

CIVIL AND ENVIRONMENTAL ENGINEERING



MAKING AN IMPACT

Students apply their
engineering skills in
service to society



Greetings from beautiful Madison!

In this issue, we highlight the tremendous

impact that our students and faculty are having both here at home and around the globe. You will learn of Assistant Professor Pavana Prabhakar's research on how microorganisms interact with and affect polymer composite structural materials, and of the outstanding work that our Engineers Without Borders (EWB) student chapter is doing to provide clean water in Guatemala and solar power in Puerto Rico. We feature Professor Steve Loheide's leadership in a "virtual university" predating the pandemic and his subsequent efforts to share lessons learned that will ultimately strengthen instruction in the post-pandemic future. We highlight senior Joel Baraka, the inventor of an innovative board game designed to teach core curriculum subjects to children in Uganda's refugee camps, a true embodiment of the Wisconsin Idea. You will also get to know a few of our remarkable students a bit better, including PhD student Sarah Peterson, senior Rahim Ansari, and senior Dalila Ricci, the 2020 recipient of the Alliant Energy/Erroll B. Davis, Jr. Academic Achievement Award.

Our department, college and campus are committed to addressing and supporting diversity, equity, and inclusion here in Madison and beyond. Associate Professor Matt Ginder-Vogel is chairing our new JEDI (justice, equity, diversity and inclusion) Committee, which is charged with implementing actionable measures to continuously improve the climate and culture of our CEE community. Notable among these activities is the establishment of a standing "JEDI minute" at faculty meetings, listening sessions with our students to gather their input, and the creation of a new CEE JEDI fund

dedicated to supporting scholarships for underrepresented students, technical and professional development activities, funding for hires of diverse backgrounds, and other initiatives that promote a welcoming and multicultural environment. Please contact Rob Herrick (rob.herrick@supportuw.org) to learn more about the JEDI fund and how to contribute.

I want to thank our dedicated alumni for your continued support and engagement with the Badger Engineering community. It was wonderful to connect with so many of you (more than 100!) during our virtual town hall, which was broadcast live from Engineering Hall on March 11. I enjoyed being able to share exciting updates from our department, introduce new faculty, and respond to many insightful thoughts and questions. There are many positive things about the remote environment we have found ourselves in, and being able to easily connect with so many of our alumni is one of them, even if only through a computer screen. If you were unable to attend the town hall, contact our communications specialist Amanda Thuss (athuss@wisc.edu) for a link to the recording, and be on the lookout for similar events in the future.

With spring finally here, more COVID-19 vaccinations becoming available every day, plans in place for a full return to campus in fall, and so many lessons learned over this challenging year, I have tremendous excitement and optimism for the future. I hope you enjoy reading about our outstanding department, and as always, feel free to reach out to me directly.

On, Wisconsin!

William J. Likos

Gary Wendt Professor and Chair
likos@wisc.edu • (608) 890-2662



ACCELERATED MASTER'S PROGRAMS

An engineering master's degree from UW-Madison gives you the credentials to get ahead. Find a program that fits your goals and lifestyle.

- Flexible online & accelerated programs
- Degrees in multiple disciplines, including six within CEE
- World-renowned faculty
- Individual attention
- Innovative partners
- Dedicated fellow students
- Rigorous courses that address real-world problems
- Ideas, inspiration and tools to apply immediately on the job

Earn the recognition you deserve, and prepare yourself today to meet tomorrow's engineering challenges.
advanceyourcareer.wisc.edu/engineering



SUPPORT CEE
allwaysforward.org/giveto/cee

Or contact:

Rob Herrick • (608) 308-5359
rob.herrick@supportuw.org





LEARNING CONSTELLATIONS:

New game helps refugee camp kids become academic 'stars'



Joel Baraka

Anson Liow

Joel Baraka has long dreamed of helping children in refugee camps get ahead in life. Now, he's invented a board game for students across sub-Saharan Africa that turns learning into fun.

Baraka, a CEE senior, and fellow engineering student Anson Liow are creating the 5 STA-Z board game for children in refugee camps. The game clusters students into groups of five and incorporates core curriculum subjects taught in Uganda—math, science, social studies and English—and breaks them down into easy-to-understand parts.

Baraka was born in the Democratic Republic of Congo, but his family fled to Uganda's Kyangwali Refugee Settlement to escape civil war in his home country. He came to UW-Madison through the King-Morgridge scholars program.

While in high school in South Africa, Baraka occasionally returned to Uganda to see family. On one such trip, he visited his previous elementary school and noticed that kids in the back would often lose focus and play among themselves. This, tied to his firsthand experience of attending school in the same environment, sparked an idea.

"Even during breaks when they were not having class, I could see them inventing simple games and just playing," he says. "So I had the thought: What if school was more of a place where children are not expected to come and sit in class and just watch the teacher teach? What if there was a game where you could teach math? You'd have the child in the front and the child in the back engaged at the same time."

In summer 2018, Baraka met Liow while the two lived in the same university housing at UW-Madison. They became fast friends and found connections in their backgrounds: Baraka growing up in a refugee camp and Liow's volunteering as a teacher for refugee kids in Malaysia.

"For me, being involved with this startup is about making an impact, and there's so much we can do outside of our regular responsibilities as students," Liow says. "Joel showed me how much of an impact a simple idea and hard work can make."

For Joel, two big lessons from UW-Madison have helped with the idea. The first is the Wisconsin Idea, and sharing the knowledge he's gained at the university to help and inspire others. The second, he says, is finding

the tenacity to tackle challenges head-on, thanks to the College of Engineering's rigorous curriculum.

"That's what life is all about—taking on challenges and solving problems," he says. "That's engineering, too. You can't just learn it by just reading books. You learn it by doing hard challenges in your classes, by working with other students on hard projects."

To date, the two have raised more than \$12,000 on GoFundMe for their startup, My HOME Stars, and produced 200 game sets of the 5 STA-Z to support two primary schools in the Kyangwali Refugee Settlement.



Interdisciplinary team discovers microbiome's effects on polymer composites

Polymer composites are durable, lightweight replacements for wood, metal or other materials and are used widely in everything from infrastructure to airplanes and cars.

A CEE researcher is shedding new light on how common bacteria can degrade those materials.

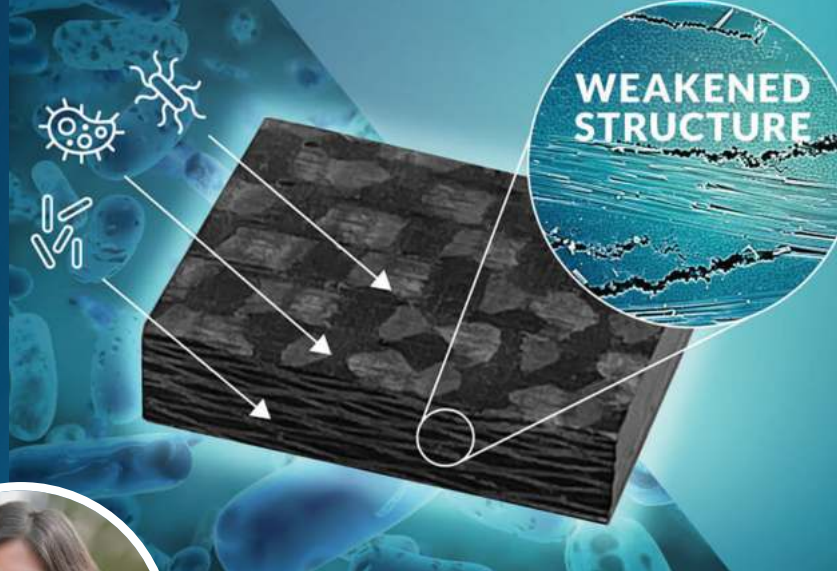
"A lot of studies have focused on how these polymer materials would respond to environmental conditions like temperature, moisture or ultraviolet light," says Assistant Professor Pavana Prabhakar. "They've rarely been studied in the context of microbial interactions."

Prabhakar and her collaborators identified four bacterial groups that have detrimental interactions with the acrylate, esters and bisphenol commonly found in polymer composites. The group published its findings in the journal *Communications Materials*.

Research on microorganisms interacting with polymer composites has focused on individual types of cultivated microbes that aren't necessarily common in natural environments, according to Prabhakar. Instead, the team studied microbes found more frequently in nature.

"We wanted to look at the whole diverse community of microbes that exists in the environment to see how they impact our polymer composites," Prabhakar says.

The way bacteria affect these materials can vary. Some bacteria feed directly on the materials to consume them as carbon



compounds. Other types of bacteria produce hydrogen and hydrogen sulfide gases within the composites, which can weaken structural integrity.

Prabhakar and her colleagues used metagenomics to probe microorganisms that live on the surfaces of polymer composites in natural settings. Prabhakar says it's the first time the technique has been used in such a fashion and it provided a tremendous advantage for studying entire microbial communities at one time.

Looking forward, the study may also help structural engineers to understand environmental stressors of polymer composite materials and how to design them to resist microbial degradation.

"Right now, we're looking at the overall degradation of the material," says Prabhakar, the Charles G. Salmon Fellow of Structural Engineering. "But can they cause localized stressors in addition to other stressors that exist in the environment? That's something we will continue to look at."

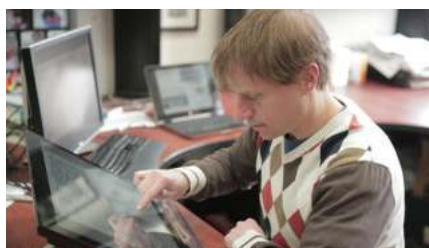
Building the foundations for virtual instruction

The shift to remote instruction brought about by the COVID-19 pandemic has been as much a learning experience for teachers across the United States as it has been for students.

Professor Steve Loheide is part of a group of hydrology experts at several universities who are working to ensure faculty in the field can build upon lessons learned during the pandemic's early stages. The National Science Foundation is funding the group's work through a RAPID grant.

"The COVID-19 pandemic forced this huge and instantaneous shift to online teaching at universities in the U.S. and globally," he says. "Faculty weren't entirely prepared for it and did the best that they could in the spring."

In the College of Engineering, Loheide emerged as a leader for online instruction as UW-Madison shifted to remote learning



in spring 2020. As the pandemic dragged on through the year, Loheide says, the focus shifted from triaging to getting through the "new normal" to building foundations for a long-term community of practice.

"We don't want the huge effort that people at all these universities are putting in to be a one-time thing," he says. "We're trying to build resources to have this community of practice to share what we're doing—essentially pooling those resources for everyone to use."

Sharing expertise in a virtual space is an idea Loheide is already familiar with through his participation in the Consortium of Universities for the Advancement of Hydrologic Science, Inc. (CUAHSI) virtual university. CUAHSI is funded by the NSF and is a collaborating partner in the RAPID grant. Loheide believes that experience and the work being done now to build a strong community of practice will ultimately make for better instruction in the post-pandemic future.

"I think everyone will be rethinking the way we teach and some of the tools we develop will stick with us," Loheide says. "We'll get better and more effective, and we'll find ways to integrate them into our teaching, even when we don't have to do big portions of it online."



Ansari draws on love of water, environment for engineering career

Rahim Ansari has long held a love of the water.

The Madison native has spent countless hours fishing and canoeing on the lakes and waterways around the city and on visits to Wisconsin's state parks. During his junior and senior year in high school, Ansari worked as a student researcher under Wisconsin Distinguished Professor Daniel Noguera. He always wanted to attend the UW-Madison, and seeing wastewater engineering up close in Noguera's lab solidified his decision to pursue a civil engineering education.

Now, Ansari is a senior and expects to graduate in August 2021. He's accepted an offer to begin his career with MSA Professional Services as a water/wastewater engineer and says the position will allow him to follow his passions and continue to learn about water and wastewater treatment and design.

Ansari conducted research under Noguera for three years. While with the group, he worked on pilot-scale reactors at the Nine Springs wastewater treatment plant in Madison as well as in the lab.

"For an entire year, I was struggling with this reactor, but it was a really interesting process," he says. "At one point, we had complete ammonia removal, which is to say this little bottle had all the microorganisms we needed to remove all of the ammonia we were feeding into it. I got to present those findings at the university's undergrad research symposium."

Now that he's a LEED Scholar through the engineering Diversity Affairs Office, Ansari also mentors younger students, as upperclassmen did for him when he was new to the college.

"One of best parts of the LEED Scholars program is that we have seniors mentoring freshmen—so people who have gone through it all talking to new students, and telling them that it can be tough, but everything is going to be ok," he says. "No matter what happens, the faculty and administration here at the college want to see you succeed. They want to help you. You're never really alone here—you have thousands of teammates who are cheering you on."

Paying it forward, Peterson hopes to inspire future women in STEM

For inspiration for her future, Sarah Peterson draws from her past.

As a high school student, Peterson was unsure of what she wanted to pursue as a career. She'd always enjoyed math and found a spark in an AP physics class under a teacher with an engineering degree.

"She was always so excited to teach students and to influence us to become STEM majors," Peterson says. "Seeing her push herself past obstacles as a woman in STEM, listening to the stories she'd tell us, and taking on the challenges she'd give us really made me want to push myself and do something out of my comfort zone. I wanted to do something exciting and hoped that one day I could also inspire other females to join STEM fields."

Peterson has finished her undergraduate studies with a bachelor's degree in civil engineering from UW-Madison and is staying on to earn a PhD under Professor Chin Wu. She studies coastal erosion and shore habitats, and soon will publish a research paper on shoreline analysis in Kenosha County in southeastern Wisconsin with Wu. The research focuses on how to better prepare communities to combat shore erosion.

"I've been researching under Professor Wu for about a year and a half," Peterson says. "He's a huge role model for me and really inspired me to take the leap and continue a PhD program. Professor Wu has been amazing at challenging me, and I've

grown so much in the little time I've been working with him."

And now Peterson, as a woman in STEM herself, wants to use her experiences to inspire future women in STEM.

"I want to create an atmosphere to let young women know that they can achieve their dreams and they're capable of doing whatever they



put their minds on," she says. "I want to be there for women who are having doubts—and for women who are excited and want to learn more about the field. I want to help them push for their dreams."



Engineers Without Borders brings water and solar power to people in need

They call it “water for dignity.”

The people of Zapote, Guatemala, now have reliable access to clean water thanks to the work of the UW-Madison student chapter of Engineers Without Borders (EWB). The project concluded in fall 2020 and is the culmination of an effort that started in 2017. More than 100 UW-Madison students and townspeople created a water system in Zapote with about 130 house connections and two distribution tanks.

“We received photos of the tap stands actually working and running,” says chapter president Ryan Docter, a structural engineering graduate student. “Some of these taps have a lot of really cool decorations on them. On one of the tanks, it’s painted, ‘Proyecto De Agua Potable La Dignidad,’ which means the ‘The Water Project For Dignity.’ That really showcases how much it means to them to have water.”

Just 20 to 30 percent of the Zapote community had access to water prior to the project, through a mix of hand-

dug wells or connections to a separate, unreliable system. Some of the houses already connected to another system had issues with improper water storage, which led to coliform contamination.

“We visited one house that was on a neighboring system and the man who lived there hadn’t received water for three months,” Docter says. “If you were on that system, you might not get water when you needed it. The community would have to rely on neighbors; if one neighbor had a tap running, it would be their responsibility to distribute water appropriately.”

The project covered a massive area, with the spring itself in nearby mountains. To get the water to the town, students and residents had to build suspended crossings—water bridges, essentially—that traversed ravines. Docter says the Zapote project is the largest water distribution project an Engineers Without Borders student chapter has undertaken.

In addition to its work in Guatemala, the UW-Madison EWB chapter concluded

work on a project at the Hogar Albergue de Niños Jesús de Nazaret children’s shelter in Mayaguez, Puerto Rico. It’s the chapter’s first project in Puerto Rico after establishing connections on the island in 2018.

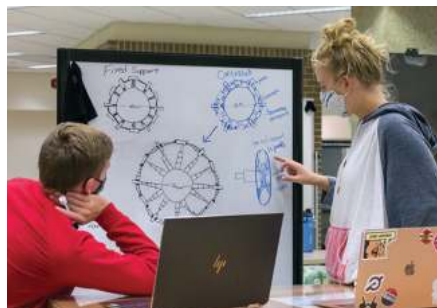
Hurricane Maria decimated the children’s shelter in 2017. It, and subsequent natural disasters such as recent earthquakes, devastated the island’s electrical grid, which has since been prone to blackouts. For help building a solar array to provide more stable power, the shelter connected with Engineers Without Borders and the UW-Madison chapter through the Puerto Rican government.

The student chapter initiated a project to build a 25-kilowatt photovoltaic solar panel array with more than 90 panels at the shelter and oversaw the work from start to finish.

“This was our first crack at an electrical and solar-focused project like this,” Docter says. “It’s a big deal that we were able to get it done so quickly and successfully.”

LAYING THE FOUNDATION:

First-year students build prototype magnetic shields for space travel



In fall 2020, first-year College of Engineering students tackled a project of out-of-this-world proportions: how to design a magnetic shield system to protect astronauts on long interplanetary journeys.

Their clients—Paolo Desiati and Elena D'Onghia—have high praises for the students' work, which may lay the groundwork for future technological breakthroughs. D'Onghia is an associate professor of astronomy, and Desiati is a senior astrophysicist who works with the Ice Cube Neutrino Observatory.

As technology improves, space agencies around the world continue to explore how it can help them create systems that could protect astronauts on long journeys. Desiati and D'Onghia hope to collaborate with NASA on one such project. That brought them to the InterEngr 170 freshman design course, which provides students from across all of the college's departments the opportunity to work on multidisciplinary teams on real-world projects.

"The idea of working on a project that NASA is making; it's not a normal project that a client would give to first-year students," D'Onghia says. "It's engaging for us to be able to work with students who are so young—yet doing work that is so valuable that they're contributing to something that is a worldwide challenge and of great interest to this country."

Students broke into four teams to plan prototype magnetic shielding system designs and develop presentations to explain their work. They 3D-printed

scaled-down models of their systems. Future research teams may build upon those designs for further development and, ultimately, full-scale testing.

Desiati says it's evident that the college attracts extremely talented students who will go on to do great work. Though the COVID-19 pandemic prevented him and D'Onghia from meeting in person with the students, he says the quality of their work was evident.

"I can see from the results in what they put together that they work very well together," Desiati says. "Interdisciplinary work is fundamental for scientific advancement. Each field has its own language. The challenge is finding the right way to interface these languages to feed into each other, and these students did that beautifully."

Erroll B. Davis Award recognizes high-impact CEE undergrad

For Dalila Ricci, the interpersonal connections are what makes engineering special.

Ricci is a fifth-year senior in CEE and a recipient of the 2020 Alliant Energy/Erroll B. Davis, Jr. Academic Achievement Award. The awards are given each year to recognize the academic and community service of engineering and business students from traditionally underrepresented groups at UW-Madison and UW-Platteville.

Ricci began her time at UW-Madison as a materials science and engineering student, but transferred to civil and environmental engineering after learning about the Construction Engineering and Management Program.

"People think engineering isn't a people-oriented major," she says. "They think you're in labs all the time, and that's not the experience I wanted. I wanted the interaction and personability that comes

with being in engineering. With project management, you're working on teams, you're working on long-term projects where communication is key. I really fell in love with that idea of interpersonal communication that the program drives into you."

Ricci transferred into the CEM program in the second semester of her sophomore year. That same semester, she applied for internships and talked with professors and fellow students to find opportunities to get early hands-on experience.

She's worked with J.H. Findorff & Son in Madison on a project to build the Exact Sciences Discovery Campus on the city's west side. In the summer of 2020, Ricci worked on the Pier 26 project in New York City, which opened to the public in the fall.

Beyond her work in the field and in the classroom, Ricci stays busy with countless activities around campus. She's long been involved with the Society of Hispanic Professional Engineers, first as a

member, and now, to internal vice president as in fall 2020.

"We have this vision of underrepresented minorities succeeding in STEM, and having that ideal personified in that organization is why I'm a part of it," she says. "We've traveled out of the country to conferences to meet with like-minded people. That's the organization I'm proud of because I've been in it since the very beginning and I've grown so much because of it."



Dalila Ricci

Civil and Environmental Engineering
1415 Engineering Drive
Madison, WI 53706

With new funding, Hicks focuses on negative emissions



Photo by Bryce Richter/UW-Madison

Assistant Professor Andrea Hicks received funding from the Research Corporation for Scientific Advancement, the Alfred P. Sloan Foundation and Thistledown Foundation for a negative emissions research project.

Hicks' project, "Investigation of the carbonation dynamics synthetic silicates: Guiding the development of net-negative production process and deployment in enhanced rock weathering," is one of eight from across the United States and Canada to be awarded funding. The awards cap

off the inaugural year of Scialog: Negative Emissions Science, which brought together more than 50 early-career faculty to focus on scientific challenges of global significance. The initiative's goal is to create a community of researchers and foster discussion and collaboration on untested ideas under the guidance of senior scientists.

Hicks, who is a leader in using life cycle assessments to determine the long-term environmental impacts of various systems, was named a Negative Emissions Science Fellow in August 2020 and was selected to participate in the inaugural Negative Emissions Science conference in November.



The Department of Civil and Environmental Engineering will host its 24th annual Golf Outing on Friday, Sept. 10, 2021. Gather with alumni, industry colleagues, faculty, staff, and students for a day of fun and fundraising in support of the department at Pleasant View Golf Course in Middleton, Wisconsin. Registration for the golf outing opens in May.

For more information, visit golf.cee.wisc.edu.