NC STATE Engineering

CCEE NEWS

DEPARTMENT OF CIVIL, CONSTRUCTION, AND ENVIRONMENTAL ENGINEERING

RETHINKING PFAS REMOVAL 34

SPRING 2023

IN THIS ISSUE

ABOUT THE COVER

CCEE alum Yoko Koyama shows off an artificial intelligence tool used to aid in per- and polyfluoroalkyl substance (PFAS) removal from drinking water.

EDITOR
Taylor Wanbaugh

CCEE PUBLICITY COMMITTEE
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OTHER CONTRIBUTORS TO THIS ISSUE
Emily Berglund, Tasnim Hassan, Matt Shipman

PRODUCTION STAFF
Danielle Herman, Jie Sun, Candice Wallace

CCEE News is published by the Department of Civil, Construction, and Environmental Engineering to share information among faculty members, staff, students, alumni and friends of the department.

Jackie MacDonald Gibson

LETTER FROM THE DEPARTMENT HEAD

Welcome to our *Spring 2023 newsletter*. It is a pleasure to update you on happenings in the department.

I am writing this letter just after our December graduation, where I had the honor to congratulate nearly 100 of the next generation of engineers. Commencement speaker **Wes Lowder** (MSCE 1985) counseled the graduates to "be ready to bring your best self, a good work ethic and a good attitude to your career." Lowder is vice president of S&ME, a major civil, construction and environmental engineering firm, where he began working nearly four decades ago as a student intern while pursuing his CCEE degree. Class valedictorian **Daniel Isenhour** advised graduates to follow the teachings of legendary NC State basketball coach Jim Valvano by remembering "where you started, where you are and where you are going."

This newsletter features several stories highlighting the continuing contributions of the CCEE family to the many aspects of civil infrastructure:

- **Yoko Koyama** (MSENE 2021) developed a groundbreaking artificial intelligence tool to guide design and operation of water-treatment systems for the removal of per- and polyfluoroalkyl substances (PFAS) from drinking water. Global concern about PFAS continues to grow due to their widespread occurrence and failure of conventional drinking water-treatment technologies to remove them. Koyama's work will advance progress toward preventing human exposure to these chemicals.
- Ph.D. student **Morgan DiCarlo** and professor **Emily Berglund** helped the Orange County Water and Sewer Authority in North Carolina analyze how their customers respond to water advisories. Their work will help utilities improve their responses to water emergencies like water main breaks and low-pressure events.
- Ph.D. student **Qian Luo** and **Brenna Copeland** (BSENE 2021), advised by Associate Professor **Jeremiah Johnson** and Assistant Professor **Fernando Garcia Menendez**, published research that will help to guide power utilities on transitioning to lower-carbon power sources. Their work showed that the benefits of these transitions exceed the costs, but they must be carefully planned to avoid unintended negative consequences for low-income and minority communities.

Also featured are stories about activities and award-winning teams organized by CCEE's many student groups. We report on the Construction Alliance, NC State's chapter of the American Society of Civil Engineers, Student Energy Club, Global Water Sanitation and Hygiene Student Chapter and Geo-Institute Graduate Student Organization. The breadth of their activities illustrates the many ways in which our students (undergraduate and graduate) can engage in meaningful, hands-on projects that build their skills outside of what they learn in the classroom.

As you read this newsletter, I hope that you get a sense of the tremendous accomplishments in our teaching, research and extension programs and our contributions to sustainable infrastructure. I also hope you will consider regular contributions to the department. Your gifts provide help with the many activities that make us strong but are not supported by the state — from field trips for undergraduates to student travel to national engineering competitions and conferences to scholarships that help students who otherwise could not afford their education to fellowships that help us recruit and retain the world's best students and faculty members. We need your ongoing support as we strive for excellence in all that we do.

Please let me know if you are in the area and would like to meet me and/or tour Fitts-Woolard Hall.

Jackie MacDonald Gibson
CCEE Department Head

How do communities comply with water advisories during pipe breaks?

A water main breaks every two minutes in the U.S., wasting more than two trillion gallons of treated drinking water annually, according to the *American Society of Civil Engineers 2021 Report Card for America's Infrastructure*. These events can lead to negative water pressure in the system, which increases the risk of contamination. Water advisories are used to limit water consumption, but consumer compliance with advisories is critical to maintain pressure and avert the need for boil water orders.

Professor **Emily Berglund** and Ph.D. student **Morgan DiCarlo** worked with the Orange County Water and Sewer Authority (OWASA) in North Carolina to explore how customers complied with a recent water advisory using water consumption data collected through Advanced Metering Infrastructure (AMI). AMI provides high temporal and spatial resolution of water consumption data, which are analyzed to identify changes in water use behaviors.

The main pipe leaving OWASA's water treatment plant broke in November 2018, leading to a loss of pressure and decreased storage levels in water tanks. More than 80,000 people in the community were asked to limit water use to essential purposes only through texts, phone calls and local news media. OWASA had previously installed AMI smart meters, which record hourly water use at customer accounts, and shared hourly water consumption data from 16,000 smart meters with the NC State research team. Researchers calculated per capita essential water use based on the essential water needed for hygiene, cooking and toilet flushing.

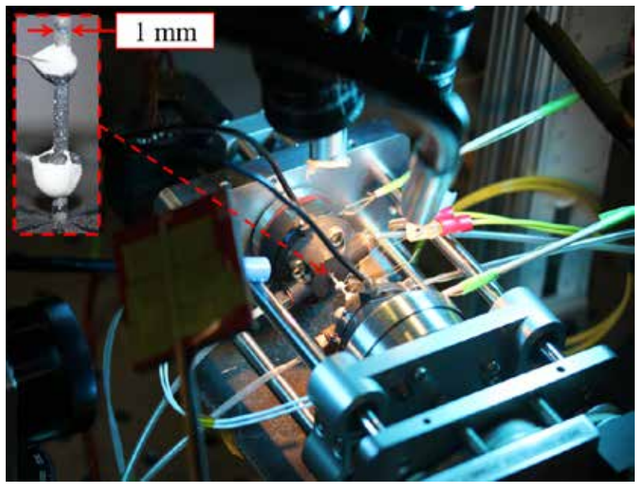
Through analysis of smart meters and occupancy data, researchers found that about 30% of the households reduced their water consumption to essential use. As a result, water use was reduced by 27% during periods of peak water use and by 16% across the duration of the event.

"Utilities need an understanding of household-level responses during water service disruptions to enhance resilience and mitigate consequences," Berglund said. "AMI data can be analyzed to gain insight about customer compliance during water service interruptions and subsequent water advisories."

This research identified that the way people interpret "essential uses" for water can affect compliance rates of water advisories. Utilities can reevaluate the language used in communicating water advisories to emphasize the importance of compliance to reduce susceptibility to waterborne illnesses and other health risks. This research was published in *Water Research* in August 2022 (**doi.org/10.1016/j.watres.2022.118802**). ▪

RESEARCH UPDATES

How can we measure material properties using a small test specimen?



Top: High temperature multiaxial miniature testing system developed at NC State. Bottom: Application of hybrid-heating technique and infrared thermography to obtain uniform temperature distribution.

Materials that can withstand extreme temperatures are used in jet engines, nuclear power plants and many civil engineering structures. The development process of these materials is expensive and time-consuming because it requires rigorous testing to measure material strength in an extreme environment.

Researchers can save processing time by testing a smaller size specimen. However, it is much harder to perform material testing on a small specimen since both the application of a thermal load on a small specimen and the measurement of deformation are experimentally challenging. The experimental techniques used to test a standard size specimen cannot be used for a small test specimen.

Tasnim Hassan, CCEE professor, and **Farhan Rahman**, CCEE postdoctoral researcher, collaborated with Department of Mechanical and Aerospace Engineering researchers Gracious Ngaile and Lin Li, to devise innovative experimental solutions that allow high-temperature material testing using small-size specimens.

The researchers developed a novel heating technique to apply uniform temperature distribution on a small specimen called hybrid heating, which uses Joule heating by passing electricity through a metal test specimen in conjunction with small custom-developed heating coils. When electricity passes through a metal test specimen, it heats up due to its internal resistance to the flow of current. Since this resistance is dependent on the cross-section of the test specimen — which changes during a test — a non-contact temperature control system using infrared thermography was devised. This novel hybrid heating system allows researchers to achieve uniform temperature on a small test specimen.

To measure the deformation of a small test specimen at high temperatures, researchers used the stereo digital image correlation (stereo-DIC) method — an optical technique that relies on multiple cameras to capture images of the test specimen as it deforms.

"What is unique about our stereo-DIC setup is that we developed an optimization framework that addresses the relationships among test specimen size and curvature, specimen to camera distance, stereo-angle, lens and camera sensor properties," Rahman said. "This ensures high measurement accuracy from the stereo-DIC setup, which is important for accurate material property determination."

The non-contact temperature control and deformation measurement systems allow researchers to measure material properties at high temperatures using small test specimens. The novel experimental techniques were devised as part of a new multiaxial miniature testing system (MMTS) researchers developed through a National Science Foundation research grant. The MMTS was designed to perform in-situ tests within a scanning electron microscope and thereby correlate material microstructures to their properties. ▪

What are the immediate and long-lasting effects of reducing coal power generation?

A new CCEE study drawing on data from Texas and surrounding states finds that the most common strategies for reducing greenhouse gas emissions from power generation also produce enough health benefits to completely offset the cost of these "decarbonization" efforts. However, the study found that while Black and low-income communities also benefit, they still face higher levels of air pollution and related health effects.

"Other researchers have also examined health benefits associated with decarbonization, but we expanded on that work in two ways," said **Jeremiah Johnson**, associate professor and a lead investigator for the study.

"First, we examined issues related to environmental justice and equity. Second, we investigated how health benefits associated with decarbonization can inform operational decisions in the power sector. If we can determine which specific plants are having the greatest impact on human health, and when, then power systems can modify power generation at those plants to reduce human health impacts."

"In terms of environmental justice, it is well established that some people suffer more from the effects of air pollution than others, and we wanted to explore whether decarbonization efforts might make things better or worse for the communities who suffer the most," said **Qian Luo**, Ph.D. student and first author of the paper.

The researchers evaluated the impacts of six decarbonization strategies. Three involved using different power generation methods to replace coal-fired power plants: solar power, wind power and natural gas. Two strategies involved implementing "carbon taxes" at different levels — effectively increasing the costs of electricity generation based on the amount of carbon dioxide that power plants emit. The sixth strategy involved requiring power plant operators to include the economic costs of health effects caused by emissions in their decision-making. The carbon tax and health damages strategies would significantly increase the expense of coal power, indirectly encouraging a shift to power generation that produces fewer emissions.

The researchers drew on power generation data from across Texas, as well as health data from Texas and other states affected by air emissions from Texas's power plants. The data was fed into an integrated suite of new and existing computational models to better understand the health effects of the various decarbonization strategies at the local level.

The researchers estimated the number of deaths attributable to air pollution for each scenario and then monetized those estimates using "value of a statistical life" estimates developed by the federal government to perform cost-benefit analyses.

The researchers found that all six decarbonization strategies reduced adverse health effects from air pollution more than enough to offset the cost of implementing the strategy.

However, while health benefits accrued to the entire population, some areas still suffered from more air pollution than others. These areas tended to be low-income areas or neighborhoods with large Black populations.

"While there are health benefits under every decarbonization scenario — which is good — there is still a significant environmental justice gap," said **Fernando Garcia Menendez**, assistant professor and co-author of the paper. "For example, the gap between Black neighborhoods and other neighborhoods either stays the same or gets worse. In other words, while Black neighborhoods benefit from decarbonization, they don't benefit as much as other neighborhoods. And the same holds true for low-income neighborhoods across all races."

The findings were also sufficiently precise, pointing to specific emissions from specific plants at specific times, to inform operation decisions that could reduce human health impacts even if the plants are not taken completely offline.

"The takeaway message here is very simple: reducing coal power generation has significant, immediate health benefits," Johnson said. "And all of the techniques under consideration for reducing coal power generation produce meaningful benefits."

The paper, "Diverse Pathways for Power Sector Decarbonization in Texas Yield Health Co Benefits but Fail to Alleviate Air Pollution Exposure Inequities," was co-authored by **Brenna Copeland**, a former CCEE undergraduate.

The research was supported by the National Science Foundation, under grant number 1934276, and the Alfred P. Sloan Foundation. It was published in the journal *Environmental Science and Technology* in September 2022 (**pubs.acs.org/doi/full/10.1021/acs.est.2c00881**).

A version of this story first appeared in NC State News. ▪

NEW **RESEARCH PROJECTS**

In the second half of 2022, CCEE launched new research projects with funding from federal and state agencies, foundations and industry sponsors. This support will enable CCEE faculty members, their research teams and their collaborators to address problems in infrastructure and the environment in North Carolina and around the world.

FEDERAL GRANTS

Sankar Arumugam, professor and University Faculty Scholar, will collaborate with Anantha Aiyyer and Carl Schreck (Department of Marine, Earth and Atmospheric Sciences) to lead a National Science Foundation (NSF) study on how watershed conditions and atmospheric and oceanic conditions cause monthly flooding in the Southeast and South Central (SESC) U.S. Given the increasing strength and frequency of tropical storms — 2020 set a record with 30 named storms in the Atlantic Ocean, and 12 made landfall in the SESC — this project will enhance understanding of flood hazards and will also better inform a wider community of forecasters and decision makers. The project team will engage with climate offices, the National Environmental Modeling and Analysis Center at the University of North Carolina at Asheville and the National Centers for Environmental Information. The team will also collaborate with faculty members and graduate students from minority-serving institutions as part of the summer internship program at NC State.

Arumugam will also collaborate with Brian Reich (lead PI) and Emily Hector (Department of Statistics) on an NSF grant focused on developing approaches for revising the U.S. Geological Survey (USGS) flood frequency curves, which are commonly used to design flood control structures, under changing climate conditions. The analysis will provide high-resolution maps of anticipated changes in flood risk and local flood frequency curves to inform future water infrastructure projects. The project team will also extensively collaborate with the USGS scientists, United States Army Corps of Engineers water managers and the Federal Highway Administration. The project includes a workshop that will foster synergy between statisticians, hydrologists and federal, state and local managers to share ideas, approaches and solutions to flood risk prediction, and opportunities and approaches for revising the flood frequency curves.

Arumugam will lead an NSF study on developing artificial intelligence (AI)-based methods to scale large Global Climate Model (GCM) projections to watershed-scale applications. GCMs are typically used to develop climate projections to predict extreme events such as droughts and floods. Spatial resolution of GCM projections has improved due to increasing computational power but is still inadequate for watershed-scale applications where extreme event prediction is needed to enable planning. AI techniques are powerful in modeling global climate data and could develop more detailed spatial and temporal future climatic projections. The potential impact is improved planning for — and resilience to — extreme events at the watershed scale. The downscaled data using AI techniques will also be archived in online software development platforms Figshare and GitHub for dissemination. The researchers will also work with focused user groups, such as reservoir management and social media, for active distribution of the developed data products.

Tasnim Hassan, professor, will collaborate with Korukonda Murty (PI), Jacob Eapen (Department of Nuclear Engineering) and William Weber (University of Tennessee Knoxville [UTK]) to investigate the mechanical performances of advanced alloys — combinations of metal elements manufactured for unique or extreme features including high thermal resistance and mechanical strength — of next-generation nuclear plants (NGNP) through a Department of Energy (DOE) grant. Miniature specimens, exposed to radiation through ion irradiation by the UTK investigators, will be tested in situ using miniature testing systems within a scanning electron microscope under elevated temperature

and fatigue loading. The NC State investigators will use the in-situ testing laboratory developed at NC State through NSF and DOE equipment grants for the dynamic characterization of failure mechanisms. They will use the test data to develop multiscale computational models that can simulate progressive damage accumulation and, thereby, the failure or remaining life of critical components in NGNP.

STATE AND LOCAL

Shane Underwood, associate professor; **Cassie Castorena**, associate professor; and **Richard Kim**, Jimmy D. Clark Distinguished University Professor, received funding from the North Carolina Department of Transportation (NCDOT) to evaluate the viability of augmenting asphalt mixture design practices with performance-related testing. Current design procedures require contractors to conform to the compositional requirements of the NCDOT, but involve relatively little performance-related testing. Recent projects suggest that ultimately this practice can lead to variable long-term performance. The researchers will work to identify the most appropriate testing protocols for incorporation into mix design and quality assurance/control operations, establish test-performance targets and develop implementation guidelines.

William Rasdorf, professor, working with **Ali Hajbabaie**, associate professor; **Hayden Edwards**, graduate student; and Amir Molan (University of Mississippi), received funding for an NCDOT research project to assess innovative intersection designs aimed at improving traffic flow and reducing congestion through intersections while more safely handling increasing traffic volumes. New intersection designs can result in shorter travel times, fewer crashes and better pedestrian service. The researchers seek to determine locations in North Carolina that are best suited for these new designs, the design cost and potential cost benefit over conventional designs, what kind of traffic control devices (signs, pavement markings and signals) are needed, how to promote public acceptance and how to encourage greater adoption by departments of transportation.

Castorena and **Underwood** received funding from the NCDOT to study the variability of reclaimed asphalt pavement (RAP) and recycled asphalt shingles (RAS) sources in North Carolina. The team will identify how processing and stockpiling practices affect recycled material

Andy Grieshop and Tarek Aziz working alongside Ph.D. student Leah Weaver and undergraduate researcher Jimmy Lewis on a research project in Cary, North Carolina.

NEW **RESEARCH PROJECTS**

consistency and investigate the effects of recycled material variability on asphalt mixture performance. The study will identify improved measures for quality assurance and quality control of RAP and RAS stockpiles to promote increased recycling without compromised pavement performance.

Morton Barlaz, Distinguished University Professor, and **Ranji Ranjithan**, professor, received funding from Montgomery County, Maryland, to assist the county with long-term solid waste management planning. They will use a solid waste lifecycle model developed in CCEE called SwolfPy to evaluate the greenhouse gas implications of three alternatives including (1) continuing to use the county's mass burn waste-to-energy facility, (2) disposal at an out-of-state landfill that will require truck and rail transport and (3) development of a new landfill in Montgomery County.

Elizabeth Sciaudone, research assistant professor, received funding from NCDOT to assess the vulnerability of the NC 12 highway, which links the peninsulas and islands of the northern Outer Banks on the coast of North Carolina. Bimonthly changes to the shoreline position, topography and land cover are being tracked to evaluate present — and forecast future — vulnerabilities of the coastal highway. This applied research project provides up-to-date information to NCDOT for long-range planning to maintain a transportation corridor on the coastal barrier islands.

Andrew Grieshop, associate professor, and **Tarek Aziz**, assistant professor, are working with the Town of Cary, North Carolina, to study a novel "smog-eating pavement" deployed as part of a pilot program. Researchers will investigate the impact of the coatings on near-road air and stormwater quality. If proven to be effective, Cary officials could deploy the coatings in neighborhoods throughout the town.

Fernando Garcia Menendez, assistant professor, received funding from NC State's Office of Research and Innovation under the Climate Change thematic focus area of the Fall 2022 Research and Innovation Seed Funding (RISF) Program. The research will support climate change mitigation in Latin America by linking reduced deforestation policies to air quality and public health co-benefits.

INDUSTRY / NONPROFIT / FOUNDATION

Sankar Arumugam, professor and University Faculty Scholar, received funding from drinking water utility Tampa Bay Water (TBW) in Florida to study how the TBW system could be better managed under droughts arising from climate change and increased demand. Researchers will develop and analyze a number of potential scenarios of hydroclimate to optimally manage surface water and groundwater and desalination plants under increased demand.

Douglas Call, associate professor, received funding from the Novo Nordisk Foundation to study and develop an electrochemical technology that uses renewable electricity and enzymes (biological catalysts) to convert carbon dioxide and nitrogen gas into fertilizers. The project is led by Sonja Salmon (Wilson College of Textiles) and involves multiple researchers across NC State and Denmark Technical University. The study aims to understand how to orient and "wire" enzymes to electrodes. The goal is to scale up the technology and convert the greenhouse gas carbon dioxide into the industrial chemical formate and nitrogen gas into ammonium for fertilizers.

Kevin Han, associate professor, and **Abhinav Gupta**, professor, received funding from the NC State Center for Nuclear Energy Facilities and Structures (CNEFS) to develop a holistic approach to the design and construction of nuclear reactors through advances in digital engineering, which will allow quick assessments of design changes throughout construction.

Gupta and Xu Wu (Department of Nuclear Engineering) received funding from CNEFS to develop an AI framework for monitoring of degradation in nuclear structural systems and equipment. Degraded locations can sometimes go undetected by current inspection techniques. The proposed research utilizes sensor responses to generate an AI database for predicting degraded locations and degradation severity. ▪

Picture This

From local North Carolina high school classrooms to Chicago, Dallas and the state of Washington, CCEE faculty members and students spent last semester presenting research, attending conferences and working in the field. Check out these photos of some of their activities.

Nearly 100 undergraduate and graduate students, along with friends and families, gathered in the McKimmon Center on Friday, Dec. 16, for the Fall 2022 Commencement Ceremony. Alumnus and S&ME Vice President **Wes Lowder** (MSCE 1985) delivered the baccalaureate address, speaking on the importance of developing trusting relationships, striving to continue learning new things and planning for the future while also living in the present. ▪

Saran Bodda, a research faculty member for NC State's Center for Nuclear Energy Facilities and Structures, recently presented his research at the U.S. Department of Energy and U.S. Nuclear Regulatory Commission Natural Phenomena Hazards workshop in Rockville, Maryland. Bodda's research interests include uncertainty quantification using statistical approaches, risk-informed validation, probabilistic risk assessment (PRA) for external hazards, AI-based approaches for structural health monitoring, development of advanced algorithms for PRA, Bayesian approaches to update probabilistic seismic hazard curves and coupled analysis of primary-secondary systems. ▪

Picture This

Distinguished University Professor **Morton Barlaz** has led an annual weekend camping and whitewater rafting trip for interested CCEE students for more than 10 years. This year, 17 undergraduate and graduate students and their friends and partners dodged rocks and rapids outside of Dillsboro, North Carolina, splashing their way down the Tuckasegee River in mid-September. The trip included camping, hiking and an outing to local breweries. ▪

Students from the Geo-Institute Graduate Student Organization at NC State planned an outreach activity at Leesville High School in Raleigh, North Carolina. Students designed and built deep foundations then measured the average differential settlement. ▪

Several CCEE faculty members and students attended the American Concrete Institute Convention in Dallas in October. More than 2,500 professionals and students from around the world attended the convention, which brought together concrete industry experts to discuss the improvement of the design, construction and maintenance and repair of concrete projects. ▪

Picture This

Idil Akin, associate professor, traveled to Washington's Bolt Creek Fire site to study post-wildfire slope stability as part of her National Science Foundation CAREER project. "Thanks to our amazing collaborators at the USDA Forest Service Rocky Mountain Research Station, we got early access to the site and collected valuable data. We have a new theory of post-wildfire debris flow initiation mechanisms, and we are excited to go back to the lab and test." ▪

General contractor Brasfield & Gordie gave CCEE students and members of NC State's chapter of the American Society of Civil Engineers a tour of its North Hills Expansion project in Raleigh, North Carolina. ▪

Nineteen CCEE students, postdocs and faculty members attended the American Geophysical Union Fall Meeting 2022 in December in Chicago. Several gave poster presentations and spoke at the conference. The event drew more than 25,000 attendees from more than 100 countries. ▪

A SMARTER, SPEEDIER HIGH-RISE

Photos courtesy of Morris Moreno

Soaring 850 feet over downtown Seattle, the Rainier Square Tower is a sight to behold. The 58-story mixed-use behemoth turns a mirror on the city — literally — with its thousands of mirrored glass panels sloping up into the sky.

But it isn't just aesthetically magnificent. The tower is best-known for its innovative new structural construction: a concrete-filled, composite plate shear wall system — also known as SpeedCore. The 2022 Paul Zia Distinguished Lecture on the design and construction of the Rainier Square Redevelopment Project highlighted the system's ability to brace the tower against Seattle's wind and seismic activity while also cutting the construction time to just 22 months.

Now in its 21st year, the Paul Zia Distinguished Lecture Series was established in 2002 to showcase some of the world's most exciting and challenging projects and the engineers who work to make them happen. The lecture series honors Professor Emeritus **Paul Zia**, a former professor and department head of CCEE and a structural engineer who is eminent in research, professional society leadership and practice. For more than 50 years, he has been engaged in teaching, research and consulting in many areas of concrete materials, reinforced and prestressed concrete structures, and construction, advising more than 60 master's and doctoral students.

"What's really special about this lecture is that it not only honors Dr. Zia, but it is a wonderful opportunity to link students to the real world of engineering and give them a chance to see how what they learn at CCEE can translate to doing really big things," said CCEE Department Head **Jackie MacDonald Gibson**. "It also introduces the public and the broader community to the great work that can come from civil, construction and environmental engineering. Dr. Zia is such an incredible example of how research in civil engineering can make people's lives better. His work has led to safer structures for all of us."

At this year's lecture, Amit Varma, Karl H. Kettelhut Professor of Civil Engineering and director of the Bowen Lab for Large-Scale Civil Engineering Research at Purdue University, and Ron Klemencic, chairman and CEO of Magnusson Klemencic Associates, discussed how the use of SpeedCore and steel-concrete composite construction aided in the durability and accelerated the timeline of the project.

SpeedCore's shear wall core system uses steel plates instead of traditional rebar and formwork between concrete elements, reducing the amount of time necessary to create the floors of the tower. According to the American Institute of Steel Construction (AISC), the steel in SpeedCore can support up to four floors of decking by itself, making it possible to erect four floors in a week. The system, developed by Varma in collaboration with Magnusson Klemencic Associates, Purdue University and the University at Buffalo (The State University of New York), was originally estimated to shave about eight months off Rainier Square's construction schedule in comparison to traditional methods. In actuality, it took just 22 months to deliver the project — 10 months ahead of the original schedule.

In addition to the composite steel plate core, outrigger and belt trusses were added about two-thirds of the way up the tower. The trusses act in the same way that ski poles help a skier: they add balance and stability to the building.

"It's something that's never been done before: A whole new structural system, a whole new way to assemble a building," Klemencic said.

QUICK FACTS ABOUT THE RAINIER SQUARE TOWER

- **$600 million** project completed in 2020
- **Second-tallest building in Seattle** at **850 feet tall**
- **58 stories** adding up to **1.4 million square feet** of mixed-use space
- Curved architecture designed to complement the adjacent 40-story, 1977 Rainier Tower, shaped like an inverted pyramid

Presenters

RON KLEMENCIC

Klemencic is chairman and CEO of Magnusson Klemencic Associates, an award-winning, 185-person structural and civil engineering firm founded in 1920 and headquartered in Seattle. He has designed projects in 29 states and 25 countries, with some as large as 11.5 million square feet and as tall as 112 stories, including San Francisco's Salesforce Tower, St. Regis Chicago and Rainier Square in Seattle. An industry innovator and one of the preeminent high-rise structural engineers practicing today, Klemencic is sought by developers, architects and contractors worldwide for his creativity, "big picture" approach and unique ability to consistently produce cost-effective and inventive designs. He has championed numerous innovations throughout his career — from implementing performance-based seismic design for high-rise buildings, to the development and successful application of the first-of-its-kind, non-proprietary SpeedCore structural system, to recent advancements in performance-based wind design and structural fire design.

AMIT VARMA

Varma, Karl H. Kettelhut Professor of Civil Engineering and director of the Bowen Lab for Large-Scale Civil Engineering Research at Purdue University, has dedicated his academic and professional life to the development of innovative steel-concrete composite structures for built infrastructure including commercial, residential and industrial buildings and nuclear power plants. He has conducted fundamental research including large-scale experimental investigations and numerical analyses to evaluate and improve the structural behavior of steel-concrete composite members, connections and overall structural systems subjected to various extreme loading conditions including seismic, fire, blast and missile impact loading. His research products are the basis of (and directly cited in) several AISC codes/specifications for the design of steel-concrete composite structures for building structures and safety-related nuclear facilities. These codes/specifications govern the design and construction of all steel building structures and safety-related nuclear facilities in the U.S. and are also used extensively around the world by engineers, consultants, regulators and building officials. ▪

CCEE STUDENT AMBASSADORS HELP GUIDE THE PATHS OF PROSPECTIVE STUDENTS

When prospective students are considering applying to CCEE, they can be plagued with many questions as they try to differentiate NC State's program from others. They may wonder what makes the department special, what programs are available for new students and how they can get involved on such a big campus.

That's where the CCEE undergraduate ambassadors step in. This year's 10 carefully selected ambassadors come from diverse backgrounds and areas of study within the department and bring their different perspectives to the table to help guide potential students.

A student ambassador's role is to be a representative of the department while maintaining a wide range of responsibilities including outreach, recruitment events and providing a student perspective when giving tours to potential students and visitors.

"Student ambassadors are chosen based on their ability to speak confidently and knowledgeably about opportunities within the department," said **Rudolf Seracino**, program advisor and professor. "They should be enthusiastic about representing the department and engaging with prospective students, and committed to actively participating in the program."

A few of CCEE's new student ambassadors weighed in on why they chose NC State's program, their campus and department involvement, and plans for the future. Answers are edited for clarity and brevity.

Elizabeth Michelle Bates, *Senior, Environmental Engineering*

Why did you choose NC State?

I chose NC State for the opportunities being a part of the Wolfpack provides. Earning an engineering degree from NC State's ABET accredited program opens the door for several opportunities before and after graduation.

Are you involved in any clubs or organizations on campus?

I work as a student team lead on the Engineering Career Fair Team and have leadership positions in the NC State Air and Waste Management Association and Global WaSH chapters.

What has been your favorite class at NC State?

My favorite class at NC State has to be either CE 383: Hydrology and Urban Water Systems or CE 488: Water Resources Engineering. I have been able to directly apply what I learned in class to my internship.

What is your favorite part of Fitts-Woolard Hall?

The Environmental Engineering Teaching Lab. It provides a space for hands-on experiments to learn more about processes discussed in class.

What are your plans after graduation?

I plan on joining the workforce as a water resources engineer and start working toward becoming a professional engineer. After a few years, I plan to return to academia and earn a master's degree in business or economics.

Ethan Steadman, *Junior, Construction Engineering*

Why did you choose NC State?

NC State offers students a strong sense of community and opportunities to pursue their interests.

Are you involved in any clubs or organizations on campus?

I enjoy playing intramural sports through NC State's Wellness and Recreation Center.

What has been your favorite class at NC State?

CE 263: Introduction to Construction Engineering. This class taught me important and practical information necessary to pursue a career in construction.

What is your favorite part of Fitts-Woolard Hall?

The study lounges: I like using these spaces to complete school work and meet up with friends in between classes.

What are your plans after graduation?

I plan on working for a general contracting company in the Triangle area after graduation.

Lillie Williams, *Junior, Civil Engineering*

Why did you choose NC State?

Throughout high school, NC State was always one of my top choices due to its reputable engineering program. After touring the school and getting a feel for the atmosphere, I felt it would be the best fit for me both personally and academically. I talked to several alumni who all spoke very highly of their experiences at NC State and felt that an NC State education would provide me with the opportunities necessary for a successful future.

Are you involved in any clubs or organizations on campus?

I am a part of the Goodnight Scholars Program, and I am involved in CRU ministries.

What has been your favorite class at NC State?

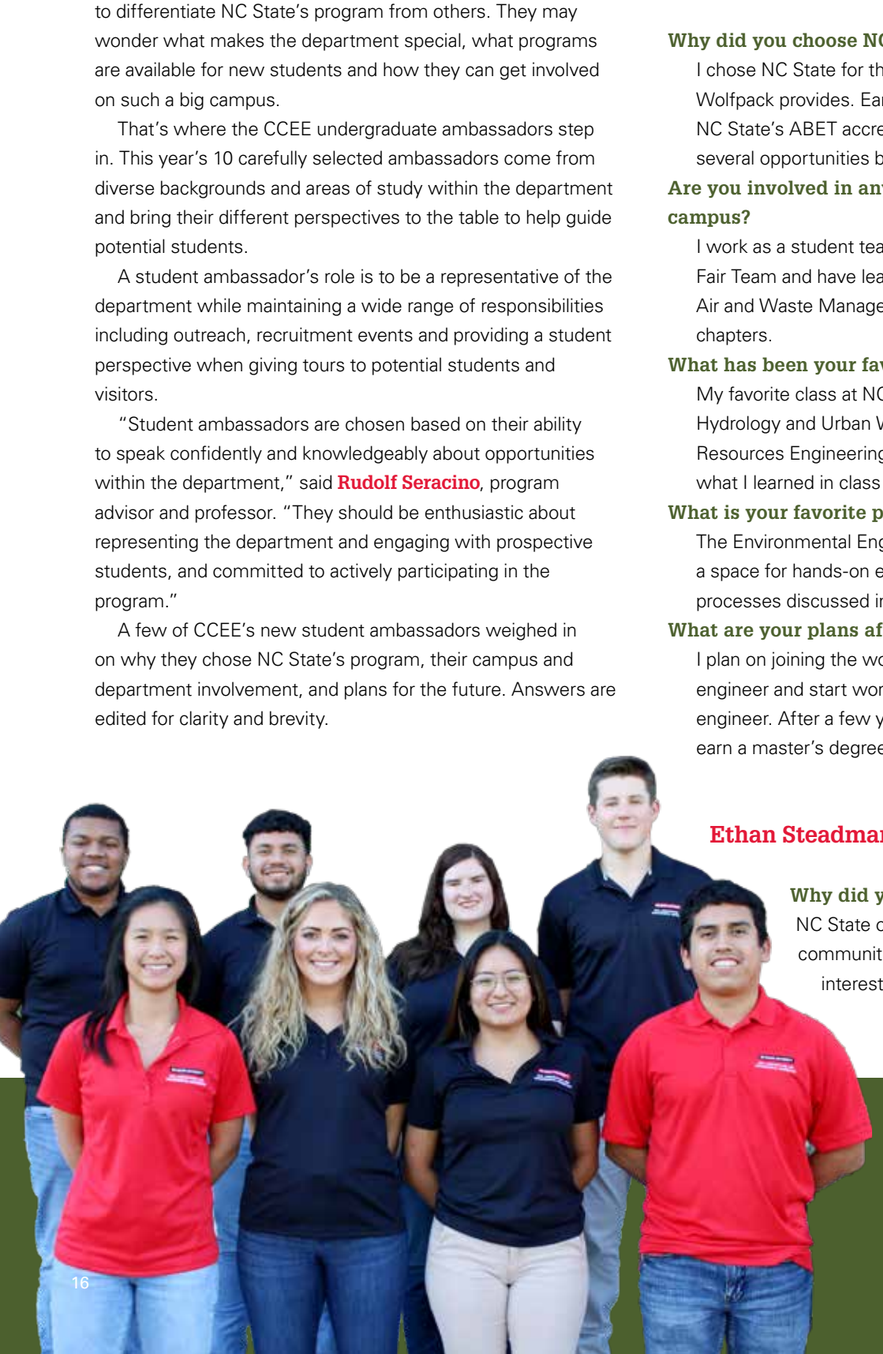
My favorite class at NC State has been CE 250: Introduction to Sustainable Infrastructure. I took CE 250 in my first semester after transferring into the civil engineering department and immediately was assured that I made the right decision to join the department. The projects and assignments we completed were very applicable to my past internship experiences and I felt I was being prepared to answer real-world questions.

What is your favorite part of Fitts-Woolard Hall?

It has tall windows on each floor that create an open and bright atmosphere. Fitts-Woolard is the first thing that catches my eye while on Centennial Campus, and I always look forward to my classes that meet there.

What are your plans after graduation?

I hope to work for a consulting engineering firm, specifically on a water/wastewater team. I have internship experience from the last two summers in this field and would love to pursue a career where I can work in this sector of civil engineering. ▪



Front (left to right): Ting Ting Lin, Courtney Fry, Cecilia Sánchez, Andres Aguilar-Alvarez. Back (left to right): Isaiah Coleman, Brayan Esquivel, Lillie Williams, Ethan Steadman. Not pictured: Elizabeth Michelle Bates, Kaitlyn Zych.

Elizabeth Michelle Bates

Ethan Steadman

Lillie Williams

Morton Barlaz

Distinguished University Professor **Morton Barlaz** won the **American Academy of Environmental Engineers and Scientists Gordon Maskew Fair Award**. Barlaz was chosen based on his contributions to the environmental engineering profession through his exemplary professional conduct, recognized achievements in the practice of environmental engineering and science and significant contributions to the control of the quality of the world's environment.

Abhinav Gupta

Professor and Director of NC State's Center for Nuclear Energy Facilities and Structures **Abhinav Gupta** was named to the **External Advisory Board of the Methods and Tools Innovations for Seismic Risk Assessment** (METIS) **Project**. Launched in September 2020, METIS brings together 16 partners from nine different countries focused on three facets of seismic risk assessment of nuclear reactors — hazard, fragility and consequence — to improve nuclear reactor safety assessment and develop tools for the more accurate evaluation of nuclear power plant resilience under different seismic conditions.

David Johnston

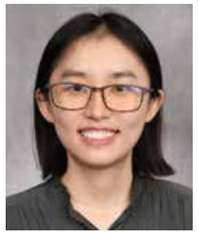
Edward I. Weisiger Distinguished Professor Emeritus **David Johnston** was elected **Honorary Member of the American Concrete Institute** (ACI) in recognition of his contributions to the ACI and the concrete industry. Honorary Member is the institute's highest honor. Johnston was chosen for his dedication to students of concrete construction, his commitment to ACI committee work related to reinforcement detailing and design loads, and his contribution to the 2014 edition of *ACI SP-4: Formwork for Concrete*.

Undergraduate student **Jimmy Lewis** won **NC State's Visual Artist Award** in the 3D art category for his wooden sculpture, Fan Carved Bird #9. The birds he makes are a part of a 100-bird collection that he committed himself to in January 2022. Lewis is a senior studying environmental engineering. He has been woodworking since 2017 while in high school.

Jimmy Lewis

Cristina Lorenzo-Velázquez

Ph.D. student **Cristina Lorenzo-Velázquez** was awarded a **Global Travel Grant from the Seismological Society of America**. The grant offers student and early-career members financial support to attend and present at scientific conferences and workshops anywhere in the world. Lorenzo-Velázquez, who is advised by Associate Professor **Ashly Cabas**, attended the Latin American and Caribbean Seismological Commission Assembly in Quito, Ecuador, in October.



Qian Luo

Ph.D. student **Qian Luo** was awarded a **2022 scholarship from the Association of Energy Engineers** (AEE). AEE's Scholarship Program supports motivated and dedicated students in the fields of energy engineering, sustainability and environmental engineering. Luo is advised by Associate Professor **Jeremiah Johnson** and Assistant Professor **Fernando Garcia Menendez**.

Brina Montoya

Associate Professor **Brina Montoya** received a **Boosting Research Ideas for Transformative and Equitable Advances in Engineering Pivot Grant from the National Science Foundation** (NSF) that will allow her to pursue additional training on cutting-edge scientific methods related to her research on biological methods to improve the stability of soils. These highly competitive grants are intended to "enable researchers to quickly adapt to the fast-moving pace of research and create new knowledge and research products in their field by infusing new concepts from a different discipline or sub-field," according to the NSF.

AWARDS&HONORS

James A. Rispoli

Professor of Practice **James A. Rispoli** was reappointed to the **Department of Energy's Environmental Management Advisory Board**. The board, which has 16 members, works to identify applicable private and public sector best management practices and provides counsel to the U.S. Assistant Secretary of Energy. Rispoli served as Assistant Secretary of Energy from 2005 through 2008.

Rudi Seracino

Professor **Rudi Seracino** was elected a **Fellow of the American Concrete Institute** (ACI). Less than 5% of ACI members earn this recognition. Candidates, who are required to have been ACI members for at least 15 years, are recognized for their outstanding contributions to the production or use of concrete materials, products and structures in the areas of education, research, development, design, construction or management and for their significant contributions to ACI through committees and/or local chapters.

Jessi Thangjitham

Ph.D. candidate **Jessi Thangjitham** was one of 30 NC State students awarded an inaugural **Goodnight Doctoral Fellowship**. The award recognized Thangjitham's academic success as a civil engineering student and is renewable for up to four years. The prestigious award provides an additional supplement directly to the student and covers the cost of student fees.

TWO PH.D. STUDENTS COMPETE IN NC STATE THREE MINUTE THESIS COMPETITION

James East

Adam Schmidt

CCEE Ph.D. students **James East** and **Adam Schmidt** were among 10 NC State graduate students selected to compete in the university's 8th Annual Three Minute Thesis (3MT) competition hosted by the Graduate School on October 25, 2022.

First held at The University of Queensland in 2008, the 3MT competition celebrates the exciting research being conducted at universities worldwide and seeks to cultivate students' academic, presentation and research communication skills.

During preliminary competitions held Oct. 3-5, judges heard from 40 master's and doctoral students on a wide array of research topics. The 10 finalists chosen represented six colleges at NC State. The students competed for cash prizes and a chance to represent NC State at the Conference of Southern Graduate School's regional 3MT competition.

"Trying to distill two years of research as a master's student or five years as a doctoral student into a three-minute presentation with one slide is challenging," said Peter Harries, dean of the NC State Graduate School. "It is so inspiring to see students impart the importance of their work, the relevance to broader issues, and getting to hear about the great research that's happening at NC State within the context of the 3MT competition. It's a way the NC State community and those from outside the institution can access a portion of the incredible research being undertaken by graduate students."

East and Schmidt first competed in CCEE's smaller-scale departmental 3MT competition on April 18, 2022. East, advised by Assistant Professor **Fernando Garcia Menendez**, gave the winning presentation on examining air pollution from space using satellite data to better understand the impact of emissions globally. Second place went to Schmidt, advised by Assistant Professor **Eleni Bardaka**, who gave a presentation on the social and economic impacts of new transit systems. ▪

Photos courtesy of the NC State Graduate School

Five alumni inducted into **2022 CCEE HALL OF FAME**

From left to right: Dan Pleasant, Sami Rizkalla, Louis Rossi, Sepideh (Sepi) Saidi, James Trogdon

The Department of Civil, Construction, and Environmental Engineering Alumni Hall of Fame was established to inspire our current students and our alumni and to celebrate the accomplishments of those extraordinary graduates who have used their education to excel in a profession, career or service.

The five inductees of the 2022 CCEE Hall of Fame represent an inspiring, interesting and influential group of alumni. Membership in the Hall of Fame is limited to about 1% of CCEE alumni.

This year's Hall of Fame Induction ceremony was held on Nov. 4, 2022.

Deborah Bell Young (Global Capital Health, Safety, & Environmental Engineering Director, Honeywell International, Inc., retired), was inducted into the CCEE Hall of Fame in 2021. While speaking at the ceremony, she pointed out that, while the inductees all had very different paths to success, they have all had a major impact on the engineering industry and the CCEE community.

"Through our careers, we have touched many lives by teaching, mentoring, leading and being a part of this community and servicing and doing philanthropic work for NC State," she said. "Thank you for being exemplary alumni for CCEE."

CCEE Ph.D. candidate **Jessi Thangjitham**, who is advised by **Mervyn Kowalsky**, Christopher W. Clark Distinguished Professor of Structural Engineering, also spoke at the event, saying it is obvious that "this group has made a major impact on our engineering community.

"Leadership, service and excellence was a universal theme amongst all the graduates. Congratulations on the well-deserved honor," she said. "I think I can say on behalf of the NC State students that you inspire us to exhibit traits of leadership, service and excellence while we pursue our own great accomplishments."

CCEE Head **Jackie MacDonald Gibson** said that the purpose of the Hall of Fame is to "inspire our current students and alumni and to celebrate the extraordinary accomplishments of our graduates from this program who are seeking to be the best that they can be.

"Congratulations to all the new inductees, and thank you for being an inspiration to all of us."

Read more about each of the 2022 inductees:

DAN PLEASANT

Dan Pleasant, PE, earned his BSCE in 1972 and MCE in 1973. He has worked at Dewberry for more than 40 years, beginning as manager of a startup office in Danville, Virginia, and ultimately serving as Dewberry's chief operating officer for 12 years. Though he now is working a limited schedule, he continues to guide critical initiatives for Dewberry, including championing its corporate acquisition program. Pleasant has also managed the acquisition of seven companies for Dewberry, including the 2021 acquisitions of two engineering firms in the Southeast and the 2019 acquisition of an engineering firm based in California. Pleasant also continues to be very active with Dewberry's clients, serving as an executive client manager for several strategic clients. He has also held the roles of president of Dewberry Engineers Inc., a division of more than 1,800 employees, and president of Dewberry's Southeast division. Under his leadership, he has successfully directed numerous complex planning and design assignments requiring the coordinated effort of professionals with a range of disciplinary expertise. Such assignments include serving in executive management roles for public and private sector clients for multimillion-dollar capital programs.

Pleasant has been active in numerous local, regional and state organizations, including serving as a board member and chair of the Virginia Economic Development Partnership, as a member of the CCEE advisory board, as a director for the publicly traded American National Bank and Trust Company, and on the board of the Virginia Chamber of Commerce. In 2022, he received the NC State COE's Distinguished Engineering Alumnus award, which was established by the College in 1966 to honor engineering graduates for outstanding achievements in planning and direction of engineering work; fostering professional development of young engineers; contributing to knowledge in the field of engineering; or bringing distinction to the university through engineering achievement.

Jackie MacDonald Gibson and Sami Rizkalla

SAMI RIZKALLA

Sami Rizkalla moved to the U.S. in 1971 after working as a practicing structural engineer in Egypt. He earned his MSCE in 1974 and Ph.D. in 1976 from NC State. He then started his academic career as an assistant professor in the Department of Civil Engineering at the University of Manitoba, Canada, where he moved up the ranks and was promoted to professor in 1988. Rizkalla served as an associate dean in the college's faculty of engineering from 1992 to 1994. During his career, he served as president and scientific director of the Canadian Networks of Centers of Excellence on "Intelligent Sensing for Innovative Structures." Rizkalla was largely responsible for the design and construction of the first "smart" bridges in North America reinforced with durable fiber-reinforced polymer (FRP) materials. In 2000, he returned to NC State as a Distinguished Professor of Civil Engineering and Construction. He remained at the university until his retirement in 2017. Rizkalla also served as the director of the department's Constructed Facilities Laboratory and the site director of the National Science Foundation Industry/University Cooperative Research Center (I/UCRC) on the Repair of Buildings and Bridges with Composites and director of the I/UCRC on Integrating Composites into Infrastructure. He was among the founding members of the American Concrete Institute (ACI) Committee 440: Fiber-Reinforced Polymer Reinforcement and served as the committee chair from 1997 to 2003. His research includes more than 300 refereed journal publications. During his 40-year career in academia, Rizkalla served as the chair/co-chair of more than 70 research-based M.S. students and more than 30 Ph.D. students. His research and contributions to the profession have been recognized by many awards, including being named a Fellow of the American Society of Civil Engineers, Canadian Society for Civil Engineering, International Institute for FRP in Construction, Prestressed/Precast Concrete Institute (PCI) and ACI. He also received a Lifetime Achievement Award from the International Institute for FRP in Construction, PCI Distinguished Educator Award and was recently named an honorary member of the ACI.

Several CCEE Hall of Fame members attended this year's induction ceremony.

LOUIS ROSSI

After earning a BSCE in 1967 and an MSCE in 1969, **Louis Rossi** worked as a planner for the newly created New York State Department of Transportation (NYSDOT). In the 1970s, railroads were in a financial crisis. New York was struggling to save those companies, and NYSDOT organized a rail division to find a solution. An unusually young Rossi was put in charge. He quickly created a plan and got the buy-in of federal and local governments, businesses and other stakeholders with conflicting interests. He conceived and implemented New York's TurboTrain, an early high-speed gas turbine passenger train running from New York City to Buffalo, New York. Sadly, those trains were disposed of by Amtrak in 1980. He became the director of transportation planning and focused on infrastructure. Working with U.S. Sen. Daniel Patrick Moynihan and staff, the Federal Surface Transportation Act included procedures whereby every project had to be reviewed for its impact on pedestrians and cyclists. This required every state to have a bike/pedestrian program manager. The 1996 plan is still in place and is used as a model for other states. His system of statewide signed bicycle routes has evolved into the multiuse Empire State Trail.

Following retirement to Florida in the 1990s, he authored *Cycling Along the Canals of New York Volume 1 and Volume 2*, which popularized bicycle tourism in New York. He volunteered with the Florida Department of Transportation and the Lake County, Florida, sheriff to improve cycling policies and helped create a network of Children's Bicycle Safety Clubs as well as the Lake County bike racing team.

Rossi passed away on Aug. 16, 2020. He was a smart, energetic and creative civil servant who positively influenced many forms of transportation for residents of New York and Florida.

SEPIDEH (SEPI) SAIDI

Born in Tehran, Iran, **Sepi Saidi** was raised with a large emphasis on education and the need to be independent. Through her years of primary school, Saidi excelled in science and math, leading to her dual bachelor's degrees in civil engineering and agricultural engineering in 1993 from NC State.

With a $35,000 home equity loan and the will to succeed, Saidi opened the doors of Raleigh, North Carolina-based SEPI (a division of TranSystems) in 2001. She is the founder of SEPI and has been CEO for 21 years. Since its founding, the organization has grown domestically to become an *Engineering News-Record* Top 500 Engineering company, with gross revenue of $36 million in 2021.

Early on, Saidi recognized the value of relationships. Starting with her involvement in the American Council of Engineering Companies of North Carolina, Saidi increased her participation in professional organizations and served as the board chair of the Raleigh Chamber of Commerce (the third female chair in nearly 100 years). She also serves as chair of the North Carolina Chamber.

Fittingly, there are many similarities between Saidi and her company, SEPI. SEPI's four core values are intrinsically woven into the fabric of the culture, driven by its leader: Be Brave, Be Open, Choose Positivity, Pursue Excellence.

From left to right: Sami Rizkalla, Dan Pleasant, James Trogdon

JAMES TROGDON

James Trogdon earned a BSCE in 1984 and an MSCE in 1990. He is the former secretary and chief executive officer of the North Carolina Department of Transportation — which represents the second-largest state-maintained transportation system in the U.S. with more than 80,000 miles of roads, seven ferry routes, intercity passenger rail, public transit, aviation and more than 12,000 employees.

Trogdon led the effort to substantially compress project development timelines and obtain legislative enactment of the state's largest transportation bond. He helped increase transportation revenues while providing a substantial increase in capital program delivery. These efforts resulted in the acceleration of projects across the state that had been delayed for decades.

In addition to his 27-year transportation career, Trogdon retired in 2016 as the Deputy Adjutant General, North Carolina National Guard. He was commissioned as a second lieutenant in 1983 as a Distinguished Military Graduate Reserve Officer Training Corps at NC State. He served in the Engineer Company, Engineer Battalion and Brigade Commands, performing engineering construction missions in more than a dozen countries throughout the world in support of combatant command theater engagement strategies. He was mobilized and deployed on active duty in 2003 in support of Operation Noble Eagle. He was again deployed on active duty in 2006 for Operation Iraqi Freedom as Commander, 105th Engineer Group in support of Multi-National Division North and the 25th Infantry Division during the Iraq "surge." Trogdon was selected in 2011 by the U.S. Secretary of Defense to the Joint Task Force Panther as Commander of all Department of Defense assets in support of the 2012 Democratic National Convention and National Special Security Event.

In 2022, Trogdon was named North Carolina Transportation Lead of AECOM. He will develop strategic relationships with key stakeholders and oversee the delivery of a broad range of transportation infrastructure projects spanning numerous market sectors across North Carolina. ▪

NOMINATIONS OPEN NOW

The CCEE Alumni Hall of Fame was established in 2017 with 19 inaugural inductees. There were three more inductees each year in 2018 and 2019, nine in 2020, six in 2021 and five in 2022. Induction criteria include:

- Service to the profession including advances to the technology or fundamental principles of the nominee's chosen field or career
- Service to the local, national or global community
- Service to the university
- Service to the welfare of society

If you want to nominate someone to be considered for 2023, you will find instructions and the form at **go.ncsu.edu/cceehalloffame**. Nominations are due by June 15 of each year.

GRAD **STUDENT SPOTLIGHT**

Our research and teaching are only possible with the assistance of our nearly 300 graduate students. We shine a spotlight on a few students.

LUCAS FORD

Lucas Ford is a fifth-year Ph.D. student with a concentration in computing and systems. He manages CCEE's high-performance computing cluster, giving guest lectures in computational courses and assisting other members of the department on software-heavy research projects. He grew up in Cherryville, North Carolina, and is advised by Professor **Sankar Arumugam**.

What influenced you to go into engineering?

FORD (F): I have always been a tinkerer and loved puzzles, so engineering has always been a natural fit for me. Once I realized that the skills and knowledge that come along with being a successful engineer would be very transferable and allow me to work on problems in a variety of areas, it was really a no-brainer.

What problem(s) are you trying to solve? Why was NC State / CCEE a good fit for you?

F: Currently, I am working on improving how we represent the impacts of reservoirs on streamflow in the models used to understand potential climate impacts on land surface.

Since I also received my B.S. in environmental engineering from NC State, staying in the CCEE department provided an easy transition to graduate work. However, the ability to study computing and systems while working on interesting engineering problems was ultimately what made the decision to stay for graduate school so easy.

Where did your passion for this particular focus come from?

F: My desire to work on a variety of problems in different fields is what led to my passion for computing. With the seemingly ever-increasing complexity of problems our society faces, I knew that the ability to leverage computational resources effectively would put me in a great position to work on interesting and important problems throughout my career.

Where do you see yourself in five years?

F: After graduation I will be working at BotBuilt, a startup in Durham, North Carolina, where we build houses using robots. In five years, I plan on being a lead software engineer at BotBuilt, helping improve the efficiency of the residential construction industry.

GRAD **STUDENT SPOTLIGHT**

BORIS GOENAGA

What influenced you to go into engineering?

GOENAGA (G): I wanted to be an engineer to solve problems that affect our society. With my research, I want to help reduce accidents and reach the goal of zero deaths on our roads.

What problem(s) are you trying to solve? Why was NC State / CCEE a good fit for you?

G: I decided to come to NC State because of the well-known quality of the transportation research group. The group's research covers the various areas of study within the transport community. In this group, you have the opportunity to be directly involved in areas that are hard to find anywhere else. For example, you can study the effect of climate change on the resilience of our road infrastructure while also focusing on the particle interactions that affect the mechanical properties of road materials.

Where did your passion for this particular focus come from?

G: I have always been passionate about highway design, management and construction. I did my master's in Colombia, and my thesis focused on pavement deterioration models. Since my graduation, I have worked in this area. In 2015, I had the opportunity to start working as an instructor professor at my hometown's university. This experience lasted four years. I had the chance to explore the world of transportation logistics and transportation planning.

Where do you see yourself in five years?

G: In the short term, I will be a postdoc at NC State. In the future, I want to be a faculty member at a well-known institution or to be in a research position.

Boris Goenaga is a fourth-year Ph.D. student with a concentration in transportation systems and materials, studying the relationship between highway safety and pavement condition. He grew up in Colombia and is co-advised by Associate Professors **Shane Underwood** and **Cassie Castorena**. Goenaga is involved with the Transportation Research Board and has presented his work at the board's annual meeting.

ARIADNE PALMA PARRA

What problem(s) are you trying to solve?

PARRA (P): I am studying the behavior of bridges under multidirectional seismic loading to provide design and analysis recommendations. This research is funded by the Alaska Department of Transportation & Public Facilities. I am also a member of the Seismic Design and Performance of Bridges committee of the Transportation Research Board, where I have learned a lot about the current research needs in the field of seismic bridge design.

What influenced you to go into engineering? Where did your passion for this particular focus come from?

P: I have always enjoyed and excelled in mathematics and physics. I was drawn to structural engineering because of the potential to improve the resilience of structures, especially to resist natural hazards, and its direct impact for people in these areas.

Why was NC State / CCEE a good fit for you?

P: I moved to North Carolina when I was halfway through my civil engineering studies in Bogota, Colombia. I believe it was serendipitous that NC State was only an hour away from where I lived with my mom. The CCEE department advisors were really helpful with this transition. I was excited that I could continue my undergraduate studies. I met many different people, made lasting friendships and overcame many obstacles and difficult situations that made me grow and learn about myself. I have continued my graduate studies here at NC State and am very grateful for all the opportunities and experiences.

Where do you see yourself in five years?

P: I would like to be working in the industry as a structural engineer and continue building my professional experience — perhaps as a bridge engineer. I plan to remain involved in supporting Corazón Pacífico using my field of expertise and explore how we as structural engineers can contribute to a more sustainable environment.

Ariadne Palma Parra is a fourth-year Ph.D. student with a concentration in earthquake structural engineering. She grew up in Barranquilla, Colombia, and has lived in North Carolina since the end of 2013. She is advised by Professor **Mervyn Kowalsky**. She has been involved with the Earthquake Engineering Research Institute Student Chapter at NC State since 2015 and currently serves as an outreach coordinator. She is also part of Corazón Pacífico. She recently joined the ESCALA community founded by Assistant Professor **Ashly Cabas**.

GRAD **STUDENT SPOTLIGHT**

SAVANNA SMITH

What influenced you to go into engineering?

SMITH (S): I really enjoyed math and science growing up. The only career with math that I really knew about was accounting until my high school math teacher mentioned that I should look into engineering. It was right around the same time I watched a documentary about water desalination, and I was mesmerized with the idea of making clean water. I love getting to solve real-world problems for the public using science and math.

What problem(s) are you trying to solve? Why was NC State / CCEE a good fit for you?

S: The big problem I'm trying to solve is to clean poop water better, for everyone. CCEE is a great fit for me for many reasons. First, I love the problems I get to work on here and the people that I work with. I've learned so much from the faculty and my peers here. Our department culture is unmatched: Professors clearly enjoy working together, graduate students are friendly and always willing to help each other out, and professors treat graduate students as future peers and collaborators.

Where did your passion for this particular focus come from?

S: Growing up in Hawaii, there was a big focus culturally on environmental sustainability and protecting the land and water we use. This focus — plus growing up in the middle of the Pacific Ocean and then later living on the Gulf Coast in Texas — gave me a really strong care for our water. Biology can seem like magic sometimes, so it's really rewarding to get to be a poop water magician.

Where do you see yourself in five years?

S: I see myself continuing to work at the intersection of microbiology and sanitation. I'm not sure what path I want to take yet. I could see myself as either a teaching professor or in a research position at a national lab or at a water/wastewater biotechnology company. ▪

Savanna Smith is a fourth-year Ph.D. candidate with a concentration in environmental engineering. Her research looks at how and why microbial communities form the way they do in engineered bioreactors. She grew up in Kealakekua, Hawaii, and Rockport, Texas, and is advised by Glenn E. and Phyllis J. Futrell Distinguished Professor #2 and Alumni Distinguished Undergraduate Professor **Francis de los Reyes III**. Smith is involved with NC Safewater, a student group associated with NC One Water and the national American Water Works Association and Water Environment Federation groups.

There are more than a dozen chapters of professional organizations available for CCEE students. Membership is a way to meet peers, make industry connections, strengthen leadership skills and engage in community service. Participation offers the chance to attend conferences, compete against peers from other institutions, learn outside of the classroom and interact with professional engineers.

Construction Alliance

The NC State Construction Alliance student group brought home first place in the Bid Simulation category at the Associated Schools of Construction (ASC) Region 2 Student Competition in Peachtree City, Georgia, on Nov. 15. The team, which was led by captain **Maile Kennaugh**, included **Anto Ovid**, **Rashmita Patel**, **Sai Chand Bollineni**, **Myat Mon Aye** and **Shantanu Sangwan** and was advised by E. I. Clancy Distinguished Professor **Edward Jaselskis**.

"This is an outstanding accomplishment, and it is the best result that an NC State team has ever achieved in the ASC competition," said **Abdullah Alsharef**, a CCEE postdoctoral research scholar who served as the team's coach.

As part of the competition, teams were required to deliver submittals such as a pre-construction report, cost estimate, five dimensional building information modeling and present their work. The student competition included schools across Alabama, Florida, Georgia, Mississippi, North Carolina, South Carolina and Virginia.

American Society of Civil Engineers (ASCE)

The NC State chapter of ASCE hosted a field day event with the University of North Carolina at Charlotte's ASCE chapter on NC State's Centennial Campus on Oct. 29. The event included a concrete cornhole competition, pumpkin stacking, a tour of Fitts-Woolard Hall and an employer presentation from the event's sponsor, ARCO Design/Build.

"This was the first major event the chapter held following the COVID-19 pandemic, and it was a great way to reestablish the chapter's presence on campus with some friendly competition against UNC Charlotte's ASCE chapter," said **Cecilia Sánchez**, vice president of the NC State chapter of ASCE.

The activities exposed chapter members to engineering-related competitions such as concrete cornhole. Students had to design, build and cast a cornhole board using concrete. In the spirit of Halloween, students also participated in a pumpkin stacking competition that required them to use engineering concepts and calculations to build a tower of pumpkins.

The NC State chapter of ASCE hosted a field day event with UNC Charlotte's ASCE chapter last fall.

Members of the CCEE student groups gathered in Fitts-Woolard Hall to paint canvases as part of a group mixer.

Student Energy Club, Global Water Sanitation & Hygiene Student Chapter (Global WaSH), Geo-Institute Graduate Student Organization (G-I GSO) and ASCE

NC State's Student Energy Club, Global WaSH, G-I GSO and ASCE chapters held a CCEE Student Group Mixer in Fitts-Woolard Hall in November and showed off their artistic skills by painting canvases with fun fall designs.

The event gave current and prospective club members an opportunity to mingle with fellow students and learn more about each organization through group leader presentations. More than 30 students attended the mixer.

"The mixer had a great turnout," said **Marlee Strong**, president of G-I GSO. "Most undergraduate students are unaware that G-I GSO is one of ASCE's specialty institutes. We introduced our organization as part of ASCE and several ways that undergraduate students can benefit by being involved in G-I GSO. Some of these opportunities include participating in national undergraduate competitions at the annual GeoCongress conference, networking with local geotechnical engineers at monthly seminars and getting involved with undergraduate geotechnical engineering research." ▪

FACES OF CCEE

Our FACES of CCEE media project celebrates outstanding alumni and illustrates to current students the varied careers available to them. This is an ongoing project, so if you'd like to bring someone to our attention (including yourself), then please do so. We want to know what our alumni are doing. Please send an inquiry or information to our communications director, **Taylor Wanbaugh** (twanbau@ncsu.edu).

MICHAEL MUNN
(BSCE Construction Option 1995)

Munn has served as president and CEO of McAdams since 2010. He first joined the 430-employee company in 1997 as an entry-level project engineer but quickly climbed the ranks to lead the Raleigh, North Carolina-based business. Munn is responsible for directional leadership of the organization, as well as corporate business development, with a focus on client relations and key strategic initiatives. He has made significant contributions to the growth and advancement of McAdams throughout the company's footprint in North Carolina and Texas.

HAROLD HOUNWANOU
(MSENE 2018)

A native of Benin, West Africa, Hounwanou, PE, joined the Little Rock Water Reclamation Authority as a utility worker on the Manhole Adjustment/Rehab Crew and was promoted to project administrator (Developer-Funded) in July 2018. He now serves as the authority's director of Collection System Maintenance. The sanitary sewer service provider collects, treats and disposes reclaimed water for more than 71,112 homes and businesses. Hounwanou oversees the maintenance of and repairs to all assets within the Little Rock, Arkansas, collection system.

SUSAN LEWIS
(BSCE 1983)

Lewis, PE, began working for Cherryville, North Carolina-based Beam Construction in 1985 as a project manager/estimator. She was promoted to vice president in 1989 and succeeded her father as president in 1994. She oversees 90 full-time employees across the Carolinas who tackle projects ranging from 5,000 to 350,000 square feet. She earned her MBA from the University of North Carolina at Charlotte in 1989. Her husband, Art Lewis, is also a CCEE alumnus, and all three of their sons graduated from NC State.

CAMERON SMITH
(BSCE Construction Option 1996)

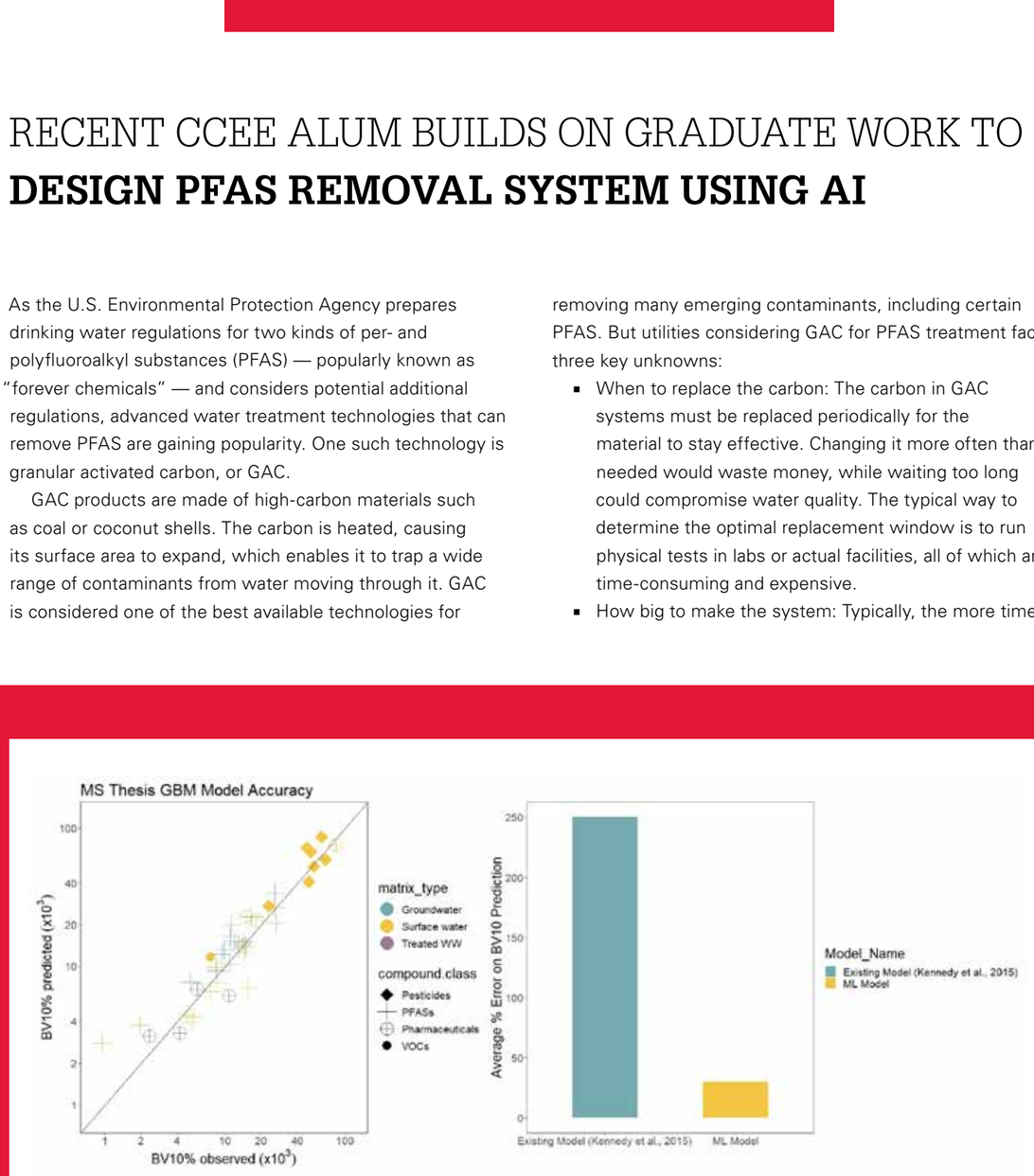
Smith has served as senior director of Capital Project Management within the Finance and Administration Facilities Division at NC State for more than a decade. The unit consists of 28 architects, engineers, accountants and administrative professionals responsible for design, construction and accounting for a capital program worth more than $1 billion. Under Smith's leadership, CPM manages informal and formal design services, formal construction management, capital budgeting/accounting and the Historically Underutilized Business program. Smith also serves as the university's capital projects coordinator and primary liaison to the University of North Carolina System and State Construction offices in support of his team's efforts to deliver projects ranging from small renovations to new multimillion-dollar facilities.

RECENT CCEE ALUM BUILDS ON GRADUATE WORK TO **DESIGN PFAS REMOVAL SYSTEM USING AI**

As the U.S. Environmental Protection Agency prepares drinking water regulations for two kinds of per- and polyfluoroalkyl substances (PFAS) — popularly known as "forever chemicals" — and considers potential additional regulations, advanced water treatment technologies that can remove PFAS are gaining popularity. One such technology is granular activated carbon, or GAC.

GAC products are made of high-carbon materials such as coal or coconut shells. The carbon is heated, causing its surface area to expand, which enables it to trap a wide range of contaminants from water moving through it. GAC is considered one of the best available technologies for removing many emerging contaminants, including certain PFAS. But utilities considering GAC for PFAS treatment face three key unknowns:

- When to replace the carbon: The carbon in GAC systems must be replaced periodically for the material to stay effective. Changing it more often than needed would waste money, while waiting too long could compromise water quality. The typical way to determine the optimal replacement window is to run physical tests in labs or actual facilities, all of which are time-consuming and expensive.
- How big to make the system: Typically, the more time water spends moving through GAC, the more effective the GAC is at removing the desired contaminants. But that longer contact time — or empty bed contact time (EBCT) — requires a bigger, more expensive GAC system. There's a point where increasing GAC system size starts to yield only a small increase in PFAS removal, meaning the costs start to outpace the benefits. But it's very difficult for operators to identify the optimal EBCT.
- What commercial GAC product is best for their facility: There are multiple GAC products on the market. What's more, every treatment plant has a unique combination of water quality characteristics and pollutants. The GAC product that's most effective for one facility might not be for another.



The graph on the left shows the results of using machine learning (ML) to predict the breakthrough of various pollutants in granular activated carbon (GAC) systems. The closer the symbols are to the diagonal line, the more accurate the model's predictions. The right-hand chart compares the degree of error in that ML model to the error in an older model that used traditional statistics (Kennedy et al., 2015). The difference between the two shows that the ML model is far more precise when it comes to recommending an optimal time frame for changing out GAC. These graphs were adapted from the graduate research of Yoko Koyama, who brought the ML tool to Hazen from CCEE and further developed it with a team of colleagues. Citation: Kennedy, A. M., et al. "Full- and pilot-scale GAC adsorption of organic micropollutants." *Water Research*, vol. 68, 2015, pp. 238–248.

Recent CCEE grad **Yoko Koyama** (MSENE 2021), with engineering consulting firm Hazen, has developed a groundbreaking tool that can help answer those questions without any physical tests. It's not just faster and cheaper: It's the most comprehensive data-driven GAC assessment tool to date.

The model was pioneered by Koyama, an assistant engineer at Hazen, during her graduate studies with S. James Ellen Distinguished Professor **Detlef Knappe**.

"I was hired by Detlef to do a series of bench testing on GAC, but I was encountering challenges in the lab and hitting roadblocks as COVID-19 shut things down," Koyama said. "I shifted my focus to computing after realizing that I was better at modeling than conducting lab experiments. Detlef's former post-doc, **Cecile Zhi**, inspired me to build a huge database that has served as the basis of everything that came after it today."

After graduating and joining Hazen, Koyama refined it with a team of colleagues whose expertise spans PFAS removal technology, machine learning, product development and user interface design. The result is a powerful, accessible tool for evaluating PFAS treatment options. Here's what makes it distinctive:

Comprehensive breakthrough data

In GAC filtration, a contaminant's breakthrough means how much of it is escaping in treated water relative to how much is in the pre-treated water. For example, 10% breakthrough means 10% of a pollutant's original concentration is getting through the filter. Breakthrough curves are graphs showing how breakthrough changes with the amount of water (or time) that passes. They help operators predict when the GAC will become ineffective and determine when it needs to be changed to prevent that.

There are reams of studies showing the breakthrough curves of PFAS and other organic pollutants in GAC systems. But individual studies can only reveal so much, as every water system has unique conditions. The GAC prediction tool is based on a database of more than 600 breakthrough curves from peer-reviewed literature, engineering reports and academic research, with data spanning bench-, pilot- and full-scale settings. The data include 29 PFAS (including all regulated PFAS), 20 GAC products and 49 source waters. It's the most comprehensive PFAS treatment database to date.

Machine learning

Machine learning uses algorithms to comb massive data sets for relationships — including connections humans might miss — then generates rules based on the patterns it identifies. That's what makes it a superior predictive tool to traditional statistical analyses, which plug data into known rules.

Koyama's tool was built using a state-of-the-art machine learning algorithm. In minutes, it can predict breakthrough for PFAS compounds in a wide range of GAC treatment scenarios, with an accuracy that rivals that of lab-based tests and trumps all previous data-driven models.

Easy-to-use interface

The beta version of an application for the tool doesn't require any coding or machine learning experience to use. Drinking water experts across the firm can simply plug in a utility's water or wastewater characteristics, GAC products of choice and other key details to quickly determine the most effective GAC product and carbon replacement time frame for that client. They can also use the tool to determine the best EBCT, which can inform decisions about how big to make the GAC system.

Applications beyond PFAS

While this tool was developed with a focus on PFAS, it can also be used to evaluate GAC product performance and life cycles for other organic pollutants such as pesticides, pharmaceuticals, disinfection byproduct precursors and volatile organic compounds — which is to say, it's highly adaptable.

"Utilities that are considering granular activated carbon for PFAS removal don't just want to know how often they'll need to change out the carbon," Koyama said. "They want to know which commercial GAC product is best for their facility's unique mix of water and pollutants. Hazen's tool can answer those questions for you without spending $100,000 on testing."

Koyama credits the faculty and staff at CCEE with her inspiration for the project.

"Cecile (former CCEE post-doc) gave me the greatest idea ever when I was feeling at the lowest in my research career and also mentored and encouraged me not to give up when I doubted myself," Koyama said. "I also believe that the communication skills I developed through CCEE's Three Minute Thesis Competition have helped me succeed at my job and extend my research at Hazen. Detlef's mentorship in the research was indispensable. Even while earning a master's degree, you can conduct impactful research. Properly communicating that research to a large audience is very important."

A version of this story was originally published by Hazen. ▪

Eric Hall's (MCE 2011) scientific paper, "Comparison of Five Modeling Approaches to Quantify and Estimate the Effect of Clouds on the Radiation Amplification Factor (RAF) for Solar Ultraviolet Radiation," won an honorable mention for the U.S. Environmental Protection Agency (EPA)'s 2021 Scientific and Technological Achievement Awards (STAA). He is the only 2021 STAA award winner who won with a single-author publication. Hall is a physical scientist and quality assurance manager at the EPA's Research Triangle Park, North Carolina, facility.

Conor Kennedy (BSCE 2017) joined the College of Engineering (COE)'s 2022-23 Young Alumni Advisory Board. Formed in 2018 by the NC State Engineering Foundation, the board aims to encourage support from the growing population of COE young alumni. Kennedy works as a project manager at Brasfield and Gorrie.

Bill Martin (BSCE 2007, MCE 2010) was named to the nonprofit assessment and certification organization National Wireless Safety Alliance's Board of Governors. Martin serves as president of Tower Engineering Professionals Inc.

Rhett McLaughlin (BSCE 2000), one half of the viral YouTube duo Rhett and Link, won the YouTube Streamy Award for Show of the Year for Good Mythical Morning. The duo's videos rack up more than 700,000 hours of watch time daily.

Melanie Nguyen (BSCE 2006) was hired by Neel-Schaffer to serve as the Hydrology & Hydraulics Discipline Lead for the Carolinas and Georgia. Based in Cary, North Carolina, Nguyen will provide H&H design and project management services for Neel-Schaffer's clients across the Carolinas and Georgia. Nguyen has more than 16 years of transportation project design and management experience, including eight years with the North Carolina Department of Transportation.

Jim Ruffin (BSCE 1984) was named a non-officer member of the executive board of the UNC School of the Arts Foundation. Ruffin founded Construction Practices in 2014 and serves as the company's president.

Chris Tester (BSCON 2000) was named interim public works director for Salisbury, North Carolina. He will manage a $9 million municipal budget, supervise nearly 100 employees who maintain city-owned roadways, cemeteries and telecommunications systems, in addition to maintaining the city's fleet of vehicles and buildings.

Charlie Townsend (BSCE 2015) also joined the COE's 2022-23 Young Alumni Advisory Board. He serves as project manager at VHB in Raleigh, North Carolina.

Don Warren (BSCE Construction Option 1977) was tapped to lead Omega Construction's newly established, full-service Upstate South Carolina operation. Warren has more than 30 years of experience in design-build project delivery.

Meade Willis (BSCE 2007, MSCE 2009) was named a member of the board of directors of the UNC School of the Arts Foundation. Willis is structural engineer and owner of Select Engineering PLLC. ▪

SHARE YOUR NEWS

There are thousands of alumni of the Department of Civil, Construction, and Environmental Engineering working throughout the nation and around the globe. We invite you to provide us with updates about career accomplishments, awards or recognitions, as well as other news. We aspire to create a community of alumni who remain connected to the department and to each other. We also want to keep your contact info current so we can keep you up to date on department events. Send your information to **Taylor Wanbaugh** at **twanbau@ncsu.edu**.

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How Your Support Makes A Difference

Top: Students perform research in the Constructed Facilities Lab. Bottom: Students work in lab space in Fitts-Woolard Hall.

Photos by Marc Hall

ENDOWED FACULTY SUPPORT

Faculty members are the heart and soul of the Department of Civil, Construction, and Environmental Engineering, which is home to more than 50 dedicated scholars and educators. Endowments and named professorships are an essential part of our effort to recruit and retain the very best faculty and then provide them with opportunities to explore new research ideas with the involvement of graduate and undergraduate research assistants. Relative to our peer institutions, the department has a low number of endowed professorships.

ENDOWED GRADUATE FELLOWSHIPS AND AWARDS

We strive to attract the best and brightest graduate students from the U.S. and around the world. Departmental rankings, faculty recruitment, research success and undergraduate education all depend on the presence of talented graduate students. Competition for the best graduate students is intense, and finances can be a deciding factor for students when choosing a graduate program. To recruit the best students, and to create a vibrant learning environment for undergraduate students, CCEE must be able to provide competitive graduate fellowships.

ENDOWED UNDERGRADUATE SCHOLARSHIPS

Undergraduate scholarships enable us to prepare tomorrow's leaders in civil, construction and environmental engineering. Students are drawn to NC State and CCEE by our reputation for excellence. Cost is a major consideration for students and their families. Scholarships represent a mechanism to support and reward our top students.

CCEE ENHANCEMENT FUND

A regular gift to the CCEE Enhancement Fund makes it possible to provide students the best possible education and extracurricular experiences. The enhancement fund allows us to respond to emerging needs and exciting challenges.

For example, in 2020 we deployed teams to the field for time sensitive monitoring of SARS-CoV-2 before external funding was available. Your support enables recruitment and retention of the best and brightest faculty and students, support for our student organizations, field trips to complement classroom instruction and opportunities for faculty and students to present at conferences. Our enhancement fund is critical to the department as we strive to continue to provide opportunities for students and faculty.

RECOGNIZING OUR CORPORATE SPONSORS

Our corporate sponsors may opt to provide support for specific research areas, enabling faculty members to pursue a new research idea. Sponsorships are also available for this newsletter, the welcome back ice cream each fall and our graduate symposia. These symposia allow students to prepare a poster to describe their research and make a presentation to the local engineering community. The activities of our student groups are also dependent on external financial support.

The **Firm of the Month** program recognizes corporate partners who have made an ongoing commitment to the department. It allows us to thank and promote our partners while educating our students about current engineering practice. Our new large monitors in Fitts-Woolard Hall provide opportunities for firms to display information highlighting notable projects and other information. The Firm of the Month program provides participating firms with name recognition for recruiting and business opportunities, demonstrates to students the ways in which they can use their degrees, and provides information on employment opportunities. ▪

2022 CORPORATE DONORS

The firms listed here have provided endowments or made contributions from August 2022 through the end of December 2022. Many on the list have supported multiple activities in the department. We would like to extend our sincere appreciation.

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The department has a wide variety of programs that are made possible by private financial support. For more information on opportunities to help, please contact **Michael Auchter,** our director of development, at **mrauchte@ncsu.edu**.

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Department of Civil, Construction, and Environmental Engineering
NC State University
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