

MAGAZINE SPRING / SUMMER 2022



NEXT LEVEL

Engineering
North Carolina's
Future fuels
STEM growth

TWENTY-FIVE YEARS IN, WOMEN IN ENGINEERING PROGRAM REMAINS STRONG



The new Women in Engineering Program, sponsored by the College of Engineering Office of Academic Affairs, offers a support system for women engineering students that includes a peer mentoring program, a student-alumnae network, a day-long retreat and opportunities to participate in tutoring programs for elementary students and outreach teams for K-12 schools. For more information, contact Laura Bottomley, Women in Engineering Program coordinator, at (919) 515-2315 or send e-mail to laurab@eos.ncsu.edu.



Bottomley (center) uses two audience volunteers and a fluorescent bulb to demonstrate energy fields to a group of middle school students.

THE WINTER 1998-99 COLLEGE OF ENGINEERING NEWSLETTER ADVERTISED THE NEW PROGRAM (TOP), WHILE THE SUMMER 1999 ISSUE FEATURED A STORY ON BOTTOMLEY (BOTTOM).

By 1997, more women were starting to enroll in engineering programs across the United States. To help recruit these women and support them once they arrived on campus, the few women who were already in the College saw a need to develop a program for them.

Sarah Rajala had just been named associate dean for academic affairs in 1996 — the first female associate dean in the College of Engineering. Rajala was often “the first” or “the only” woman throughout her studies and career. She came to NC State in 1979 as the first tenure-track woman faculty member in the Department of Electrical and Computer Engineering (ECE). When she interviewed for the

job with ECE, she noticed there was a faculty restroom. When she was hired, it became a men’s faculty restroom.

Through conversations with female faculty members in the College and in other science, technology, engineering and mathematics (STEM) disciplines about their challenges and experiences, Rajala realized that together they could broaden support for women in STEM at NC State.

“You send the message that you’re trying to improve it for everybody, and hopefully it does improve for men, underrepresented communities and women,” she said.

Rajala recruited **Laura Bottomley**, a former student in ECE who earned

her Ph.D. in electrical and computer engineering from NC State, to return to the College to head up the new Women in Engineering (WIE) Program as a half-time position. As a faculty member at Duke University, Bottomley had some experience with STEM outreach to younger students.

“But of course, I also had lived experience,” she said.

Bottomley got WIE off the ground quickly, modeling early programs on those at other institutions, including a mentoring program and a summer bridge program. Within a couple of years, the College secured funding so that Bottomley could run the program full time. One of WIE’s early breakthroughs came in 1998, when NC State established a K-12 outreach program for students. Known today as The Engineering Place, it has reached more than 1 million students from kindergarten through graduate school.

Over the last 25 years, WIE has always been evolving, with Bottomley applying research on young women in STEM to practical principles, updating programs to help women overcome barriers and become more prepared and confident to take on the engineering curriculum.

WIE and the Minority Engineering Programs have since joined forces to become Women and Minority Engineering Programs (WMEP). The incoming class of first-year engineers is 33 percent women for the first time. Read more about how the College has increased women enrollment, particularly through partnerships with other STEM disciplines, on [page 20](#). ■

Dayton named chair of Joint Department of Biomedical Engineering

Paul Dayton, William R. Kenan Distinguished Professor, was appointed chair of the UNC/NC State Joint Department of Biomedical Engineering (BME) this spring. He has served as interim chair of the department since 2019.

Dayton also holds appointments within the University of North Carolina at Chapel Hill’s Lineberger Comprehensive Cancer Center and Eshelman School of Pharmacy.

His research interests include the areas of biomedical ultrasound imaging, ultrasound mediated targeted therapies and industrial ultrasound applications, and his work has been primarily supported by the National Institutes of Health and other federal funding agencies and industrial organizations. He is also the co-founder of three startup companies, two of which are now based in North Carolina’s Research Triangle Park.

An outstanding scholar and researcher, Dayton was named a senior member of the National Academy of Inventors in 2021 and a Fellow of the Institute of Electrical and Electronics Engineers in 2022.

Dayton received his B.S. in physics and comprehensive science (pre-med) from Villanova University, his M.E. in electrical engineering from the University of Virginia (UVA), and his Ph.D. in biomedical engineering, also from UVA. He pursued post-doctoral research and was later on the research faculty at the University of California, Davis. He joined the BME department in 2007 as an untenured associate professor and was appointed as associate department chair in 2012. ■

NC STATE Engineering

Welcome to the spring / summer 2022 issue of NC State Engineering magazine.



It is truly an exciting time for your College of Engineering. State leaders, recognizing the vital role that engineering and computer science research and education are playing in North Carolina’s fast-growing economy, have made a major investment in NC State and other engineering programs in the University of North Carolina System to increase the number of job-ready graduates produced each year in areas including information technology, energy, health care and manufacturing.

Engineering North Carolina’s Future is a state legislative initiative that will provide NC State with \$50 million over the next two years to catalyze a growth process to **increase enrollment** in our College by an **additional 4,000 students** over the next few years. This funding will start the hiring of additional faculty and staff members as well as facility upgrades and represents a great opportunity for our College to continue its upward trajectory among the most preeminent colleges of engineering in our nation and the world.

In our last issue we were delighted to share with you the news that **two new major National Science Foundation (NSF) research center awards** — the NSF Science and Technology Center – Science and Technologies for Phosphorus Sustainability (STEPS) and the NSF AI Institute for Engaged Learning — were received and are now being led by members of our faculty. Since that time, our faculty has continued its success in landing major research grants, including **\$6.6 million in awards** from the Department of Energy for clean energy research, **NSF Faculty Early Career Development (CAREER) awards** and a **Sloan Research Fellowship**. This success is a tribute to the outstanding quality of our faculty members and their persistence throughout these challenging times.

At the same time, we are also grateful that campus life is returning to normal as we continue to emerge from the COVID-19 pandemic and our campus is more vibrant every day. We were able to honor our newest COE Distinguished Engineering Alumnus Award recipients and dedicate our newest engineering building, **Fitts-Woolard Hall**, with in-person events last fall and celebrate the conclusion of the Think and Do the Extraordinary Campaign with a dinner this spring. This campaign, which has raised more than \$2.1 billion for the University, benefited from the generosity of **19,805 engineering donors** who have pledged more than **\$267 million**. We are very thankful for your commitment to NC State and look forward to reconnecting with you through more alumni events in the future.

I am also very pleased to share that, thanks to the generosity and foresight of alumni **Dr. Jim and Mrs. Ann Goodnight** and the Goodnight Foundation, future deans of our College will benefit from the **Louis Martin-Vega Dean’s Chair Endowment** at the College of Engineering. I am very grateful for their support of our College and deeply humbled and honored that they chose to associate my name with this very significant gift.

Finally, I hope that you will see, from these and other developments that we share in this issue, that your College has grown from a very challenging two-year period stronger than ever and with an even brighter path ahead. We could not have done this without the dedication and commitment of our outstanding faculty members, students and staff. We also could not have done this without your commitment to our College. Thank you for continued support and please continue to stay in touch with us.

Louis A. Martin-Vega, Ph.D., NAE
Dean

DEAN

Louis A. Martin-Vega

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New soundwave technology has applications in infrastructure and health care.

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Engineering and entrepreneurship often go hand-in-hand. Many NC State alumni have gone on to create successful startups.



ON THE COVER

Riddick and Broughton Halls, longtime engineering buildings on NC State's North Campus, feature exterior reliefs depicting the hope and progress of the profession. As the College of Engineering prepares for a significant step forward thanks to the Engineering North Carolina's Future initiative, the cover illustration offers a modern take on those reliefs.

Q&A

QUESTIONS FOR **ANGELITHA DANIEL**

Angelitha Daniel came to NC State in 2003, and has been director of the Minority Engineering Programs since 2013. In 2020, she started a new role as special advisor to the dean for diversity, equity and inclusion (DEI) initiatives, leading the College in cultivating a more inclusive and welcoming culture and environment.

Why was this new role created?

In the wake of the nationwide protest against racial injustice after the killings of Breonna Taylor, Ahmaud Arbery and George Floyd, we were able to seize the momentum to start something that we had been thinking about for a long time. The COVID-19 crisis along with the continued, senseless killings of Black and Brown people at the hands of police led many U.S. colleges, universities and corporations to appoint someone like myself to ensure access, equity, fairness and an environment that allows marginalized groups to feel seen, heard and welcomed.

In what areas does the College need to improve in its DEI work?

Addressing science, technology, engineering and mathematics (STEM) culture that has been built on the values and norms that benefited majority males, along with addressing the climate in our departments and programs, is critical in cultivating more inclusive learning and working environments. I often hear stories of microaggressions experienced by students and faculty and staff members of color. Everyone needs to take part in developing the cultural competency required to better understand the members who make up our College of Engineering family. When we are mindful of the people in our offices, classrooms and labs, and we have respect for those who don't look,

talk or think like us, we will be on our way to really changing the diversity landscape of the College.

What are some recent success stories?

In 2019, the College received Bronze-level recognition for the American Society of Engineering Education's Diversity Recognition Program (ADRP). Part of the application process included drafting a DEI Plan. I am proud of the work my Broadening Participation and Inclusion Committee put into developing the guiding principles for the College's first Diversity Strategic Plan, which builds upon what we submitted for ADRP, and will guide how we ensure access, fairness and equity in everything we do.

How did you start working in higher education?

I graduated from the University of Pittsburgh School of Engineering with a B.S. in materials science and engineering. I was a work-study student for the PITT Engineering IMPACT Program (now the PITT EXCEL Program), founded by the late Dr. Karl H. Lewis. Upon graduating, I was hired as their coordinator of minority recruitment. Fast forward, I have been in this space for almost 25 years and I absolutely love what I do. Having the opportunity to support not only students but faculty and staff members as well, is a true testament to Dr. Lewis' legacy.

What are the College's current DEI priorities?

The College's current DEI priorities focus on dealing with the lessons learned as a result of how COVID-19 changed how we work and live. We are educating students with different needs resulting from being educated in the virtual space and isolated from their peers. Recruiting faculty and staff members is even more challenging as well. We have to meet our constituents where they are and be sure that we are providing access to our public, land-grant institution and resources. They need flexibility in their work schedules so they can balance their personal lives. We also have to ensure that salaries are competitive to attract and retain diverse faculty and staff members. ■





“The need for cybersecurity-trained professionals is real in North Carolina.”

Laurie Williams

(NC-PaCE) will bring eight of North Carolina’s universities and community colleges together with public agencies and private-sector businesses to address a growing workforce gap and establish cybersecurity as an economic development tool for the state. In helping to protect the state’s financial and intellectual property assets from cyber threats, the coalition will help drive the state’s economy by giving North Carolina businesses the skilled workers, knowledge and support that they need to grow their existing industries and by helping to encourage entrepreneurs to start new ventures in the area of security.

Cyberseek, an organization that tracks

the cybersecurity job market, ranks North Carolina sixth in the country in terms of the number of cybersecurity job openings and puts the state at twice the national average in terms of geographic concentration/location quotient, a measure of the concentration of cybersecurity job demand. Its data lists 21,010 security job openings in the state. Average annual salaries for such roles exceed \$100,000.

A NEW COALITION that will enhance North Carolina’s economy and keep its citizens safe through education, research, services and outreach work in cybersecurity will benefit from a \$2 million grant from the National Centers of Academic Excellence in Cybersecurity located within the National Security Agency (NSA).

The North Carolina Partnership for Cybersecurity Excellence

“The need for cybersecurity-trained professionals is real in North Carolina,” said **Laurie Williams**, Distinguished University Professor in NC State’s Department of Computer Science (CSC) and co-director of the coalition. “NC-PaCE will propel the development of cybersecurity expertise necessary to support NC industry and government and to establish cybersecurity as an economic development tool for the state.”

NC-PaCE will be headquartered in NC State’s Secure Computing Institute (SCI), which was created in 2019 to be a leading center for security education and research. East Carolina University, North Carolina Agricultural and Technical State University, University of North Carolina at Charlotte, University of North Carolina Wilmington and Forsyth, Wake and Pitt community colleges are partnering institutions.

This coalition will provide companies and public-sector agencies with a diverse and specialized set of security education, research and services. Their coursework and research curriculum through NC-PaCE will be tailored to the needs of the state to ensure that a trained workforce and the latest knowledge in security are both available to address challenges that are impeding North Carolina’s economic and entrepreneurial growth.

Along with undergraduate and graduate education at partnering universities and colleges, the coalition will provide continuing education for the existing workforce and create an educational pipeline that includes outreach to K-12 schools and community colleges and specifically targets the state’s large military population. NC-PaCE will also focus on ensuring that

students from diverse backgrounds are provided with equal access to education and career opportunities in this growing field.

A planned government and industry advisory board includes representatives from across the state’s finance, energy, technology and defense sectors. An NC-PaCE survey of representatives from these and other industries and government found a strong desire for access to research focused on foundational elements of secure system development and access to graduates of both four- and two-year college and university degree programs focused on cybersecurity knowledge and skills.

Building off of previous successful efforts at NC State to obtain industry startup funding to support cybersecurity research, NC-PaCE will establish a membership model that will allow businesses and government agencies to benefit from the group’s research and expertise. That model is just one part of a plan for long-term sustainability that would make NC-PaCE a resource for North Carolina for years to come.

SECURITY POWERHOUSE

The CSC department at NC State has positioned itself as a national leader in the area of cybersecurity through research, education and extension. Along with the creation of SCI, in recent years the department has added undergraduate and master’s tracks and an undergraduate concentration in security. It has also launched a CyberCorps Scholarships for Service program available to undergraduate and graduate students with help from National Science Foundation funding.

Since 2012, the department has led an NSA Science of Security Lablet. These multi-disciplinary labs at a handful of leading U.S. research institutions promote security and privacy science as a recognized field of research and encourage rigorous research methodologies.

“Our vision is to become a national model for cybersecurity education, and economic development through cybersecurity, and to enable businesses and governments to thrive despite the ever-growing aggression and creativity of hackers,” said **William Enck**, professor in NC State CSC and the other co-director of NC-PaCE.

In the Wolfpack Security and Privacy Research Lab, computer science faculty members and students model, design, build and validate technology that protects users, systems and networks from malicious and privacy-infringing acts. Ph.D. students and lab members **Abida Haque** and **Lorenzo Neil** are interested in post-graduation positions with national labs or at large companies that have the ability to conduct meaningful research.

Neil said that he can see how the research that he is doing in areas including human factors — how the choices that users make can affect the security of systems — can have a real impact.

Haque said that earning a Ph.D. is building on her previous academic and workforce experiences and helping her to think in a different way.

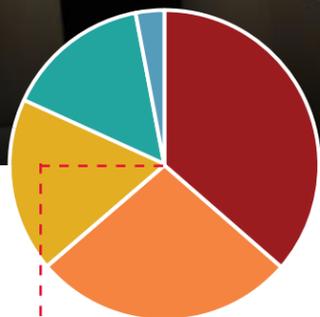
“Now you’re in charge of coming up with things that people haven’t come up with before,” she said.

For more information on NC-PaCE, including how to join as a government or industry member, contact Williams at lawilli3@ncsu.edu or 919.513.4151. ■

Cybersecurity initiative aims to help North Carolina’s economy grow

AARON BELL AND CHLOE EATER, GRADUATE STUDENT, USING THE NEW HITACHI HT7800 BIO-TEM.

New biological imaging capabilities strengthen Triangle research



Interest and use of the equipment across NC State's campus:

COLLEGE OF AGRICULTURE AND LIFE SCIENCES
35.3%

COLLEGE OF ENGINEERING
26.5%

COLLEGE OF SCIENCES
17.6%

COLLEGE OF VETERINARY MEDICINE
14.7%

COLLEGE OF NATURAL RESOURCES
2.9%

THE COLLEGE OF ENGINEERING'S

Analytical Instrumentation Facility

(AIF) has brought in new equipment, making it an area leader in biological imaging — complementing nearby facilities and strengthening research infrastructure in North Carolina's Research Triangle region.

AIF is NC State's primary shared facility for materials characterization. It draws researchers from across NC State, as well as from Duke, the University of North Carolina at Chapel Hill, the National Institute of Environmental Health Sciences and companies located in Research Triangle Park.

"We have capitalized further on our existing high-end instruments to enhance the convergence of physical, biological and life sciences research, which is a broad international trend. The new equipment provides more opportunities to help NC State and other universities move their research forward," said **Shadow Huang**, former associate director of AIF and associate professor in the Department of Mechanical and Aerospace Engineering.

The instruments include a new bio-transmission electron microscope (bio-TEM), cryo scanning electron microscope (SEM), freeze fracture system, high pressure freezer, freeze substitution unit and an ultramicrotome. The high-pressure freezer is one of only two in North Carolina, and there are only a few other ACE900 freeze fracture instruments in the U.S.

Aaron Bell, bio electron microscopy staff scientist, specializes in animal samples and started working at AIF in 2019. **Jin Nakashima**, a senior research scholar who is a plant specialist, started last October. Together, they lead AIF's Bio Sample Preparation Lab and assist researchers who want to use electron microscopy to analyze their biological samples in ways that a few years ago wouldn't have been possible at the facility.

The freeze fracture instrument in particular opens up new opportunities for AIF. When biological samples are frozen and fractured, they tend to break apart along the cell membranes, enabling researchers to see inside of the membrane, explained Bell. After fracturing, the sample is coated with

metal and carbon to create a cast of the proteins on the surface of the fractured area.

"I think of it as a topographical map," Bell said. "It has all these little bumps and looks very three-dimensional, and you can look over a whole cell in one shot as opposed to using a TEM, where you're sectioning through the whole thing."

With the new equipment and expertise also comes a new undergraduate and graduate student course. NC State's Office of Research and Innovation approached AIF about connecting with the Biotechnology Program to develop the course, Introduction to Biological Electron Microscopy Techniques. Started in spring 2022, it is focused on methods used to prepare samples for electron microscopy and covers a range of techniques and equipment.

AIF has already seen a high demand for the equipment.

"We have people from forestry and textiles and the vet school looking at ticks, salivary glands, cellulose fiber and bacteria — you name it," Bell said. "We have a lot of researchers interested in our facilities." ■

New neural-controlled ankle prosthesis improves stability

A NEW PROSTHETIC ANKLE controlled by the brain is showing promising improvements in patients' balance and stability, helping them to feel more control when doing activities like picking up an object from the ground or navigating tasks that might cause them to fall.

Surface electrodes placed over two residual calf muscles sense electrical signals from the brain telling the muscles to contract. The prosthetic ankle processes the electrical activity, and as the patient is telling their ankle to flex, the prosthesis makes the movement.

This type of neural control, called direct electromyographic control, allows the user to continuously control the limb, mimicking the way in which people without amputations move their lower limbs.

Aaron Fleming, who graduated last December with a Ph.D. from the UNC/NC State Joint Department of Biomedical Engineering (BME), was first author on a case study published last year. Along with **Helen Huang**, Jackson Family Distinguished Professor in BME, he has worked with five other participants.

Most research into robotic ankle prostheses has focused on autonomous control, which relies on algorithms to make movements while walking or standing.

"Early on, we didn't know what was going to happen," Huang said. "There wasn't anything that we could build upon."

To use the device, participants worked with a physical therapist to train their residual muscles

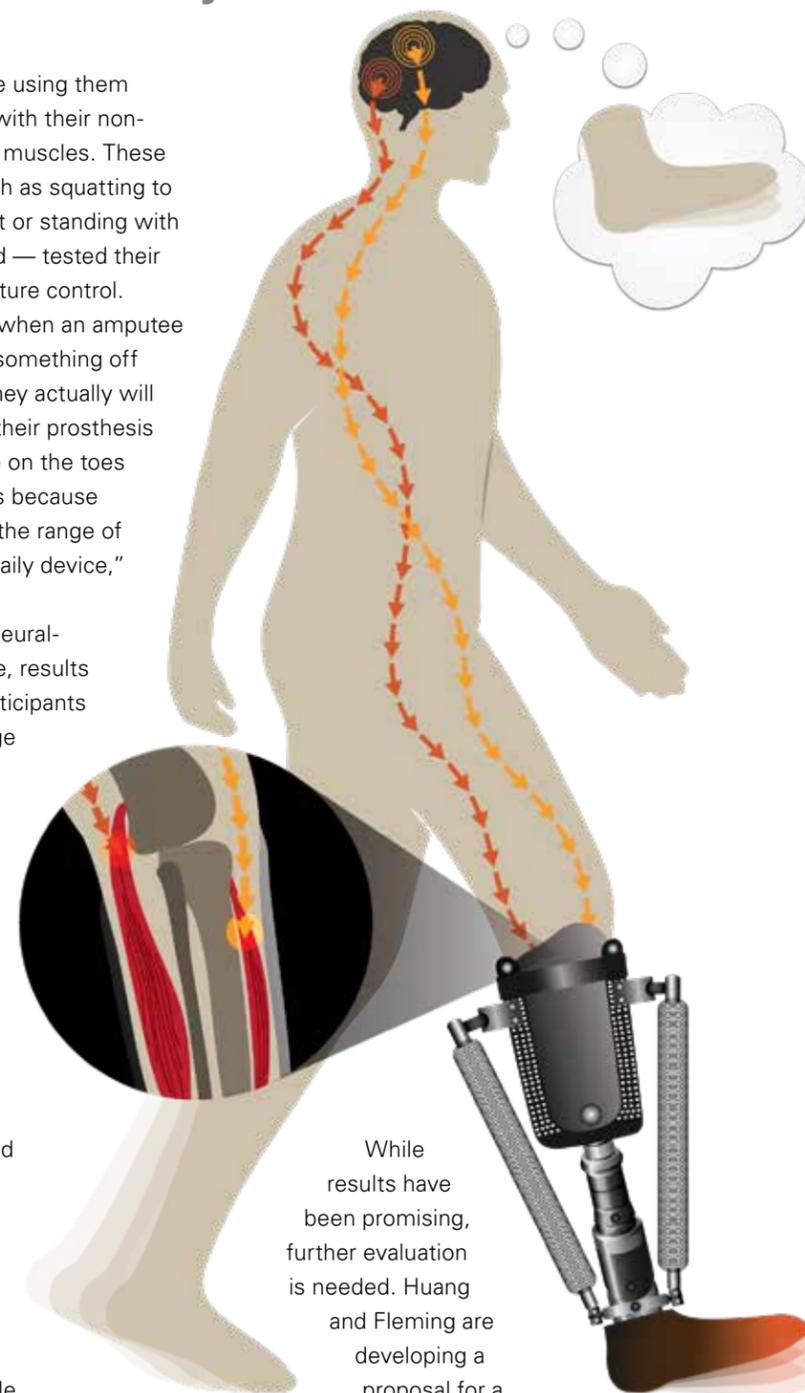
so that they'd be using them simultaneously with their non-amputated leg's muscles. These exercises — such as squatting to pick up an object or standing with their eyes closed — tested their stability and posture control.

"Oftentimes, when an amputee reaches to pick something off of the ground, they actually will rotate, like lean their prosthesis forward. They're on the toes of the prosthesis because they don't have the range of motion in their daily device," Fleming said.

But with the neural-controlled device, results showed that participants had a wider range of motion, more control and more power in their limb compared to when they were using their daily prosthesis.

Huang and Fleming hope that the improved control people have when using this prosthesis will empower them to feel more comfortable and confident participating in their communities.

"When people are using neural control, there's a real emotional impact," Fleming said. "They say they feel like they have their foot back."



While results have been promising, further evaluation is needed. Huang and Fleming are developing a proposal for a clinical trial. There is also ongoing work in the field to improve electrodes, including development of injectable ones the size of rice grains that can provide reliable signals for weeks or months at a time. ■

Havelock-based program fosters local engineering talent in eastern NC

IN THE EARLY 2000s, two NC State alumni had the vision of growing their own engineers to ensure they had enough talent to supply the needs of NAVAIR's Fleet Readiness Center East (FRC East), a U.S. Navy aviation repair and maintenance facility at Cherry Point in Havelock, North Carolina.

Chris Holder, then head of air vehicle engineering at FRC East, and **Dennis West**, then head of research and engineering, had both earned degrees from NC State's Department of Mechanical and Aerospace Engineering.

“Being able to get the entire four-year degree without leaving Havelock — it was almost a no brainer.”

DANIEL COLWELL

They approached NC State and Craven Community College about developing a site-based Bachelor of Science in Engineering (BSE) program with a concentration in Mechanical Engineering Systems (MES) at Craven's Havelock campus. While West moved on to another role, Holder, now head of research and engineering, continued to work to get the program off the ground. In 2004, **Bill Fortney** started as NC State's Eastern North Carolina regional

director of engineering, and by 2012, the first class of four graduates completed their degree.

Ten years since the first graduating class, 75 people will have graduated from the Havelock site, with 91 percent of them staying in eastern North Carolina. The program has strengthened support for the U.S. Marine Corps at FRC East, the only fleet readiness center commanded by Marines, as well as made a significant impact on eastern North Carolina's economy.

After **Ben Tosto** reached a ceiling in the construction industry, he started looking for other options. He was 30 years old, had two kids, a wife and a mortgage — relocating was not an option. He learned that he could take night courses in the site-based

MES program while still working and without leaving eastern North Carolina. He was sold.

“It was the hardest thing I've ever done in my life,” Tosto laughed, recalling his struggles of trying to work full time while studying engineering. “But I wouldn't be where I am today if it wasn't for that program.”

Tosto works for NAVAIR as a mechanical engineer. “It's very rewarding, knowing that you're making a difference in something

so large,” Tosto said. “There's a sense of pride there. When you see a military craft fly over, you look up and you know that you had a part in that.”

The program's benefits have also extended beyond FRC East. Twelve percent of its graduates have been employed locally by other companies.

“That's a really neat phenomenon that's happening that none of us anticipated,” said Fortney. “The program is helping Cherry Point but it's also helping other eastern North Carolina companies who need engineering talent.”

Havelock-based Tandemloc, which designs and manufactures cargo handling equipment, has a small group of engineers. Two of those engineers will be retiring soon, and the company needed to find a new head of engineering. Tandemloc's leadership approached **Daniel Colwell**, employed in their machine shop at the time, about enrolling in the program. Colwell had a wife, a son and a full-time job and was not able to relocate or commute for school. Now, after receiving his BSE, he is an engineer for the company.

“Being able to get the entire four-year degree without leaving Havelock — it was almost a no brainer,” Colwell said. “It was an opportunity I just couldn't turn down.”

While the program is appealing to nontraditional students like Tosto and Colwell, NC State and NAVAIR

have collaborated on efforts to draw in more traditional students — students coming directly from high school.

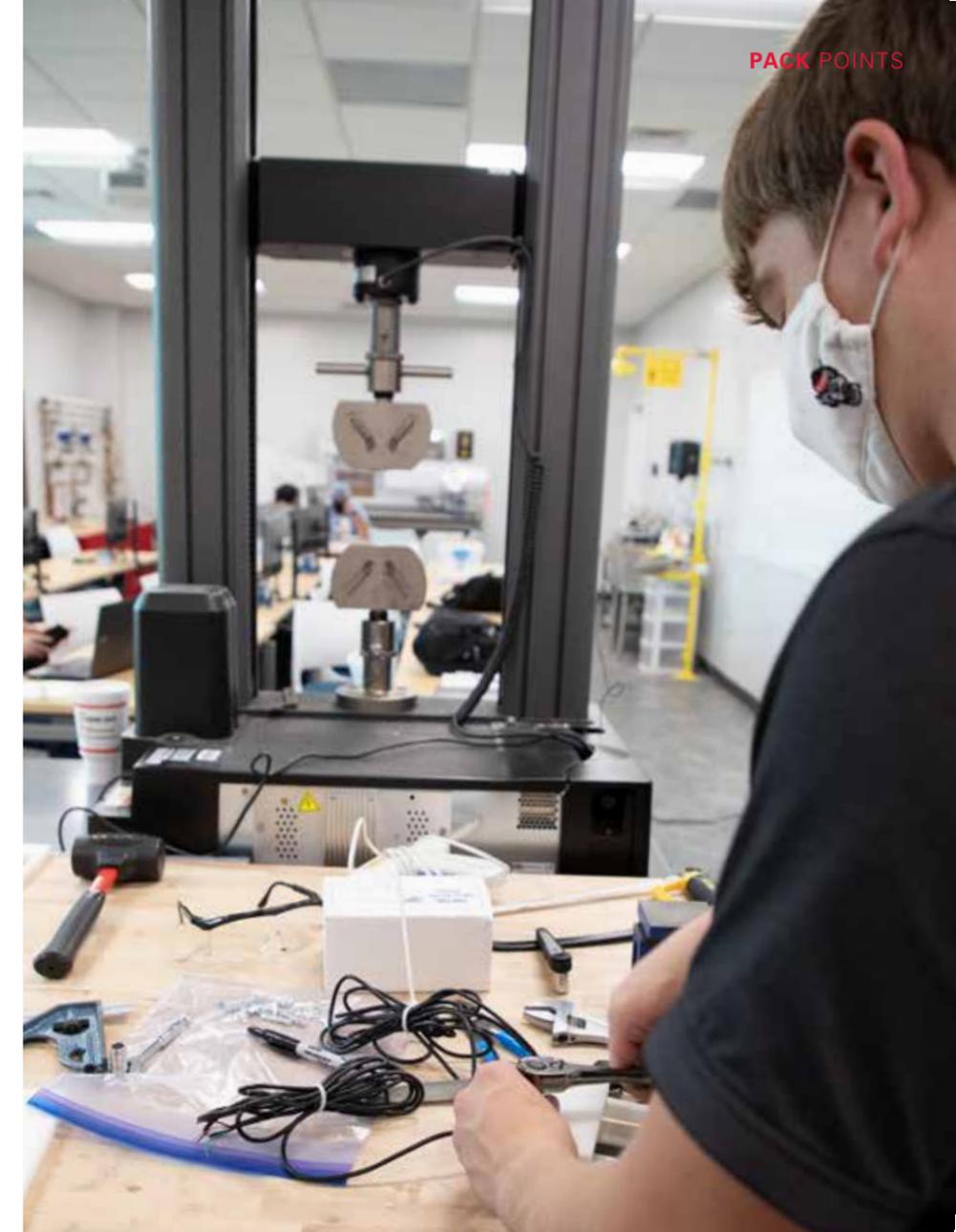
“Early on we knew that if the dream of growing their own engineers was going to be realized, we would have to invest in the K-12 pipeline,” Fortney said.

NC State and NAVAIR began visiting classrooms to expose students to engineering activities. Together, they started a middle school engineering camp. Holder and Fortney also created a Science and Engineering Forum for Craven and Carteret counties with the goal of encouraging students to consider pursuing STEM careers.

“All of that work has created an awareness of engineering in eastern North Carolina, so we have seen an increase in our traditional population,” Fortney said of the students in the Havelock MES program. “We love having the mix of traditional and nontraditional students because they help each other. Having a mix makes for a rich learning environment.”

Today, 60 percent of the site-based MES program's students are traditional, 29 percent are veterans and 11 percent are nontraditional locals.

“We're excited that the program continues to grow and will soon sustain 20 to 25 graduates every year,” said Ray Staats, president of Craven Community College. The school recently completed construction of a STEM building on



the Havelock campus that allows the college to devote significantly more space and resources to the program.

“As we're at this 10-year point, we look back and we can name students that have come through the program that we know would never have been able to have their engineering degree without this program,” Fortney reflected. “We see the change that it's made in their life. But we also see the change that they're having on the

men and women that serve us in the military because of the work that they do supporting military aviation. It's humbling realizing that we've been able to play a part in that and the significant impact that this partnership has had and is still having on eastern North Carolina. NC State, NAVAIR and Craven Community College had the foresight to make a long-term investment in eastern North Carolina, and that investment is paying off. It's a great story.” ■

New authentication system uses unclonable, microscopic features to detect counterfeits with smartphone

AS COUNTERFEIT MERCHANDISE and documents become more difficult to detect, methods for checking authentication need to become more sophisticated. A new authentication system that gets down to the microscopic level to detect counterfeits is a promising solution — especially since it can all be done using a smartphone.

Chau-Wai Wong, an assistant professor in the Department of Electrical and Computer Engineering, received a patent for this new method, which is cheaper than traditional systems like holograms and ultraviolet ink. It's also more accurate, as traditional methods rely on human judgment for the final decision.

Common items at risk for counterfeiting include tickets, IDs and merchandise packaging.

The detection method is dependent on the existence of physically unclonable features (PUFs), or the unique, microscopic structures on a surface that are almost impossible to replicate.

Given the advancement and availability of smartphones, Wong saw benefits to making the authentication method available through an app versus traditional technologies.

"With the increased imaging capability of modern smartphones, they make it easier for the technology to be widely used," Wong said.

On their smartphones, users download the app and take a few photos of their item, and then the app automatically checks them against a verification database. Within this database, previous photographs of the product from different angles are stored by

the producer so that users can compare the product in their possession.

The item's surface is illuminated as the user takes multiple photos. These photos are used to calculate the normal vector field, a verification feature that assesses the unique directions along the surface of a product. These series of directions are then referenced against the photos saved within the verification database and authenticity is verified or denied within seconds.

"Because we have a fingerprint in the database, no matter who's trying to verify the product and as long as the software is not hacked, we can be confident whether something is or is not authentic," Wong said.

While the app and verification process are being further improved, the patent now opens the opportunity for commercialization, with the verification process potentially having a promising future in the areas of supply chain management as companies have begun expressing interest.

For his work, Wong was recently awarded the Jimmy H. C. Lin Innovation Award from the University of Maryland (UMD), where he received his Ph.D. The award offers financial assistance to faculty and staff members and students throughout the expensive patenting process in order to support the spirit of invention.

The patent was originally awarded July 28, 2020, with research advice from Min Wu, professor of electrical and computer engineering at UMD. A video of the technology can be viewed at bit.ly/3LBsT1t. ■

An EYE on the future

WHEN RYAN PECAUT, industrial and systems engineering '21, approached the Engineer Your Experience (EYE) Program office with a proposal, he expected to be turned away. A professor of his had mentioned EMO Hannover, the largest industrial technology conference in the world, piquing Pecaut's interest.

He had secured funding for a previous project concerning the use of national and state parks, so he was familiar with the program. This time, though, he was coming with, in his words, "a ridiculous request."

"It wasn't a matter of 'You want to go to Germany?'" Pecaut said. "It was a matter of 'How can we make this happen?'"

Since its founding in 2019, the EYE Program has provided funds and support for hundreds of engineering students who are interested in enriching their education. EYE funds can be used for a variety of purposes: professional conferences, alternative service break trips, study abroad or student competitions. **Shelly Hoover-Plonk**, coordinator of student enhancement programs, works with students to help them take the most advantage of these opportunities.

When international and domestic travel became less feasible in 2020, the program refocused its offerings. They began funding students' technical certifications and helped start Engineering Interest Circles, a virtual networking opportunity that connects students with alumni working in their chosen fields.

"This was an excellent opportunity for them, especially



WITH SUPPORT FROM EYE, RYAN PECAUT ATTENDED THE 2019 EMO HANNOVER, THE LARGEST INDUSTRIAL TECHNOLOGY CONFERENCE IN THE WORLD.

when interaction was very limited," Hoover-Plonk said.

With students able to travel again, the program is still offering virtual opportunities as well as real-world experiences.

"The silver lining for us, in regards to COVID-19, is that we found out, by having to push for new ideas, that we could do some different things that would be supportive of our students," Hoover-Plonk said.

Recently, the program helped fund SenseNC, a multi-disciplinary student research team that competed in a virtual international competition last fall. They have also provided study abroad awards to approximately 150 students for this summer.

Students also have the opportunity to take on a leadership role. The Student Advisory Committee helps market the program and come up with new ideas for how the program can

expand to provide more diverse opportunities. The committee currently has open spots for more students who are interested.

These opportunities further expand the breadth of experience engineering students bring from their education to the workplace. Pecaut now works as a supply chain digitization manager at Procter & Gamble after completing an internship with the company.

"I am working with folks around the world who ultimately are feeding into that supply chain. Even at my internship, I was working with folks from Sweden and Switzerland and Egypt and Singapore," he said. "Being able to have a little bit of a view of how international collaboration happens while still in college is really helpful."

For more information, please contact Hoover-Plonk at smhoover@ncsu.edu. ■

"Being able to have a little bit of a view of how international collaboration happens while still in college is really helpful."

RYAN PECAUT

NSF RAPID grants support engineering research on pandemic for better future solutions



“It’s great that NSF provides these RAPID grants as it allows us to react quickly without missing opportunities to collect valuable data.”

MARIA MAYORGA

DURING REAL-TIME CRISES,

real-time research helps inform responses to ongoing issues while preparing society for future crises.

Faculty members in the College of Engineering are principal

also allows us to form an interdisciplinary team and lets us think outside of the box while showing that engineers’ work has larger societal impacts.”

All but one of the PIs and co-PIs on these grants are faculty members in ISE: **Osman Ozaltin**, associate professor; **Julie Ivy**, professor and Fitts Faculty Fellow in Health Systems Engineering; **Julie Swann**, department head and A. Doug Allison Distinguished Professor; **Leila Hajibabai**, assistant professor; and Mayorga. **Ali Hajbabaie**, an assistant professor in the Department of Civil, Construction, and

Environmental Engineering (CCEE), is working with ISE on one of the grants, as are NC State graduate students and faculty members from other universities.

ANALYZING CURRENT HOSPITAL SURGES

Ozaltin, Ivy and Mayorga are leading efforts to document how COVID-19 is influencing patient admission patterns and outcomes, and overall hospital operations. The grant, “Documenting Hospital Surge Operations in Responding to the COVID-19 Pandemic,” wrapped up in April.

investigators (PIs) or co-PIs on three Rapid Response Research (RAPID) grants awarded in 2020 by the National Science Foundation (NSF) focused on hospital surges, vaccine distribution and the well-being of college students during the COVID-19 pandemic.

“It’s great that NSF provides these RAPID grants as it allows us to react quickly without missing opportunities to collect valuable data,” said **Maria Mayorga**, a professor in the Edward P. Fitts Department of Industrial and Systems Engineering (ISE) and a co-PI for two of the grants. “It

Researchers are collecting data — including patient medical records, pre-pandemic planning guidelines and operational factors like staffing and equipment availability — from two major hospital systems: Samaritan Health Services in Oregon and MedStar Health System in Washington, D.C.

With a surge in infectious and critically ill patients, COVID-19 caused a nationwide shift in hospital system operations, including delaying non-emergency and elective surgeries while still aiding patients with severe injuries and illnesses.

“We’re seeing long-term impacts on patient care and preventative services, both from the initial stoppage of services, and then people not resuming usual levels of care as the COVID-19 pandemic continued,” Mayorga said.

Mayorga sees potential to improve hospital systems’ responses to mass casualty events by documenting observable best practices.

“Most hospital surge capacity planning focused on natural disasters or terrorist threat, with the assumption that you could seek help from outside,” she said. “With something of this scale, we want to make sure patients are not left behind.”

VACCINE DISTRIBUTION DATA PROVIDES VITAL RESOURCE

For the grant “Collection and Archiving of Vital Data on COVID-19 Vaccine Distribution,” Hajbabaie in CCEE has been working with Swann and Hajibabai since last year to collect and eventually distribute data regarding vaccine distribution

and administration to help health systems plan effective responses to future emergent events and other large-scale disasters.

Student researchers include **Kuangying Li**, an operations research Ph.D. candidate; **Asya Atik**, a civil engineering Ph.D. candidate; and **Dayang Zheng**, a senior industrial engineering and computer programming dual major.

This data — which includes vaccine allocation, distribution, shipment, inventory and administration — is being organized in an online vaccination portal that analyzes trends influencing public health efforts across different communities in different states. Researchers are observing performance factors such as the rate of vaccine spoilage and access related to gender or race and ethnicity.

Researchers first collected data from the Centers for Disease Control and Prevention, then from 14 state public health departments across the nation, with 10 additional states being targeted for future data collection. The grant ends in May.

“Vaccine distribution priorities and policies at each state can influence the efficiency of the vaccine distribution infrastructure,” Hajbabaie said.

SOCIETAL IMPACTS OF COVID-19 AT UNIVERSITIES

Ivy, along with Swann; Mayorga; Harriet Nembhard, dean of the College of Engineering at the University of Iowa; and Lauren Berrings Davis, professor of industrial and systems engineering at North Carolina Agricultural and Technical State University, are looking at student well-being.

Their research looks at students who may struggle with hunger and housing insecurity, or behavioral or mental health issues.

Under the grant “Collaborative Research RAPID: Matriculation and Well-Being Under Emergent Events (MWEE): Using Data to Empower Campus Communities in Times of Crisis,” which ends in July, they are collecting data from publicly released information and student surveys from NC State, NC A&T, Duke University and the University of Iowa.

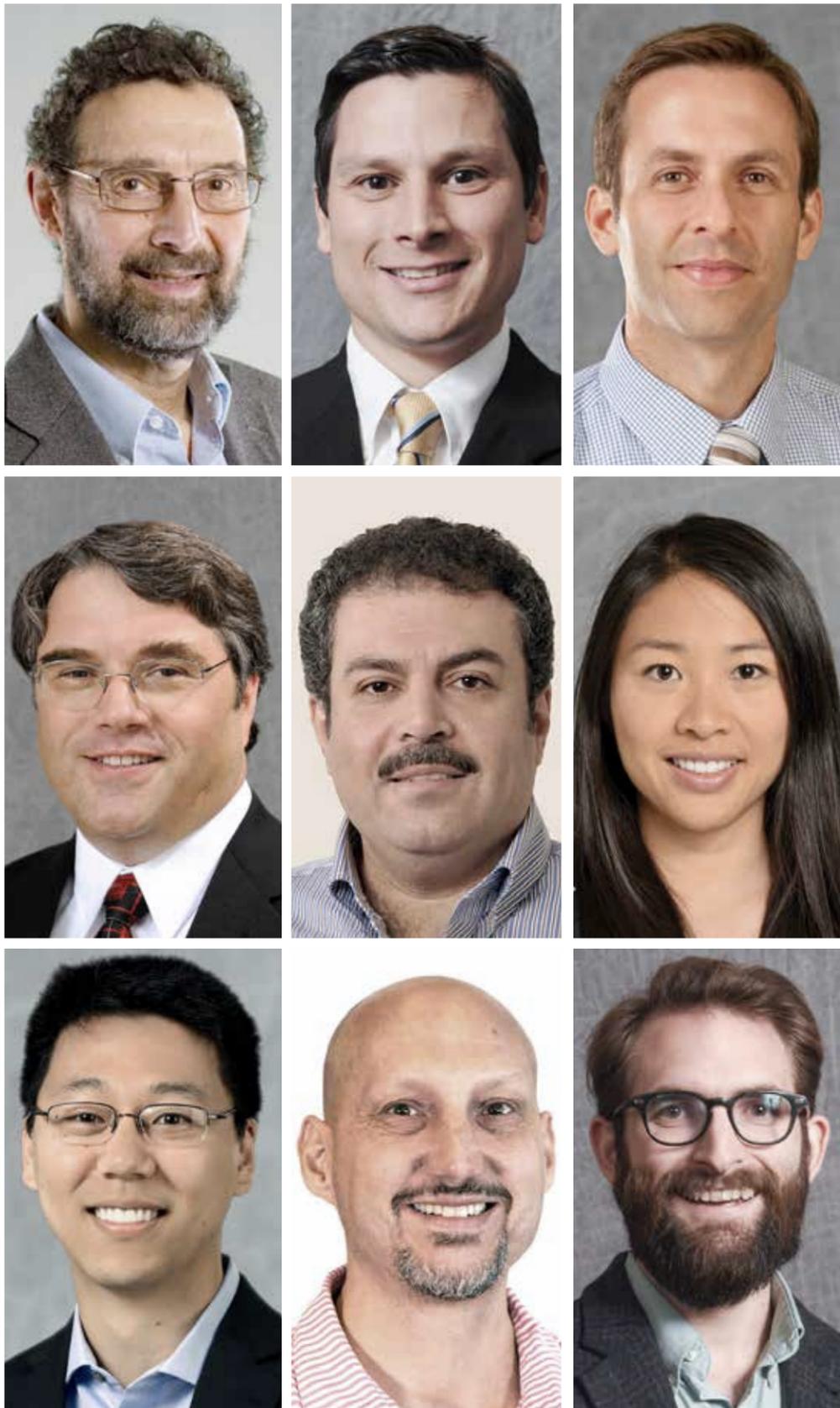
More than 150 engineering undergraduate students — who were selected as the focus demographic due to the hands-on work and difficulty of their degree programs — have participated over the course of four semesters, starting in fall 2020.

Researchers are focusing on emotional well-being, social support, life satisfaction and if students feel their needs are being met, while also accounting for university COVID-19 policies.

“We’re observing how well-being over the course of the semester is influenced by COVID-19 as it further influences policy changes that significantly affect students,” said **Danika Dorris**, a Ph.D. student in health systems engineering and student researcher in ISE.

Other institutions will be able to use the data to compare to their own campuses’ data and make plans for responding to future emergent events in order to predict the retention and graduation rates of students.

“We need to create an awareness of the downstream effects our policies have,” Mayorga said. “We have to make sure there is something in place for our most vulnerable students.” ■



TOP, LEFT TO RIGHT, MORTON BARLAZ, JOSEPH DECAROLIS, MICHAEL DICKEY, CHRIS FREY, AYMAN HAWARI, LILIAN HSIAO, ALBERT KEUNG, FRED KISH AND BRADLEY REAVES.

Hsiao receives 2022 Sloan Research Fellowship

Lilian Hsiao, an assistant professor in the Department of Chemical and Biomolecular Engineering (CBE), was awarded a 2022 Sloan Research Fellowship in Chemistry. She is the seventh faculty member from NC State to be awarded the fellowship from the Alfred P. Sloan Foundation, and she will receive \$75,000 for her research-related expenses. Hsiao's work focuses on advancing our fundamental understanding of microscopic forces in liquids and soft matter, and using that knowledge to engineer next-generation materials with unusual mechanical and structural properties.

Two receive NSF CAREER awards

Two faculty members from the College received Faculty Early Career Development (CAREER) awards from the National Science Foundation (NSF). The NSF CAREER Award is one of the most prestigious awards in support of junior faculty members who exemplify the role of teacher-scholars through outstanding research,

FACULTY HIGHLIGHTS

excellent education and the integration of education and research within the context of the mission of their organizations. They receive their funding over five years from NSF.

Albert Keung, assistant professor in CBE, will receive \$825,816 for his project, "A Synthetic Biology Platform to Map and Engineer the Diverse Epigenetic Space."

Bradley Reaves, assistant professor in the Department of Computer Science, will receive \$606,848 for his project, "Increasing Trust and Reducing Abuse in Telephone Networks."

Two CCEE faculty members serve key White House roles

Joseph DeCarolis, professor and University Faculty Scholar in the Department of Civil, Construction, and Environmental Engineering (CCEE), was confirmed by the U.S. Senate to serve as the administrator of the Energy Information Administration at the U.S. Department of Energy.

Chris Frey, Glenn E. and Phyllis J. Futrell Distinguished University Professor, is the current deputy assistant administrator for science policy

in the Office of Research and Development. He is on leave from NC State during his appointment. He has also been nominated to be the assistant administrator of the U.S. Environmental Protection Agency's Office of Research and Development.

Two engineering faculty members named AAAS Fellows

Two engineering faculty members have been elected as Fellows of the American Association for the Advancement of Science (AAAS) for 2021.

Morton Barlaz, Distinguished University Professor and head of the CCEE department, for distinguished contributions to the field of environmental engineering, particularly for advancing understanding of solid waste engineering and related fundamental biological and chemical processes.

Ayman Hawari, Distinguished Professor of Nuclear Engineering and director of the nuclear reactor program, for distinguished contributions to the field of nuclear engineering, particularly for the development of research

reactor experimental facilities and fundamental contributions to the understanding of thermal neutron scattering.

They are part of a group of eight new Fellows from NC State. AAAS, the world's largest scientific society and publisher of the journal *Science*, has been awarding fellowships since 1874.

Dickey receives 2021 R.J. Reynolds Tobacco Company Award

Michael Dickey, Camille and Henry Dreyfus Professor in CBE, is the 37th recipient of the R.J. Reynolds Tobacco Company Award for Excellence in Teaching, Research and Extension. Dickey gave his award lecture — titled "Beyond the Terminator: Liquid Metals, Stretchable Electronics and Shape Changing Materials" — at the Talley Student Union in November.

The award, established in 1981, honors a College of Engineering faculty member who has demonstrated superiority in several areas of activity that relate to NC State's three-fold mission of teaching, research and extension.

Dickey, who came to NC State in 2008, is an international

expert and leading researcher on liquid metals based on gallium. He received the Outstanding Teaching Award from the University in 2012 and the eponymous Outstanding Research Mentor Award in 2020.

Kish named National Academy of Inventors Fellow

Fred Kish, M.C. Dean Distinguished Professor in the Department of Electrical and Computer Engineering, was elected a Fellow of the National Academy of Inventors (NAI) in its 2021 class.

Kish, who joined the NC State faculty in 2019, is the director of NC State's Nanofabrication Facility. His research interests are in photonic integrated circuits, light-emitting diodes and AI-bearing III-V native-oxide technology.

The NAI Fellows Program highlights academic inventors who have demonstrated a spirit of innovation in creating or facilitating outstanding inventions that have made a tangible impact on the quality of life, economic development and the welfare of society. Election to NAI Fellow is the highest professional distinction accorded solely to academic inventors. ■

ENGINEERING EXPANSION WILL BOLSTER THE STATE'S WORKFORCE AND HELP THE COLLEGE GROW

A funding initiative from the state legislature titled Engineering North Carolina's Future will help grow the enrollment of engineering and computer science students at NC State and other engineering programs in the University of North Carolina System.

The initiative recognizes the significant growth of science, technology, engineering and mathematics (STEM) workforce-dependent industries in North Carolina and was spurred, in part, by several significant hiring announcements in the state by leading technology companies in 2021.

NC State plans to add about **4,000 engineering and computer science students** over the next few years and hire **more than 100 new faculty members**. This growth would bring the enrollment in the College of Engineering to **more than 14,000 students** and the University's total **student population to more than 40,000**.

Engineering North Carolina's Future will provide NC State with **\$20 million** over the next two years to catalyze the hiring of additional faculty members and support staff including academic advisors and laboratory personnel to support the larger student body.

The legislature is also providing the University with \$30 million to support facility upgrades to accommodate these additional students.

"NC State is providing the workforce, research and partnerships that are fueling the Triangle's flourishing tech industry that is driving huge economic impact benefits across the state of North Carolina," said Chancellor **Randy Woodson**. "We greatly appreciate the General Assembly's support and recognition of NC State's critical role in Engineering North Carolina's Future."

Helping the College grow its student enrollment, faculty and infrastructure is also critical to assuring that NC State Engineering continues to move forward to meet its full potential.



"NC State is providing the workforce, research and partnerships that are fueling the Triangle's flourishing tech industry that is driving huge economic impact benefits across the state of North Carolina."

**CHANCELLOR
RANDY WOODSON**

NEXT LEVEL

While the College has made significant advancements in its research enterprise, national reputation and rankings, none of its peers are standing still, so it must grow to continue its move up among the country's top public colleges of engineering.

BIGGER, NOT BETTER

Recent economic development announcements by Apple, Google, FUJIFILM Diosynth and many others show the rapid growth of the tech industry in North Carolina. The demand for NC State's well-prepared STEM graduates — as well as partnerships with NC State's world-leading faculty members and their research — has never been greater. As just one example, Google's new unit in Durham, NC, will be led by **Kamala Subramaniam**, an NC State electrical and computer engineering alumna who received her M.S. and Ph.D. in 2006 (*see sidebar*).

As the workforce needs of the state grow, however, NC State has not kept pace with demand; last year alone, the University turned down undergraduate

admissions to 1,400 engineering applicants who had a 3.75 or higher unweighted GPA due to lack of faculty members and space.

"These new funds will enable NC State to keep our best and brightest students in state, and will allow us to meet the needs of North Carolina's growing technical workforce," Woodson said.

Engineering North Carolina's Future will also help the College of Engineering take the next step toward its goal of becoming the leading public college of engineering in the United States.

Thanks, in part, to more than \$50 million in funding support from the state legislature beginning in 2007, the College was able to add **90 additional faculty members** and make major infrastructure investments, including the completion of **Engineering Building III** on Centennial Campus. An additional state investment of \$75 million in capital funding combined with \$60 million in private investment enabled the completion of **Fitts-Woolard Hall on Centennial Campus**.

These investments helped spur a period of significant enrollment growth and research expansion between 2006

and 2018. The College reached **\$200 million in annual research expenditures** and climbed as high as **eighth nationally in annual expenditures** among all engineering colleges. Along with that growth came national recognition; the College was ranked as high as **11th among all public colleges of engineering in U.S. News & World Report rankings of the best graduate engineering programs in the country**.

While the College has continued to operate at a high level since then, peer institutions are making major investments to grow their engineering and computer science programs. The solution for continuing NC State Engineering's upward trajectory is simple: the College must continue to grow.

"Virtually every college ranked ahead of us isn't better," Dean **Louis Martin-Vega** said. "They're just bigger. We hope that Engineering North Carolina's Future will help spur the enrollment growth and faculty hiring that we need to close that gap." ■



HOMEGROWN LEADERSHIP

Alumna Kamala Subramaniam leads Google's new hub in the Triangle

Kamala Subramaniam carries with her a number of positive memories from her time at NC State, including favorite classes, homework and project work with her classmates and eating on a graduate student budget at Golden Dragon, a local Chinese restaurant that is popular with students.

Now, Subramaniam has returned to the Research Triangle to lead Google's new hub in Durham, NC, and is poised to create more memories.

In 2021, the company announced plans to establish a new engineering unit dedicated to its cloud computing business in downtown Durham, creating more than 1,000 new jobs. Subramaniam, who came to Raleigh from her native India to earn master's and doctoral degrees in electrical and computer engineering, joined Google in 2016 after holding positions with Microsoft and other technology companies.

"North Carolina has retained a very special place in my heart and returning to the Triangle has always been something my husband and I have discussed for our family," she said. "When you touch down in North Carolina and, especially, the Triangle, after being away for so long, you can instantly see why this is one of the fastest-growing regions in the country."

A substantial part of her role will include recruiting from the strong talent pool available in the Triangle, including from NC State. Google's first intern in Durham was an NC State student who began a full-time position in January.

She describes NC State as "a place where relationships come first.

"I have had a wonderful time ever since stepping foot into the University," she said. "I remember first having to check in with the immigration office, then the grad programs office, and the College of Engineering office. Every interaction I had was kind. It was only natural that I made my best friends for life at State."

Professors and advisors helped Subramaniam create a portfolio of classes toward her degree that incorporated what the industry in her affinity field of networking would be looking for when she graduated while also providing training in core programming, system design, data structures and algorithms.

"This allowed me to experiment in any field and taught me early on that a combination of affinity and the need to constantly learn is key to satisfaction," she said.

Subramaniam has stayed connected as a member of the Department of Computer Science's Strategic Advisory Board and delivered the department's December 2021 commencement address. ■



Supporting women in COE strengthens student body

The incoming class of first-year engineering students is 33 percent women



THE WISE VILLAGE PROVIDES A PLACE FOR WOMEN STUDENTS FROM DIFFERENT STEM DISCIPLINES TO BOND, STUDY TOGETHER AND LEARN FROM EACH OTHER.

When the College of Engineering’s class of 2026 gets to campus, they’ll be part of an historic milestone. For the first time, the incoming engineering class is 33 percent women.

Reaching this point has taken years of dedicated work across NC State University, especially as the College faced years of stagnant and even declining women enrollment. In the process, faculty and staff members have learned two key lessons for success. First, programs work best when they meet students where they are. Second, when implementing a program that supports one group of students, the benefits tend to ripple out to all students.

“We began to focus on something which in retrospect seems logical. Most of the programming that we were doing ... was aimed at changing the students to fit the engineering mold,” said **Laura Bottomley**, director of the Women in Engineering (WIE) Program.

“So, we said, ‘We’re going to stop doing that. We’re going to change engineering to fit the students.’”

At the same time WIE made this shift, it combined efforts with the Minority Engineering Programs (MEP) to form the Women and Minority Engineering Programs (WMEP). For the last 10 years, WMEP’s office has offered an open, welcoming space for students. Since making these changes, the College’s enrollment of women and minorities has increased.

STRONGER TOGETHER

The WIE program launched in 1997. By 2001, the College of Engineering (COE) was involved in the planning process with University Housing and what was then the College of Physical and Mathematical Sciences (PAMS), now College of Sciences, to start the Women in Science and Engineering (WISE) Village, a living and learning community for women majoring in science, technology, engineering and mathematics (STEM) disciplines.

Jo-Ann Cohen, who was associate dean for academic affairs for PAMS and is currently a professor in the Department of Mathematics, worked together with **Sarah Rajala**, who was associate dean for academic affairs for COE, and **Susan Grant**, the director of University Housing at the time.

Knowing all along that WISE would one day be open to women from the College of Natural Resources, College of Agriculture and Life Sciences and Wilson College of Textiles, the founding members engaged with representatives from across campus.

Both Rajala and Cohen were among the first women at NC State to rise through tenure-track STEM faculty ranks, and they wanted to support women interested in

STEM disciplines, not just through a four-year degree, but also in graduate school.

“In the STEM disciplines we are doing a better job of recruiting women and improving the climate for women. But we are not there yet,” Cohen said. “Having a program like WISE that builds a cohort of women with similar interests and supports and empowers our women is a wonderful way of helping them pursue their academic passions.”

In the first 10 years of the program, women who participated in WISE were more likely to stay in STEM and matriculated into engineering majors at the end of their first year at a higher rate than women who did not live in the WISE Village.

Today, the program has grown from 56 students in its first year to almost 400 women living in the WISE Village. Demand is higher than the program is able to accommodate. Engineering students make up the largest percentage of WISE residents, but there are 44 majors represented. **Kathy Titus-Becker**, WISE’s current director, said the variety of disciplines is an asset for students.

“Students have different paths and sometimes obstacles to navigate, so it’s great to have spaces for women to feel empowered and encouraged,” Titus-Becker said. “This is especially helpful during occasional periods of tough times when they may encounter discriminatory behavior.”

READYING STUDENTS FROM GRADE SCHOOL TO POST-GRAD

Beyond making sure students feel welcome when they get to college, WMEP has also focused efforts on increasing K-12

students’ interest in engineering, as well as ensuring students are ready for their post-graduation lives.

The Engineering Place, NC State’s K-20 engineering education program, has improved recruitment to NC State and, more importantly, reached more than 1 million students, teachers and parents, helping them to realize their engineering abilities and interests. Outreach to younger students is key to getting them interested in engineering.

“The Engineering Place grew up out of the Women in Engineering Program to get the word out to more people about what engineering really is, and that everyone can do engineering,” Bottomley said.

And when students are preparing to graduate, WMEP has resources in place for their futures, too. WMEP partners with the Career Development Center to help prepare all students for interviews and networking. Recent workshops have included how to identify employers with a commitment to diversity and inclusion, confidence building and virtual interviewing.

These programs together — WMEP, WISE, The Engineering Place and the Career Development Center — are making the College of Engineering a more inclusive, welcoming environment for women, for minority students and for all students, and that is reflected in the student body’s growing diversity.

While the College is now just one of a few large public engineering schools to hit the 33 percent milestone, Bottomley is already looking ahead to the next goal — 40 percent women, and eventually, a 50/50 split.

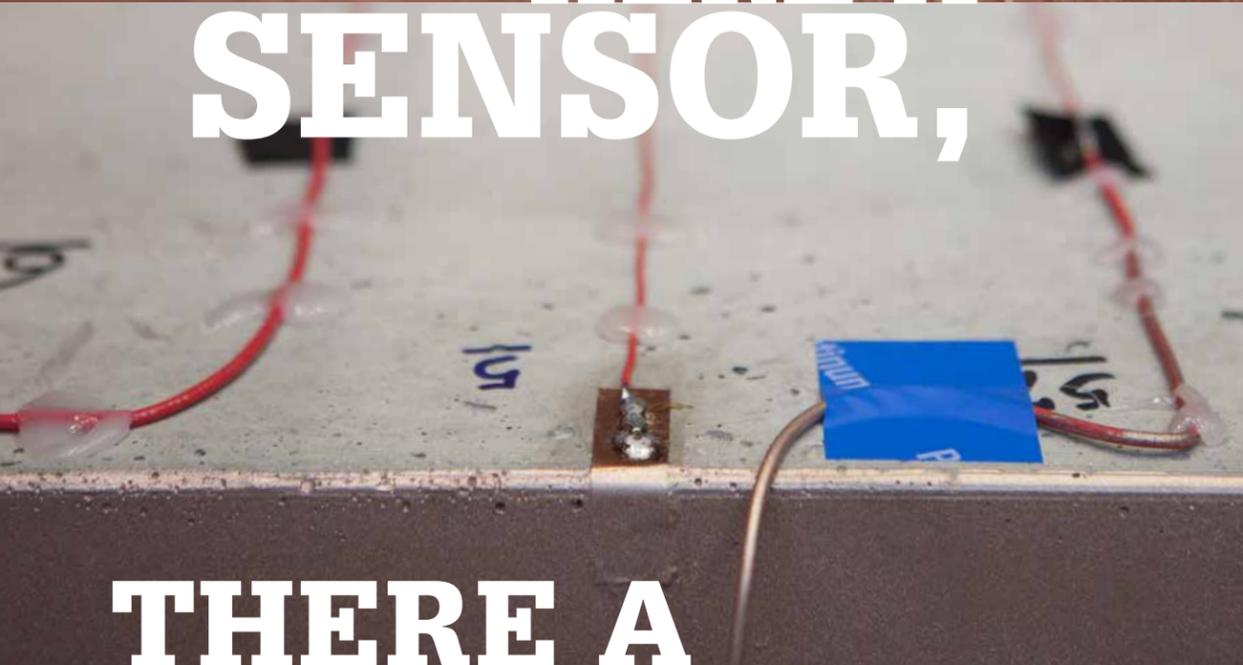
“Representation of all types is important in engineering because problems are not solved by the same types of minds that create them,” she said. “It’s well documented that more creative solutions, more cost-effective solutions, more effective solutions are created by more diverse teams.” ■



Sensor technologies can be used to detect a wide range of inputs, from temperature and light to air pressure and ultrasonic waves. Across engineering disciplines, they are used by faculty members to collect data needed for groundbreaking work in energy, health care, manufacturing, infrastructure and more. Engineering researchers, it seems, are putting sensors everywhere.

Meet a few faculty members in the College who are putting sensors to use in new ways.

HERE A SENSOR,



THERE A SENSOR...

Amay Bandodkar
Assistant professor
Department of Electrical and Computer Engineering

Amay Bandodkar's work with the National Science Foundation Center for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST) led by NC State is helping to further the center's mission of creating wearable health-monitoring devices that are powered by the human body and provide a range of data that will help wearers monitor their own health and inform their physicians' care plans.

His unique work with biochemical sensors could help lead to health monitoring devices that are not just wearable, but can be implanted within the body, producing insights that help take these devices from fitness trackers to essential diagnostic tools for everything from pain to neurodegenerative diseases.

To help solve the problem of harvesting energy from the body to drive a monitoring device, Bandodkar turned to sweat. By using sweat as the electrolyte that supplies the electrical current to a device's battery, he was able to build a sweat-powered, skin-friendly battery that requires only a tiny drop, 5 microliters, of sweat to power a wearable, wireless heart rate monitor.

Bandodkar's work landed him on the *MIT Technology Review* 2021 list of Innovators Under 35 and a recent *Newsweek* list of the Greatest American Disruptors. He also recently received the 2021 Biosensors Young Investigator Award.

Mohammad (Moe) Pour-Ghaz
Associate professor
Department of Civil, Construction, and Environmental Engineering

Mohammad (Moe) Pour-Ghaz uses electromagnetic sensors to study the durability of reinforced concrete materials and structures and fiber reinforced polymer (FRP) composites for use in civil infrastructure.

The "sensing skin" he designed can work as an early-warning system for concrete structures by measuring things like damage, the presence of damaging chemicals, strain and temperature. This data can point to small problems that may become larger problems, allowing a quicker response to damage in everything from nuclear facilities to bridges.

This skin is an electrically conductive coat of paint that can be applied to new or existing structures. Electrodes are applied around the perimeter of a structure. The sensing skin is then painted onto the structure, over the electrodes. A computer program runs a current between two of the electrodes at a time, monitoring and recording the electrical potential at all of the electrodes on the structure. This data is then used to calculate the sensing skin's spatially distributed electrical conductivity. If the skin's conductivity changes, that means the structure has cracked or been otherwise damaged.

Recent work will expand the skins' capabilities from being used on flat, straight surfaces to allowing their use on three-dimensional structures of unusual shapes. Pour-Ghaz's research group has collaborated with Aku Seppänen's group at University of Eastern Finland in developing this technology.

Alper Bozkurt
Professor
Department of Electrical and Computer Engineering

Alper Bozkurt uses microscale sensors to unlock the mysteries of biological organisms with an aim of engineering these directly or developing new engineering approaches by learning from their biology. His use of sensors enabled remotely controlled insect cyborgs, helped train puppies as successful guide dogs and created wearables tracking health and environment of patients for asthma, diabetes and sleep disorders assessment.

Recent research looks to monitor plants and pests in crop fields, measure ecosystem health in partnership with mussels and improve comfort for amputees using prosthetics.

To provide more efficient monitoring of how pests learn to adapt to insecticides used to protect genetically engineered crops, Bozkurt's team collaborated with NC State's Department of Entomology and Plant Pathology to develop pheromone-based sensor platforms to study pest activity.

By using a sensor platform to remotely monitor the feeding behavior of freshwater mussels — when mussels feed, they open their shells; but if there's something noxious in the water, they may immediately close their shells, all at once — Bozkurt and collaborators in NC State's Department of Epidemiology hope to provide an early alert of the presence of toxic substances in aquatic ecosystems.

Work with colleagues in engineering and textiles is leading to a soft, flexible sensor system created with electrically conductive yarns that could help map problematic pressure points in the socket of an amputee's prosthetic limb. ■

Sound ON



IN THIS ILLUSTRATION, AN ULTRASOUND TRANSDUCER SENDS A WAVE THAT PUSHES AGAINST ARTERIAL WALLS AND RECORDS THE WAVE PROPAGATION. AN ALGORITHM DETERMINES THE STIFFNESS OF THE ARTERIAL WALL, AN EARLY INDICATOR OF CARDIOVASCULAR DISEASE. MORE ON PAGE 27.

New technology is making waves in infrastructure and health care

Humans use sound to see where our eyes can't — like when you're putting up a shelf and tap the wall to find the studs.

Those sounds, traveling through waves, answer questions — is this where the stud is, or is this just drywall? Over the years, technologies like ultrasound have used these sound waves to produce images of things we'd never been able to see before.

Now, researchers at NC State and Mayo Clinic are developing algorithms and technologies that allow us to see even more clearly through sound.

Murthy Guddati, professor in the Department of Civil, Construction, and Environmental Engineering (CCEE), is leading research to develop more accurate, less invasive methods that have applications in infrastructure and human health. His technology that is furthest along more accurately measures bridge pile foundation depths, and he is exploring testing methods for evaluating pavement damage, profiling soil layers and detecting oil reservoirs. He is also working with biomedical researchers on more accurate health care diagnostic techniques, including one that measures stiffness in arteries, an early indicator of heart disease.

Guddati, who earned his master's degree in civil engineering and Ph.D. in computational and applied mathematics, has a strong background in theoretical

concepts, which puts him in a unique position to help investigate some of these problems. His research has been collaborative, supported by organizations including the National Science Foundation, Alaska and North Carolina Departments of Transportation (DOT), the National Institutes of Health (NIH) and Mayo Clinic.

"This wouldn't have been possible if I had not paid attention to all the math and physics," he said. "If I just jumped on these problems without developing the deep understanding, I don't think I would have made as much of a difference."

Accurately assessing infrastructure

One day, Guddati was speaking with a colleague about the longstanding problem of estimating the depth of pile foundations of aging bridges, many of which were lacking records. Pile foundations are slender columns that extend several yards into the ground to transfer the weight of the vehicles and the bridge into the soil.

"I thought, 'OK, this is something that can be converted to a simple mathematical problem,'" Guddati said. "'So maybe there is a simple solution.'"

MURTHY GUDDATI AND VIVEK SAMU, CENTER, AT NC STATE ENTREPRENEURSHIP'S 2019 EGAMES COMPETITION.





VIVEK SAMU,
PH.D. '18,
MEASURES A
BRIDGE PILE
DEPTH IN
ALASKA.

From this work came Effective Dispersion Analysis of Reflections, or EDAR, which is a novel, nondestructive evaluation technique that helps estimate the embedded depth of pile foundations. It works by tapping the bridge pile with a hammer and then measuring the acceleration of the returning waves at two places to calculate the depth from which they are reflecting.

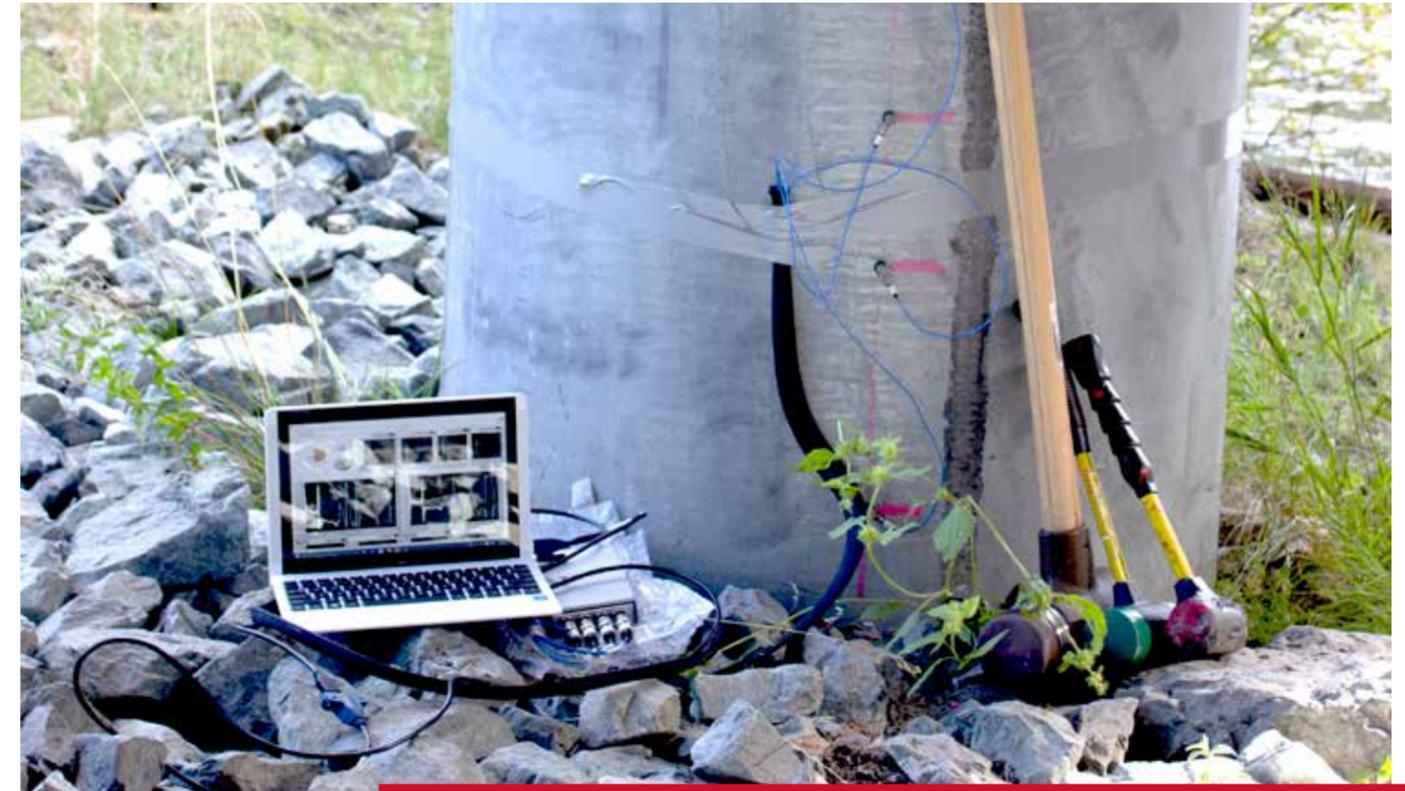
Guddati's master's student **Vivek Samu** took on the project for his thesis. Samu, who has since graduated with a Ph.D. and now works as a postdoctoral researcher, started with computer simulations, then tested the technique on a model bridge pile another CCEE faculty member had in the Constructed Facilities Lab. Samu and Guddati thought more lab testing would be needed, but their results were better than imagined, so they moved to field testing, working with two state DOTs.

Initially in the field, they ran into some issues because the waves coming back up were different from what they anticipated, which they realized was because the soil conditions were different than they were in the lab. Eventually, they were able to estimate the pile length within a 10 percent margin of error.

"Currently, we have a very promising technology that has the potential to be developed into a product," Samu said.

Working with NC State's Office of Research Commercialization (ORC), Guddati and Samu have patented the EDAR methodology and created the startup INDTI, Innovative Nondestructive Testing of Infrastructure. ORC has helped with navigating the patent process, developing business plans and raising funds.

Long term, their goal for INDTI is to provide non-destructive testing methods that can be used not just for bridge pile foundations, but to characterize all kinds of infrastructure. One such technology in development measures pavement deterioration. The plan is to expand to wide-ranging applications for aging infrastructure and translate them into commercial products.



Improving health care diagnostics

After the initial success in infrastructure, Guddati started to consider how the technology could be used in other fields, including health care, where more accurate, less invasive diagnostic tests can improve patient care.

Working with **Tuhin Roy**, former Ph.D. student and current postdoctoral researcher at NC State, and Matthew Urban, associate professor and researcher at Mayo Clinic in Rochester, Minn., Guddati received funding from the NIH to develop and test a technology that uses shear wave elastography (SWE) to measure arterial stiffness, which may be an indicator of cardiovascular disease.

"The core principle behind the SWE has been employed in geotechnical and other related fields for over a decade," Roy said.

"And now we are using similar ideas here in the biomedical field."

The technology uses the same ultrasound machines already in hospitals, and Mayo Clinic has a unique technology to excite the carotid artery with sound waves. The ultrasound transducer sends a wave that pushes against the arterial walls and records the wave propagation. These movements are tiny, on the order of 1 to 20 micrometers, and the propagating waves are run through an algorithm that determines the stiffness of the arterial wall.

"In general, the ultrasound scanners have the hardware to do the same measurements that we're performing, but not necessarily the software or the methodologies behind it," Urban said. "It's the things under the hood that we are working on so that we can actually get better estimates of arterial mechanical properties, in this case."

While measuring arterial stiffness is the furthest along, with Mayo Clinic testing the technology in studies involving human subjects, Guddati and Urban are evaluating

other diagnostics that could benefit from SWE.

Elastography methods are already used to evaluate tumor and liver stiffness, but the new methods the researchers are developing could improve diagnostic accuracy in evaluating if tumors are cancerous or in early detection of cirrhosis. Researchers are also developing a way to estimate red blood cell content in blood clots in the brain, which can help determine the best way to remove the clot. These applications are still in the early stages of testing.

Because Mayo Clinic does not have an engineering school, the partnership with NC State has been beneficial for both parties. Physicians and scientists have been receptive to these methods — which are not so different from what they currently use, just more accurate.

"When you solve a real problem, you affect lives," Guddati said. "The solutions that we provided are not necessarily complicated. But they were impactful and novel." ■

**Ricardo Sucre and
Gustavo Darquea
G., Casalú**
www.casalu.com



Casalú is a rum-based seltzer developed by three NC State alumni who wanted to create a drink authentic to the Latino experience and culture, integrating with arts, music, sports and fashion.

Ricardo Sucre, co-founder and CEO, and **Gustavo Darquea G.**, head of operations, both earned degrees in industrial engineering in 2018 and 2019, respectively. They teamed up with co-founder and CEO **Gabriel Gonzalez**, business administration '16.

The trio met through a larger group of Latino students who studied and hung out together at NC State. Sucre is from Venezuela, and Darquea is from Ecuador. The name stands for the company's vision — casa, a sense of home and heritage, and salú, an open door to all who want to share Latino culture.

"That connection that we had as Latinos, that way that regardless of where we came from, our cultures translated pretty easily into the way we share and the way we enjoy together," Sucre explained.

Sucre made the first version of the drink using a SodaStream, lemon and dark rum, which is what he drank at home. After a positive response from his friends, he reached out to Darquea, whose

ENGINEERING ENTREPRENEURSHIP

Get to know four startups created by NC State engineering alumni

Building a business takes discipline, a willingness to explore all options and an ability to think outside the box — all skills that College of Engineering (COE) alumni learned at NC State.

Engineering and entrepreneurship are often closely related, and many NC State engineers and computer scientists have created their own startups. Some entrepreneurs are just getting their businesses off the ground, while others have led successful companies for years. Among the most well-known startups created by COE alumni is Wolfspeed, Inc., formerly Cree, which develops wide bandgap semiconductors.

NC State Entrepreneurship offers many resources, including entrepreneurship competitions like the eGames, where prize money can help support startups; fellowships, such as the Miller Fellowship for recent graduates who want to pursue their venture full time; and mentorship programs including the Andrews Launch Accelerator, which provides seed money and guidance.



FROM LEFT, GABRIEL GONZALEZ, GUSTAVO DARQUEA G. AND RICARDO SUCRE.

discipline he knew he could rely on for market research and other logistics. In 2021, Casalú joined the Andrews Launch Accelerator, which provided a support system as the team navigated licensing, branding and setting the foundation for the company.

"The work that the people at the Andrews Launch Accelerator have done for us is amazing. It is an incredible resource for NC State students," Darquea said.

Casalú launched this April in Miami.



Cathy Gomes, 700 Rivers

www.sevenhundreddrivers.com

Cathy Gomes, chemical engineering '15, works by day at Merck, and spends her evenings running 700 Rivers, a sustainable lifestyle brand that sells soaps and other products made by women artisans in Bangladesh.

She is driven by her passion for making the world a better place. At Merck, she works on optimizing a treatment for bladder cancer. As CEO of 700 Rivers, she employs 28 women who are paid living wages for their work making eco-friendly products. Gomes partners with a fair-trade organization in Bangladesh that provides access to mental health care and job opportunities to women who have escaped human trafficking.

Gomes' parents immigrated to the U.S. from Bangladesh before she was born so that she and her sisters would have equal opportunities, especially in education.

"This all fit together," she said. "I have this Bangladeshi background where I understand the culture, I speak the language, and I'm so passionate about making a difference here, on top of my chemical engineering background."

Her chemical engineering background is how she landed initially on soap making, as she understands the chemistry behind it and can teach that skill to others. She also partners with South Asian farmers to source local, natural ingredients.

Gomes' long-term plan is to expand 700 Rivers into a global company. "My ultimate goal is to help empower as many women as possible, and one of the best ways to do that is through fair living wages, safe work and equal access to job opportunities," she said.

Freshspire, launched in 2018 by **Shraddha Rathod**, helps local retailers and restaurants more efficiently source food from small- and mid-size farms.

Rathod, electrical and computer engineering '18, started Freshspire to help farmers have better market access to businesses. Supported by a Miller Fellowship, she teamed up with **Matthew Simpson**, computer science, physics and mathematics '18, to develop an order, vendor and data management software. Ziwa Mukungu joined as vice president of product.

"We realized that we could provide great engineering and good software to an industry that traditionally lacked it," Rathod said. "So, we decided

to create a more efficient way to let buyers know what's available and let farmers sell their products. This results in more reliable communication so it could be transported more quickly and therefore reduce waste, improve market access for farmers and make food systems more sustainable."

Triangle-based co-op Weaver Street Market was an early client. Like many stores relying on smaller farms, sourcing was often time-consuming, handled over texts, emails and calls. Since switching to Freshspire, the co-op decreased its time spent on orders by 80 percent.

More recently, Wake County hired Freshspire to help manage its food security and emergency food programs



**Shraddha Rathod,
Freshspire**

www.getfreshspired.com

during the pandemic. Freshspire partnered with nonprofits to source food boxes supplied to people in need.

Rathod aims to expand throughout North Carolina and the East Coast. She credits her success to their user-focused and mission-driven approach.

"It's not just profits we care about, it's also social impact," she said. "Because of ... what we're standing for, we've created even more impact than we ever thought we'd be able to at this early stage."

FROM LEFT, ZIWA MUKUNGU, MATTHEW SIMPSON, SHRADDHA RATHOD.



**Alagu Periyannan,
BlueJeans by Verizon**
www.bluejeans.com

Coming from a family of entrepreneurs in India, **Alagu Periyannan** knew early on that he wanted to start his own company — and he dreamt of doing it in the Silicon Valley ever since he laid his hands on early home computers, like Apple and Commodore.

After earning his master's degree from NC State in 1992, he got a job at Apple, where he worked on the first video chat app on Mac. This early project influenced his eventual goal to make video conferencing as ubiquitous as audio conferencing, leading to his startup, BlueJeans.

"I find the best startup journey starts with having empathy for the problem

you're trying to solve," he said. He saw the power of video communication to bring people together when he was running a large R&D team across seven locations on three continents in the early 2000s.

He didn't start BlueJeans right away, working for another 10 years for streaming media and content delivery companies in Silicon Valley. In 2009, he took the leap to co-found BlueJeans, a collaborative video conferencing platform focused on high-quality audio and video, as well as top-of-the-line security options. Along the way, he realized that the most challenging parts of

creating a company were also the most exciting.

In 2020, Verizon acquired BlueJeans, and Periyannan is now the vice president of advanced collaboration technologies. "For founders considering an acquisition, remember that it's not the end, but rather another step — another event in the startup journey," he said.

Periyannan continues to support NC State entrepreneurship. He has hosted students interested in entrepreneurship during visits to Silicon Valley, showing them BlueJeans and sharing advice.

"I like to call it 'existence proof,'" he said. "If I can do it, so can they." ■

TRANSFORMATIONAL GIFT

The Goodnight Foundation endows the College's dean's chair

Two long-term philanthropic leaders for NC State have continued their outstanding support of the University by endowing the engineering dean's chair. The gift recognizes the leadership of the College's current dean and will help ensure continued success of deans who follow in his footsteps.

The **Louis Martin-Vega** Dean's Chair Endowment at the College of Engineering was created through a gift from the Goodnight Educational Foundation under the direction of **Dr. Jim and Mrs. Ann Goodnight**.

NC State's College of Veterinary Medicine has also recently announced the Randall B. Terry, Jr. College of Veterinary Medicine Dean's Chair Endowment, established with a gift from the R.B. Terry Charitable Foundation. The deanship gifts helped put an exclamation point on the end of the University's Think and Do the Extraordinary Campaign.

"We are so grateful for all that the Goodnight Educational Foundation, the Goodnights and the R.B. Terry Foundation have done at NC State," Chancellor **Randy Woodson** said. "Their incredible generosity is a reflection of the truly extraordinary work happening at the College of Engineering and the College of Veterinary Medicine — and throughout our University."

The Goodnights are NC State alumni and served as co-chairs of the recently concluded Think and Do the Extraordinary Campaign. Jim Goodnight — the founder and CEO of SAS — earned his B.S. in applied mathematics in 1965, and his M.S. and doctorate in statistics in 1968 and 1972, respectively, and the University conferred an honorary degree to him in 2002. Ann Goodnight earned her B.A. in political science in 1968, works as the senior director of community relations at SAS and serves on the NC State Board of Trustees.

The Goodnights' commitment to faculty excellence has included increased support for faculty funds and the creation of 28 endowed positions, including the dean's chair.

The Louis Martin-Vega Dean's Chair Endowment is named in honor of the College of Engineering's current dean, who has served in the role since 2006.

Under Martin-Vega's leadership, the College has seen a significant rise in enrollment, research expenditures and infrastructure, diversity among both students and faculty members, and national reputation.

"I am deeply humbled and honored to have my name associated with this position and grateful for the Goodnights' continued generous philanthropy and leadership in support of NC State," Martin-Vega said. "This endowed position will afford future deans a vital tool for pursuing their priorities related to research, teaching and programmatic needs that may not be covered through other revenue sources."

The gift comes on the heels of the announcement of a new state legislative initiative, Engineering North Carolina's Future, which will provide NC State with \$20 million over the next two years to catalyze the hiring of additional faculty and staff and \$30 million for facility upgrades, with the aim of supporting the growing student body and the University as a whole. The initiative is tied to plans to expand student enrollment in the College of Engineering from around 10,000 to 14,000 over the next few years.

"Under Dean Martin-Vega's leadership, the College of Engineering has continued an incredible upward trajectory," Woodson said. "The demand for an engineering degree from NC State has never been



higher, and this deanship, in conjunction with the Engineering North Carolina's Future project, puts us in the position to meet that demand and fuel our state's technology economy."

Martin-Vega came to NC State in 2006 after spending five years as dean of engineering at the University of South Florida. He has also held several prestigious positions at the National Science Foundation (NSF), including acting head of its Engineering Directorate and director of NSF's Division of Design, Manufacture and Industrial Innovation. Additionally, he has served as chairman of the Department of Industrial and Manufacturing Systems Engineering at Lehigh University and Lockheed Professor in the College of Engineering at Florida Institute of Technology. He has also held tenured faculty positions at the University of Florida and the University of Puerto Rico at Mayaguez.

He was elected as a member of the National Academy of Engineering in 2021. In 2011, he was inducted into the Hispanic Engineering National Achievement Hall of Fame for his commitment to college education and the promotion of diversity. Martin-Vega is a Fellow of the American Association for the Advancement of Science, the Institute for Industrial and Systems Engineers and the Society of Manufacturing Engineers. He served as president of the American Society for Engineering Education from 2016-17.

Naming the dean's position has been a priority for the College's leadership for several years. Several of NC State's peer institutions in engineering education have been able to endow their dean's positions and are reaping numerous benefits.

THE EXTRAORDINARY, DONE

The deanship gifts bring the total endowed deanships at NC State to three, the first being the Stephen P. Zelnak, Jr. Dean's Chair in the Poole College of Management.

Resources from endowed deanships will enhance teaching, learning and research across each college by providing the flexibility to direct support where it is most needed.

The five-year, comprehensive Think and Do the Extraordinary Campaign, which ended Dec. 31, 2021, raised more than \$2.1 billion. In addition to increasing scholarships, enhancing programs and funding building renovations and new construction, donor support from the Campaign more than doubled the number of NC State faculty members holding endowed positions. ■

"I am deeply humbled and honored to have my name associated with this position and grateful for the Goodnights' continued generous philanthropy and leadership in support of NC State."

LOUIS MARTIN-VEGA



Paving the way through planned giving



JENNIFER RHATIGAN

Walking the Brickyard, finding the perfect study spot inside D.H. Hill Library and working long nights in the lab problem-solving for the next research project. For NC State engineering alumni, many of these spots are iconic to their time as students.

For future generations of Wolfpack students, they too will walk the same paths and find their home with the Pack. A planned gift can help make it a reality for them.

Through planned giving, alumni and friends are providing for future gifts to the College and University through their financial and estate planning.

“Thinking about the future and when you have passed can be difficult — but by making a plan now, you can help set aside funds for causes that are important to you,” shared **Jennifer Rhatigan**, MSME '87, who set up an estate gift as part of NC State’s annual Day of Giving in March.

Rhatigan earned her Ph.D. in mechanical and aerospace engineering from Case Western Reserve University. As a mentor with NASA colleagues, students from the U.S. Naval Postgraduate School, AstraFemina and Phi Mu Sorority, Rhatigan has a passion for inspiring women and young girls with an interest in science, technology, engineering and math (STEM). When it came time to select where her gift would go — she knew she wanted to support future female leaders in STEM.

“We do not know what engineering will look like years down the road, what majors the University will have — so in planning my gift, I wanted to ensure

it was interdisciplinary and would assist in helping future female engineers,” she said. “My view is that engineering will become less ‘stove-piped’ and more interdisciplinary over time. I’d like to help that along as well.”

Choosing the right planned gift depends on personal circumstances and financial goals. Through the NC State Engineering Foundation, Inc., the following planned giving investment options are available: life income, charitable gift annuity, deferred gift annuity, charitable remainder annuity trust, testamentary life income options, charitable lead trust, retained life estate and giving with retirement plans.

In choosing to provide long-term, transformational support to the College through planned giving, these arrangements can help to provide for you/your loved ones, entitle you to charitable income and/or gift or estate deductions and to leave a legacy for the next generation.

“We are very grateful to all our alumni and friends of the College who provide generous gifts in support of our students,” said **Louis A. Martin Vega**, dean of the College of Engineering. “These gifts help the University to continue to attract the brightest and most energetic students who will make a difference in the world.”

If you are interested in exploring how a planned gift can help you achieve your financial and philanthropic goals, please contact the NC State Engineering Foundation, Inc. at enr-foundation@ncsu.edu or **919.515.7458**. ■



Fitts-Woolard Hall dedicated during homecoming celebration

DEAN LOUIS MARTIN-VEGA WITH EDWARD P. FITTS, WHO MADE AN INSTRUMENTAL GIFT TO THE BUILDING.

About 250 people gathered on Oct. 29, 2021, during NC State University’s Red and White Week for the dedication of Fitts-Woolard Hall (FWH), an important step forward in the College of Engineering’s efforts to bring together its departments on Centennial Campus.

“It’s been a long journey since 2008,” said **Louis Martin-Vega**, dean of the College. “Whether you are alumni, students, faculty, staff or friends of our College, it’s your support that has brought us here to this special moment.”

Red and White Week, NC State’s yearly homecoming event, celebrates the University’s community. FWH is a culmination of that communal spirit. At the ceremony, state and University leaders — including Chancellor **Randy Woodson** and Phil Berger, NC State Senate president pro tempore — emphasized the importance of the new building for the College’s continued growth, while students, faculty members and staff members offered demonstrations of their labs and research.

Opened in the summer of 2020, FWH houses the Department of Civil, Construction, and Environmental Engineering; the Edward P. Fitts Department of Industrial and Systems Engineering; and the dean’s administrative offices. Approximately 1,560 students and 170 faculty and staff members work and learn in the building.

At more than 225,000 square feet, FWH features state-of-the-art laboratories and classrooms that are home to research in the areas of biomanufacturing,

advanced manufacturing, rapid prototyping, health systems engineering, construction engineering and management and transportation systems.

“It was needed in terms of capacity for the growing number of students in the department, and it’s great to be located on the engineering campus where everything is happening,” said **Laura Geary**, a sales operations analyst for Intel and an industrial engineering ‘17 graduate who attended the dedication.

The building, which cost \$150 million, represented a new funding model for NC State and the University of North Carolina System, relying on private funds in addition to state funding. Completion of FWH is attributed in part to the generosity of private donations from alumni and friends of the College who have pledged gifts of more than \$49 million to help the College reach its goal of raising \$60 million for the building.

Speakers at the dedication ceremony emphasized the importance of the building in continuously supporting students through accessibility, opportunity and knowledge sharing.

“We don’t do what we do for ourselves, we do it for you,” said **Edward P. Fitts**, industrial engineering ‘61 alumnus, who together with **Edgar S. Woolard**, industrial engineering ‘56, made a \$25 million gift to the building. “(Students’) success and contributions are a true testament to NC State, and with this wonderful building you will have every opportunity to follow in (previous generations’) footsteps.” ■

“Whether you are alumni, students, faculty, staff or friends of our College, it’s your support that has brought us here to this special moment.”

LOUIS MARTIN-VEGA



College honors seven DEA award winners

FROM LEFT, LONNIE POOLE, JR.; JOHN BRANTLEY, III; LINDA BUTLER, DEAN LOUIS MARTIN-VEGA, JOSEPH PLEASANT, JR.; AND CARL STUTTS, JR.

The College honored seven winners of its Distinguished Engineering Alumnus (DEA) award during a ceremony on campus on Wednesday, Oct. 27, 2021, as part of Red and White Week.

The award was established by the College's faculty in 1966 and is the highest honor it bestows upon alumni. Recipients are traditionally honored at an awards ceremony during homecoming week. Because of the COVID-19 pandemic, no event was held during 2020.

The 2021 ceremony honored DEA recipients from 2020 and 2021, along with one alumnus from the 2019 class who could not attend that year's event.

John C. Brantley, III (2019) earned his bachelor's degree in civil engineering in 1964. After working with the Federal Aviation Agency and a private engineering firm, he founded an airport planning and design consultancy. He joined the Raleigh-Durham Airport Authority in 1977 and served as airport director for 29 years.

Linda H. Butler (2020) earned a bachelor's degree in nuclear engineering in 1986, followed by master's and M.D. degrees from University of Florida and University of North Carolina at Chapel Hill, respectively. Since 2009, she has served as vice president of medical affairs and chief medical officer at UNC REX Healthcare in Raleigh.

Carl S. Stutts, Jr. (2020) earned a bachelor's degree in chemical engineering in 1968 and an MBA from the University of Houston. He retired as chairman and CEO of Cyanco, a leading global supplier of sodium cyanide for gold mining, and is focused on work with nonprofits.

Gregory N. Washington (2020) earned bachelor's,

master's and doctoral degrees in mechanical engineering in 1989, 1991 and 1994, respectively. He is president of George Mason University in Fairfax, Va. He served previously as dean of the Henry Samueli School of Engineering at the University of California, Irvine.

Christina H. Koch (2021) earned a bachelor's in electrical engineering in 2001 and a bachelor's in physics and master's in electrical engineering in 2002. As an astronaut on the International Space Station, she set a record for the longest single spaceflight by a woman. Koch conducted six spacewalks, including the first three all-women spacewalks.

Joseph M. Pleasant, Jr. (2021) earned a bachelor's degree in industrial and systems engineering in 1972. He retired after 42 years with Premier, Inc. and its predecessor organizations, where he served as CIO and senior vice president. Pleasant also served as chairman and a founding member of the Coalition for Healthcare eStandards and a founding member of the College for Healthcare Information Management Executives organization.

Lonnie C. Poole, Jr. (2021) earned a bachelor's degree in 1959 in civil engineering. He is the founder and retired CEO and chairman of Waste Industries USA. He and his wife, Carol Johnson Poole, provided a naming gift for the Lonnie Poole Golf Course as well as the lead gift for the Carol Johnson Poole Clubhouse. They also endowed the Poole College of Management at NC State.

Koch and Washington were not able to attend the 2021 ceremony because of prior commitments. ■

 **NC STATE**

Thank you for making
Day of Giving
extraordinary for the
COLLEGE OF
ENGINEERING

\$1,504,048
raised in total

1,443
gifts made to the College

6
University-wide challenges won

100%
of department match challenges
completed



Alumni, faculty members, staff, students and friends of the College of Engineering came together to show their support and help the **College of Engineering (COE)** write its next chapter on **Day of Giving** on March 23, raising **\$1,504,048** from **1,443 gifts**.

Started in 2019 at NC State, Day of Giving is a one-day event to raise money to support all of the opportunities at the University, including groundbreaking research, scholarships for students and facility upgrades. The donations given on this day support the College in improving its already world-class education.

For the University, this year marked the most gifts ever received on a single day. The University received 14,533 gifts totaling \$23,060,336.

Throughout the day, the College won several giving challenges, including **most student gifts in a single hour** and **most alumni gifts in a single hour**. At the end of the day, COE finished in **third place for most gifts received**, behind only the Division of Academic and Student Affairs and the College of Agriculture and Life Sciences.

Among the departments that make up the College, the Department of Civil, Construction, and Environmental Engineering (CCEE) received the most gifts, followed by the Edward P. Fitts Department of Industrial and Systems Engineering (ISE) and the Department of Mechanical and Aerospace Engineering.

COE
community
bands together
to support
students and
research

The nine academic departments also engaged in a friendly competition, trying to receive the most gifts to win a greater share of \$15,000 in prize money from Dean **Louis Martin-Vega**.

The alumni advisory boards for CCEE, ISE and the Department of Electrical and Computer Engineering each offered

matching fund challenges for their department's alumni. Three other departments' match challenges were made possible through donations from individuals: **Al Banes**, emeritus faculty member in the UNC/NC State Joint Department of Biomedical Engineering; **Pranav Hangalur**, who worked as a research assistant for Department of Materials Science and Engineering Head **Don Brenner**; and **Mark Wyatt**, an alumnus of the Department of Computer Science.

The College received several major gifts. In 2006, alumnus **Dick Franklin** established the Kenneth D. and Wanda B. Franklin ISE Merit Scholarship Endowment for juniors and seniors in industrial and systems engineering. This year, he made an additional donation to this fund so that students can continue to complete their education with less financial burden.

Alumnus **Timothy Humphrey** also gave to an existing fund, the Timothy L. Humphrey Women and Minority Engineering Initiatives Award. He gave the original gift in 2020 to Women and Minority Engineering Programs, which recruits, retains and mentors students who are traditionally underrepresented at the College.

The College is grateful to everyone who supported NC State engineering on this day by participating in social media challenges or donating. These gifts ensure that the next generations of NC State engineers will continue to improve the world around them. ■



ANNUAL GIVING

ENGINEERING FOUNDATION

Have you made your annual gift to the College of Engineering?

Gifts from alumni like you keep the College moving forward by supporting faculty and student recruitment and retention efforts. Your donation is a great way to make sure the opportunity that meant so much to you is there for students today. If you would like to include the College of Engineering in your yearly charitable donations, here are some options for giving back.

If you have already made your 2021-22 gift to the College of Engineering, please accept our sincere thanks. If you have questions or would like to learn more about your giving options, contact Angela Martin at 919.513.1714 or anstalli@ncsu.edu.

WAYS TO GIVE

- Make your gift online at go.ncsu.edu/engineering-giving
- Use the return envelope included in this magazine to pay by check
- Make a gift over the phone by calling 919.515.7458

JOIN THE DEAN'S CIRCLE

Annual gifts of \$1,000 or more qualify for membership in the Dean's Circle, the College's leadership annual giving program. For alumni up to 10 years after graduation, gifts of \$250 or more qualify. Visit go.ncsu.edu/engineering-deans-circle for more information.

INCREASE YOUR IMPACT

Explore your company's matching gift policy, which may greatly enhance the level of support you can extend to deserving students. Visit www.matchinggifts.com/ncsu and contact your human resources representative to learn more.



FROM LEFT, GARY GILLESKIE, CHAD HENRY AND PAMELA TOWNSEND.

College advocates through Industry Partners Event Series

From the materials used to make this magazine's pages to the chemical composition of its ink, an engineer was involved in the development of this item and many other everyday objects in one form or another. The NC State Engineering Foundation puts on the Industry Partners Event Series to showcase engineering's significant influence in manufacturing pieces of our everyday lives — and the College of Engineering's (COE) role in preparing the next generation of engineers.

Held annually since 2016, the Industry Partners Event Series invites North Carolina business and government leaders to speak with COE students, faculty and staff members and alumni to learn about industry research and economic development from a local to global scale.

Pamela Townsend, a senior vice president and consultant for WSP, USA, and the chair of the Engineering Foundation's advocacy committee, sees the event series as a way of making the public aware of the College's value to different industries while advocating for resources to support continued growth.

"It's important to understand the impact of the College and the resources needed to continue the College's mission and to keep making that impact," Townsend said. "The needs of the industry are driving a need for the College to expand."

The series' focus on North Carolina is not only linked to NC State, but the local economic growth in Research Triangle Park as global industries decide to invest in and move into the area.

Previous advocacy themes include the College's economic impact on the state's rural areas, the

College's COVID-19 response and NC State's Biomanufacturing Training and Education Center (BTEC)'s need to grow to increase workforce training and research.

Chad Henry, a corporate VP and general manager at Novo Nordisk and a 2021 panelist on BTEC, recognized how these topics tie directly into some of the biggest challenges that the industry is facing: talent resources and growing leadership.

"Industries such as mine are growing exponentially and we're seeing North Carolina becoming the next Silicon Valley with the amount of companies moving in and competing," Henry said. "We're looking to grow our talent and the NC educational system has a responsibility to assist in increasing that talent pool."

Gary Gilleskie, executive director of BTEC and a 2021 panelist, sees the series as a way to highlight the unique features of the College and what it has to offer students and the industries they become involved in.

"No matter how you look at it, there is a demand for a more skilled workforce and as industries are growing, so are the opportunities locally and worldwide," Gilleskie said.

The Engineering Foundation will host its sixth Industry Partners Event Series panel this fall, with a date, time and theme to be announced soon. ■

"Industries such as mine are growing exponentially and we're seeing North Carolina becoming the next Silicon Valley."

CHAD HENRY

Take the Next Step in Your Career with 17 Online Graduate Degrees Available from NC State's College of Engineering

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Visit engineeringonline.ncsu.edu to learn more.

Dean family endows second professorship to help strengthen engineering's future



FROM LEFT, BILL DEAN, FRED KISH AND DAN STANCIL.

To recruit the best faculty members, the College of Engineering needs the best resources. While the College already has world-class research facilities, exceptional faculty members and a smart, well-rounded student body, its competitors have the same. Endowed professorships are key recruitment tools that help set the College apart in its efforts to attract and retain top faculty talent.

These endowments provide salary and funds for faculty members' research activities, which helps get new programs off the ground and enrich student experiences. An investment in faculty members is an investment in NC State students, who are the future of engineering.

Two of the College's strongest supporters know this well. **William H. Dean**, president and CEO of M.C. Dean, is a 1988 electrical engineering alumnus. His father, **Marion Casey Dean**, is the retired president and CEO of the company and a 1967 electrical engineering alumnus. In 2017, they endowed the M.C. Dean Distinguished Professorship in Electrical and Computer Engineering. In 2021, they endowed a second professorship to cap off the NC State Think

and Do the Extraordinary Campaign, which finished with 104 new endowed professorships across the University.

"The impact it makes is significant," Bill Dean said. "It is a real measure of the University's competitiveness, and it's one of the things we can do as a private benefactor to have a direct impact on our own College."

Bill Dean remembers the influence and support of some of his professors in the Department of Electrical and Computer Engineering (ECE), especially those who taught math-intensive courses that helped him learn inductive reasoning skills critical to his role leading M.C. Dean.

Headquartered in Tysons, Va., M.C. Dean is a global leader in cyber-physical solutions. Founded in 1949 by Marion Caleb Dean, father of Casey Dean and grandfather of Bill Dean, the company has grown from an electrical specialty contracting business with 55 employees to a billion-dollar company with more than 5,100 employees and 34 offices globally.

M.C. Dean develops cyber-physical solutions across fields for private enterprises, including 80 percent of all Fortune 500 companies, and for almost every

"People who learn to integrate software and design and infrastructure, when it comes to our sector, they're going to be people who lead the industry."

BILL DEAN

federal agency. Employees work on large-scale projects that require the integration of software development and infrastructure design for mission critical facilities, health care, security and more.

"People who learn to integrate software and design and infrastructure, when it comes to our sector, they're going to be people who lead the industry," Bill Dean said.

Fred Kish, the first M.C. Dean Distinguished Professor and director of the NC State Nanofabrication Facility (NNF), also recognizes the need for students to have skills integrating hardware and software.

Coming to the College with 30 years of experience working for Hewlett-Packard and Infinera Corporation, he brought with him valuable expertise and knowledge of industry needs. This includes engineers who are skilled in the broader areas of semiconductors, photonics, optics, communications and sensing.

"There's a tendency today for students to be less focused on developing solutions that are hardware intensive, or, at a minimum, have hardware and software together," Kish said. "Those wind up being some of the most important and valuable skills, when people can put multiple disciplines like that together."

While working in industry, Kish made several important contributions to LED lighting. He helped invent and commercialize the highest-performance red-orange-yellow visible LEDs in the 1990s, which became the most common technology used in red, orange and yellow traffic and automotive lights. He also co-invented and helped commercialize the first large-scale photonic integrated circuits and the first fully integrated system-on-a-chip for optical communications.

Kish always had an interest in academia, but it was the endowed professorship that drew him to NC State.

"This professorship, to me, was table stakes to come to NC State," he said. "So, without that, I would not have been able to make the transition."

Kish's current work is focused on leading the NNF, which is home to a full range of micro- and nano-fabrication capabilities used by companies and universities. He is also leading development of new research initiatives at NC State on semiconductors and is involved in efforts related to the Creating Helpful Incentives to Produce Semiconductors for America (CHIPS) Act, part of the \$300 billion America COMPETES Act currently being considered by Congress. He is advising three graduate students and will eventually teach courses on semiconductor optoelectronics and fabrication. In 2021, he was elected a Fellow of the National Academy of Inventors.

"The prestige of the appointment has opened a lot of doors relative to interacting with other companies and universities," he said. "And that goes both for things that we're doing to further develop the NNF as well as things that we're doing to cultivate launching research initiatives at the University."

Dan Stancil, ECE department head, said what Kish has brought to ECE is exactly why endowed professorships are such an important tool for strengthening the department. Hiring faculty members with world-class reputations and strategic leadership abilities is a priority. Kish fits that bill.

"Under Kish's leadership, the Nanofabrication Facility has significantly expanded its capabilities, enabling a wide range of ongoing research projects," Stancil said. "He is also providing strategic leadership in the area of semiconductor nanofabrication to enable us to position ourselves to address federal research directions relating to this area of increasing national priority."

The second M.C. Dean Distinguished Professorship has not yet been awarded, but it will be valuable for strengthening the ECE department by attracting a new leading scholar to the department or recognizing an outstanding faculty member. ■

SPOTLIGHT

FOUNDING MEMBERS OF YAAB LEAVE BEHIND A LEGACY OF ENGAGEMENT AND GROWTH



From the board

Learn more about the work of the NC State Engineering Foundation, Inc. Board of Directors

FROM LEFT TO RIGHT, BHAVANA BARTHOLF, MARCUS BELVIN, ZACHARY HORTON, ANDREW PITA, JENNIFER RHATIGAN AND JIM STEWART.

The NC State Engineering Foundation (NCSEF) was established in 1944 to aid and promote, by financial assistance and otherwise, engineering education and research at NC State. A board of directors made up of alumni and friends of the College of Engineering (COE) works with the college development staff and dean of engineering to set the Foundation's agenda. The board is led by President **Deborah B. Young**, CE '77, and Vice-President **Scott Stabler**, MAE '82.

NEW MEMBERS

The Foundation Board has added five new members, plus a new student representative:

- **Bhavana Bartholf**, IMSEI '00
- **Marcus Belvin**, CSC '01
- **Andrew Pita**, EE '08, '10
- **Jennifer Rhatigan**, ME '87
- **Jim Stewart**, ME '70
- **Zachary Horton**, ISE '23 (student representative)

The following members have completed their terms and rotated off of the board after dedicating several years of distinguished service:

- **Calvin Carter**, MSE '77, '80, '83 (8 years)
- **Suzanne Gordon**, CSC '75, MA '75, ST '80 (12 years)
- **Len Habas**, EE '66 (12 years)
- **Carl Stutts, Jr.**, CHE '68 (8 years)

DIRECTORS SET THE COURSE FOR THE FOUNDATION'S FUTURE

Young led efforts in 2021 to develop the Strategic Plan for the next five years with support from **Lindsay Smith**, senior director of development; past members of the Board of Directors; and college development staff.

The plan is focused on four strategic pillars:

- Enhancing academic experience
- Intentional advancing of diversity, equity and inclusion
- Deepening active alumni engagement by developing relationships with 70,000 COE alumni
- Ensuring an effective and resilient Foundation with interaction between and alignment of the engineering departments and University through stewardship

"The pillars will direct and drive a successful plan of action," Young said. "The actions will enhance and maintain the recognition of COE as preeminent."

Stabler chairs the Strategic Planning Committee, which will lead efforts to bring the plan to life. "Our board is ready to translate intent into quantifiable action," he said.

Initiatives already under way include:

- Helping expand the base of fully engaged alumni
- Ensuring diversity, equity and inclusion are key factors in Board composition and action
- Being ambassadors for the COE in community and business settings
- Ensuring the Board coordinates effectively with NC State Engineering advisory boards and University alumni/development resources

The Foundation Board is also helping raise funds for professorships, fellowships and scholarships. This is particularly important given the recently announced plan to expand the College of Engineering's student enrollment by 40 percent. "We're excited about the opportunity to work with Dean **Louis Martin-Vega**, Executive Director **Griffin Lamb** and University staff on this generational expansion," Stabler said. ■

One of the consequences of a rapidly growing student population is that the College of Engineering's alumni base keeps getting younger. Currently, 36.2 percent of all alumni of the College graduated in the last 15 years. In 2018, the Young Alumni Advisory Board (YAAB) was started to engage this group and help them feel connected to their alma mater and each other. The original class of the board included just 12 members and has since grown to 31 members, including five who were added last fall.

Now, those original members' terms are coming to an end, and they can look back on what they have accomplished in just four years.

Jon Gomes, mechanical engineering '10, '11, a Raleigh native who still lives in the area, now works for NuScale Power designing small modular reactors. He is proud of the way YAAB grew and found its purpose.

"Honestly, at first, our end goals appeared a bit nebulous," Gomes said. "But after a few meetings and some constructive dialogues, we were able to transform our ideas into actions. Soon, we started achieving meaningful results, from getting engineering alumni to attend homecoming events to maximizing our participation for Day of Giving. If you attend a board meeting now, you'll see that it runs like a well-oiled machine."

Their impact on their fellow young alumni has measurable results. **Beth Quinn**, civil engineering '06, '08, '11, said that this is due in part to changing perceptions of philanthropy.

"Sometimes as young alumni, being asked to donate to the University can be overwhelming a year or two into your career," Quinn said. "I think that Day of Giving has become a way to connect with other alumni and students through the challenges during the day and that has gotten the younger people more involved. Young alumni and students can give directly to departments or organizations within the University that directly impacted their lives."

As the board members leave, they are looking forward to how they can continue to be involved. Quinn, who lives in Cary and works for the Department of Transportation in the engineering development

squad, is already signed up to volunteer for this year's First-Year Engineering Design Day.

Gomes is looking forward to watching the board continue to evolve and meet new challenges over the coming years.

"Whenever I'm talking with engineering students these days, I'm pleased to see a lot more diversity and varying interests compared to 15 years ago," said Gomes. "Of course, today's students will become tomorrow's young alumni. It's imperative to recognize that so the College can sustain its connections with young alumni as that population continues to grow, both in size and in diversity." ■

YAAB MEMBERS AT ONE OF THEIR FIRST BOARD MEETINGS IN 2018.



Favorite college memories from two YAAB members:



JON GOMES:

"If I had to pick one, probably all of the overly enthusiastic late-night Rock Band sessions we had in our dorm rooms."



BETH QUINN:

"During my senior year, our concrete canoe team finally beat Clemson at the American Society of Civil Engineers Regional competition to take first place. The department hosted an ice cream social to congratulate them. It built a lot of camaraderie between the students."

NC State Engineering Foundation surpasses campaign goals

The NC State Engineering Foundation, Inc., established in 1944, is the fundraising arm of the College of Engineering. For more information on the Foundation, including financial statements, audits and tax identification number, please visit foundationsaccounting.ofa.ncsu.edu/foundations/nc-state-engineering-foundation-inc.

With the **Think and Do the Extraordinary Campaign** at its end, the College of Engineering raised almost **\$268 million** over the course of five years, an incredible outpouring of generosity from our dedicated alumni and friends in support of undergraduate scholarships, graduate fellowships, professorships, improved facilities and the programs that make our student experiences exceptional, such as the Women and Minority Engineering Programs.

One of the concluding highlights from this campaign was the establishment of the Louis Martin-Vega Dean's Chair Endowment through a gift from Goodnight Educational Foundation under the direction of **Dr. Jim and Mrs. Ann Goodnight**. The endowment is named in honor of the College's current dean, **Louis Martin-Vega**.

The NC State Engineering Foundation, Inc., led efforts as the College surpassed its initial goal of \$230 million a year ahead of schedule. NC State University as a whole raised more than \$2.1 billion, becoming one of just 12 public universities to close a fundraising campaign at \$2 billion or more.

A total of **19,805** donors supported the College through **54,591** gifts during the campaign. With your help:

- **183 scholarships and fellowships** were created.
- **32 named professorships** were established.
- **131 bequest expectancies** were committed.
- **Fitts-Woolard Hall**, the largest campus-building naming in University history, opened its doors in 2020 and was dedicated on Oct. 29, 2021. ■

LONG-EZ AIRCRAFT DONATION TO INCREASE TEACHING, LEARNING OPTIONS

For **Arthur (Art) Grantz**, the sky was never the limit growing up.

"All through my teenage years, I would fly with my dad (Walter)," shared Grantz, who earned his Ph.D. in aerospace engineering from NC State in 1989. "The love for flying and aircraft is one of the reasons I went into aerospace engineering and ultimately earned my own pilot's license."

Walter Grantz' passion for flying led him to building his own Long-EZ aircraft — a tandem two-seater with a swept main wing with root leading-edge strakes and winglets, foam-fiberglass sandwich composite structure and a "canard" front wing that makes the plane stall resistant. Powered by a Lycoming O-235 engine, he completed the aircraft in 1991.

"The Long-EZ appealed to my dad because it had great cross-country speed, range and was affordable to build. He researched it very carefully and went to the Experimental Aircraft Association (EAA) Airshow at Oshkosh, Wisconsin, to see them in person before starting on his own project," Grantz said. "After it was finished, I did get the chance to fly with Dad in the Long-EZ and in the early 1990s, we flew into the Oshkosh EAA Airshow together and got to park the airplane among the many other Long-EZ's and Rutan designed aircraft."



Walter Grantz passed away in 2018 and requested the plane be donated to a university to help inspire other young engineers. Art Grantz and his mother Barbara asked **Srinath Ekkad**, head of the Department of Mechanical and Aerospace Engineering (MAE) if the department would be interested. He accepted enthusiastically.

In collaboration with the NC State Public Art Committee, University Communications, University Facilities and MAE, the aircraft was installed in between Engineering Buildings II and III on Centennial Campus. With a new NC State red and white branded wrap, the Long-EZ aircraft brings students, alumni and visitors an opportunity for a closer look at aviation.

"We hope to use the airplane to demonstrate pilot controls and control surfaces to students starting in aerospace engineering," said MAE Professor **Ashok Gopalarathnam**, who helped facilitate the donation.

"The Long-EZ is also a unique airplane in terms of its aerodynamic configuration. Students will be able to learn about the canard configuration and winglets by examining this airplane."

As the first full aircraft donated to MAE, Gopalarathnam and Grantz hope students take advantage of the educational experience to see first-hand an experimental aircraft that is similar to the rapid prototypes of aircraft and subsystems they will eventually build.

"Barbara and I are very happy with the care that NC State has taken in displaying the aircraft and hope that it is enjoyed by the students as much as it was enjoyed by my father." ■

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You're inspiring

Share your story with the College of Engineering for the Inspiring Engineers series.



The Inspiring Engineers series shares diverse stories, career paths and experiences that were all in some way shaped by NC State Engineering. All of us have a story to tell. You can share yours by filling out the Inspiring Engineers form at go.ncsu.edu/inspiringengineers or by scanning the QR code with your phone. Your accomplishments make the College stronger, and we are proud of our alumni who are making a difference in their communities. Your stories inspire our current students and future engineers, who are already making an impact on campus and beyond.

We're also looking forward to introducing you to a few of NC State Engineering's inspiring stories through regular speaking events on Zoom. Stay tuned for more details on the upcoming event in May.

For questions about the event, contact **Michael Auchter** at mrauchte@ncsu.edu.

