FALL 26

IMPACT

LYLES SCHOOL OF CIVIL AND CONSTRUCTION ENGINEERING

OUT OF THE SHADOWS

New research challenges traditional assumptions about classroom lighting for autistic students

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PURDUE UNIVERSITY

Lyles School of Civil and Construction Engineering

ADVANCED DIGITAL TWINS REVEAL HOW FIRES SPREAD—AND HOW TO STOP THEM | PAGE 8

MESSAGE FROM THE HEAD

The new school year is underway and with it comes a fresh sense of excitement and anticipation for what is to come. It also serves as a good reminder of why what we do here is so impactful.

Our students in the Lyles School of Civil and Construction Engineering have immense potential as eventual leaders in their fields. Whether it be in industry, research or education, what they learn here today has a tremendous impact on not just their futures, but all our lives as they go on to lead, create and safeguard our communities, the environment and the following generation of engineers.

Our school — and Purdue University as a whole — has always set its focus forward, as we persistently pursue The Next Giant Leap to amplify our impact in society. That impact, of course, begins in the classroom. Our faculty are some of the absolute best in their fields, and they all possess a strong passion for education and sharing their knowledge with the civil engineers of tomorrow.

We also have researchers — on campus and around the world — hard at work, investigating how to improve water systems, how communities can better respond and recover from natural disasters, and how to make our daily commutes both faster and safer.

Our mission to amplify impact has never been a set of empty words — it is what we all continually strive to do. And this edition of Impact Magazine will highlight some of our work that aims to improve our world.

These stories include research into creating better, more vibrant indoor environments for people with light sensitivities; creating smarter, safer mass transit systems; preserving the freshwater at the Panama Canal; and better prevention and mitigation of wildfires in the United States.

These are just a handful of the innovative research projects taking place at the Lyles School of Civil and Construction Engineering, and I look forward to sharing even more of these stories in future publications.

Best regards,

Robert J. Frosch
Interim Head and Professor of Civil Engineering
Lyles School of Civil and Construction Engineering

Vice Provost for Academic Facilities
Purdue University

IN THIS ISSUE:

ON THE COVER

An interdisciplinary research team led by Thanos Tzempelikos, professor of civil and construction engineering and Herrick Labs faculty, is exploring the effects of artificial lighting and natural daylight in schools and autism-support facilities.

Photo Illustration by Charles Jischke

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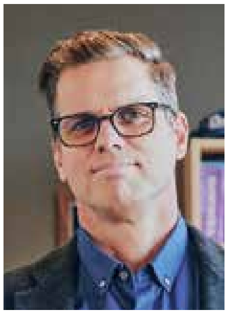
NEWS & EVENTS



NEW SCHOOL HEAD NAMED

Purdue Engineering has selected Michael D. Todd as the next Bob Bowen Head of the Lyles School of Civil and Construction Engineering.

Currently a distinguished professor at the University of California San Diego, Todd joined the faculty in 2003 and has served as chair of the Department of Structural Engineering since 2023. Before moving to academia, he worked as a research engineer and section head at the U.S. Naval Research Laboratory in Washington, D.C.

Todd's appointment is effective Jan. 1, 2027. He will replace Interim Head Robert Frosch.

CONGRATULATIONS GRADUATES

Congratulations to the Lyles School of Civil and Construction Engineering class of 2026! This past spring, we celebrated more than 200 undergraduates and 50 graduate students as they earned their degrees.

SYMPOSIUM ON STEEL TO CONCRETE CONNECTIONS

In August, the Lyles School of Civil and Construction Engineering hosted the inaugural edition of the International Symposium on Steel to Concrete Connections (SySCCon). This symposium brought together experts from academic institutions, research organizations, and industry from around the world to provide an exceptional platform for discussing the latest advancements in the field of steel-to-concrete connections.

Professor Pablo Zavattieri traveled to Panama to present his team's 3D-printed barrier technology to members of the Panama Canal Authority.

PROTECTING THE PANAMA CANAL

Bioinspired barrier would reduce saltwater intrusion while maintaining vessel traffic

A Purdue invention seeks to preserve one of the world's most vital waterways.

Since 2024, Pablo Zavattieri, the Jerry M. and Lynda T. Engelhardt Professor in Civil Engineering, has been developing a 3D-printed barrier for the Panama Canal.

The novel structure is designed to hold back saltwater intrusion while safeguarding freshwater supplies for local communities.

The idea emerged in 2023, when Zavattieri and visiting researcher Nelson Pachao began discussing how architected materials and large-scale deployable structures could offer new engineering solutions to global challenges.

"One problem of interest is examining how climate change, increased water demand from Neopanamax traffic and declining freshwater availability in Gatun Lake have exacerbated the problem," Zavattieri said. "These challenges threaten both human consumption of water and the number of daily transits in the canal, reducing revenue. We knew the canal was facing an increasingly difficult challenge. The question became whether we could rethink the problem from an engineering perspective."

Zavattieri said Luis Alfaro (MSCE '77, PhD '80, CEAAA '10), former vice president of the Panama Canal Authority (ACP), has served as a critical connection to the organization. Alfaro's involvement has helped bridge Purdue research and Panamanian infrastructure priorities. Alfaro carefully reviewed the concept, provided valuable technical feedback and helped the team refine the idea while introducing it to key stakeholders within the ACP. Supported by the Lyles School, Zavattieri and Pachao presented their technology to ACP engineers and leadership in Panama, a move that sparked a formal partnership to test its feasibility.

The Purdue team is developing a 3D-printed/fabricated reconfigurable and navigable waterway barrier (RNWB) designed by Zavattieri and Pachao. Zavattieri describes the RNWB as an "underwater reconfigurable, flexible skin" inspired by nature that opens and closes like an aperture to minimize the mixing of saltwater from the Pacific Ocean into the freshwater Gatun Lake — the primary freshwater source in the area.

"In addition to the environmental benefits, this could also lead to greater canal capacity," Zavattieri said. "The objective is simple, if we can reduce the amount of freshwater lost during droughts while maintaining navigation, then we can help the canal face one of its biggest challenges. The 2023 drought, and the conditions expected this year because of El Niño, make that challenge even more relevant."

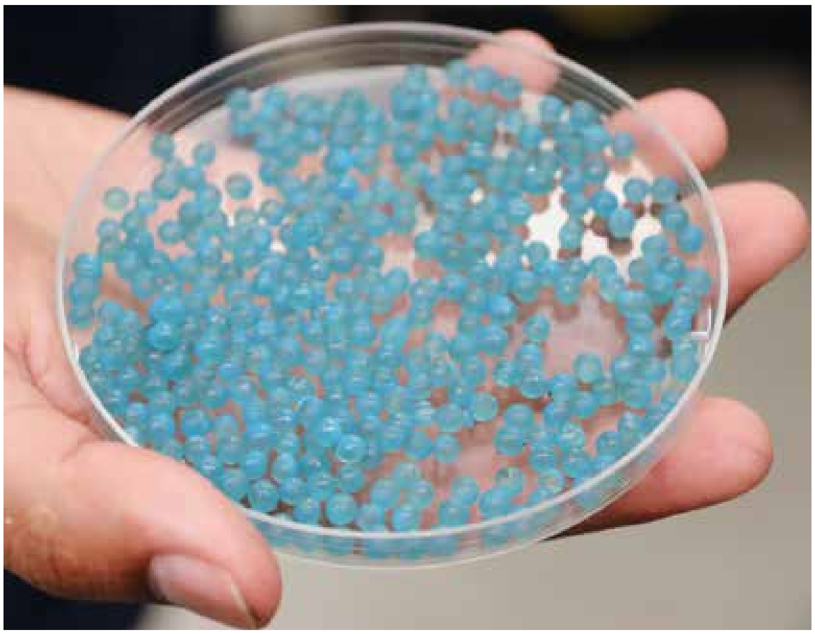
PhD student researcher Juan Fernando Cucuyame said the team is currently optimizing the model design for the RNBW, but early tests have been promising.

"We are always looking for ways to improve the build and work on new design iterations, but what we are seeing has been very encouraging," Cucuyame said. "We are nearing a point where we can take our work out of the lab and test it in the field."

To further aid in their research, Purdue awarded Zavattieri's team a research grant through its Trask Innovation Fund to develop University-owned intellectual property for commercial use. Zavattieri said the Trask award will fund a six-month project to advance the RNWB by refining its design, fabricating a proof of concept and conducting controlled tests on campus.

Beyond the Panama Canal, Zavattieri has also begun discussions with the U.S. Army Corps of Engineers about potential applications of the technology to navigation locks in the United States, and with the California Department of Water Resources regarding saltwater intrusion challenges in the Sacramento-San Joaquin Delta.

SMALL PARTICLES BIG IMPACT



NEW GRANULAR TECHNOLOGIES COULD ADVANCE SEISMIC ISOLATION AND SHOCK ABSORPTION

Purdue Civil Engineering PhD student Kike Garzon-Sabogal prepares a batch of granular material particles for testing.

Research into functionalizing granular materials for vibration control has the potential to have impact throughout the engineering field.

From the development of a highly dissipative granular material to the design of granular metamaterials capable of filtering vibrations in specific frequency ranges, Marika Santagata, professor of civil and construction engineering, said "the potential applications are wide-ranging."

The "engineered particles" conceived to increase energy dissipation are formed by a rigid core encapsulated in a soft shell. "This particle-scale design explores the idea that mediation of particle contacts by a soft lossy phase can enhance dissipation under dynamic excitation," said PhD student Kike Garzon-Sabogal, who developed the methodology to manufacture the particles in the lab.

Experiments performed by Garzon-Sabogal show an increase in the small strain damping ratio by as much as an order of magnitude. The research team envisions potential applications in shock absorption and seismic isolation.

Equally promising is the group's work on granular metamaterials formed by layers of randomly packed grains organized in a periodic structure, Santagata said.

"While other researchers have previously used discrete granular elements for filtering vibrations, we believe this work provides the first experimental evidence of the potential for using bulk granular materials, including those of geologic origin, which geotechnical engineers are most familiar with," Santagata said. "The architecture of the layers and the contrast in their properties allow us to precisely define the range of frequencies that are filtered, with further tuning enabled by controlling the level of confinement."

Santagata said the research also produced advancements in methods for testing granular materials. In particular, a new approach was developed that extends the capabilities of conventional resonant column testing by enabling the analysis of off-resonance data and enforcing control over the vibrations applied to test specimens.

"This represents a true paradigm shift in resonant column testing," said Santagata, who credits Professor Emeritus Vince Drnevich for working alongside her and her team.

Santagata said the new method will eventually be incorporated in an American Society for Testing and Materials standard.

DEMOLITION DRIVES DISCOVERY

RARE FULL-SCALE BRIDGE TEST IMPROVES FUTURE INFRASTRUCTURE SAFETY AND RESILIENCE

Sometimes the best way to make a bridge safer is to blow it up.

In the winter of 2025, Lyles School of Civil and Construction Engineering researchers had the rare opportunity to test a working bridge to the extreme. The team, led by Professor Robert Connor, worked with a contractor who installed explosive charges to the recently decommissioned Black Hawk Bridge to study how to evaluate and design stronger bridges in the future.

"There have only been a handful, maybe three in the U.S., of real-world tests at this scale," said Connor, the Jack and Kay Hockema Professor in Civil Engineering and Director of Purdue's Center for Aging Infrastructure (CAI) and the Steel Bridge Research, Inspection, Training and Engineering (S-BRITE) Center. "We almost exclusively have to rely on computer models when it comes to studying and predicting bridge failure — which are great tools, of course — but to actually learn in real-time and see exactly what happens to a working bridge when it receives major damage in specific areas is invaluable."

The Black Hawk Bridge was a historic structure that carried Iowa Highway 9 and Wisconsin Highway 82 traffic across the Mississippi River, connecting Lansing, Iowa, to Crawford County, Wisconsin. Constructed in 1931, the bridge spans 1,630 feet and is comprised of cantilever through truss main spans along with five steel truss approach spans and one multi-girder approach span.

Connor's team first loaded one of the truss approach spans with a total of 125,000 pounds of sand to simulate active traffic weight, then installed explosive charges to create a controlled fracture on a tension diagonal member on the bridge's south truss. To further explore the limits of the system's redundancy, Connor's team also removed additional members from the damaged south truss.

While the team is still reviewing the data, Chaz Kieffer III, PhD candidate and research engineer, said one major takeaway is that the bridge has proven to be far more redundant than what any simple hand calculation or computer model predicted.

"Standard engineering assumptions dictate that truss bridge members are nonredundant, meaning we should expect a total collapse or extreme displacements after failure of a primary tension member," Kieffer said. "But the bridge performed far better than industry expectations would dictate. The bridge maintained its structural geometry with negligible deflection, providing clear evidence of the uncredited redundancy inherent to the overall system."

In addition to gaining greater insight on the true strength of the bridge, Connor said this experiment also will greatly improve future computer models.

"Being able to use real-world, proven data to strengthen our computer models will be something civil engineers the world over can benefit from," Connor said. "With this new calibration data, the industry will gain further confidence in the complex analytical models used for such evaluations. This will allow more widespread use of such tools and a better understanding of bridges under extreme conditions. The overall result is a more reliable and robust transportation system and a better use of limited resources, which is critical as infrastructure continues to age."

The project was made possible through a highly successful collaboration between Purdue University, Kraemer North America, VEIT, Genesis Structures, the Iowa Department of Transportation and the Wisconsin Department of Transportation.

DESIGNING FOR DAYLIGHT

Researchers rethink classroom lighting for autistic students

Before an autistic child can process a teacher's words, they must process the room itself. Light, sound, and layout dictate comfort and focus in ways researchers are only beginning to unlock.

A research team led by Thanos Tzempelikos, professor of civil and construction engineering and Herrick Labs faculty, is exploring one piece of that puzzle — the role of natural daylight in schools and autism-support facilities.

Funded by the National Science Foundation and conducted in partnership with Ball State University, the project brings together experts in architectural engineering, autism behavior and education to study how children respond to different lighting conditions.

"These kids have extreme sensitivity to environmental conditions, and that includes both artificial and natural light sources," Tzempelikos said.

The challenge is that many schools serving autistic students keep blinds closed for much of the day to avoid overstimulation. While that approach may reduce immediate sensory triggers, it can also limit exposure to daylight, which plays a critical role in sleep, circadian rhythms and overall well-being.

"We want to understand what triggers negative behaviors with respect to daylight," Tzempelikos said. "The goal is to improve some of these behaviors by controlling daylight in buildings instead of closing the blinds all the time."

The three-year project seeks to answer three questions: whether daylight influences behavioral responses, whether researchers can predict those responses through computational modeling, and how those findings can be translated into practical design guidance for schools and caregivers.

FROM OBSERVATION TO DESIGN

To gather data, researchers are conducting both controlled laboratory studies and observations in real classrooms. In the lab, children engage in familiar activities such as drawing, reading and puzzles while researchers adjust lighting conditions and monitor responses. Observers track behaviors such as blinking, repetitive movements and attention to windows to better understand how changing daylight conditions may influence behaviors, comfort and engagement. In schools, researchers observe students in their everyday learning environments.

"Conducting research in both settings is important because in the controlled experiments we understand the fundamental mechanisms," Tzempelikos said. "In the classroom, we can observe children in their natural setting to see whether they display similar patterns of behavior."

The project emerged from a gap Tzempelikos and his collaborators observed in both research and practice. While designers and educators have long recognized that autistic children may be sensitive to lighting conditions, little evidence exists to guide decisions about daylight in classrooms. In visits to schools, the research team found a wide range of approaches — some facilities kept blinds closed throughout the day, while others allowed direct sunlight into learning spaces with few controls.

Researchers hope the study will move the conversation beyond assumptions and provide data-driven recommendations that balance sensory comfort with the well-documented health benefits of daylight exposure.

LEARNING ACROSS DISCIPLINES

Postdoctoral researcher Sichen Lu (BSCE'18, MSCE'20, PhD'25) said the project also demonstrates the value of interdisciplinary collaboration.

"Projects like this allow students to see how engineering research connects directly to people's lives," Lu said. "We worked closely with researchers at Ball State who study autism behavior, which gave us perspectives we would not normally encounter in a traditional engineering project."

That collaboration required students to move beyond building performance and environmental measurements to consider human-centered outcomes.

"As graduate students, we learned how to communicate across disciplines and work with partners who approach problems from very different backgrounds," Lu said. "Those experiences help prepare us for future research and industry careers where complex challenges rarely fit within a single field."

Students on the team also learned about the realities of conducting community-based research. The project required partnerships with schools, autism-support facilities and families, along with months of data collection in both controlled and real-world settings.

"It was rewarding to see how many people were interested in helping make this work possible," Lu said. "It showed us how research can bring together different expertise to solve problems that matter to communities."

For Tzempelikos, that interdisciplinary approach reflects the broader mission of architectural engineering.

"Buildings are built for people," he said. "We need to maintain a healthy, comfortable and efficient indoor environment for everyone."

The first-of-its-kind study could help schools create spaces that better support learning, health and well-being — one window, and one beam of daylight, at a time.

PREDICTING FIRE BEFORE FLAMES

Digital twins reveal vulnerabilities across wildfire-prone communities

Each year, approximately 60,000 wildfires break out across the United States, with many igniting or spreading through the wildland-urban interface (WUI), where homes, infrastructure and natural landscapes converge. To help communities better prepare for and reduce wildfire impacts, the National Science Foundation has awarded nearly $2.5 million to a multidisciplinary research team led by Purdue University.

The project is led by Ayman Habib, the Thomas A. Page Professor of Civil Engineering, with collaborators at Purdue; University at Buffalo; University of California, Los Angeles; and the NSF National Center for Atmospheric Research. The team is developing multi-resolution digital twins of the wildland-urban interface that integrate geospatial data collected at multiple spatial scales, resolutions, sensing modalities and time periods. These digital twins will provide realistic virtual representations of WUI communities that can be used to evaluate wildfire behavior, assess community vulnerability and test mitigation strategies before fires occur.

"Our goal is to develop a new generation of digital twins that support the proactive prevention and mitigation of wildfires at the wildland-urban interface," Habib said. "By combining detailed geospatial information with advanced fire behavior models, we can evaluate wildfire risk under different conditions and determine how changes in the landscape, vegetation and built environment can reduce fire spread and improve community resilience."

A major challenge is that existing geospatial datasets are collected at different resolutions, formats and time scales, making it difficult to create comprehensive digital twins that accurately represent both urban and wildland environments. The research team will develop new methods for integrating these diverse datasets into a seamless, multi-resolution representation of the WUI, providing the level of detail needed to capture wildfire behavior from the landscape scale down to individual structures and vegetation.

"Once completed, this project will provide communities with a powerful decision-support tool for wildfire planning, resilience and recovery," said Mona Hodaei, CCE graduate student researcher. "We will build digital twins that allow planners and emergency managers to explore 'what-if' scenarios, quantify wildfire risk and evaluate strategies that can reduce future losses." To develop, validate and refine the digital twin framework, the researchers will leverage extensive pre- and post-fire datasets from two catastrophic wildfire events: the 2025 Los Angeles wildfires and the 2016 Gatlinburg, Tennessee, wildfire. These case studies represent dramatically different climates, landscapes, vegetation types, ignition sources and community characteristics, enabling the team to develop broadly applicable methods for wildfire risk assessment and mitigation. The resulting multi-resolution digital twins will provide a scientific foundation for designing safer, more resilient communities and for supporting informed decisions that reduce wildfire impacts before disasters occur.

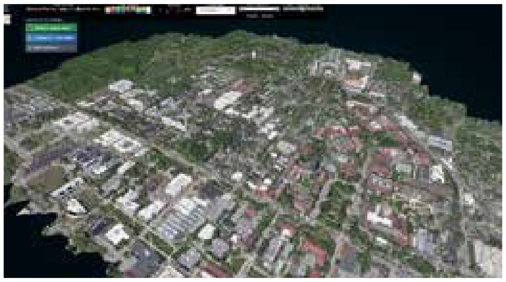


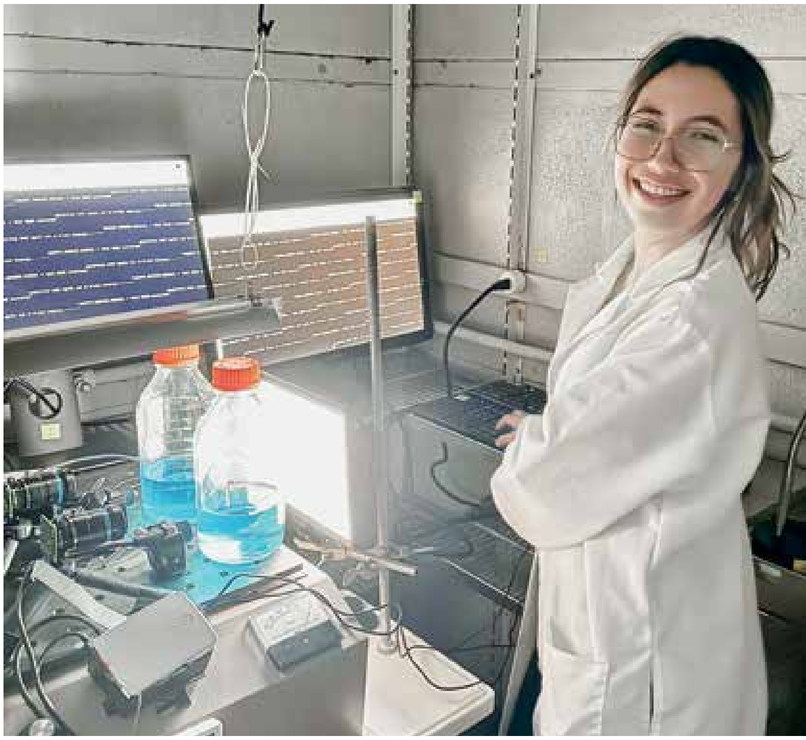
Figure 1 – Digital twin of the Purdue campus generated by Habib's research group.

Figure 2 – Close-up example of a digital twin of the Purdue campus generated by Habib's research group.

A cloud of smoke from a Colorado wildfire billows over a residential neighborhood in Boulder.

WHEN BLUE IS GREEN

AI and algae power a new future for sustainable seafood



Amanda Lopez-Savage uses an automated IoT-enabled platform that integrates real-time intracellular lipid sensing and machine learning to monitor microalgal bioprocesses in the laboratory.

As the U.S. imports most of the seafood it consumes, Purdue researchers are working to change that. Amanda Lopez-Savage, a recent PhD graduate of the School of Sustainability Engineering and Environmental Engineering, and Zhi (George) Zhou, associate professor of civil and construction engineering, are leading the “When Blue is Green” (BiG) project, an ambitious effort to expand domestic seafood production through innovative aquaponics systems.

By developing zero-waste, grid-independent and economically viable production models, the team aims to strengthen regional seafood supplies, reduce the nation’s $17 billion seafood trade deficit and lessen the environmental impact of food production. Working with partners across the entire blue food supply chain, the researchers are building the evidence needed to make sustainable, U.S.-grown seafood more competitive and accessible.

Central to their research is the creative integration of machine learning and a patented biomimicry technique to enhance algal lipid productivity.

“By optimizing cultivation through predictive modeling and leveraging viral lysis for efficient lipid extraction, we unlock algae’s potential as a sustainable source of high-value products, including feed ingredients, specialty chemicals and human food supplements,” Zhou said. “Furthermore, our approach facilitates nutrient recovery, allowing for the direct integration of these processes into aquaponics systems to advance circularity.”

Their approach also facilitates nutrient recovery by integrating these innovations directly into aquaponics systems, promoting a circular, sustainable model.

What sets their work apart is a holistic, data-driven “digital-biological” framework that bridges two of the biggest hurdles in algal biofuel production: upstream cultivation and downstream extraction. Their machine-learning random forest models accurately predict the optimal environmental drivers to maximize lipid output, while the biological approach — using the PBCV-1 virus for viral lysis — triggers algae to accumulate valuable lipids without expensive chemicals or harsh stressors. By integrating these strategies, Lopez and Zhou have developed a highly efficient, sustainable and cost-effective production cycle that overcomes traditional, energy-intensive bottlenecks.

The concept of viral lysis, a naturally occurring biomimetic process, has proven to be a significant enhancement to engineering systems, while machine learning and artificial intelligence (AI) — modeled after the human brain — have transformed the approach to complex scientific questions. They believe that the full potential of AI in this field is only beginning to be realized.

“In my PhD research, I explored how AI can be applied to close the gap between what we can predict, what we can optimize and what we can ultimately control during bioprocessing,” Lopez said. “Although AI may be the missing analytical layer between biological complexity and control, integrating it into the dynamic and unpredictable reality of living unicellular systems in the laboratory is challenging and remains largely unexplored. To address this knowledge gap, I developed a unified framework using AI as the central engine for discovery, optimization, inference and anticipation during microalgal bioprocessing.”

Lopez’s work at the intersection of AI and sustainable biofuel production led to three significant innovations: a machine learning model that streamlines lipid production predictions in algal cultures; a highly efficient technology that uses unsupervised learning and fluorescence imaging to boost microalgal lipid reserves by 165%; and an AI-powered optical sensor that enables real-time, cost-effective monitoring of lipid biosynthesis and metabolic stress for intelligent bioreactor control.

Together, these three projects have opened new avenues in experimental biology and computational intelligence, signaling a transformative era for sustainable bioprocessing and the future of blue foods. With their innovative work, Lopez and Zhou are laying out the foundation for intelligent, efficient and environmentally responsible bioreactor systems — offering real hope for a more sustainable food future.

HOLDING FAST

Testing an innovative concrete anchor for offshore wind

The global energy sector is undergoing a significant transition as it shifts toward renewable energy. Researchers at Purdue's Bowen Laboratory for Large-Scale Civil Engineering Research are advancing anchoring technology for offshore renewable infrastructure by developing and testing innovative materials and anchorage systems.

Renewable energy sources such as solar, wind and geothermal offer promise but require significant space, while hydroelectric dams can have major environmental and social impacts. Floating wind and solar farms are gaining momentum because they harness strong winds and sunlight over water without occupying valuable land. Their success, however, depends on durable anchoring systems.

A team led by Lyles School of Civil and Construction Engineering professors Akanshu Sharma, Jan Olek, Pablo Zavattieri and Jeffrey Youngblood and post-doctoral researcher Deepak Suthar is testing a concrete-based suction anchor as an alternative to traditional steel anchors. The research is being conducted in collaboration with Sperra, a Boulder, Colorado-based company that designs structural systems for energy projects in aquatic environments.

Concrete is abundant, resilient and more resistant to saltwater corrosion than steel, making it an attractive option for offshore applications.

"There's increasing momentum to build wind and solar farms on large bodies of water, which sidesteps the need for land reclamation for major projects," Suthar said. "These floating farms use open ocean, sea and lake surfaces to harness strong, consistent winds and unimpeded sunlight — eliminating the need for land and reducing their physical footprint."

Purdue's project centers on a 40%-scale concrete suction anchor developed with Sperra employees Taylor Marchment, Mason Bell and Alexander Mendez Chavez. Supported in part by the National Science Foundation, the team built a reinforced concrete test anchor measuring 60 inches wide, 12 inches thick and 12 feet long to replicate real-world conditions.

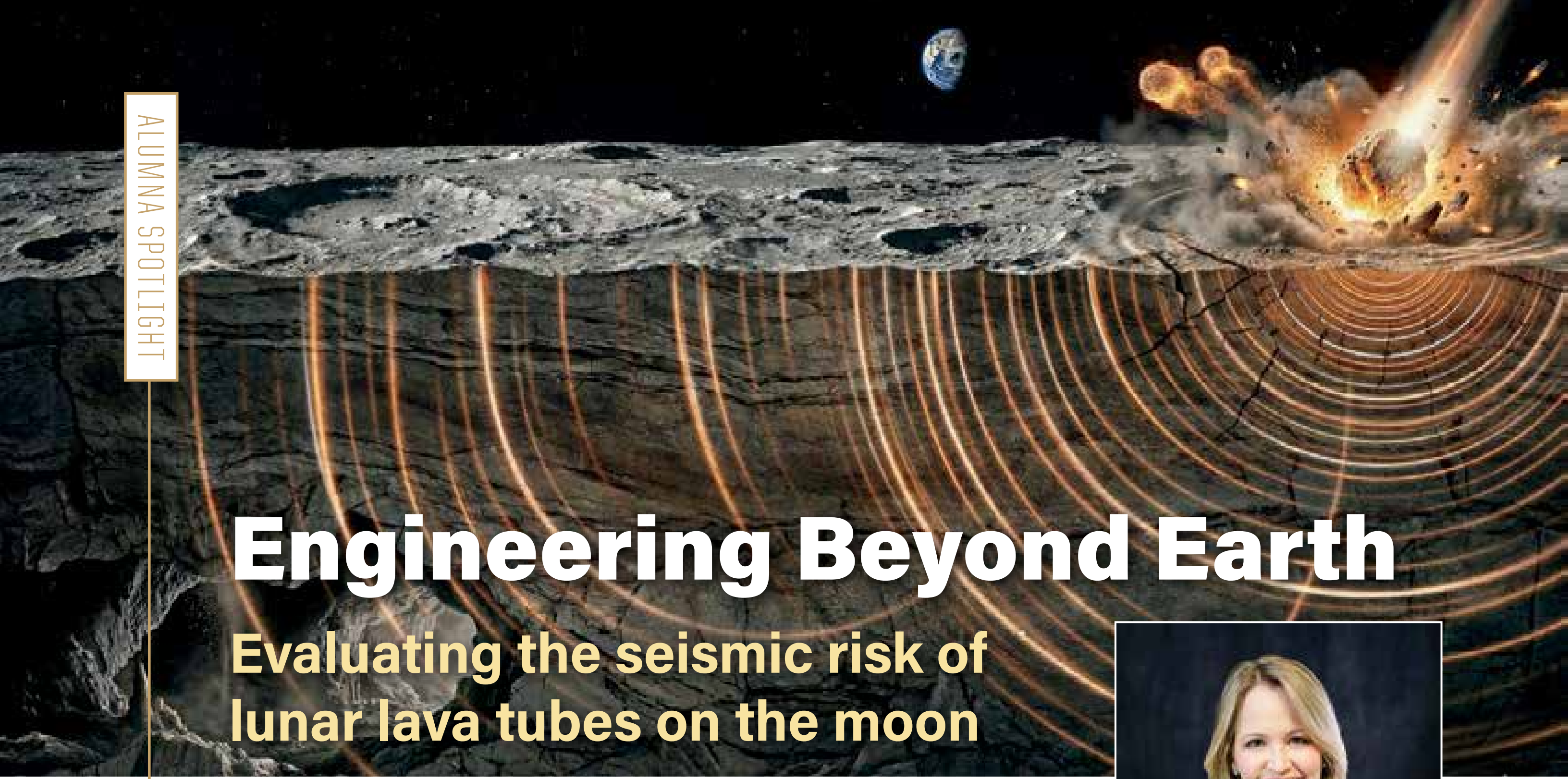
The anchor was tested under pullout loading until it failed through a concrete breakout mechanism as part of a broader research program investigating 3D concrete printing and automated construction methods for offshore infrastructure. The failure load closely matched predictions from computer models and previous small-scale tests, demonstrating that concrete suction anchors can perform effectively at scale while identifying opportunities to improve strength, optimize connections and simplify construction.

"This first-of-a-kind test on the concrete suction anchor is a testament to Bowen Lab's capabilities as the leading lab for highest quality large-scale structural testing," Sharma said. "Several challenges, including the circular geometry, scale of the specimen, complex 3D-printed concrete connections and ensuring safety during the test, were overcome through the commitment of the Purdue and Sperra teams. We look forward to continuing and furthering this exciting work."

Next steps include developing more durable anchor designs, evaluating sustainable concrete mixtures and alternative reinforcement materials, and refining automated 3D-printing methods to speed construction. The team hopes those advances will further improve the performance and affordability of offshore renewable energy infrastructure.

"Collaborating with the Purdue University team on this NSF STTR Phase II project has been critical to validating the design and engineering of our concrete suction anchors," said Jason Cotrell, founder and CEO of Sperra. "The successful structural test demonstrates the potential for robotic concrete manufacturing methods to support the development of durable, cost-effective offshore infrastructure."

Members of Purdue's Bowen Laboratory team working on the research project. Left to right: Jaeseok Jeong, graduate student researcher; Akanshu Sharma, associate professor; Deepak Suthar, post-doctoral researcher; Jayesh Shivtarkar, graduate student researcher.



Engineering Beyond Earth

Evaluating the seismic risk of lunar lava tubes on the moon

Juliana Spohr Pereira (MSCE'17) is redefining the boundaries of civil engineering — both on Earth and beyond. With an unconventional academic path that bridges journalism and civil engineering, she brings a unique perspective to her research and communication.

Her educational journey began in Brazil, where she obtained degrees in both journalism and civil engineering. International experiences — like honing her English in Canada, studying dam safety in the Netherlands, researching flood mitigation in Spain and interning on bridge projects in Florida — have shaped her global outlook. Now, as a PhD student at Purdue, Pereira is on the cutting edge of extraterrestrial engineering, focusing on how we can safely inhabit the Moon by evaluating the seismic risks of lunar lava tubes.

Her decision to attend Purdue's Lyles School of Civil and Construction Engineering was driven by the school's global reputation, exceptional research facilities and renowned faculty. After earning the Science without Borders scholarship from the Brazilian government, Pereira sought out a place that offered research opportunities beyond what was available at home.

"Purdue is known as the Cradle of Astronauts," she said. "Where else could I work on the moon? I am incredibly grateful to have the support of the Purdue community and my amazing advisor, Antonio Bobet."

Pereira also expressed gratitude for Pete Mitnick (BSCE'77) whose donations support her research endeavors, and to Scott Hinkel, senior director of development, who made this connection possible. Pereira's expertise lies in geotechnical engineering. During her master's degree, she investigated deep-pile foundations for major infrastructure projects. Now, she applies advanced knowledge of rock mechanics, numerical modeling and tunnel stability not just to terrestrial projects, but also to underground structures for space exploration.

At the heart of Pereira's research are lunar lava tubes — vast underground tunnels formed by ancient volcanic activity on the moon. These hidden spaces offer a promising solution for building permanent lunar habitats, as their rocky ceilings shield astronauts from harsh conditions such as radiation, meteorites and temperature extremes. Using sophisticated finite element analysis, Pereira models how these tunnels would withstand moonquakes and meteoroid strikes, helping ensure that future lunar settlers can live and work safely beneath the moon's surface.

After extensively studying the effects of moonquakes, Pereira is now turning her attention to meteoroid impacts — another serious threat to lunar structures. By harnessing the iSALE shock physics code, she simulates the dramatic collisions and the seismic waves they unleash. This work will help define the safest tube dimensions and roof thicknesses, as well as the engineering reinforcements needed to make lunar settlements a reality.

Beyond her groundbreaking research, Pereira is passionate about mentoring the next generation of engineers. She believes in the power of combining technical prowess with communication skills — her background in journalism has been invaluable in making complex data accessible and effectively teaching and mentoring students.

She urges students to get involved early through research, internships and leadership roles, emphasizing that the greatest growth happens outside the classroom. Building strong professional networks, she says, is vital. The Women in Engineering program at Purdue provided a community where she could give back, mentoring over 80 students every year. Pereira's dedication to both research and mentorship continues to inspire future engineers to pursue excellence, collaboration and service in their own careers.

DRIVING
SMARTER MASS TRANSIT

INTELLIGENT INTERSECTIONS PROMISE FASTER, SAFER AND GREENER PUBLIC TRANSPORTATION

Purdue Civil Engineering PhD student Yilin Wang demonstrates the MMITSS system in Ann Arbor during the IEEE Intelligent Vehicle symposium.

Purdue researchers are preparing to take the next giant leap forward in American mass transit.

Yiheng Feng, associate professor of civil and construction engineering, is leading a research team working to deploy a multi-modal intelligent traffic signal system (MMITSS) in the Midwest. This system is designed to improve the efficiency, safety and reliability of signalized intersections by enabling real-time communication between vehicles, roadside infrastructure and traffic signal controllers through connected vehicle technology.

"We believe this will be a big step forward for mass transit in the United States," Feng said. "Not only will this help to reduce transit time in implemented areas, but it will increase traffic safety and will have a positive environmental impact with reduced energy consumption."

MMITSS is a transit signal priority (TSP) application that helps transit vehicles, such as buses and light rail, move more efficiently through signalized intersections by reducing unnecessary stops and delays. The software-defined solution works with different types of hardware devices that enable smarter and more responsive traffic signals.

"By improving travel time reliability and keeping buses on schedule, TSP enhances the overall transit experience and makes public transportation a more attractive option for commuters," Feng said. "Increased transit ridership can help reduce traffic congestion, lower vehicle emissions and decrease energy consumption, supporting broader goals of sustainable and environmentally friendly transportation."

Feng's team has been testing the system in Ann Arbor, Michigan, on its bus system where his team reports positive results, particularly in efficiency.

"We have demonstrated that deploying MMITSS reduces both bus delays — even during rush hour — without negative impact on regular traffic," said PhD student researcher Yilin Wang. "Through these deployments, we aim to dramatically improve transit systems and strengthen the capacity of urban public transportation to better serve the communities that depend on it."

This fall, Feng's team will further expand its research and implement the system in Detroit's QLine — a 3.3-mile light rail system that runs through the city with 13 stops. Doctoral researcher Yumeng Bai notes that MMITSS will optimize the light rail system's efficiency and schedule precision, making the service far more reliable for riders.

"The QLine project gives us a valuable opportunity to extend MMITSS beyond bus operations into a new transit setting, light rail service," Bai said. "Through our demonstrations at ITS America, we showed how MMITSS can support smarter, real-time signal priority decisions in a complex urban corridor like downtown Detroit. This is a meaningful step toward improving schedule reliability and providing riders with a smoother and more dependable transit experience."

The U.S. Department of Transportation supports this research through its Advanced Transportation and Congestion Management Technologies Deployment program, which funds both the Smart Intersection and Intelligent Woodward Corridor projects.

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