, they can likely be programmed to do so," Jahanshahi said. "Anywhere from other quantities, such as nutrient levels, to possible soil and water contamination."

While the School of Electrical and Computer Engineering further develops its uses, Jahanshahi's team is working on testing the sensors themselves to improve their reliability. He and postdoctoral researcher Rih-Teng Wu are developing AI-based approaches for efficient and reliable quality control of low-cost sensors during the manufacturing process.

The process involves building an AI model through pictures taken of the sensors. The program can then reliably predict a future sensor's quality by comparing its library of recorded information.

"Right now, the sensors have shown to be incredibly promising in what they can do. However, there is still some uncertainty in the robustness of the sensor — some fluctuations," Wu said. "We want to reduce that uncertainty and make sure to improve the quality."

Wu said testing both the sensors and the AI program will continue for several more months as both are still being developed and improved upon. New prototypes for both continue to be developed and refined.

Throughout 2021, Jahanshahi's team will study sensor aging and aim to use sensor diversity and machine learning to correct for long-term drifts. Additionally, the team has installed sensors at commercial farms in the 10-county region around the University.

This project is funded by Lilly Endowment through the Wabash Heartland Innovation Network.

MORE ONLINE→ https://engineering.purdue.edu/SMART

PhD student Xing Li tests the effectiveness of UV radiation on a pathogen sample.

A WAVE OF DISINFECTANT

UV RADIATION COULD HOLD THE KEY TO COMBATING AIRBORNE DISEASES

In the near future, destroying an airborne pathogen could be as easy as flipping a switch.

Ernest “Chip” Blatchley, the Lee A. Rieth Professor in Environmental Engineering, and his team are currently working on applications of UV radiation to control coronaviruses and other airborne pathogens. The structure of these pathogens makes them particularly susceptible to UV radiation.

“UV technology continues to prove to be incredibly effective in combating coronaviruses and it has been vastly underutilized,” Blatchley said. “One reason is that while UV radiation is damaging to these pathogens, it is also damaging to human skin and eyes. However, there have been recent discoveries with far-UVC radiation that may overcome this limitation.”

Blatchley said far-UVC — a narrow range of wavelengths between roughly 200-230 nm — has been shown to be effective and efficient for disinfection and decontamination of high-use spaces as well as HVAC systems and cabinet areas. It has also been shown to be far less damaging to human skin and eyes than conventional UV radiation, which could allow for people to remain in these spaces — provided the UV sources are properly used.

“The concern with UV radiation is its effect on skin and eyes, but far-UVC is absorbed by the stratum corneum and the corneal epithelium which are the exterior cells of the skin and eyes, respectively, and which are non-growing (dead) cells — so it doesn’t actually affect the skin or eye cells that are reproducing,” Blatchley said.

UV-based systems for air disinfection have been demonstrated to be effective for reducing transmission of a number of diseases that are known to be transmitted via airborne routes, including the common cold, influenza, measles and tuberculosis. The results of recent research have demonstrated that these same UV-based systems are likely to be even more effective for inactivation of coronaviruses, including SARS-CoV-2, the virus that causes COVID-19.

Civil engineering PhD student Xing Li said tests over the past 12 months have yielded very promising results. Ongoing research in this area is addressing the rates of virus inactivation by UV exposure as well as development of guidelines for testing and validation of UV-based systems for air disinfection.

“For much of what we’re researching, there isn’t a lot of existing work to follow,” she said. “While we conduct and report our efforts, we also are working to develop what should be the standard methods to disinfect these spaces.”

Blatchley’s team will continue to monitor the effectiveness of UV and far-UVC disinfection while also developing protocols for others to follow as greater international interest develops on combating current and future coronavirus outbreaks.

ROAD TO THE FUTURE

Around 50 percent of car crashes resulting in a fatality or injury in the United States happen in or near intersections, according to the Federal Highway Administration. That amounts to two million intersection-related crashes annually, the majority of which are attributed to human errors, such as speeding, following too closely, fatigue and distracted driving.

Yiheng Feng, assistant professor in the Lyles School of Civil Engineering, is Purdue's co-principal investigator in a $9.95M U.S. Department of Transportation project designed to increase safety through "smart intersections." The next-generation traffic control system gathers and transmits information in real time to connected and automated vehicles (CAVs).

"Currently, intersections are equipped with loop detectors that are buried beneath the pavement," Feng said. "When a vehicle drives over the loop, it communicates to the traffic signal to change. But there's no capability to gather information when the car is not within the detector area, that's the limitation of the loop.

"The CAV technology enables vehicles to connect with infrastructure and communicate their speed and position. Likewise, smart intersections are equipped with advanced roadside sensors such as radar, cameras and infrared cameras to detect all the objects nearby, not only the CAVs, but also pedestrians and cyclists."

That information can be instantaneously sent to CAVs in the vicinity, triggering onboard warnings when cars are approaching dangerous situations. The University of Michigan Transportation Research Institute is heading up the project and experimental smart intersections have been installed in downtown Ann Arbor, Michigan, where 3,000 cars were equipped as connected vehicles. It sounds like a lot, but only amounted to about 3% of the total vehicle population in the area.

"We must demonstrate the benefits of connected vehicles so consumers are incentivized to purchase them," Feng said. "There is a marginal cost associated with installing the connectivity devices but the potential safety benefits are substantial."

When an impatient driver is sitting behind a bus that's stopped to unload passengers, it's not uncommon to see the driver swerve around the bus. But what if there's a pedestrian crossing the intersection? If the intersection has sensors to identify the pedestrian, projecting both the pedestrian's trajectory and the vehicle's trajectory, infrastructure can detect a potential crash and warn the driver to stop. Similarly, infrastructure could detect black ice on the road ahead, warning drivers to slow down.

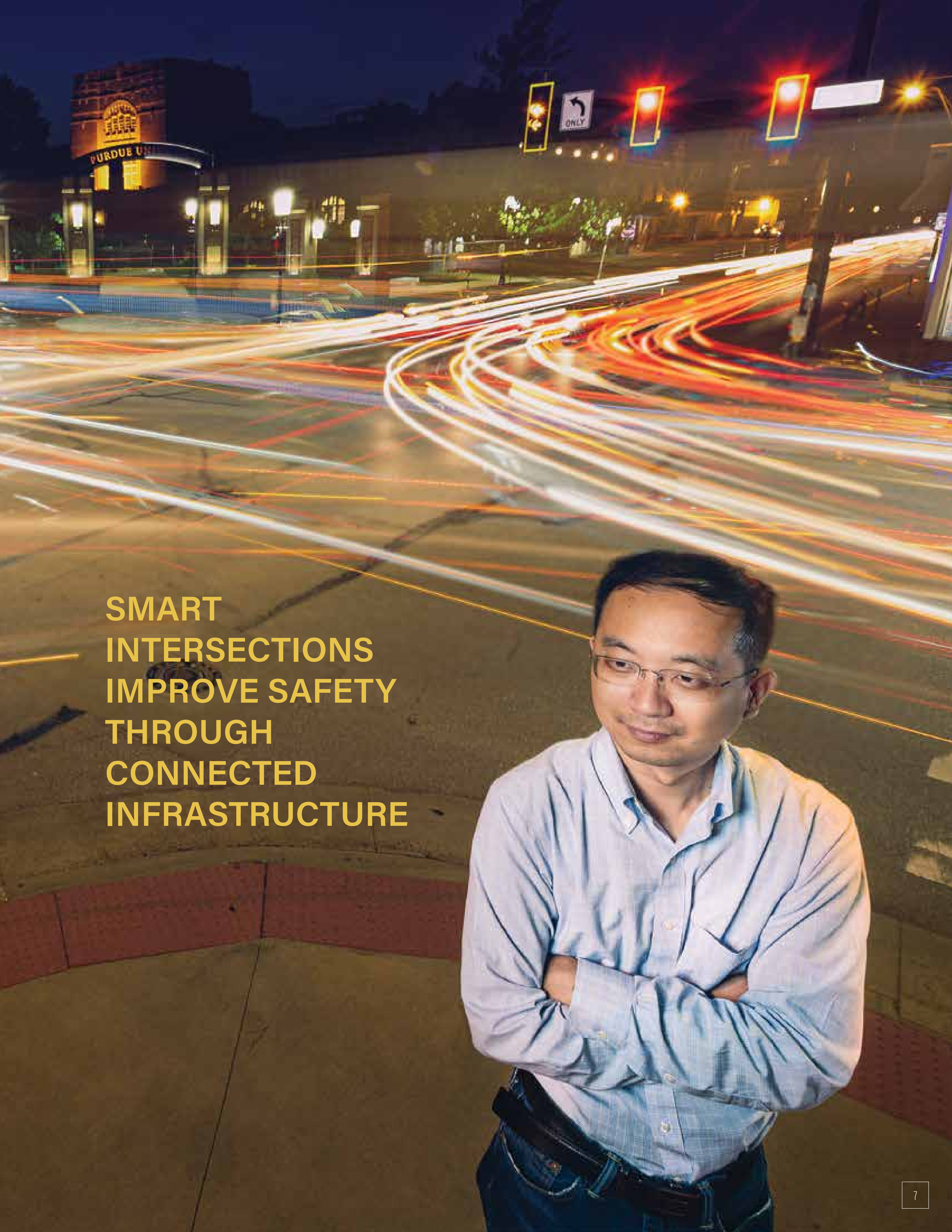
Feng envisions a future where all vehicles are connected, allowing for greater data collection and improved traffic management as well as safer intersections. But what about privacy concerns?

"Gathering personal identifying information from the vehicle is forbidden," Feng said. "The smart intersections collect data on the speed and trajectory of a vehicle, but not the car's make or model, the license plate or anything like that. It is critical that we respect privacy when conducting this type of research."

Drivers who use Waze, Google Maps or other GPS systems to navigate their routes already receive warnings about slowdowns in traffic, debris in the path of travel or vehicles stopped along the side of the road. Implementing smart intersection and CAV technology across the nation would provide similar hazard updates, just integrated into the operation of the vehicle, rather than through an app. Smart intersections would have other benefits, too.

"In addition to increasing safety, improving mobility is another primary goal of the project," said Feng. "Smart intersections could reduce the time drivers spend sitting at red lights when there's no traffic coming from the other direction."

The Purdue team will be responsible for developing core algorithms such as sensor data fusion, traffic state estimation and signal optimization that enable intelligent traffic control, Feng explained. Team members also will work with industrial partners to plan, deploy and test the developed algorithms at the smart intersection locations.



SMART INTERSECTIONS IMPROVE SAFETY THROUGH CONNECTED INFRASTRUCTURE

MASS TRANSPORTATION'S NEXT STOP

User preference may influence implementation of large-scale transit electrification

When it comes to advances in mass transit, researchers must think beyond the implementation of the technology itself and consider what it will take to get the public to use it.

Lyles School of Civil Engineering Professor Konstantina "Nadia" Gkritza's research team has partnered with the U.S. Department of Energy and Utah State University to study and break down the technical barriers to large-scale transit electrification. The project is titled "Increasing Affordability, Energy Efficiency, and Ridership of Transit Bus Systems through Large-Scale Electrification."

"As we get closer and closer to the implementation of electric mass transit vehicles, such as buses, we need to learn how likely the public will utilize them and what can be done to increase the public's perception and usage," Gkritza said. "Electric buses and other greener options are all great for the environment, but they will not generate as many benefits if people don't use them."

To tackle this dilemma, the multi-organization project aims to address electric bus infrastructure planning, smart operations, energy-efficient route optimization and grid impact analysis, as well as aspects of public utilization such as travel behavior study and new mobility integration. Collaborators include the National Renewable Energy Laboratory, Argonne National Laboratory, Utah Transit Authority, the Tri-County Metropolitan Transportation District of Oregon and PacifiCorp.

Currently, the Purdue team is addressing opportunities for public utilization by identifying and surveying both public transit users and non-users, and articulating policy implications and recommendations for a wider adoption of electric buses.

"I feel like the technology and industry support is there but what's really preventing us from achieving our goals is human preferences," Gkritza said. "We really need to identify what must be done to achieve a higher user rate, whether it be incentivizing users, bringing down costs or creating easier and affordable access."

Research team member and civil engineering master's student Jonathon Sinton said the team aims to target public transit users first, then survey more of the public to gain a better idea of what can be done.

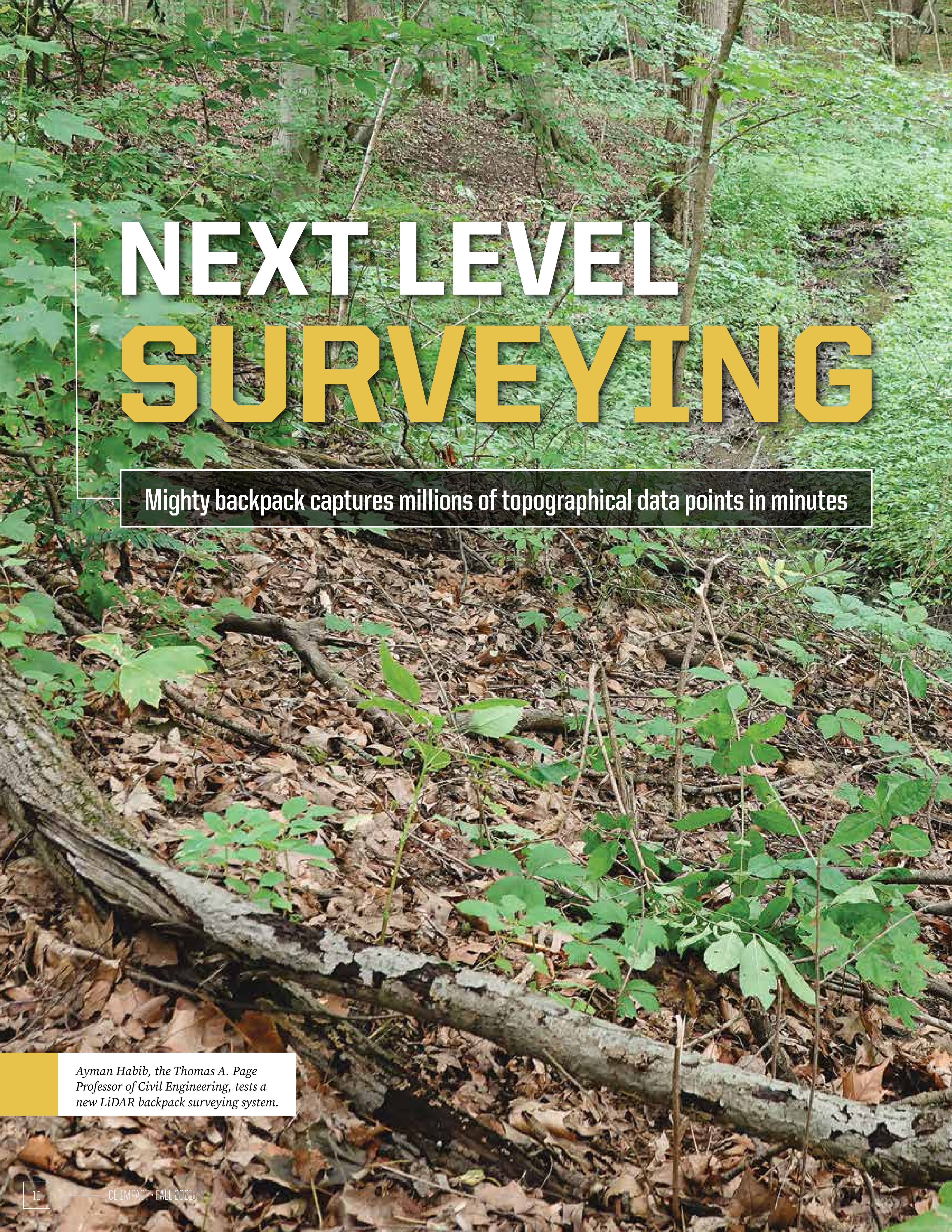
"The overall goal is to learn what is important to them and what their concerns and preferences are," Sinton said. "Electric public transportation is just starting to be implemented in this country and it will likely continue. We need to find out how to make it effective."

The research is affiliated with the Advancing Sustainability through Powered Infrastructure for Roadway Electrification (ASPIRE) center. ASPIRE is designated as an Engineering Research Center (ERC), the National Science Foundation's flagship program for transformative multi-institutional research. It is one of four new ERCs announced in August 2020.

ASPIRE is the only ERC dedicated to advancing sustainable transportation. ASPIRE is responsible for developing a broad set of solutions for zero-emissions transportation systems that improve air quality, enhance economic prosperity and impact thousands of students and businesses through workforce development and R&D opportunities. After 10 years, it is anticipated to achieve graduated status and will continue as a self-sustaining research center.

"THE TECHNOLOGY AND INDUSTRY SUPPORT IS THERE BUT WHAT'S REALLY PREVENTING US FROM ACHIEVING OUR GOALS IS HUMAN PREFERENCES."

—Nadia Gkritza
Professor, Lyles School of Civil Engineering, ASPIRE Campus Director and University Faculty Scholar



NEXT LEVEL SURVEYING

Mighty backpack captures millions of topographical data points in minutes

Ayman Habib, the Thomas A. Page Professor of Civil Engineering, tests a new LiDAR backpack surveying system.

Surveyors have been measuring and documenting the topography of the Earth for thousands of years. Though the instruments have evolved from the early days of rope stretchers to modern total stations, it's been challenging to collect accurate data efficiently when surveying heavily wooded areas, until now. A team of Purdue researchers is revolutionizing traditional ground surveying methods with a new technology that maps millions of elevation points in mere minutes simply by walking around the area wearing a backpack.

"We've developed a backpack system equipped with GPS and inertial navigation systems as well as LiDAR sensing," said Ayman Habib, the Thomas A. Page Professor of Civil Engineering. "The LiDAR system sends more than one quarter million pulses per second. Each one of these pulses derives an XYZ coordinate. The traditional total station and digital level surveying method captures a few hundred points a day in wooded areas. Using this new technology, millions of points are captured within a few minutes."

The team has tested the new techniques at Ross Camp — a site 10 miles southwest of campus purchased by David Ross (BSME 1893) in 1926 to provide civil engineering students a training camp to practice the latest surveying technology. By Indiana standards, the site has significant vertical relief with some valleys more than 100 feet deep and vertical slopes of more than 35%. This rugged terrain has been used to compare traditional surveying methods against the LiDAR-equipped backpack. It took a team of four about seven hours to capture 140 points using two total stations. A backpack unit mapped the same area in 15 minutes.

Traditional surveying techniques will yield more accurate results when surveying solid surfaces, however for areas with soft terrain, such as forests and shorelines, the backpack method measures within an inch of accuracy. And its capabilities will have impact far beyond the construction industry.

"This technology has multiple applications," Habib said. "It can be used to capture the biometrics of trees growing in a forest, map crops in a field, monitor erosion that could lead to landslides or evaluate the conditions of a shoreline. Some of this information can be captured through manned aircraft systems but that's an expensive undertaking and therefore only performed on an annual or biennial basis. This technology enables scientists to gather data at a higher frequency which is essential to develop timely mitigation measures."

Habib doesn't see his technology replacing traditional ground surveying methods such as total stations, but rather complementing their use. Total stations may still be the preferred method for mapping solid surfaces, but the advanced technology of the LiDAR backpack empowers surveyors with greater capabilities for about twice the cost of a total station.

"One area of focus is how to harness the developments in sensor technology to give the user community the ability to use these technologies at an affordable price while delivering the level of accuracy they would get from traditional techniques, if not better," Habib said.

Darcy Bullock, Lyles Family Professor of Civil Engineering, collaborates with Habib on the project and joined him for many of the backpack test runs. As the director of the Joint Transportation Research Program at Purdue, Bullock said he's excited about the impact Habib's technology will have on the transportation sector.

"Anytime a road is built near woods or wetlands, the entire area needs to be topographically mapped before construction," Bullock said. "Accurate mapping is critical to estimate the cost of removing vegetative matter such as stumps, roots, buried logs and other debris to make way for the new road. This new technology will reduce labor, improve the quality of the data and increase safety for surveyors. It's difficult work to haul around traditional equipment, crawling up steep slopes and over rugged terrain to mark every tree and boulder. The ability to accurately map the topography of these areas just by walking around with a backpack, it's an absolute game-changer."

PRESERVING THE PAST, PREPARING THE NEXT GENERATION

ALUMNA EMILY BYL RESTORES INDIANA LANDMARKS AND MENTORS CURRENT STUDENTS

Lyles School of Civil Engineering alumna Emily Byl has two passions: restoring landmarks of the past and guiding civil engineers of the future.

Byl (BSCE '14, MSCE '16) is a Professional Engineer at ARSEE Engineers Inc. in Fishers, Indiana, where she has been involved in several restoration projects. Most recently, she helped restore the terra cotta façade at a former Coca-Cola Bottling Plant in northeast Indianapolis now known as the Bottleworks District. Byl also had the pleasure of working on four of Indiana's historic county courthouses so far, and she enjoys working at universities throughout the state such as Indiana State, Butler and IUPUI.

"What first attracted me to civil engineering was my interest in historic buildings," Byl said. "Historic buildings are the heart of their communities. These buildings represent where we come from. Not only is it more sustainable to restore an existing building, it's also exciting to bring life back to that part of the community."

In addition to her interest in restoration, Byl said she had always enjoyed math and science and, upon enrolling at Purdue, she was fairly confident civil engineering was what she wanted to pursue. However, it was not until she took part in the Civil Engineering Cooperative Education Program (co-op) — where she worked for ARSEE — that she felt truly confident with her decision.

"Both the program and the company helped me gain a greater understanding of what I could do with my Purdue degree," she said. "Choosing to do co-op was the best decision of my college experience. Co-op furthered my understanding of what I learned in class and taught me how it related to my future career."

Byl also noted her Maymester abroad in New Zealand for Professor Ayhan Irfanoglu's earthquake engineering course in 2014 was an eye-opening experience following the Christchurch earthquakes in 2010-2011. Learning about rebuilding a city devastated by earthquakes served to strengthen her desire to become a civil engineer who restores buildings and communities.

After earning her bachelor's degree, Byl would go on to pursue her master's at Purdue and was advised by Robert Frosch, senior associate dean of engineering for facilities and operations and professor of civil engineering. Graduate coursework and work as a research assistant expanded her understanding of civil engineering and allowed her to gain the knowledge she needed to succeed in her chosen career path.

Now, as a professional engineer, Byl often finds herself on campus to serve as a mentor to civil engineering students. In addition to serving on the CE Professional Practice Advisory Board, she is also a regular speaker in the Contemporary Issues in Civil Engineering course and an active supporter of Purdue's chapter of Chi Epsilon, the civil engineering honor society.

"I love coming back to campus and meeting with students," Byl said. "It's great to let them know what options and possibilities are out there for them. I want the students to take advantage of the many opportunities awaiting them as Purdue civil engineering graduates."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ONLINE MASTER'S DEGREE

Program continues to expand to meet the needs of today's professionals

In the winter of 2021, Purdue University's School of Civil Engineering launched its Online Master's Degree Program. The program offers a world-class graduate degree in civil engineering with the flexibility of an entirely online program. In just 30 credit hours, learners dive deep into their chosen discipline and learn from the same world-renowned faculty who teach students on campus.

"While we're still less than a year into our program, our sights are set on continuing to expand and improve it so that professionals who are looking to earn their degree while maintaining their careers can gain the absolute maximum value for their time," said Dulcy Abraham, professor of civil engineering.

The program has already started to earn national recognition. The *U.S. News and World Report* has ranked it the No. 2 online master's program in the country for 2022. In 2021, the program saw 17 new students start in spring, 10 in the summer, and 29 new students are expected to start in fall.

"This program is our newest addition to the school's offerings and is strongly supported by our world-renowned faculty," said Rao S. Govindaraju, Bowen Engineering Head of Civil Engineering and the Christopher B. and Susan S. Burke Professor of Civil Engineering. "It has been years in the making to ensure our online learners get the best education possible."

About the program

The Online Master's Degree program offers interdisciplinary tracks in sustainable water; infrastructure, resiliency and sustainability; and smart mobility.

The sustainable water track provides coursework related to water quantity, taught through coursework in hydrology and hydraulics, and water quality, taught through coursework related to water treatment.

The infrastructure, resiliency and sustainability track focuses on the latest advancements in the analysis, design and construction of buildings, bridges, roadways, industrial facilities and power plants such as sustainable materials and non-destructive evaluation, digital twinning for planning and construction and design for natural hazards and resilience.

The smart mobility track focuses on emerging technologies in transportation engineering such as autonomous, connected, electrified and shared micromobility transportation systems. Techniques for assessing the safety, efficiency, sustainability and societal impacts of these systems will be useful to a broad cross section of professionals, including engineers and policymakers.

Over the summer, Purdue Civil Engineering introduced a MicroMasters course in Materials Engineering for Intelligent Infrastructure. The program will benefit students with the advanced and emerging technology for intelligent infrastructure. This program will also help students kick-start or rise in a career in one of the fastest-growing tech fields today.

Admission considerations for Spring 2022 are open. Contact Jenny Ricksy, graduate program administrator, at jricksy@purdue.edu for more information.