

NC STATE

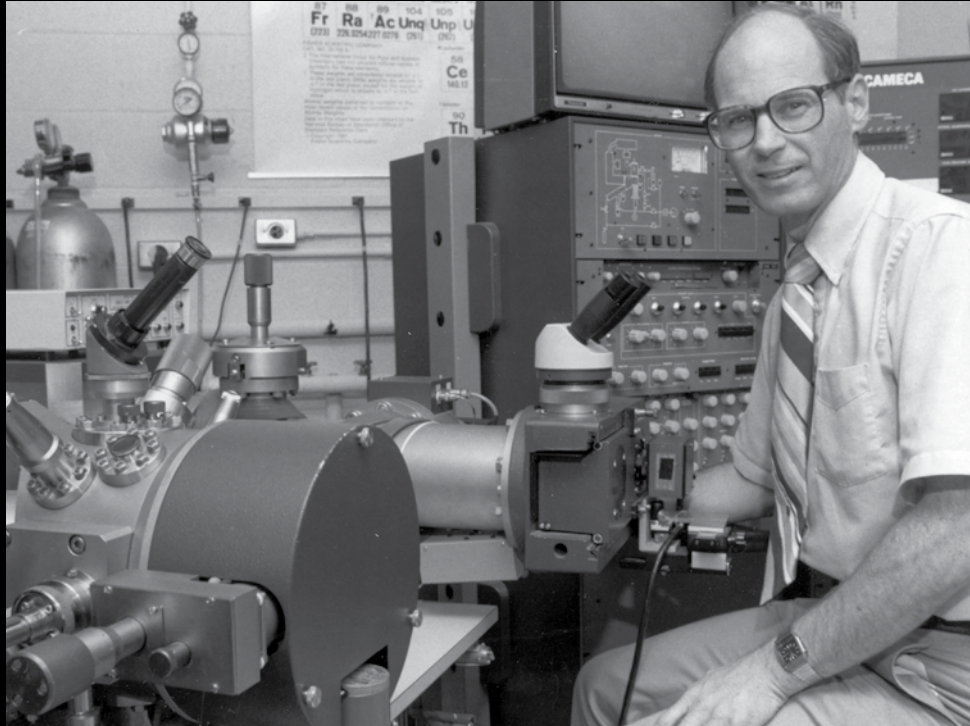
Engineering

MAGAZINE SPRING / SUMMER 2024

pack power

NC State takes lead
on wide bandgap
semiconductors
innovation hub

RESEARCH IN SILICON CARBIDE AT NC STATE GOES BACK DECADES



When the Office of Naval Research (ONR) in the 1980s wanted to upgrade its radar and communications systems, it considered the possibility of new devices using silicon carbide, a wide bandgap semiconductor (WBG) that can operate at higher voltages and temperatures than silicon.

The problem was that very few researchers in the United States were working with it. **Robert F. Davis**, then a professor in the Department of Materials Science and Engineering (MSE) at NC State University, was one of them. With funding from the National Science Foundation and the Army Research Office, Davis' research group was studying how silicon carbide and other high-temperature materials deform under persistent stress.

"We were among only a few people in the world who were working on

silicon carbide for any reason," Davis remembers.

Davis received ONR funding to begin work on growth of silicon carbide thin films that could be used for high-power and high-temperature electronic devices. In order to do that, Davis and members of his lab had to design and build a chemical vapor deposition system for high-temperature growth of silicon carbide thin films. Subsequently, they also had to develop a system for high-temperature growth of silicon carbide bulk crystals from which the films are derived. Neither of these were easy tasks because of how difficult the material is to work with.

In 1987, several graduate students and a postdoctoral researcher in Davis' lab were among the founders of a company called Cree Research, Inc. The Cree founders realized that blue LED

lights were not being commercially produced anywhere in the United States. The founders saw an opportunity to produce blue lights with silicon carbide and combine them with red and green LEDs to create a full-color LED display.

Cree led to a company called Wolfspeed, which is the world's largest producer of silicon carbide materials and has made a \$5 billion investment in a new production facility in Chatham County, North Carolina.

A member of the National Academy of Engineering, Davis joined the NC State faculty in 1972 and retired from the University in 2004. He is the John and Claire Bertucci Distinguished Professor of Engineering Emeritus at Carnegie Mellon University. Since

2010, NC State MSE has held the Robert F. Davis Distinguished Lecture Series to honor his accomplishments and to bring internationally recognized researchers to campus.

That work in Davis' lab was the beginning of a half-century of research in silicon carbide in NC State's College of Engineering. That legacy has led to several startup companies and has helped enable NC State faculty members to lead research centers related to WBG semiconductor power devices.

On **page 28**, learn more about that history and about CLAWS, a new Department of Defense Microelectronics Commons hub that is the latest research center led by NC State working on WBG semiconductor power device research and commercialization. ■

Misra named head of Department of Electrical and Computer Engineering

Veena Misra was named the permanent head of the Department of Electrical and Computer Engineering (ECE) at North Carolina State University in May 2024. Misra, who was selected after a nationally competitive search, has served as interim department head since July 1, 2023.

A three-time graduate of the department, Misra is an M.C. Dean Distinguished University Professor in ECE and is the founding director and lead principal investigator of the National Science Foundation (NSF) Engineering Research Center (ERC) on Advanced Self-powered Systems of Integrated Sensors and Technologies (ASSIST) led by NC State. Founded in 2012, ASSIST is developing wearable, self-powered devices that provide continuous monitoring of the wearer's health as well as the surrounding environment.

Misra is a Fellow of the Institute of Electrical and Electronics Engineers. Her awards and honors include an NSF CAREER Award and NSF Award for Professional Opportunities for Women in Research and Education, a Department of Education GAANN Electronic Materials Fellowship and a NASA Team Excellence Award.

She will lead one of the largest and most accomplished departments of its kind in the country. NC State ECE is ranked as a top-15 department globally by the *Shanghai Ranking* and has led two NSF ERCs at once — ASSIST and the Future Renewable Electric Energy Delivery and Management (FREEDM) Systems Center. In recent years, department faculty members have helped establish and lead an IBM Innovation Center in quantum computing and Commercial Leap Ahead for Wide Bandgap Semiconductors (CLAWS). ■

NC STATE Engineering

Welcome to the
spring / summer 2024
issue of the *NC State
Engineering* magazine.

With my first academic year as your dean of engineering in the books, I'm filled with optimism for the future of our College of Engineering and am excited to be in my dream job.

My onboarding process has included walking tours of our academic departments and centers, alumni events and even an afternoon of video games with students in our **new Esports Lab** in the James B. Hunt Jr. Library (*see the inside back cover of this issue for more*). I've listened and have learned a great deal about what makes this College such a special place, and it's helped me to form a vision for where we are headed.

The College is entering a period of significant change, beginning with our plans to expand. Leaders in the North Carolina General Assembly who recognize the state's opportunities for continued economic expansion and the vital role that NC State Engineering would play have asked us to increase enrollment by **4,000 students** over the next few years. The Engineering North Carolina's Future initiative will enable us to keep more of our state's brightest and most talented students close to home and meet the workforce needs of our booming aerospace, software, biotechnology, construction and energy industries. You can learn more about expansion on *page 16*.

Our outstanding research enterprise is helping to train our students in the skills that they will need in the workplace and is creating economic development opportunities in North Carolina. On *page 28*, you'll learn about the **CLAWS Microelectronics Commons hub** led by our faculty members that builds on decades of research at NC State on wide bandgap semiconductor power electronics. Our Department of Mechanical and Aerospace Engineering is home to a **new hypersonic wind tunnel** that will be an asset to military and commercial applications of high-speed travel (*more on page 20*). And we've just announced the **new Bezos Center for Alternative Proteins** at NC State, which will help meet the nutritional needs of the global population.

Our engineering and computer science students are routinely being recruited and securing job offers before graduation and even receiving help from these new employers with tuition. One of my core beliefs is that there is no better path to upward mobility for young people than an engineering degree. I'm thrilled that the expansion is going to allow us to offer this transformative opportunity to more North Carolinians.

But completing this expansion the right way will require a great deal of hard work and support, and we have significant challenges to overcome along the way. As we grow, we must never lessen our commitment to the recruitment, retention and success of all students who walk through our doors. We'll do that by creating and maintaining a culture where they feel supported, have the resources they need to thrive and can truly reach their full potential.

I'm confident that we will come through the expansion process stronger and ready to lead our state and nation as one of the premier public colleges of engineering.

As we think about the future, it is clearer than ever that we must adapt to the ways artificial intelligence is changing our classrooms, laboratories and workplaces. Stay tuned for more on how our College is a leader in engineering the tools of the future and putting emerging AI technology to work, including a **College-wide symposium** in September on our Applied AI Initiative.

Thank you again for your warm welcome and for your continued support of the College of Engineering. I look forward to engaging with more of our alumni community and to forging a bold path forward together.

Jim Pfaendtner, Ph.D.

Louis Martin-Vega Dean of Engineering

DEAN

Jim Pfaendtner

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NC STATE ENGINEERING ALUMNI MAGAZINE

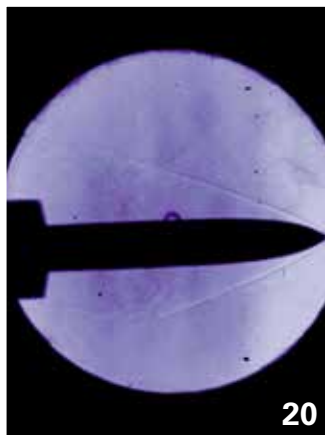
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Questions?

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NC State is leading Commercial Leap Ahead for Wide Bandgap Semiconductors (CLAWS), a Department of Defense Microelectronics Commons hub with the goal of increasing domestic production of wide bandgap semiconductors.

Q&A

QUESTIONS FOR ARNAV JHALA

Arnav Jhala, associate professor in the Department of Computer Science, is the faculty advisor for NC State University's Esports Club and has helped in the planning and development of the new Gaming and Esports Lab. Currently on sabbatical, he is a co-founder of Jabali, a company building an AI engine to democratize video game design.

How did you get involved in esports research and program development?

As a graduate student at NC State, I was a teaching assistant for the game development class in 2004. This was just before our official game development concentration was established. I joined the faculty in 2016 and have been managing the curriculum for the game development program along with colleagues on the department's undergraduate programs team. My research has spanned several areas of games including AI-assisted design, reinforcement learning for games and gameplay analytics.

Please describe the Gaming and Esports Lab.

The esports and gaming spaces within Engineering Building III and the James B. Hunt Jr. Library serve as pioneering hubs where we can lay the foundation for programs and research initiatives. Esports is rapidly gaining popularity in the realm of media, and we are poised to extend the legacy of our campus and state's athletic dominance into this exciting new frontier. By championing esports, we not only acknowledge the burgeoning community within our student body but also seize the opportunity to shape the future workforce. From game development to cloud computing, cybersecurity to content production, our aim is to cultivate talent and expertise that will drive innovation and success in this dynamic industry.

Why is NC State well-positioned to step into a leadership role in growing collegiate esports programs and research?

Building a thriving, comprehensive esports program at a state university campus necessitates several key components: a vibrant student community, robust engagement and support from all levels of administration, an interdisciplinary group of faculty members deeply committed to integrating esports into their research and outreach endeavors, backing from the university administration and state legislature, and enthusiasm from private institutions. It is this unique combination that positions us to assume a leadership role in the esports landscape.

How does the College of Engineering fit into this program?

Several departments offer cutting-edge research and curricula in pertinent fields such as game development, computer graphics, software engineering, networking, human-computer interaction, ergonomics, social media analytics and educational gaming.

Will the esports program influence existing academic programs?

The esports program, along with the resources available, will significantly increase our ability to innovate in curriculum development,

such as the introduction of developing networked multiplayer games for computer science students in the game development concentration, setting up highly instrumented multi-user interfaces for the study of skilled human-computer interaction and adding to our campus strength in digital transformation of education.

What is your favorite game to play and/or watch?

I watch *League of Legends* and *Smash*, and it was great to be at the spring finals last year at PNC Arena. While I have many favorites across genres, the *Legend of Zelda* series has consistently given me joy in terms of interaction design, art, music and narrative. As a bansuri flutist, *Spirit Tracks'* soundtrack is my favorite. Currently I am playing *Hades* and *Sea of Stars* with my children. ■





Office for Faculty Development and Success has a new name, but same core values

WHEN LISA BULLARD

was hired to join the NC State University College of Engineering (COE) faculty in 2000, she was assigned the course she'd be teaching a week-and-a-half before the semester started.

"I was hired from industry," she said. "I had never taught a course before. ... And it was really hard."

Fortunately, Bullard, who is now an Alumni Distinguished Undergraduate Professor and director of undergraduate studies for the Department of Chemical and Biomolecular Engineering (CBE), had mentors within the department.

Christine Grant, a fellow CBE professor, recognized the need for mentorship among the COE faculty. In 2008, she created an office formerly known as Engineering Faculty Advancement to support faculty members in their many responsibilities, including teaching, but also in the tenure and promotion process, grant applications and research. Eight years after her own struggles to adjust to academia, Bullard was on the office's first faculty roundtable.

Now, the office is evolving under a new name: the Office for Faculty Development and Success (OFDS). It has grown from two full-time employees to three full-time employees and a postdoctoral research scholar who are working together to offer new programs with an emphasis on community.

Led by **Joel Ducoste**, associate dean for faculty development and success and professor in the Department of Civil, Construction, and Environmental Engineering (CCEE), OFDS has established a mission to "create opportunities for a community ecosystem where faculty achieve professional fulfillment and advance each other's success," — a mission that remains close to Grant's original goals.

But it is doing this at an expanding College of Engineering that is navigating a work environment altered by the Covid-19 pandemic.

"Faculty are scattered spatially across our campus to support the different realms of responsibilities and activities that they are engaged in, but because of that spatial distance... the connectedness, the opportunity to chat and build bridges are not as easy as they were in the past," he said. "We're trying to create opportunities and to build those bridges across these different realms — a bridge to a lot of different things to allow that connection to happen."

A COE COMMUNITY

The College of Engineering is growing quickly, with more than 40 new faculty members starting last year. To help make sure the changes OFDS is making are in line with faculty needs, the team assembled a faculty advisory committee representing all career levels and departments. Bullard is one of the members.

"They were proactive and reaching out to faculty stakeholders, to make sure that the programming that they plan to offer is meeting the current needs of faculty and

meeting the needs of a diverse range of faculty, both with regard to different roles and also different experience levels," she said.

Teaching resources are still a common need, both for new and later-career faculty members who want guidance on the latest teaching technology and strategies. Faculty members are experts in their fields, but many receive little training on how to run a classroom.

Megan Morin, associate director of OFDS, has a Ph.D. in learning and teaching in STEM with a focus on engineering and technology. She is a former middle school science teacher. Morin has helped lead efforts to identify faculty development needs through a COE-wide assessment. She also brings with her prior experience with the Kern Entrepreneurial Engineering Network (KEEN), a national STEM-based network that provides resources on the latest teaching trends, to support the new Wolfpack Engineering Unleashed (WEU) program, which emphasizes fostering engineering education and inspiring students.

"The WEU initiative and the KEEN resources are one way for us to facilitate a conversation with faculty about how we can support the faculty in engaging students on their research teams and in their courses," she said.

"Giving them the tools so that they can pick and choose which type of engagement is best suited for the type of learning exercises that they are doing in their classroom I think will be a huge benefit," Ducoste added.

Morin and Ducoste want faculty members to feel empowered to bring new strategies and ideas into

their courses and make learning fun for both the faculty member and the students.

They are also aware of the importance of faculty members learning from and mentoring each other across campus and within their departments. OFDS will be meeting with each COE department, starting with CCEE, to discuss specific departmental needs.

While many efforts are tailored to needs specific to academia, like workshops and guidance on teaching, tenure and applying for grants, OFDS is also emphasizing fun and establishing new faculty communities.

"In any faculty meetings we've had in the last few months, the number one thing faculty want is community," Morin said.

In response, OFDS is planning more events and ramping up its communications efforts. It created a faculty LinkedIn group, debuted a new website and started a monthly email newsletter.

In the first issue sent out in January, **Jim Pfaendtner**, Louis Martin-Vega Dean of Engineering, shared how his passion for exercise shifted from running marathons to doing CrossFit. OFDS wants faculty members to be able to bring their entire selves to work and not just think about research and teaching.

Underneath all of OFDS' efforts is a mindfulness of the length of faculty members' to-do lists.

"We know what's practical for faculty," Morin said. "It takes a long time to learn certain skills for student engagement, so we're just trying to drop tidbits along the way for them to gain some of these skills ... wherever they are in their career." ■



NC State Active Minds chapter encourages conversations about mental health

SAV POWERS KNEW she wanted to do something to help her fellow engineering students with their mental health. She just didn't know what.

Powers, who recently graduated with a B.S. in chemical engineering, reached out to **Lisa Bullard**, Alumni Distinguished Undergraduate Professor and director of undergraduate studies in the Department of Chemical and Biomolecular Engineering, to ask for her advice. Bullard encouraged Powers to connect with her fellow students.

"So I thought, let me start in chemical engineering," Powers said. "I asked if she could send out an email for me, asking if

students wanted to be involved in a chemical engineering mental health advisory board, and so she sent us an email."

When Powers was flooded with responses wanting to help, her plans expanded to encompass the entire College of Engineering (COE).

"I wanted to make a difference on campus in my last year because I know that there's something that we can do as students," she said. "There's something that we can do to bring some hope to campus."

She reached out to the COE Office for Diversity, Equity and Inclusion for advice and met with **Angelitha Daniel**, the College's

assistant dean for diversity, equity and inclusion. Daniel told her about Active Minds, a national organization founded by Alison Malmon, who created the group as a junior at the University of Pennsylvania in 2003 following the death of her brother by suicide.

Shortly after, one of Powers' professors recommended she join up with **Abigail Wucherer**, who graduated in spring 2024 with a B.S. in mechanical engineering. Together, they created an Active Minds chapter on campus in fall 2023.

"One of my childhood best friends was one of the students who died by suicide last year," Wucherer said. "And so it was really in an enormous place of grief that I got connected to Sav. She's very optimistic, very hopeful about what kind of impact we could have on the College of Engineering, and to both honor my friend and in being very aware of the mental health crisis on campus, I started working with her to see what we could do."



The Active Minds parent organization, headquartered in Washington, D.C., now has 1,000 chapters across campuses and communities in the U.S. They work with millions each year through awareness campaigns, events, advocacy, outreach and more.

As an official chapter, Active Minds leaders at NC State University are responsible for submitting a chapter report each quarter. In return, the national organization shares resources such as stickers, pins and bracelets to give out. They have also been in communication with the Active Minds chapter at the University of North Carolina at Chapel Hill.

"Active Minds is a national nonprofit with a global presence," said Wucherer. "There are high school chapters, college chapters and there's presence in workplaces. They're everywhere. They're very well established with a ton of resources."

Together with Daniel, who is their faculty advisor, Powers and Wucherer organized a campaign

"We're trying to change the conversation about mental health on campus and create opportunities for us to connect students and faculty members to the resources that are present..."

ABIGAIL WUCHERER

in classrooms, during which they shared mental health resources with professors. They worked with **Jim Pfaendtner**, Louis

Martin-Vega Dean of Engineering, to share a video about his mental health journey during Stress Less Week in February. A big part of their work is making students aware of the resources available, such as the embedded counselors.

One of the initiatives Wucherer is most proud of is their successful campaign to get phone numbers for a mental health crisis line added to student ID cards.

"Our long-term plan is to get these crisis line numbers printed," she said. "But we were able to get temporary stickers to add to student ID cards in the meantime. We distributed over 4,000 of those stickers with Insomnia Cookies last semester. It was a huge effort with over 40 volunteers to pass out these stickers and cookies over a two-week span, but was really, really successful, and it's great to see the student reaction to it and provide space to have a conversation about mental health on campus."

Active Minds also set up wellness stations during the exam period, where they distributed candy and

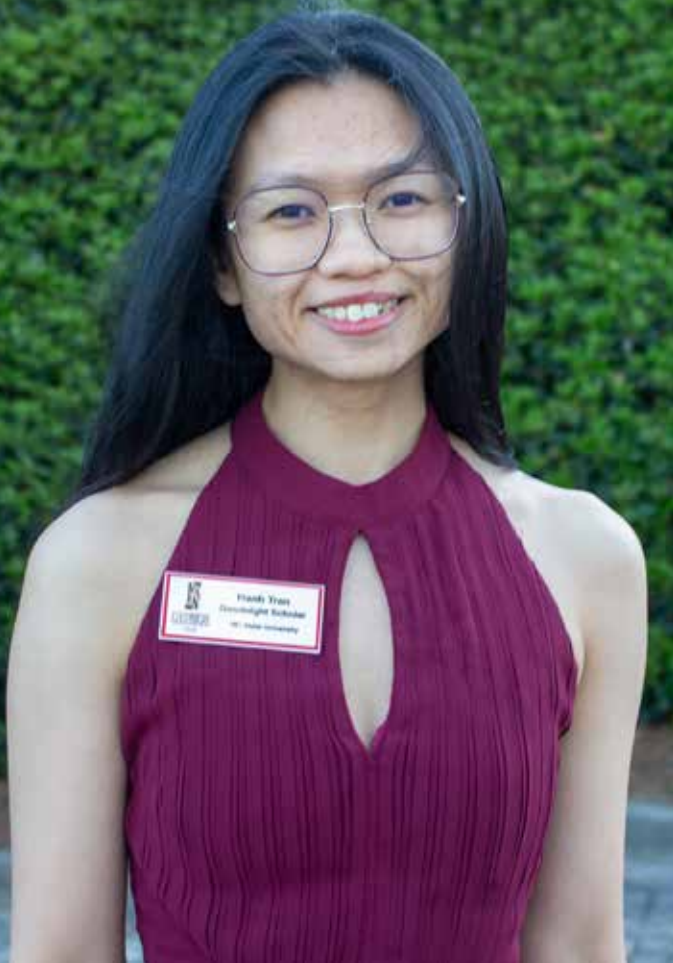
did fun activities with their fellow students.

"We're trying to change the conversation about mental health on campus and create opportunities for us to connect students and faculty members to the resources that are present on campus and make sure that everyone knows that they have access to help should they need it," Wucherer said.

"The majority of the time, a student will turn to a peer before anyone else when they're struggling with their mental health," she added. "We want to make sure that students are equipped to be able to address that. The expectation is not that the student is acting as a therapist, but can connect them to the counseling center and all of those various resources."

Powers and Wucherer hope the organization will live on beyond their time at NC State. Last year, they had about 50 students in the club.

"We are currently working on future leadership," Powers said. "We've been sending out emails and we have some students who would like to be in future leadership. We have identified several new leaders who we're trying to train and then also we're just open to looking for new leaders, anyone who wants to join and be a part of Active Minds." ■



Community college partnership program provides pathways for engineering students

“I realized that I do want to help people, but by being a nurse, I only get to help a couple people at a time,” she said. “But by becoming an engineer, I can help thousands more.”

Initially, Tran reached out to Charles Goodman, an instructor at Pitt Community College (PCC) in Greenville, North Carolina, who told her about the Engineering Pathways Program.

Through the program, various schools within the University of North Carolina System partner with several

community colleges around North Carolina to make it easier for students to transition from a community college. Program members meet twice annually to discuss best practices and pain points for students, share course materials and connect with NC Community College System representatives.

The program has grown more competitive over the years due to its success. Engineering transfer students who come through the program and graduate from NC State leave with similar GPAs to those students who entered NC State as part of the Engineering First-Year Program.

Those who work with the Pathways Program aim to provide

information on course offerings so students can take needed courses at partnership institutions, to provide course materials to partnership programs and more.

According to **Kim Roberts**, the College’s director of recruiting, enrollment management and educational partnerships, one of the program’s most important goals is to help students take classes that they need to graduate on time.

“An associate in science is drawn out kind of generically,” said Roberts, who also noted that the program led to an associate in engineering degree rather than just an associate in science.

“You could use that time to launch yourself into any number of majors at a four-year institution,” she said. “Sure, you could be taking history and religion and all that, but you can take those anytime. Let’s take more calculus, more physics and chemistry.”

Tran took several STEM classes at PCC, which she said helped her prepare for her time at NC State University. She is currently studying biomedical engineering at NC State and is a Goodnight Scholar and a Goldwater Scholar.

“It definitely put me in a better position to transition,” she said. “I wouldn’t say seamlessly, but it definitely made the transition a little easier.” ■

HANH TRAN STARTED COLLEGE in 2011 as a nursing student.

She wanted to change the world and to her, that meant joining the medical field. Unfortunately, finances and her mental health kept her from graduating at the time.

“It wasn’t until 2014 when I actually had a little stint in the military, I got medically discharged for something that wasn’t in my control,” she said. “I was actually at a very low point in my life and I got to a point where it just clicked for me and I started thinking, ‘If I feel this way about my own life, I wonder how many others are affected by this?’”

That was when Tran changed her focus.



NC State chapter of National Society of Black Engineers wins Chapter of the Year awards

THE NATIONAL SOCIETY OF BLACK ENGINEERS (NSBE) chapter at NC State University won two chapter awards this year at the 50th annual NSBE Convention held March 20-24 in Atlanta. Forty-seven NC State students attended, the highest number ever for the chapter.

NSBE divides its chapters into six regions. NC State’s chapter earned the Medium Chapter of the Year and overall Chapter of the Year awards in region II.

“Our chapter has put in a lot of effort this year,” said **Sarah Musa**, a senior computer science major who will be chapter president for the 2024-25 academic year.

Jenni Mangala, who graduated in May 2024 with a B.S. in electrical engineering and is returning to finish her master’s degree through the accelerated bachelor’s/master’s program (ABM), was chapter president for 2023-24. The chapter has grown significantly since she joined in 2020. When students returned to campus in 2021, she and other

NSBE members started reaching out to their friends about joining.

Bryan Wilson, former vice-president of the chapter, was one of the people they reached. Wilson also graduated in May 2024 with a B.S. in electrical and computer engineering and is returning for his master’s degree through the ABM program.

Mangala and Wilson joined the chapter’s executive board their junior years, and the team built on previous leadership’s efforts to balance company- and networking-based meetings with fun, community-based meetings.

The team also implemented a service requirement for students to complete in order to travel to regional and national conferences. The chapter organized events with local schools and K-12 groups.

“Building off of that community engagement inspired people to be really active in service, and then it was just this positive feedback loop where more people are coming to meetings,” Mangala said.

Chapter members were thrilled with their recognition at the convention. They even celebrated with Chancellor **Randy Woodson** when they happened to be on the same return flight to Raleigh.

Both Mangala and Wilson recognized the leaders who came before them. The work they’ve done to broaden NSBE’s reach is important for Black engineering students at NC State.

“Having a space where you get that encouragement, you get mutual support, but you can show up as yourself and you don’t have to put on this face and talk a certain way or act a certain way ... it’s a sense of belonging and encouragement that you can’t really get from anywhere else,” Mangala said.

Wilson added that for him, it has been inspiring to see younger and older Black engineers together at NSBE conventions.

“I can never forget the impact that going to my first convention had when I went into this space of like, quite literally thousands of other Black engineers,” he said. ■

“... it’s a sense of belonging and encouragement that you can’t really get from anywhere else.”

JENNI MANGALA



Computer engineering student wins second runner-up Miss India USA 2023

COMPUTER ENGINEERING MAJOR Ishita Pai Raikar doesn't take days off.

Pai Raikar, who is also minoring in philosophy and cognitive science, is the corporate chair for Women in Electrical & Computer Engineering, a Grand Challenge Scholar, a Social Innovation Fellow, an Oaks Leadership Scholar and an intern at Future World Alliance.

Pai Raikar is also the second runner-up Miss India USA 2023.

"I personally am super passionate about blending engineering, research, social innovation, entrepreneurship and arts into a harmonist purpose," Pai Raikar said. "I see such opportunities like the pageant as a platform to amplify this purpose. I truly believe NC State University is big on promoting this."

The pageants — Miss India USA, Mrs. India USA and Miss Teen India USA — featured 57 contestants from multiple states. All three focus on Indian women residing in the United States. There are gown portions, introductions and more.

Miss India USA also included

a talent portion, for which Pai Raikar showcased dance. She is a professional Indian classical dancer with 15 years of experience. She recorded the narration for the talent portion of the competition herself at an NC State library.

"I wanted to give a social message, so my story started off with a girl coming of age, growing up in a kingdom," she explained.

"She trains to be a warrior princess, but then societal opinions about what women should do in this world obstruct her. She's kind of lost until she hears a goddess from within her. That gives her power and strength."

Though unintentional, Pai Raikar conceded that the message of her dance applies to what it is like for her to be a woman in STEM, especially managing as much as she does.

"Managing time is a million dollar question," she said with a laugh. She added that during the fall semester, she was in a pageant the week of finals. She ended up postponing one of her tests with the support of her professor.

Pai Raikar, who grew up in India and Singapore, has been participating in theater since she was a little girl. Her parents were convinced she would be a performer.

Instead, she went into engineering.

"I really feel fueled by the passion that so many different interests and ideas could come together to build something even greater," she said. "So on campus, I've been also involved with the entrepreneurship department, specifically, the Social Innovation Fellows. So I'm part of that and that also kind of always keeps me curious and engaged in thinking about what problems can be solved from the resources that we have."

While she plans to pursue artistic endeavors for years to come, Pai Raikar's main career interest is AI ethics.

"I hope to delve deeper into the Ph.D. side of it," she said. "More research. That's currently the plan, but we'll see how things turn out." ■

COE alumna Christina Koch headlines Red and White Week



DURING RED AND WHITE WEEK last fall, Chancellor **Randy Woodson** hosted his first live Red Chair Chat with **Christina Koch**, NASA astronaut.

Behind the stage, the moon and stars were projected to make it appear as if Woodson and Koch were talking in space, an appropriate setting for an astronaut who spent 328 days in space in 2019-20 and who is scheduled to return in 2025 to orbit the moon.

During his Red Chair Chats, Woodson interviews high-profile alumni, faculty and staff members, and friends of NC State University on video. Koch's Red Chair Chat was part of the chancellor's annual fall address. More than 400 people attended, and the event was live streamed on the NC State University YouTube channel. It can be viewed at go.ncsu.edu/christinakochredchairchat.

Koch earned a B.S. in physics and a B.S. and M.S. in electrical engineering from NC State. She gave the virtual commencement

address in December 2020, and she even made a visit to campus while aboard the International Space Station in 2019 through a live virtual downlink.

During the conversation, Koch shared why she selected her two majors: physics, for her love of the theoretical, and electrical engineering, for reasons similar to those of many NC State engineers.

"Physics represented studying all of those just fundamental things that are universal," she said. "But I also love tinkering. My dad and I had what we came to call 'shed heaven.' That's the shed in the backyard where you tinker with everything, you fix the lawnmowers. And I loved hands-on. I loved taking things apart, figuring out how things worked. So, I knew I had to put those two things together."

On her next trip to space, Koch will be going as a mission specialist for Artemis II. She is one of four astronauts selected by NASA for the mission, which will be testing out the life support systems of the

Orion spacecraft. The crew will also be seeing if they can turn the spacecraft into a radiation shelter for long-duration space flight and deep space missions, among other objectives.

"We see our mission as humans to bring every one of y'all's aspirations and dreams about exploring with us and to bring back the perspectives that we hope to gain looking back at Earth as it will be one small planet in the space of our window," she said. "And what does that mean? What perspective does that give us as humans and how does it unite us?"

Later in the week, the College of Engineering closed out Red and White Week with a tailgate ahead of NC State's football game against Clemson. Alumni stopped to celebrate the College's 100th anniversary in 2023, eat BBQ and have a chance to meet **Jim Pfaendtner**, Louis Martin-Vega Dean of Engineering, who started his new position just a couple of months before Red and White Week. ■

AquaPack Robotics refreshes its design cycle

UNTIL RECENTLY, AquaPack Robotics would build an autonomous underwater vehicle (AUV) named SeaWolf, repair and use it until it was ready to retire, and then scrap the old robot for parts to build a new one.

The student-led team, which is open to all NC State University students, participates every summer at the RoboSub competition. Over the school year, members repair and improve their current robot or build a new one, then test its abilities through a variety of tasks.

But over the last school year, the AquaPack team spent more than 70 percent of its time designing a new robot, SeaWolf 9, while updating and practicing with its current AUV, SeaWolf 8.

“That was one of the big things we wanted to change about the organization’s design cycles,” said **Chris Mori**, 2023-24 club president and Ph.D. student in electrical engineering. “That allows us to keep the old robot to teach people while also having a stable

competition vehicle. Whereas the new robot, it really gives us a lot of flexibility and a lot more time to make good design decisions... And promoting that kind of design cycle is more akin to what you would face in the real world.”

MAKING THE FINAL

For this summer’s competition in Irvine, California, AquaPack will use SeaWolf 8. Next year, they want to compete with both SeaWolf 8 and SeaWolf 9, and then exclusively use SeaWolf 9 in 2026.

The team hopes to improve on its 2023 RoboSub results in San Diego, where despite low expectations — some team members weren’t sure they’d get the robot past the qualification test — they finished with a score 300 points higher than in 2022.

“We weren’t expecting that because we overhauled three systems: our acoustic system, our software system and our control board,” said **Tajah Trapier**, former

club president and current Ph.D. student in materials science and engineering.

Since then, AquaPack has made even more changes to SeaWolf 8. Members revamped the passive sonar system, changed its coding framework from Java to a new, user-friendly language called Rust, implemented a new torpedo system and replaced some 3D-printed parts with metal parts.

This year, the team believes it can make the RoboSub final.

“All of the genuine problems from before are more or less gone,” Mori said. “We’re in a place where this is the robot. It’s stable. It does its job. And it didn’t explode.”

“The goal has always been to make the finals,” Trapier added. “Just now we’re in a position where it seems like it’s a lot more feasible considering all of the work we put into SeaWolf 8.”

To prepare for competition, the AquaPack team tests SeaWolf in pools at least 10 feet deep, usually at Carmichael Gymnasium. They also schedule time at a nearby outdoor pool to make sure the AUV’s camera is functioning well in different lighting conditions. Tests can take up to five hours. Working over long periods of time is good practice for the seven-day competition, which involves an orientation day, a qualification day, three



days of semi-finals and one day for the final.

RoboSub starts with a qualifying task called “Gate.” The AUV has to pass through the gate at any depth. Once it gets through, it relies on computer vision and acoustic signals to navigate an obstacle course of several tasks: following a path, touching a buoy, dropping objects into a bin and removing the cover of a bin, shooting torpedoes through two different-sized holes and surfacing within a floating octagon.

The competition is intense, and often frantic. A minimum of 36 international teams participate each year, and all are vying for practice time in the pool. The days start at 6 a.m. so that students are there in time for the 6:45 a.m. raffle that determines the first round of 30-minute testing timeslots. AquaPack organizes students into shifts to help reduce

fatigue and increase the number of students able to participate in the competition.

PREPARING FOR FUTURE SUCCESS

As a student-led 501(c)3 organization, AquaPack has its own budget of about \$50,000 funded by dues, corporate sponsors, university programs and grants. The group has 40-50 members cycling in and out throughout the year, with a core group of about 20 people who regularly work on the robot.

Mori and Trapier have been involved since they were undergraduate students at NC State, and they are transitioning out of leadership roles. Both are optimistic about the future of AquaPack, which had a boost in membership in 2023-24, with 80 percent of members showing up to at least one event per week. They are also excited about

the new design cycle and having two AUVs available.

“It really is almost a startup atmosphere where you have this one goal,” Mori said. “We have these people with this technical knowledge and experience, and we’re building end-to-end and dealing with the budgeting, dealing with the logistics.”

Most AquaPack members join because they are interested in robotics. But many, especially leaders, learn much more, including entrepreneurship skills, teaching and teamwork.

“I just always thought robots were cool,” Trapier said. “Our club fosters more of a family environment, and so it became more of a case where I really want to make sure this thrives and continues to grow. I just wanted to support the team as much as possible and make sure it does as well as possible.” ■

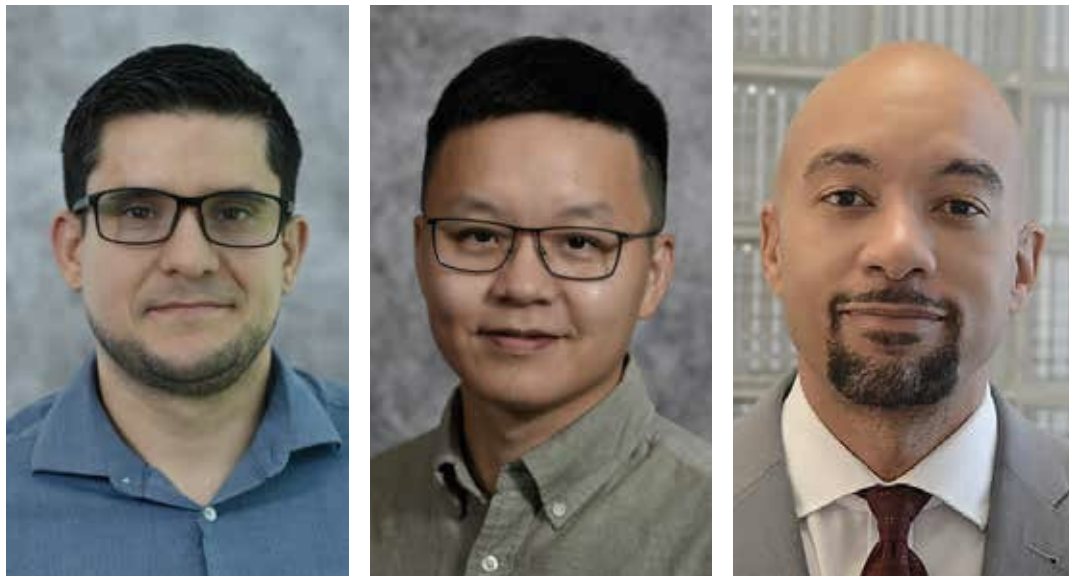
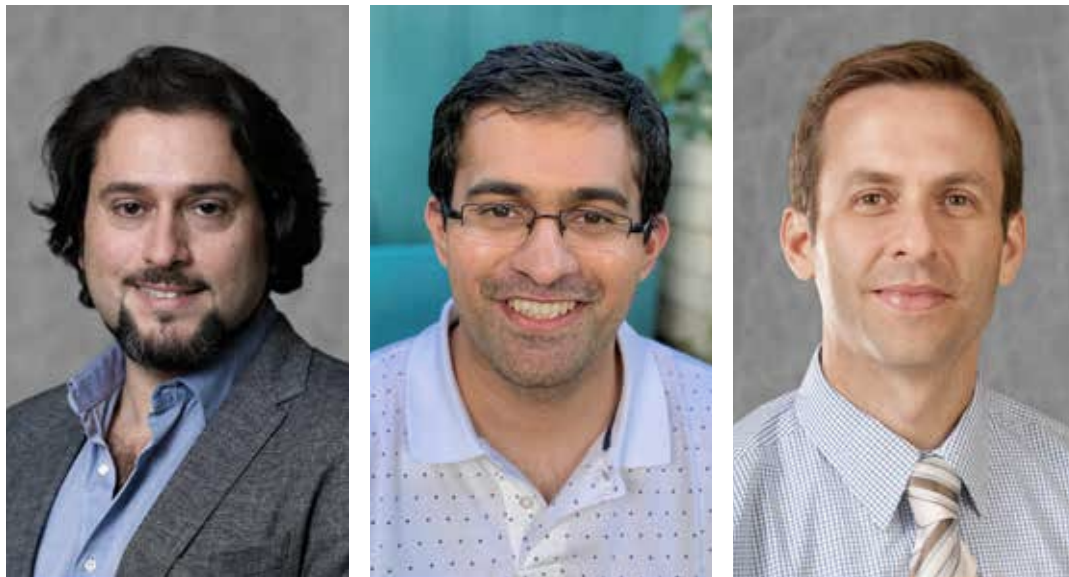
A RENDERING OF SEAWOLF 9.



“...promoting that kind of design cycle is more akin to what you would face in the real world.”

CHRIS MORI

FACULTY HIGHLIGHTS



Two faculty members win NSF CAREER Award

Adolfo Escobedo, associate professor in the Edward P. Fitts Department of Industrial and Systems Engineering, received a Faculty Early Career Development (CAREER) Award from the National Science Foundation (NSF) for his groundbreaking work in the foundations of mathematical programming, a systematic approach using mathematical models and algorithms for optimal decision-making. Escobedo's focus on enhancing optimization software reliability holds significant implications for science, engineering and business.

Yin Liu, assistant professor in the Department of Materials Science and Engineering (MSE), received his CAREER award for his research in optical metasurfaces. His research focuses on low-dimensional materials for their novel optoelectronic properties and potential applications. His research team is interested in using transmission electron microscopy imaging and spectroscopy in combination with optical spectroscopies to understand excitons, polaritons and optically active quantum defects in 2D materials.

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, excellent education and the integration of education and research within the context of the mission of their organizations.

Yuan honored with 2023 R.J. Reynolds Award

Fuh-Gwo Yuan, Samuel P. Langley Distinguished Professor in the Department of Mechanical and Aerospace Engineering, received the 2023 R.J. Reynolds Tobacco Company Award for Excellence in Teaching, Research and Extension.

Yuan's research interests include structural health monitoring/management, nondestructive evaluation, artificial intelligence and machine learning, multi-functional materials and composite structures design, nano/meso scale sensors, advanced computing tools with smart sensors, damage prognosis and energy harvesting. He has authored or co-authored more than 300 publications. He has mentored

more than 100 individuals ranging from Ph.D. students to visiting scholars. He is widely regarded as a gifted educator, and he is passionate about bringing cutting-edge research opportunities to the classroom.

Yuan also serves as a faculty member at the National Institute of Aerospace, where he has been leading research that is strengthening ties between NC State and the NASA Langley Research Center. He is a tireless ambassador for the University, resulting in significant NASA funding for College of Engineering faculty members.

Reynolds selected for the 2024 Fulbright-Hays Seminar Abroad

Kanton Reynolds, director of undergraduate programs and associate teaching professor in the Edward P. Fitts Department of Industrial and Systems Engineering, was selected for the Fulbright-Hays Seminars Abroad Program in Colombia. Reynolds will travel to Bogotá, Leticia, Cali, Medellín and Barranquilla to

meet with university leaders and to participate in knowledge exchange about climate change and the work Colombia is doing to build a more sustainable future.

Three faculty members among most cited researchers in the world

Three College of Engineering faculty members were recognized on Clarivate's 2023 list of Highly Cited Researchers.

Aram Amassian, professor in MSE, develops and uses robotics and artificial intelligence to establish formulation-process-structure-property relationships in organic, quantum dot and metal-halide hybrid perovskite semiconductor materials.

Amay J. Bandodkar is an assistant professor in the Department of Electrical and Computer Engineering whose research includes work with the interface of electronics, materials science and biology to realize next-generation conformal sensors and energy devices with broad applications

in wearables, implants and distributed systems.

Michael D. Dickey, Camille and Henry Dreyfus Professor in the Department of Chemical and Biomolecular Engineering, studies and researches new ways to pattern, actuate and control soft materials, such as gels, polymers and liquid metals. A common theme of his research is the importance of thin films, interfacial phenomena and microfabrication.

Williams named Goodnight Distinguished University Professor

Laurie Williams was named the inaugural Goodnight Distinguished University Professor in Security Sciences at NC State. Williams, a professor in the Department of Computer Science, is the co-director of NC State's Secure Computing Institute, director of the NSF-backed Secure Software Supply Chain Center located at NC State and co-director of the North Carolina Partnership for Cybersecurity Excellence funded by the National Security Agency. ■

TOP, LEFT TO RIGHT: ARAM AMASSIAN, AMAY J. BANDODKAR, MICHAEL DICKEY, ADOLFO ESCOBEDO, YIN LIU, KANTON REYNOLDS, LAURIE WILLIAMS AND FUH-GWO YUAN.

ENGINEERING EXPANSION WILL HELP MEET THE WORKFORCE NEEDS OF THE GROWING NORTH CAROLINA ECONOMY

MOVING FORWARD

“Our students are in high demand...
They are highly valued employees.”

TOM WHITE

After graduating from NC State University with undergraduate degrees in computer science and economics in 2020, **Oscar Molina** had a decision to make.

As he prepared to start a career, Molina considered relocating to one of the country's technology hot spots, including Seattle, the Bay Area and Austin. Yet, there was a desire to remain close to family in North Carolina and to the University that he'd come to love and the

friends that he'd made there. Molina was a student ambassador in the Department of Computer Science during his time on campus, and the former Goodnight Scholar has stayed active with that program as an alumnus, serving on interview committees for the next generation of scholarship recipients.

Thankfully, he didn't have to choose.

After an internship with Deutsche Bank as an undergraduate student, Molina accepted a position with the company after graduation and works as a software engineer at its offices in Cary, North Carolina.

The Research Triangle region of North Carolina is booming, regularly landing on top-10 lists of the best places to live and work, attracting newcomers from across the nation and expanding opportunities in software, aerospace and

biomanufacturing, among other industries. For NC State graduates like Molina, it means being able to start a career with a top company without having to leave the area.

“You can have a very good balance of what you can do, what you can afford and what you want,” he said of living and working in the area.

The availability of that career and life balance is getting attention. Since 2010, Raleigh has been the second-fastest growing metropolitan area in the country out of 384 such areas. New residents, and top technology companies, have flocked to the area.

In recent years, Apple and Google announced plans to open offices in North Carolina and create thousands of jobs. They are joining the likes of SAS Institute, Cisco, IBM and other technology companies that have a large presence here and rely



on NC State to provide them with the talent that they need to thrive. Recognizing a need for NC State to do even more to meet demand as the state continues to grow, the North Carolina General Assembly in 2021 announced Engineering North Carolina's Future. This initiative is designed to increase NC State's capacity to enroll and graduate engineering and computer science students in order to help meet North Carolina's workforce needs.

Under the plan, the College of Engineering will add 4,000 undergraduate and graduate students to its enrollment over the next few years and expects to grow by over 100 faculty positions to ensure that the College will continue offering the highest-quality educational experiences for its students. Engineering North Carolina's Future also includes investments to expand programs at the University of North Carolina at Charlotte and

North Carolina Agricultural and Technical State University.

While the demand for College of Engineering graduates like Molina is high, so too is the demand for seats in NC State's engineering classrooms. This year alone, the College received more than 12,000 applications for a coveted 1,800 seats in its 2024 class of first-year, full-time students.

"Engineering North Carolina's Future will help our College welcome more of the state's high-achieving students who want to study at one of the nation's leading engineering colleges," said **Jim Pfaendtner**, Louis Martin-Vega Dean of the College of Engineering. "We're poised to help meet the workforce needs of our state's most important industries by producing more outstanding engineers and computer scientists."

The expansion initiative began with a pledge of \$20 million in one-time funds for faculty and staff hiring and \$30 million in capital funding. In 2023, legislators appropriated \$10 million in recurring funding for

expansion, as well as \$200 million for a new engineering classroom building on Centennial Campus.

HIGH DEMAND

When statewide economic development leaders talk to companies about opportunities in North Carolina, **Tom White** is often part of the conversation. White is the director of economic development within NC State's Office of External Affairs, Partnerships and Economic Development.

White shares information about research expertise or extension resources that can be made available to new companies, often bringing along a faculty expert from the College of Engineering

whose work closely aligns with the potential employer's industry. He also comes armed with data about the availability of NC State engineering or computer science graduates to meet the company's hiring needs.

"Our students are in high demand," White said. "They are highly valued employees."

The process of adding capacity to graduate more of those in-demand students has already begun. The College has hired additional faculty members in key disciplines since 2021 and is taking advantage of existing facilities on Centennial Campus in new ways to increase teaching and research capacity. Mann Hall on North Campus, which is being renovated, will serve as a hub for first-year College of Engineering students. For many years, Mann was the home of the Department of Civil, Construction, and Environmental Engineering before that department relocated to Centennial Campus.

Adding the new classroom building on Centennial is a few years away, and no location has been determined yet. It will be the first new engineering building at NC State since Fitts-Woolard Hall opened its doors in 2020.

Engineering expansion will afford more excellent North Carolina students a chance to discover everything that the College has to offer and choose their own career path.

Erin Snider came to campus from her native Lexington, North Carolina, with plans to become an engineer. She hadn't thought much about computer science as an alternative.

"I didn't really understand what the possibilities were, but as soon as I did, I fell in love with them," Snider said. She graduated with an undergraduate degree in computer science in 2017 and earned an MBA from NC State in 2021.

She works for SAS Institute as a software manager in the company's fraud and security intelligence division. Thanks to her NC State education, and the opportunities available in North Carolina, she was able to stay put and also have a great career.

"Raleigh is the perfect size for me," she said. ■

State budget allocates \$3 million for nuclear reactor feasibility study

NC State University established the first civilian nuclear research reactor on a university campus in 1952 and still operates a 1-megawatt PULSTAR reactor on North Campus in Burlington Labs. Now, thanks to a \$3 million investment from the legislature, the Department of Nuclear Engineering and the University can begin thinking about what comes next.

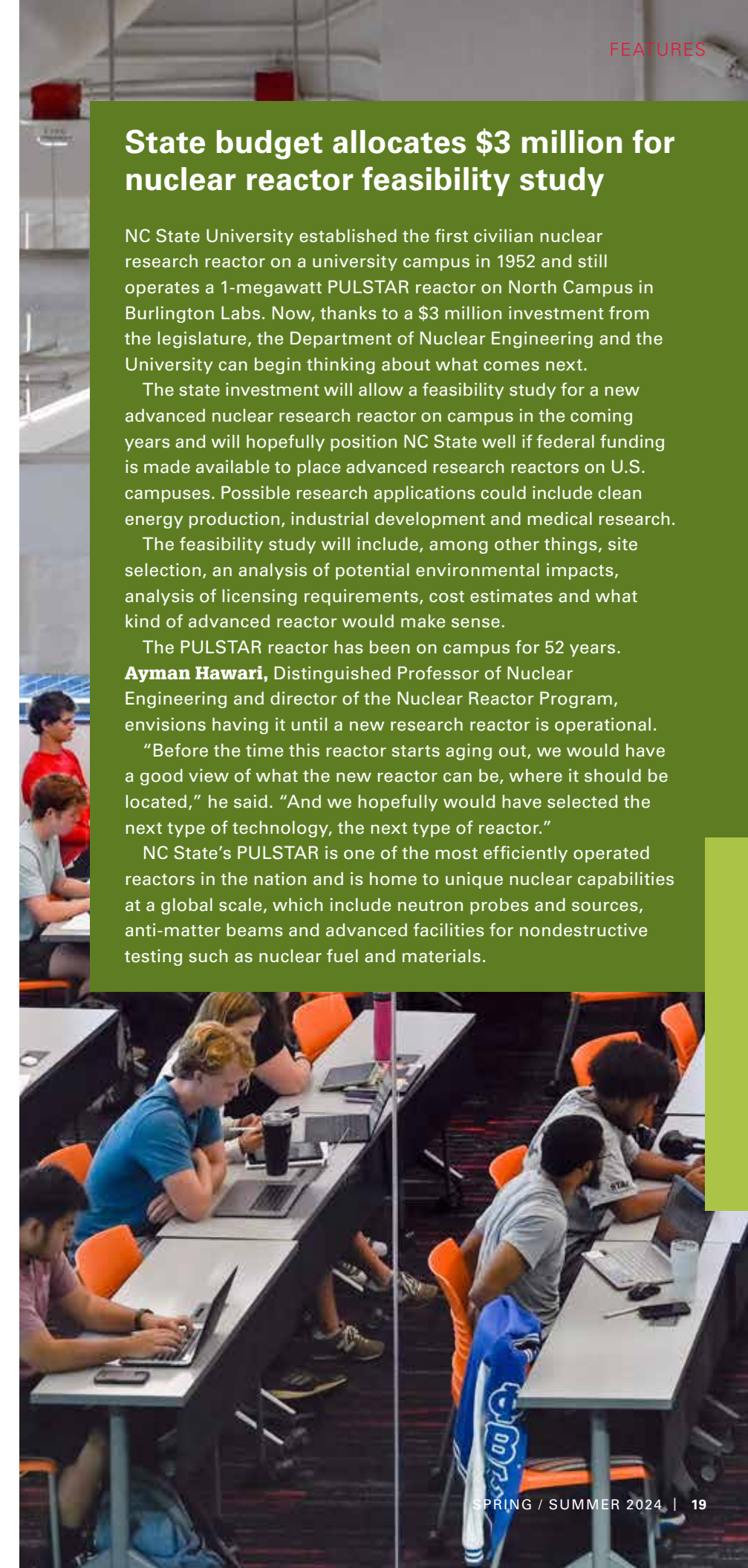
The state investment will allow a feasibility study for a new advanced nuclear research reactor on campus in the coming years and will hopefully position NC State well if federal funding is made available to place advanced research reactors on U.S. campuses. Possible research applications could include clean energy production, industrial development and medical research.

The feasibility study will include, among other things, site selection, an analysis of potential environmental impacts, analysis of licensing requirements, cost estimates and what kind of advanced reactor would make sense.

The PULSTAR reactor has been on campus for 52 years. **Ayman Hawari**, Distinguished Professor of Nuclear Engineering and director of the Nuclear Reactor Program, envisions having it until a new research reactor is operational.

"Before the time this reactor starts aging out, we would have a good view of what the new reactor can be, where it should be located," he said. "And we hopefully would have selected the next type of technology, the next type of reactor."

NC State's PULSTAR is one of the most efficiently operated reactors in the nation and is home to unique nuclear capabilities at a global scale, which include neutron probes and sources, anti-matter beams and advanced facilities for nondestructive testing such as nuclear fuel and materials.



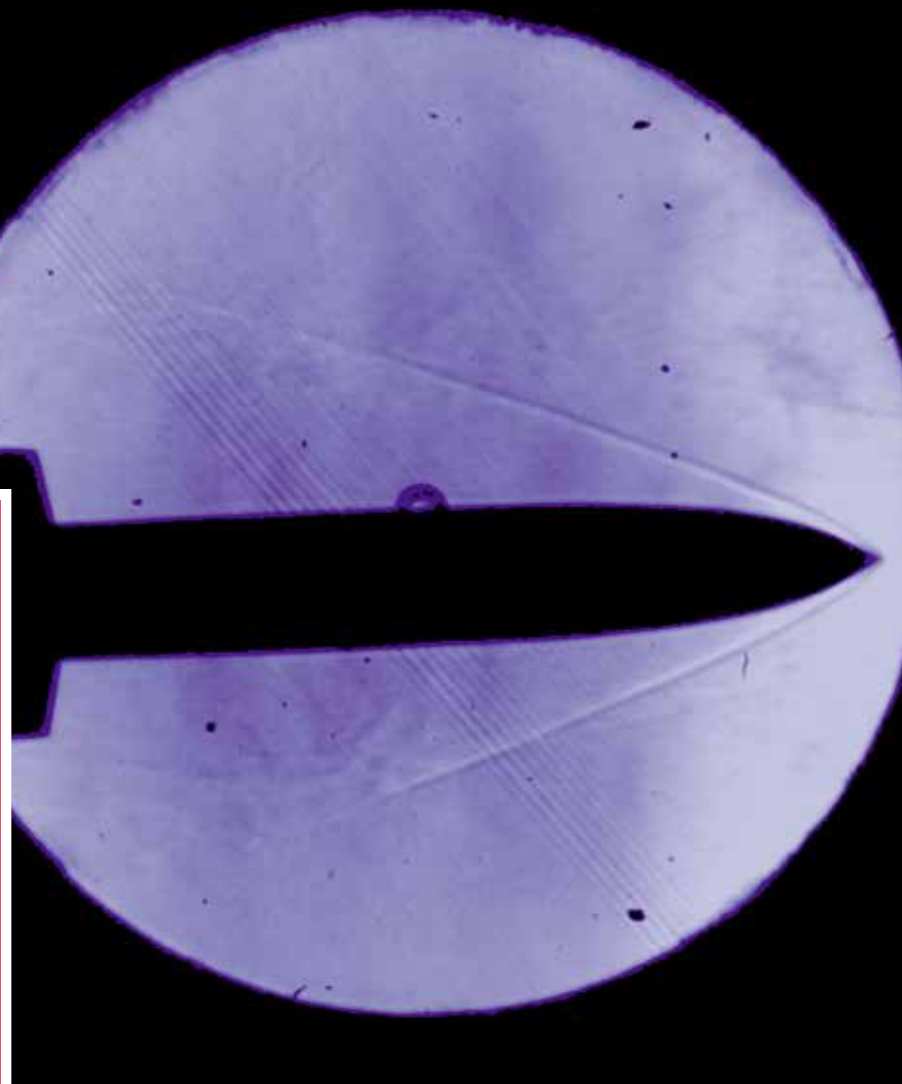
MACH 6 IS HERE

Student-built hypersonic wind tunnel up and running

NC State University research capabilities are a lot faster now that a **long-duration hypersonic wind tunnel is officially running**.

Hypersonic wind tunnels reach speeds up to Mach 6, or six times the speed of sound. At hypersonic speeds, **it would take just three hours to fly around the globe**. This tunnel is capable of operating for up to 15 seconds at Mach 6, which is enough time to simulate real flight operations and component behaviors.

“This facility is one of a kind in the entire nation,” said **Venkat Narayanaswamy**, professor in the Department of Mechanical and Aerospace Engineering (MAE). **“There isn’t another university-scale facility that provides this much versatility to perform a wide range of scientific and engineering investigations, and approaches real flight conditions as closely as our facility does. This opens a new door for the next generation of research.”**



ABOVE PHOTO: THE OBSTRUCTION CREATED BY THE MODEL ROCKET IN THE WIND TUNNEL FLOW CAUSES A SUDDEN REDUCTION IN THE FLOW VELOCITY NEXT TO THE ROCKET IN THE FORM OF SHOCK WAVES. THIS LEADS TO A SUDDEN CHANGE IN THE REFRACTIVE INDEX OF THE WIND TUNNEL FLOW, CAUSING THE LIGHT TO BEND AND SHOWING THE COMPLEX SHOCK WAVES AROUND THE MODEL.

REIMAGINING FLIGHT

The Department of Defense (DoD) has started two projects geared toward developing the next generation of aircraft that use smart materials to fly faster, turn and descend more quickly, and operate with better fuel efficiency.

The first is focused on developing the next generation of hypersonic platforms that can change their shape during flight, called morphing platforms. It is sponsored by the Surface Morphing and Adaptive Structures for Hypersonics (SMASH) program, which is a consortium comprising national labs and universities put together by the Army Research Laboratory and Naval Research Laboratory.

“We no longer talk about rigid materials,” Narayanaswamy said. **“We look to employ smart materials and research how we can integrate advancements that are happening in materials and electronics into hypersonic technologies and take them to the extreme.”**

For the second project, sponsored by the DoD’s Joint Hypersonic Transition Office, researchers are building the next generation of propulsion systems that will first be used by the military before transitioning to commercial aircraft to speed up passenger flight.

“Where we are in hypersonic and space technologies is where the internet was in the 1960s,” Narayanaswamy said. **“Back then, the internet was meant for communication between soldiers and military personnel in the battlefield where they wanted a secure way to pass on information. Once that technology entered the civilian world for day-to-day applications, you cannot imagine a world without the internet. Similarly, once we transition our hypersonic technologies to a civilian world, we are going to completely reimagine the way we think about travel and data in a way that will completely change our daily lives.”**

Emma Cavanaugh, a Ph.D. student in aerospace engineering, is working on a SMASH project and developing next-generation morphing technologies by fusing the cutting-edge in smart materials with hypersonic propulsion and controls. Her research is focused on inlet design optimization, with an emphasis on determining the best inlet geometry to accommodate varying speed conditions.

The inlet brings the air into an air-breathing propulsion system, which uses atmospheric air to generate exhaust gasses for propulsion.

“An inlet for an airbreathing propulsion system is the first place that flow is seen,” Cavanaugh explained. **“This portion of the system is primarily responsible for compressing the incoming air. Once compressed, the air goes through a series of decelerations and accelerations throughout the isolator, combustion chamber and nozzle such that sufficient thrust is generated for the aircraft to reach supersonic and hypersonic speeds. These effects can be further amplified by altering the geometry associated with the propulsion system.”**



Aircraft components like inlets are designed to work most efficiently at specified Mach speeds. But in real-life conditions, those speeds can vary quite substantially.

“If we can make some kind of inlet that has the ability to accommodate for those different conditions then that’s going to be of a lot greater use for industry and government,” she said.

BUILDING FOR INDUSTRY

While there are exciting developments to come from the hypersonic wind tunnel, students also gained valuable experiences from building it. They had to meet extremely high standards throughout the process.

In the final weeks, the student team was obsessing over all the small details.

Shaan Stephen, a master’s student in MAE who has worked on the tunnel since he was an undergraduate student, said the most important lesson he learned is that documentation is critical.

When the students operated the tunnel for the first time, they were prepared for a loud noise, like one made by the supersonic wind tunnel.

“It didn’t make a loud sound at all,” Stephen said. **“We were all expecting that and confused if it ran or not, but after we realized it did and we actually saw the shock wave, we were pretty excited.”**

Narayanaswamy had a different reaction to the lack of noise, calling it **“reassuringly quiet.”** Loud noise indicates high pressure, and with a functioning vacuum system, the pressure should be low when the tunnel reaches hypersonic speeds.

“If it were noisy, that means our tunnel did not work at all,” he said.

Despite the differing reactions to the noise levels, Narayanaswamy and the students shared similar reactions

to the tunnel’s first run: excitement, relief and pride.

“It’s such an intricate piece of engineering, and all credit to the student team,” Narayanaswamy said. **“Their due diligence and being meticulous, that’s something I was able to appreciate in the students. That’s what I’m really proud of: the fact that they could remain enthusiastic despite the delays and difficulties during the facility construction.”** ■

ACCELERATING DISCOVERY

Self-driving labs are the future. NC State is at the forefront.

There are vast numbers of undiscovered molecules and materials that offer solutions to the challenges in health care, the environment, energy and other areas facing our world. Using artificial intelligence (AI), robotics and lab automation, self-driving labs (SDLs) are teaming up with human scientists to accelerate the rate at which we can solve these challenges.

At NC State University, researchers are among the global leaders in creating SDLs. **Milad Abolhasani**, associate professor and University Faculty Scholar in the Department of Chemical and Biomolecular Engineering (CBE), has been developing SDLs since 2017. His group is the first to make SDLs with microfluidic reactors for advanced functional materials, and it is now working with other NC State researchers to build SDL infrastructures.

Using AI and automated robotics, SDLs are capable of automatically designing a material or molecule, and of synthesizing and analyzing it in an iterative manner to find a new compound with desired properties. They are making the material and molecular discovery process faster and more efficient.

SDLs are of increasing interest in fields such as semiconductors, pharmaceuticals and specialty chemicals. But they are difficult to make, and in their early stages, researchers are working to define best practices before SDLs become more accessible.

“What I would like to see in the next five to 10 years is SDLs becoming like a robotic co-pilot for human scientists that they can use to perform their scientific tasks 100 to 1,000 times faster,” Abolhasani said. “So, it becomes that these robotic copilots augment the human scientists’ knowledge and intuition in running experiments and making decisions. This is the future of human-AI-machine collaboration.”

INDUSTRY PARTNERSHIPS

Eastman, a global specialty materials company, has a long-standing partnership with the CBE department. Abolhasani’s group is working with Eastman to develop SDLs that will reduce the time and resources spent on research and development of discovering more effective and sustainable chemical manufacturing methods so scientists can study more challenging chemical transformations.

In February 2024, NC State and Eastman researchers published a paper on a self-driving catalysis laboratory called Fast-Cat, which analyzes how ligands affect chemical reactions used in industrial and pharmaceutical applications. Ligands are molecules that control and speed up chemical reactions. There is a need for deeper understanding of how they work, as well as for discovery of new ones, to make the process more efficient. Fast-Cat provided a full analysis of a ligand in just five days, compared to the six-plus months it would have taken with conventional testing.

HOW DO SDLs WORK?

SDLs operate in a closed loop of design-make-test-analyze under parameters set by a researcher. An SDL uses AI for autonomous design of the targeted compound and an automated robotic lab for rapid synthesis and characterization of the compound. It generates a predictive model of the reaction using AI to autonomously decide the next set of tests, and uses the new experimental data generated to make a better model, and so on.

As an example, the Artificial Chemist 2.0 — one of the earliest SDLs developed by Abolhasani’s group in 2020 — identifies and manufactures quantum dots, which are semiconductor nanocrystals used in LEDs and solar panels. A researcher gives Artificial Chemist 2.0 certain parameters it needs in a quantum dot, and the SDL then identifies the optimal material and most efficient means of producing that material. That process takes less than one hour.

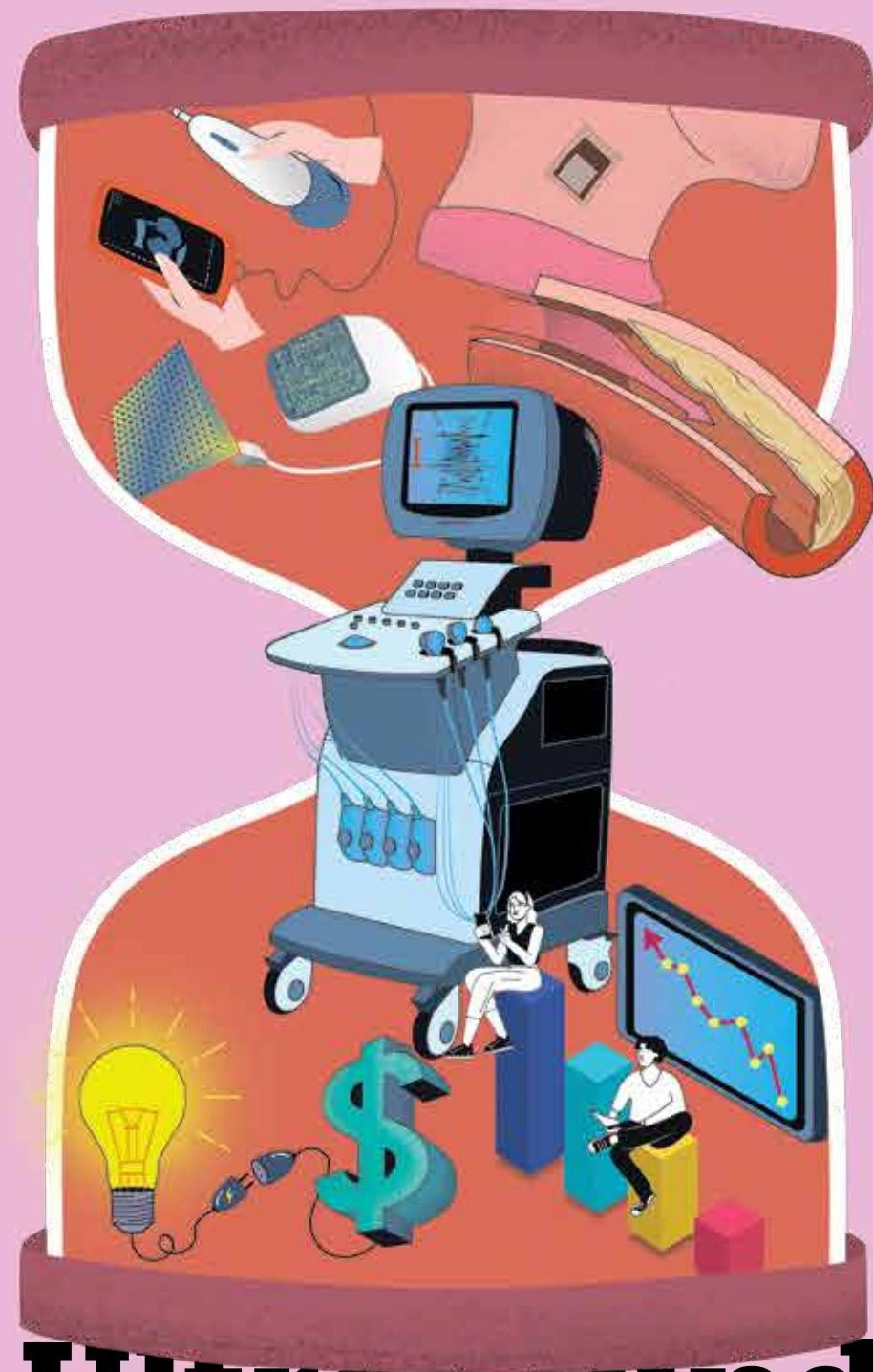
SDL STANDARDS

Worldwide, there are few fully functional SDLs. As they are more widely adopted, researchers are defining best practices, with an emphasis on reproducibility and trustworthiness.

In January 2024, NC State hosted the National Science Foundation-sponsored Future Labs Workshop on democratization and innovation in SDLs attended by more than 100 people.

“We discussed the best possible way would be to not just have centralized or distributed self-driving labs: it’s an ‘and,’” Abolhasani said. “You need to have centralized, customized SDLs facilities like national labs, and then you need to have distributed, low-cost access to SDLs so that every researcher can potentially use a specific version of these powerful research acceleration tools that suits their needs in a chemistry or materials science lab.” ■

THIS ILLUSTRATION WAS CREATED BY A HUMAN ILLUSTRATOR AND GENERATIVE AI.



Ultrasound for the future

New NIH-funded program emphasizes
ultrasound research commercialization

Ultrasound is one of the best-known medical imaging devices. It is safe, cost-efficient and relatively portable, making it one of the most accessible diagnostic and therapeutic medical technologies.

And its potential goes far beyond what it is being used for today.

"I think ultrasound is going to impact public health by providing a lot more information to a lot more people a lot more easily," said **Caterina Gallippi**, professor of biomedical engineering. "There's a term that's sometimes thrown around, and that's called the democratization of ultrasound. Meaning that everyone has equal access to it, or at least ready access to it."

Innovations in ultrasound like handheld devices, wearable sensors and the use of artificial intelligence (AI) are already helping improve access to it. Smaller, handheld ultrasound systems are less expensive, costing as little as \$2,000 compared to the \$100,000 for a traditional system. More advancements in the field are coming, and to ensure these developments are effectively contributing to the democratization of ultrasound, it's important for researchers to be factoring in the needs of physicians and patients.

To help prepare biomedical engineers to be better trained in conducting their

research and pursuing innovation with end users in mind, Gallippi applied for T-32 funding from the National Institutes of Health — which requires that a program provides unique experiences to students and prepares them to meet critical health care needs — to create a training program focused on ultrasound and entrepreneurship.

The Unified Medical Ultrasound Technology Development (UNMUTED) Predoctoral Training Program teaches students entrepreneurship skills that they can apply to their doctoral research and beyond. The earlier students start thinking about how their research might translate to a commercial space, the more prepared they will be to commercialize their research and make a broader impact.

The program is the first of its kind, and the Joint Department of Biomedical Engineering at North Carolina State University and the University of North Carolina at Chapel Hill is the perfect home for it due to ready access to clinical settings and to medical imaging companies in Research Triangle Park.

Selected students do not have to be biomedical engineers, but they do have to be working in a lab focused on ultrasound research. UNMUTED fellows are part of the program for two years. They take two graduate-level courses on technology commercialization and startups, go

through several entrepreneurship trainings, shadow physicians in clinical settings to see how they are using ultrasound and complete a summer internship to learn more about industry.

"When [applying for the grant], I had to really think hard about what we are going to offer the trainees in this program that's different or unique, because really any Ph.D. student who's studying ultrasound in the Triangle has access to a large pool of expertise, resources and collaborations," Gallippi said. "And I started to think about not only the environment in terms of expertise in ultrasound, but also in terms of the potential for commercially translating technology."

KNOWING YOUR USERS

One of the most common reasons a startup fails is because its founders never determined if there was a customer for the technology it created.

That's a lesson the first two UNMUTED fellows, Ph.D. students **Roshni Gandhi** and **Shureed Deepto Qazi**, took away from the National Science Foundation (NSF) Innovation Corps (I-Corps) program.

The immersive I-Corps program focuses on training participants to perform customer discovery, with

the goal of commercializing research projects to broaden their societal and economic benefits. Gandhi, Qazi and Gallippi completed the training through Kickstart Venture Services, an Innovate Carolina department that provides entrepreneurial and commercialization resources to research-based startups and the UNC-Chapel Hill community. UNC-Chapel Hill and NC State are both part of the NSF Mid-Atlantic I-Corps Hub.

The UNMUTED team performed customer discovery for a university invention that detects blood viability using ultrasound. They came up with a hypothesis on how the product would help hospitals and blood banks. Rather than pitching their product, they interviewed 20 potential users, asking them unbiased questions about their processes for determining blood viability.

“We learned after interviewing lots of different people, like emergency medical technicians and directors of blood banks, that our product actually didn’t necessarily have a space in that market,” Gandhi said.

Most blood banks and hospitals use an expiration date system to determine blood viability. The researchers found in their interviews that there was little blood being wasted, and that the main problem is a shortage in blood donations.

But just because their product didn’t have a critical need in one market doesn’t mean it won’t be useful somewhere.

“There’s never a negative result [in the I-Corps program],” said Mireya McKee, director of KickStart. “You learn from that. Pivoting is a vital skill that all of us in research and in startups need to learn how to do. Just because something doesn’t work out the way that you’re trying to do it doesn’t mean that there’s not another market out there.”

MAKING WAVES IN ULTRASOUND ENTREPRENEURSHIP

Emphasizing entrepreneurship is not new to Joint BME. Several faculty members and students have launched startups from their research. Coming up with a way to immerse students in commercialization and entrepreneurship training early in their academic years has been a natural progression.

“The companies that have spun out from BME, the faculty, innovators, the trainees that support the development of the intellectual property, they’re very committed to commercialization,” said Judy Prasad, associate director of KickStart. “They show a strong interest in entrepreneurship.”

As they move forward with their research, both Qazi and Gandhi recognize the value of their early forays into entrepreneurship-based experiences.

“I wanted to get some of the knowledge that it takes to commercialize these technologies,” Qazi said. “For the first couple years of the Ph.D., you’re focused on finishing your classes. And you don’t feel too deep into your research yet, so I thought it’d be cool if I could learn about commercializing.”

Qazi, who is part of Gallippi’s lab, is

interested in the diagnostic applications of ultrasound and in using machine learning to help decipher imaging results. He is also working on a project on clutter filtering to improve 3-D Doppler ultrasound imaging, which is used to measure blood flow.

Gandhi is a member of BME Chair **Paul Dayton’s** lab, which has launched several startups. She is currently focused on nanodroplet sonothrombolysis, a therapeutic ultrasound-based technique used to break up blood clots.

“Microbubble sonothrombolysis has been well-studied in the past, and I’m focusing on nanodroplet sonothrombolysis, and that’s more novel,” she said. “There’s a lot more to be done in that field and more that I can discover.”

Ultrasound is only going to become more accessible and easier to use, while its applications continue to grow in two extremes: more advanced computer architecture that enables high-resolution imaging, and more portable, handheld and wearable

devices that can be brought anywhere.

UNMUTED will help students have a leg up as they discover their own research breakthroughs that contribute to ultrasound innovation.

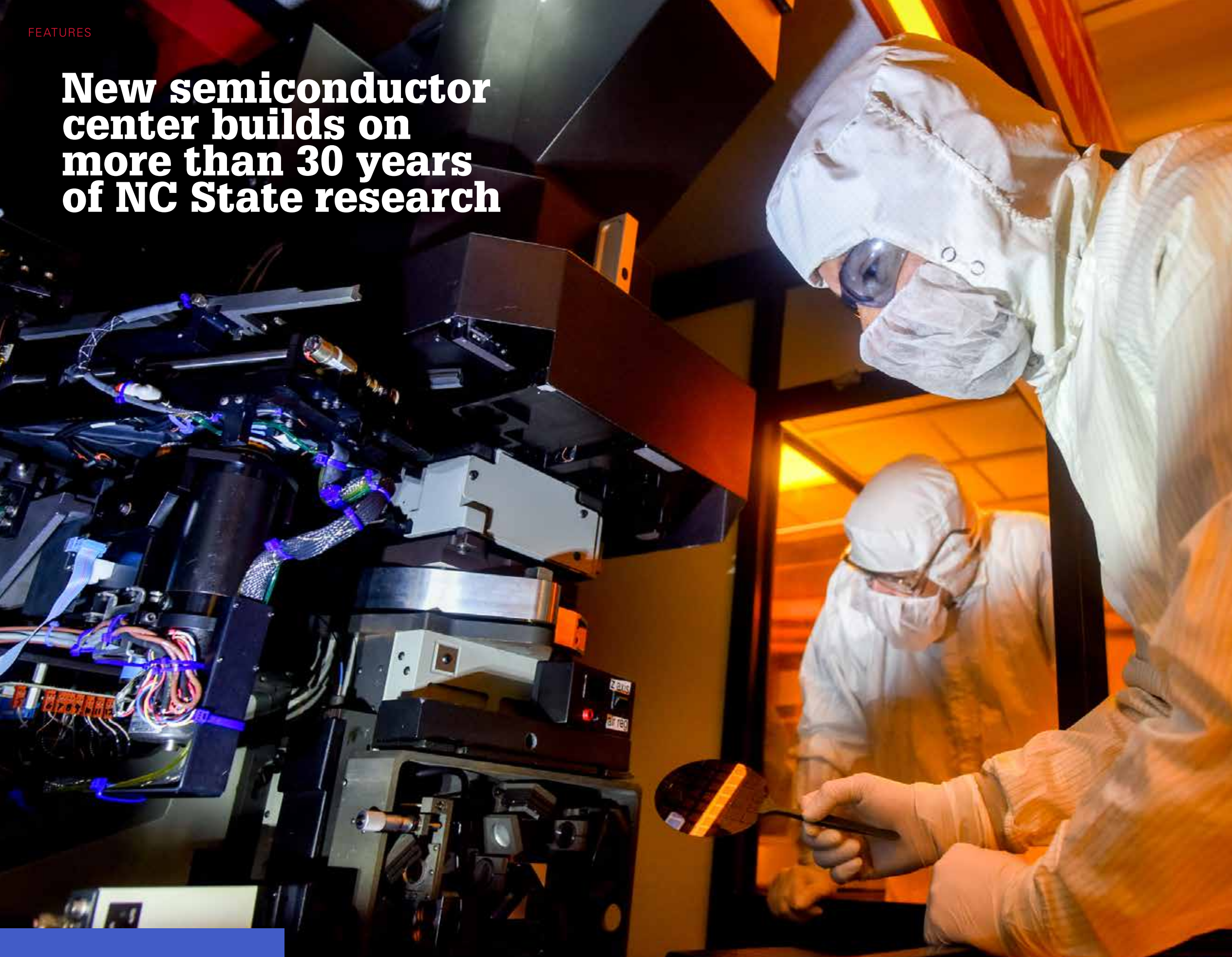
“We hope that our students are trained to look at their science with that sort of critical eye,” Gallippi said. “And that they proactively take steps to support the development of that technology toward commercial impact.” ■



“The companies that have spun out from BME, the faculty, innovators, the trainees that support the development of the intellectual property, they’re very committed to commercialization...”

JUDY PRASAD

New semiconductor center builds on more than 30 years of NC State research



pack power

B. Jayant Baliga came to NC State University in 1988, fresh off the success of a truly world-changing invention during his time as a researcher at General Electric.

In 1980, Baliga invented the insulated gate bipolar transistor, a more-efficient high-power semiconductor switch that has saved humankind trillions of dollars in energy costs with its implementation in lighting, automobiles and manufacturing. Today Baliga, Progress Energy Distinguished University Professor in NC State's Department of Electrical and Computer Engineering (ECE), still calls 1980 his "big year."

It was also the year in which he began pursuit of another research question, one that he's been working on ever since — what would the next power semiconductor material be?

"No one had bothered asking that question because everyone seemed quite happy with using silicon," he remembered.

Silicon, because of its versatility and wide availability, has been the element of choice for semiconductors since the rise of the transistor in the middle of the 20th century. In the 1980s, some researchers had begun looking at the viability of other semiconductor materials, like silicon carbide (SiC) and gallium nitride (GaN).

After 15 years at General Electric, Baliga was considering a career switch to academic research and teaching. He was drawn to NC State, in part, by work already happening in **Robert Davis'** lab in the Department of Materials Science and Engineering (MSE) to grow SiC crystals and wafers, a tricky proposition because the material is difficult to work with. Baliga thought he could leverage that work if he accepted a position at NC State.

Over the decades since, work in the College of Engineering on SiC and GaN, known as wide bandgap (WBG) semiconductors, has led to spinoff companies including Cree and later Wolfspeed, Adroit Materials, HexaTech and Kyma Technologies, and has put NC State in position to lead national research centers working in these areas.

Wide bandgap semiconductor devices are able to operate at higher voltages, frequencies and temperatures and are more efficient than current silicon semiconductors. As they become more cost competitive, wide bandgap semiconductor devices are being increasingly used in military applications, renewable energy infrastructure, communications, radar and more because of size, weight and power-efficiency advantages.

Commercial Leap Ahead for Wide Bandgap Semiconductors (CLAWS) is the latest research effort in this area led by NC State. CLAWS is a Department of Defense (DoD) Microelectronics Commons hub executed through Naval Surface Warfare Center Crane Division and the National Security Technology Accelerator (NSTXL) to bring lab to fab prototyping and critical microelectronics technology areas such as WBG semiconductor devices to the market for both military and commercial uses. In 2023, NC State was awarded an initial \$39.4 million for the first year of a five-year program to lead the center, which also includes North Carolina Agricultural & Technical State University and six industry partners.

The funding is part of a \$238 million initial investment through the Creating Helpful Incentives to Produce Semiconductors (CHIPS) and Science Act for the establishment of eight Microelectronics Commons hubs spread across the United States. In addition to the hub funding, the CLAWS program is competing for additional funding for advanced semiconductor projects for the DoD.

“The technologies hold the potential to enable future electric vehicles, power grid technologies, 5G/6G, quantum technologies and artificial intelligence applications,” said **Fred Kish**, M.C. Dean Distinguished Professor in ECE and the director of the new hub. “They are also important for national security applications by providing energy efficiency, size, weight, power and performance advantages in critical application areas including weapons systems, warfighter outfitting, position/navigation/timing, biotechnical and medical, materials processing, displays and a host of additional defense needs.”

A HISTORY OF LEADERSHIP

Baliga established the Power Semiconductor Research Center at NC State in 1991 to work on research with companies around the globe on power semiconductor device technology for use in motor drives, cellular communication, hybrid and electric vehicles, robotics and more.

Semiconductor work at NC State received a major boost in 2008, when the University was awarded the lead in a National Science Foundation (NSF) Engineering Research Center dedicated to building a new smarter electric grid that can incorporate renewable energy sources. The NSF Future Renewable Electric Energy Distribution and Management (FREEDM) Systems Center has developed a working smart-grid system and the technologies that underpin it: a solid-state transformer that allows bi-directional power flow and removes the need to convert direct current to alternating current for home use; a more efficient fault-isolation device; and the controllers and algorithms that allow them to work together. FREEDM’s research thrust areas include one focused on the development of WBG devices for utility scale applications in the new smarter grid.

This track record of research center leadership put NC State in a strong position to lead another new federally funded center, this one a member-driven manufacturing consortium dedicated to commercialization of WBG power devices and tasked with developing a commercial foundry for the development of SiC and GaN chips. PowerAmerica was one of several sites in the Manufacturing USA network established by President Barack Obama’s administration, and the former president visited the NC State campus in 2014 to announce its creation.

The Department of Energy renewed funding for PowerAmerica for another five years in 2023. Since its inception, the center has commercialized more than 10 WBG technologies. Through its education and workforce development program, it has trained hundreds of master’s and Ph.D. students — and thousands more K-12 students in STEM programs.

ELIMINATING BARRIERS

The CHIPS and Science Act recognizes the need for the United States to be a global leader in production of the semiconductor chips that will power the most important industries of the future, including renewable energy, quantum computing and artificial intelligence. As one of eight microelectronics hubs, CLAWS will eliminate existing barriers that inhibit domestic U.S. semiconductor innovations from moving efficiently to production, said **John Muth**, Distinguished Professor in ECE and principal investigator for CLAWS.

Those barriers include limited access to advanced wafers and epitaxy, fabrication processes and packaging technologies, in addition to high costs for both intellectual property and electronic design automation licenses as well as for process and metrology tooling to support manufacturing. Lack of available workforce talent and expertise is also a barrier, as is lack of access to existing fabrication facilities for prototyping.

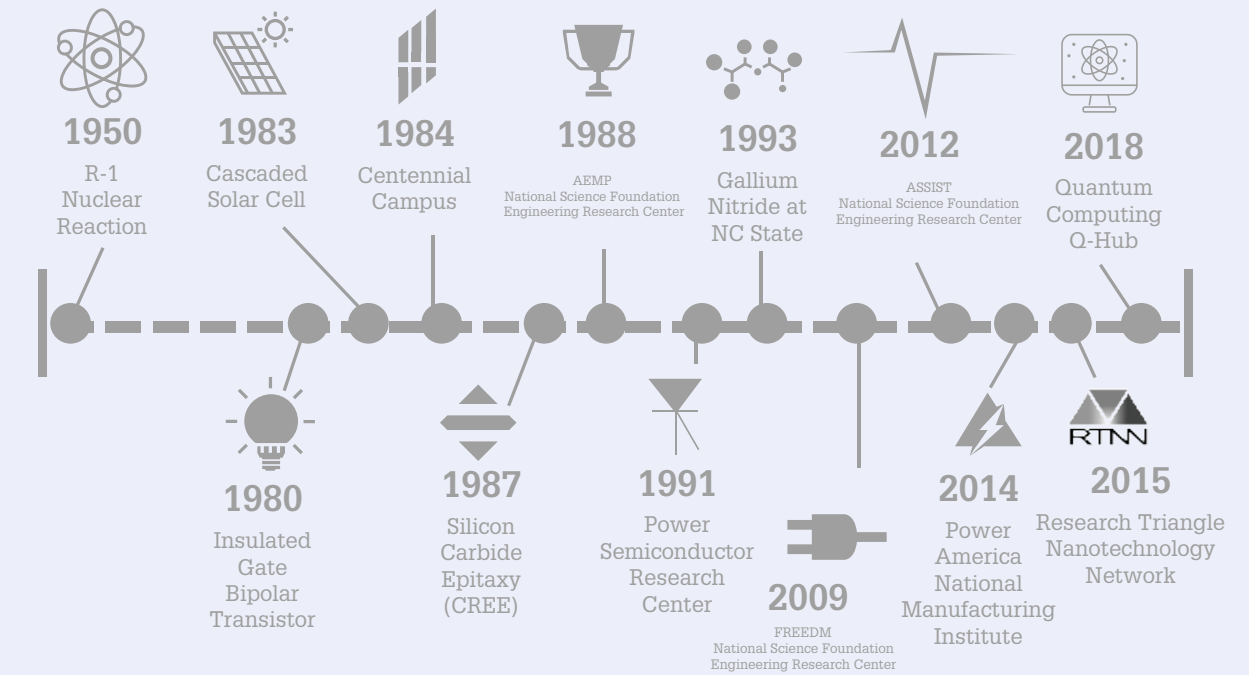
CLAWS operates under a “lab to fab” model, establishing a research foundry on NC State’s campus that will work with

“TOGETHER, WE ARE CREATING A NATIONAL R&D AND PROTOTYPING POWERHOUSE IN THE UNITED STATES...”

REZA GHANDI

NC STATE Engineering

NC State University: Decades of Innovation



industry to make research development kits to accelerate device development and transfer the process to industrial core foundries that have the ability to manufacture the devices in the volumes needed for DoD or civilian applications. This hub and core model helps cross a so-called “valley of death” that prevents many lab technologies from reaching production. CLAWS will also include a strong education and workforce development program that will include undergraduate research, summer programs for high school and community college educators and specialized short courses for the industry workforce.

CLAWS research will include ultrawide bandgap (UWBG) semiconductors such as diamond and gallium oxide, which can operate at even higher voltages. Previous research work in NC State MSE on UWBG devices has led to start-up companies.

General Electric is one of six CLAWS industry partners. Decades of NC State research expertise and the University’s track record of leadership make working with the new center an easy choice.

“GE Aerospace is excited to partner with NC State on the CLAWS hub to develop the next generation of WBG and UWBG devices for DoD and their customers,” said Reza Ghadi, principal engineer at GE Global Research. “Together, we are creating a national R&D and prototyping powerhouse in the United States for wide bandgap and ultrawide bandgap devices to accelerate lab-to-fab transitions for these critical technologies. Both GE and NC State have a long history in this field with complementary areas of



expertise that will strengthen America’s overall competitiveness in semiconductor technology.”

Like all of the new Microelectronics Commons hubs, CLAWS will address the barriers that keep university researchers and startups from taking technology all the way to commercial adoption.

“With CLAWS, we are creating this bridge between research and development and commercialization,” Baliga said. “There’s a need for a place like that.” ■



“It is with a deep amount of gratitude that I want to give back.”

MEG ALDEN

BME alumna combines medicine and entrepreneurship

As an NC State College of Engineering student, **Margaret (Meg) Stokes Alden** '02 knew she wanted to do something that would help people — but it took her a while to decide if she'd be able to make a greater impact in medicine or in engineering.

Part of the first graduating class of the Joint Department of Biomedical Engineering at the University of North Carolina at Chapel Hill and North Carolina State University (BME), Alden was leaning toward engineering during her sophomore year. But by her final semester of college, she decided on medical school.

By 2019, she was able to bring together both as a full-time pediatrician and an entrepreneur. She is the chief medical officer of Momtech, Inc., a startup that specializes in replicating the biomechanical properties of nursing. The company's main product is mōmi, a bottle nipple that mimics the natural nursing properties of breastfeeding to reduce feeding confusion.

“As a student, I wasn't sure that the work I could do as an engineer would be as close to the impact as I wanted to be, so that helped me decide to go into medicine, where I was one-on-one with the patient,” Alden said. “Now I feel like because I've had this opportunity in medicine, I can come back to my engineering ... and feel like I'm having an impact on a larger scale. It's very full circle.”

THE FIRST BME CLASS

When Alden was in high school, she attended an engineering camp at NC State and stayed in Wood Hall, learning about different engineering disciplines. Her mother, **Margaret Allred Williams**, was one of the first women to graduate from NC State with a degree in computer science.

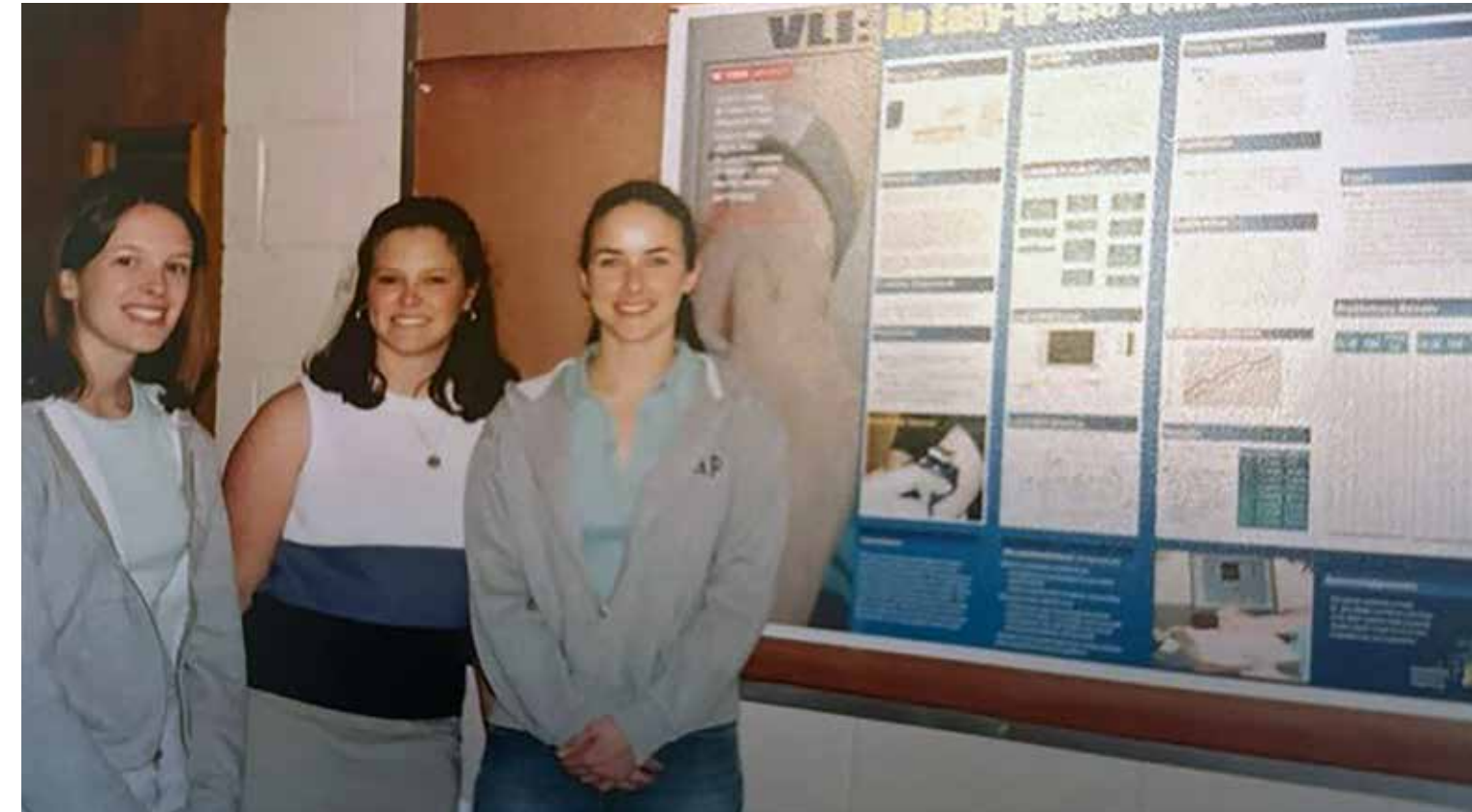
“She graduated in the 70s and had all kinds of great stories about the punch card labs that were in the basement of Nelson Hall,” she said. “She started showing her true red and white once I was there.”

Alden started at NC State as a biological engineering student, and finished with degrees in both biological engineering and biomedical engineering. She and her roommate were often among just a few other women in their engineering classes, and she remembers her mother advised her from her own experiences to keep her head down, go to office hours and not get distracted. Her senior year, she and two female classmates won the BME senior design competition.

During her years at NC State, she was close with her BME classmates as they navigated being the first students to go through the program. “Everyone went in very different directions from my class,” she said.

After graduation, she spent one year working at Olive Garden and as a bank teller at BB&T in Raleigh, North Carolina, while studying for the MCAT and completing her medical school requirements. She then enrolled at Wake Forest University School of Medicine and has lived in Winston-Salem, North Carolina, ever since.

“I originally thought I was going to do orthopedics with my engineering background, but I just really fell in love with pediatrics,” she said. “There's a lot of math and engineering, which is sort of a geeky reason to love it. But it's very different medicine because it really depends on the size of the child and there's a lot of special consideration to be made based on how big they are.”



MEG ALDEN, CENTER, AND HER TEAM WON THE BME SENIOR DESIGN SYMPOSIUM FOR THEIR VEIN FINDER DEVICE.

EMBRACING ENTREPRENEURSHIP

After finishing a five-year tenure in a leadership role at her practice, Alden wanted to do something different. She spoke with one of the eventual co-founders of Momtech, who told her he'd be in touch if he came across something that fit her expertise. A week later, he came to her with the idea for mōmi.

The mōmi nipple mimics the function of the natural nipple: it is soft and stretchy, and it has a single duct that babies can compress with their tongue to regulate the flow, rather than having to cover the opening with their tongue on other types of bottles.

“The majority of moms have to incorporate breast and bottle feeding together when they are feeding their baby. Introducing a bottle can be a stressful process as there is often a risk of choking, nipple confusion and even nursing strikes, when the baby will not go back to breastfeeding,” Alden explained. “The mōmi bottle will not disrupt breastfeeding. It allows the baby to be fed and allows the mom to settle into her nursing journey and for them to meet back together without having a disruption.”

Managing her full-time role as a pediatrician and as a CMO requires blocking time and multitasking. But she

is excited for next steps. Momtech plans to release a breast pump soon.

GIVING BACK AND SUPPORTING WOMEN

Last year, Alden signed NC State Innovation and Entrepreneurship's Founders' Pledge, which demonstrates a commitment to giving back to the University in the future.

“I credit a lot of what I have achieved and hope to achieve to the education I got at NC State, the people I met while I was there and also the foundation that it gave my mother,” she said. “It is with a deep amount of gratitude that I want to give back.”

Having benefited from scholarships, Alden is a proponent of improving access to education and of women working together in engineering and entrepreneurship.

“It can be a very daunting field, but also extremely rewarding,” she said. “And I would encourage women to network amongst themselves and with their peers, and to be unafraid to look less than 100 percent and be willing to accept help from professors and from each other — with the goal of bringing more women along in these fields.” ■

Woolard leaves legacy of service, leadership

Edgar S. Woolard Jr.'s funeral arrangements included a request that, in lieu of flowers, charitable donations be considered for two worthy causes. One was the Sunday Breakfast Mission in Wilmington, Delaware, Woolard's longtime home and headquarters for DuPont, the company that he spent a career with and led for six years. The other cause was NC State University's College of Engineering.

It came as no surprise to those who knew Woolard, a renowned business leader and loyal and involved alumnus of NC State who passed away on Dec. 4, 2023, at his home in Palm Beach Gardens, Florida. He was 89.

Woolard graduated with a bachelor's degree in industrial engineering in 1956. He spent his career at DuPont, rising to the role of chief executive officer and chairman of the company's board from 1989 to 1995. In retirement, he served several companies as a board member and chairman including Apple, IBM and Citigroup.

Woolard began his contributions to his alma mater in the early 1980s, working as an advisor to NC State chancellors, serving on the University's Board of Trustees and helping lead two University capital campaigns.

Louis Martin-Vega, a former dean of the College of Engineering, said that Woolard was a very involved alumnus who was always advocating for the College. The two first met at an alumni event soon after Martin-Vega started as dean in 2006.

"He was very proud of being an alum," Martin-Vega said. "He was always there. He was very encouraging. He liked that we had high aspirations."

In 2018, Woolard and fellow NC State industrial engineering alumnus Edward P. Fitts Jr. (1961) made a combined \$25 million donation that helped to fund a new engineering building on Centennial Campus. Named Fitts-Woolard Hall, the building is home to the College of Engineering's administration and the Department of Civil, Construction, and Environmental Engineering and Edward P. Fitts Department of Industrial and Systems Engineering (ISE). That donation represented a key step toward moving the entire College to Centennial. Fitts' and Woolard's gift represents the largest gift given for a campus building naming in NC State's history.

HAPPY TO SERVE

Fitts met Woolard when he saw an opportunity to invest in and contribute to strengthening the pair's home department. Fitts sought out other alumni to join him, including Woolard, and the two developed a strong friendship through their shared passion for the ISE department.

Fitts knew Woolard by reputation and, since they both spent winters in Jupiter, Florida, he called Woolard to introduce himself. They met over breakfast and Fitts laid out his vision for the department.

"It was over this conversation that I explained what I was thinking about for NC State ISE, and would he consider serving on the five-person committee we were developing," Fitts remembers. "He said, 'Tell me more,' and 'Let me think about it.' Within the next few days, he called and said yes, he'd be happy to serve. What a compliment."

The two became close friends and co-advisors who worked together on several efforts that benefited NC State, culminating with their gift that named the new building. Along the way, their home department was named the Edward P. Fitts Department of Industrial and Systems Engineering to honor Fitts' support.

Fitts remembered his friend as a thoughtful, creative, intelligent and compassionate leader who, above all, was dedicated to his wife, Peggy, and their children. Woolard retired early from DuPont to spend time with his family and, he said, to repay Peggy for all the years spent supporting him and his business career.

"Ed Woolard was a very special, unique, caring person who touched so many lives during his

exemplary time on earth," Fitts said. "He shall be missed by everyone who knew him."

Paul Cohen got to know Woolard well when Cohen served as department head in ISE. Cohen is now an emeritus faculty member in the department.

He said that, beyond his financial support, Woolard was also very generous with his time. He was always willing, Cohen said, to talk through issues that he was having as department head or to connect him with important people.

Cohen described Woolard as someone who was easy to get along with and was straightforward with his approach and could always ask just the right questions.

"It didn't take very long for him to get to the heart of the matter," Cohen said.

Woolard's most notable board service may have been with Apple, where he served as chairman during the company's leanest years in the mid-1990s. The company found success and a cult following for its Macintosh computer but went into a long decline when Steve Jobs was fired as chairman in 1985. Woolard convinced Jobs to return to the company and the two worked closely together to bring Apple back to success.

"I was extremely pleased and proud to have helped Steve Jobs build a strong board, talented management team and a great company," Woolard said in an NC State Engineering magazine story in 2016. "It was exciting, terrific fun and resulted in an outstanding business success story."

ALWAYS A WOLFPACKER

Woolard is the recipient of NC State's Industrial and Systems Engineering Distinguished Alumni Award (2006), Watauga Medal (2001), Meritorious Service Alumnus Award (1998), College Alumnus of the Year Award (1988) and Distinguished Engineering Alumni Award (1988).

He was as supportive of NC State athletics as he was of engineering and was a die-hard Wolfpacker.

Woolard's other philanthropic efforts included forming the Woolard Family Foundation and actively supporting many causes including Sunday Breakfast Mission, Delaware Art Museum, International Tennis Hall of Fame, Christian Outreach Efforts, Autism Delaware, Meals on Wheels and Christ Church Christiana Hundred. ■

EDGAR S. WOOLARD JR.





Three honored with Distinguished Engineering Alumni Award

WINNERS OF THE DISTINGUISHED ENGINEERING ALUMNUS AWARD FOR 2023 WITH DEAN JIM PFAENDTNER, FROM LEFT: PFAENDTNER, ADMIRAL DARYL L. CAUDLE, DEBORAH BELL YOUNG AND ROBERT E. TROXLER.

Three College of Engineering graduates — **Admiral Daryl L. Caudle**, **Robert E. Troxler** and **Deborah Bell Young** — received the Distinguished Engineering Alumni (DEA) Award during a dinner and ceremony on campus on Oct. 25, 2023, as part of Red and White Week.

The award was established by the College’s faculty in 1966 and is the highest honor bestowed upon alumni.

Caudle earned a bachelor’s degree in chemical engineering from NC State University in 1985. He also holds a master’s degree in physics from the Naval Postgraduate School, a master’s degree in engineering management from Old Dominion University and a doctor of management in organizational leadership from the University of Phoenix School of Advanced Studies.

Caudle was promoted to Admiral (four-star rank) in 2021, as he assumed command of U.S. Fleet Forces Command. In this role, he manages a \$16 billion budget and has responsibility for over 125,000 sailors and civilians, 125 ships and submarines, and 1,000 aircraft. Prior to this, he served as commander, Submarine Forces; commander, Submarine Force Atlantic; commander, Task Force (CTF) 114; and commander, Allied Submarine Command, among other roles.

Caudle is a loyal and consistent donor to both the College of Engineering and his home department.

Troxler earned a bachelor’s degree in electrical engineering from NC State in 1983. He earned master’s and doctoral degrees, also in electrical engineering, from the Georgia Institute of Technology in 1986 and 1992, respectively. His graduate research was supported by a NASA Graduate Student Researchers Project Fellowship through Marshall Space Flight Center in Huntsville, Alabama.

He is the director of advanced technologies at Troxler Electronic Laboratories in Research Triangle Park. His work with the company concentrates on electromagnetics, optics, sensor design, acoustics and applications of nuclear physics toward instrumented devices typically used in the fields of geotechnical and civil engineering. He holds over 80 U.S. and international patents.

Troxler has been an active volunteer for and philanthropic supporter of the College of Engineering and the Department of Electrical and Computer Engineering (ECE). In 2016, Troxler built on a legacy established by his father when he named the William F. Troxler MakerSpace in ECE.

Young earned a bachelor’s degree in civil engineering in 1977, becoming the first Black woman to earn a civil engineering B.S. from NC State. She then went on to become the first Black woman to earn a master’s degree in civil engineering-environmental engineering from the University of Pittsburgh. She also earned an MBA at Duke University.

Young began her career with a consulting firm. In 1980, she joined Honeywell International (Allied Signal, Inc.) in Colonial Heights, Virginia. Over a career of nearly 35 years, she held several leadership roles including director of Health, Safety and Environmental for several divisions.

Young has completed two terms as a member of the NC State Engineering Foundation Board of Directors and is the first Black person/Black woman to have served as its president. She is a consistent supporter of the Department of Civil, Construction, and Environmental Engineering; the College; and NC State. ■



Record-setting Day of Giving ensures the longevity of COE

It was the kind of excitement the Wolfpack was used to in March. Buzzer beaters, upsets and runaway wins were the norm.

By 9 p.m. on March 20, every alumnus, faculty and staff member, student and friend making a gift to the College of Engineering on Day of Giving set a new record. Previously, the highest single day total for gifts raised was 1,725. By 11 p.m., the College was just 50 gifts shy of meeting its highest goal of 2,000 gifts. Within 30 minutes, the COE community surpassed that goal, culminating in 2,172 gifts by midnight.

This year’s success will result in tangible benefits for the College’s students, faculty members and staff members. For example, the Department of Computer Science will use the gifts to continue recruiting new faculty members and helping them start their lives and careers in Raleigh, North Carolina. The Edward P. Fitts Department of Industrial and Systems Engineering will purchase student memberships to the Institute of Industrial and Systems Engineers, creating opportunities for students to apply for more scholarships and make important industry connections.

Jim Pfaendtner, Louis Martin-Vega Dean of Engineering, celebrated the day with Mr. and Ms. Wuf

around Centennial Campus. They visited students at popular Centennial hangout spaces — the On the Oval Food Hall and the Corner — and dropped by some of the industry partners’ on-campus offices to say hello to alumni and thank them for their generosity.

Alumni **Rhett McLaughlin** and **Link Neal**, best known as the duo behind the YouTube channel Good Mythical Morning, established the Rhett & Link Engineering Innovation Scholarship Fund for one third- or fourth-year student. This full-ride scholarship will allow one student the freedom to fearlessly pursue mythicity, the trait integral to their brand. They describe mythicity as “a desire to learn and do new things, an appreciation of originality and a tendency to not take yourself too seriously.”

This gift from the College’s most internet-famous alumni helped spur on the remarkable day, as did two anonymous major gifts of \$1.25 million and \$2 million each. Overall, the College raised \$4,841,507.

Alumni banded together to win three hourly giving challenges for the College and unlocked every departmental giving challenge, resulting in an additional \$77,814 raised. The Department of Civil, Construction, and Environmental Engineering won the competition among departments, receiving 353 gifts. ■

THANK YOU TO OUR MAJOR DONORS

John and Happy Amein

Michael Creed

Dick and Wanda Franklin

Candance Gingles

Basil Hassan

Jake and Jennifer Hooks

Yan Kolbas

Rhett McLaughlin and Link Neal

Ioannis Papapanagiotou

Don and Joan Stancil

David L. Stout, Jr.

The numbers listed in this article are the official numbers. They are different from what was reported on the Day of Giving website, which was not updated after Day of Giving officially ended at 11:59 p.m. on March 20.

ANNUAL GIVING

ENGINEERING FOUNDATION

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

Gifts from our generous alumni like you keep our College of Engineering moving forward by supporting our growing faculty and student body. Your donation is a great way to make sure the opportunity that meant so much to you is there for students today.

HOW TO GIVE

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GIVE TO THE ENGINEERING LEADERSHIP FUND

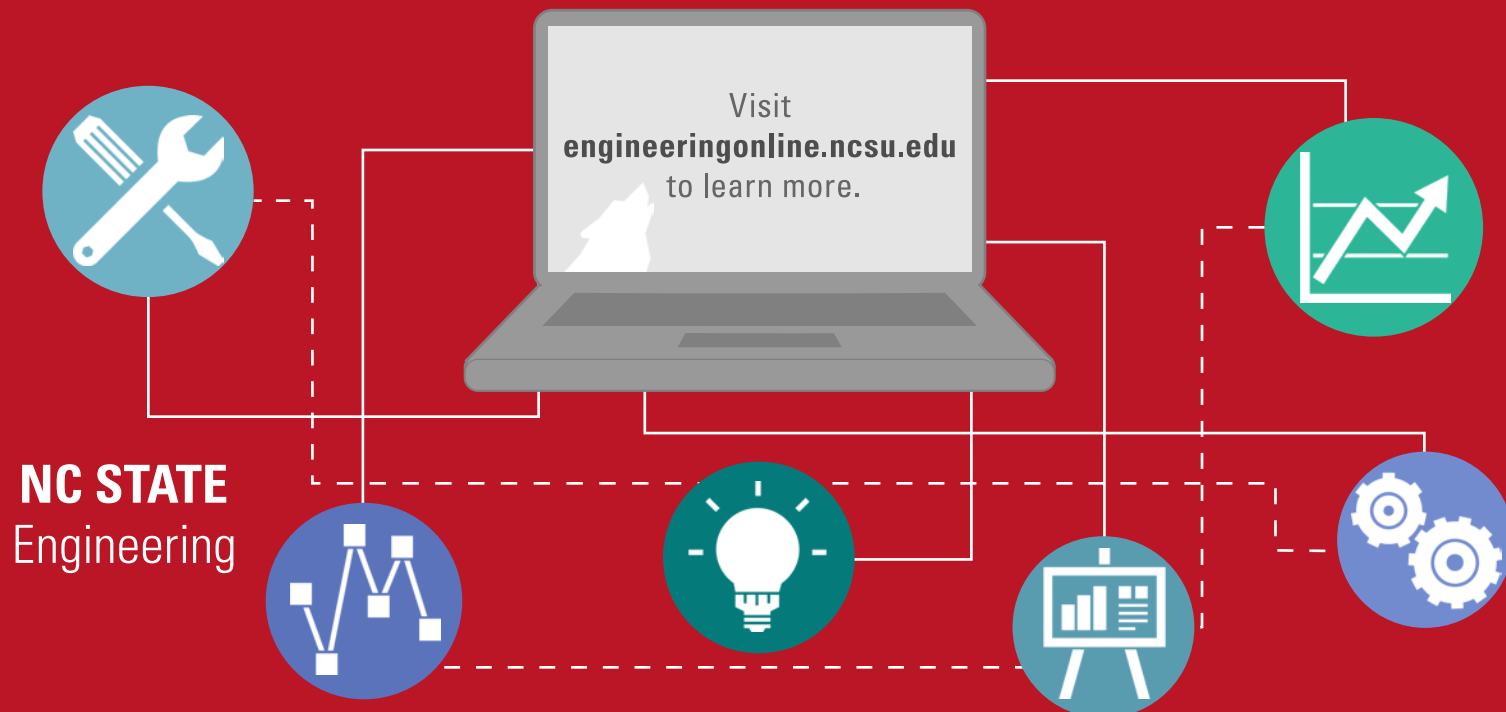
Gifts made to the Engineering Leadership Fund are used at the discretion of the dean and support College-level initiatives.

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. go.ncsu.edu/engineering-deanscircle

If you have already made your annual 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 Hannah Kunkel at heallen3@ncsu.edu.

Take the next step in your career with **19 online graduate degrees** available from NC State's **College of Engineering**.



Call Linda Krute, director of distance engineering education programs, at 919.515.5440 for more information.

Crowdfunding campaigns support COE academic programs

Over the last year, NC State College of Engineering (COE) staff and faculty members have led three successful crowdfunding campaigns for student-centered programs in the COE Office of Academic Affairs.

These campaigns were selected by NC State Crowdfunding, which manages six to seven campaigns each semester. NC State Crowdfunding connects alumni, friends, family and community members with causes they're passionate about and helps students and faculty and staff members bring their ideas to life.

For more information about future campaigns and how to support them, please contact **Molly Andrews**, assistant director of philanthropy, at meandre2@ncsu.edu.

ALTERNATIVE SERVICE BREAK IN RWANDA

Launched during the fall 2023 semester, this campaign raised double its fundraising goal for the annual spring Alternative Service Break (ASB) trip to Rwanda led by the Women and Minority Engineering Programs. The campaign's funds covered costs for students to participate in cultural experiences during their trip.

Danielle Lewis, who graduated in May 2024 with a B.S. in industrial and systems engineering, was a student team leader for this year's trip after attending in 2023.

"If it weren't for ASB, I would not have the same awe and excitement for learning about and immersing myself in new cultures," she said. "I believe that incorporating and understanding international perspectives yields creative and remarkable results, which is an invaluable quality I want to possess as an emerging engineer."

THE ENGINEERING PLACE

The Engineering Place (TEP) met its first crowdfunding campaign goal in fall 2023 to support its engineering outreach programs to engage students in engineering problem-solving and careers with

learning experiences hosted at schools and on Centennial Campus. The campaign funded TEP's travel to K-12 schools and provided resources for hands-on, take-home engineering projects that encourage students to continue the engineering design process, sharing what they are learning with their families.

"Their excitement as they engage in hands-on projects while creatively solving engineering challenges is contagious, and their enthusiasm extends the impact of the activity even further as they develop their STEM identity," said **Leah Bug**, director of TEP. "I believe crowdfunding worked because our community really cares about investing in the future generation and increasing their understanding of engineering."

SUMMER RESEARCH EXPERIENCES FOR INCOMING GRAND CHALLENGES SCHOLARS

Through the Grand Challenges Scholars Program (GCSP) Undergraduate Research Experience, students participate in mentored research. During the 10-week summer program, they are paid a stipend, which is funded by the engineering enhancement fee. But because incoming first-year and transfer students have not yet paid the fee, they are not eligible for a stipend.

Olgha Qaqish, director of the GCSP, decided to initiate a crowdfunding campaign that ran during the spring semester to support incoming students interested in summer research.

"My idea is that during the fifth week, incoming students come in, and students already in the program have gained five weeks of research experience and can be peer mentors," she said. "For the next five weeks, they can work together in a community of practice." ■

BY THE NUMBERS:



Support Students in Learning International Perspectives, Rwanda ASB Trip
43 donors
\$10,050

The Engineering Place
45 donors
\$5,201

Support Engineering Students in Research Around Grand Challenges
69 donors
\$5,323

Computer Science



Computer science alumnus **Drew Banks** is giving back in a big way

Drew Banks wants to build a culture of philanthropy.

Banks, who graduated from NC State University in 1984 with a bachelor's degree in computer science, donates each year to the College of Engineering.

Education is a priority for him and his husband, Nick Rubashkin, and both of them have put a lot of thought into how to implement that in their giving.

"For both of us, we're both from lower middle class backgrounds," Banks said of himself and Rubashkin. "We're both the kids that sort of jumped a class through having educational opportunities."

Banks' most recent gift to NC State is designated for the Women and Minority Engineering Programs, The Engineering Place and scholarship support for students in the College of Engineering.

"Education is important to both of us, and we have been trying our entire relationship to determine what that means in terms of philanthropy," he said. "We started when my husband's father was a grade school

teacher and one thing we started was a tiny little scholarship at the school. That process helped me realize how much I wanted to craft our own goals and embed those in how we gave back."

Banks and his partner worked for a year to get the scholarship in place. After that was finished, they knew they wanted to do more.

"We've looked at all of our schools, including the Massachusetts Institute of Technology and Stanford, and considered which ones could make the biggest impact," he said. "Because of the cultural diversity of NC State, we thought it could be NC State, but it wasn't until I started conversing with **Anna [Knight]**, director of philanthropy and realized that NC State can craft our gift in the way we wanted, which is focused on minority outreach."

Banks is the co-founder of Pie Digital and an expert in visual communications. He successfully worked to globally expand two European start-ups — Prezi and

the statistics department, where he ran statistical analyses on soil content.

"I think it was my second year when I decided to stay in Raleigh and find a summer job, and my boss recommended I work for a small stats company started by a former NC State stats professor," Banks said. "That's how I was first introduced to **Jim Goodnight**."

Goodnight, founder of SAS Institute and philanthropist, funds the Goodnight Scholars Program. The program invites qualifying North Carolina residents who meet the family income and academic program requirement to apply to the program every spring before awarding a select group of students tuition assistance comparable to a full academic scholarship.

This is the kind of philanthropy that inspires Banks.

In addition to education, Banks is also interested in politics and women's rights. The second is especially personal to Banks and Rubashkin, as Rubashkin is an associate professor of obstetrics and gynecology at the University of California, San Francisco.

"That's always been a third component of our philanthropy," he said. "Making sure that women not only have access to reproductive services, but also that when they choose to give birth, that their wishes are respected."

Education, though, will always be a priority, and Banks is grateful he can make a difference through

NC State. He said that if he were to speak with someone thinking about donating to NC State, he would definitely recommend it if, one, they cared deeply about education and, two, they wanted to work with someone who would help them create gifts that they can customize based on their priorities.

"For me, building a culture of philanthropy means doing exactly what NC State is doing," he said. "Understanding that everyone's philanthropic goals differ and doing your best to match the philanthropic goals of your donors with your financial needs, and doing it in a scalable way so that you can fund as much as possible with ongoing philanthropic efforts."

"NC State has outreach to STEM schools across the state, regardless of their funding levels or the percentage of their students that go on to higher education," he added. "That is really important to us." ■

"For me, building a culture of philanthropy means doing exactly what NC State is doing."

DREW BANKS

YOUNG ALUMNI

SHARE CAREER PATHWAYS THROUGH SURVEY



From the NC State Engineering Foundation Board of Directors

FROM LEFT TO RIGHT, BOBBY BARNES, RYAN BURKETT, BETH SMITH, PAMELA TOWNSEND, AND RADHIKA VENKATRAMAN.

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 works with the college advancement staff and the dean of engineering to set the Foundation's agenda.

years while maintaining quality, retaining (and expanding) staff, adding new facilities and sustaining market-leading research. This, in a nutshell, is the challenge facing our new College of Engineering dean, Jim Pfaendtner. The NC State Engineering Foundation Board is focused on helping the dean in his stated goal of "doing expansion right."

So, what does "doing expansion right" mean from our perspective? It means finding ways to expand the number of engineering alumni who annually support the College. It means being effective advocates for the College in professional and civic settings, creating and sustaining relationships that benefit both our alumni and the College. The Engineering Foundation Board members will also set the example by supporting the Dean's Leadership Fund and other forms of philanthropy.

The 40 percent expansion goal, made possible by critical support from the North Carolina General Assembly, is recognition of the economic engine that engineers represent, but it is also recognition of the quality and caliber of engineers that NC State produces. Being an NC State engineering graduate was a "door opener" during my career. And like other board members, I see this as an opportunity to give back and ensure this expansion is a success. I hope you share our pride in NC State Engineering and will consider making a gift to the College at give.ncsu.edu/engineering and/or attending a local gathering when the dean comes to your area. Together, we can lead the way into the next 100 years of NC State Engineering.

— **Scott Stabler**, BSME '82, President, NC State Engineering Foundation Board of Directors ■

BOARD PRESIDENT SHARES PERSPECTIVE ON BOARD'S ROLE IN ENGINEERING EXPANSION

Imagine stepping into a new job with the expectation of growing the enterprise by 40 percent over the next few

MEMBER UPDATES

The board of directors has added five new members:

- **Bobby Barnes**
- **Ryan Burkett**
- **Beth Smith**
- **Pamela Townsend** (returning for a second term)
- **Radhika Venkatraman**

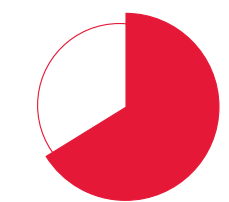
The following members have completed their terms:

- **Bruce Baldwin**
- **Mike Creed**
- **Rashida Hodge**
- **Sam McCachern**
- **V. Nelson Peeler**

GET INVOLVED

To learn more about board service for the College of Engineering or to nominate someone, contact **Griffin Lamb** at grlamb@ncsu.edu.

The College of Engineering's Young Alumni Advisory Board (YAAB) sent a survey to U.S.-based young alumni who graduated between 2008 and 2018 asking about their internship and work experience gained during their degrees, their career experiences post-graduation and engagement with the College of Engineering. Alumni who graduated after 2018 were excluded from the survey because they recently received a similar survey from NC State University. Below is a snapshot of some of the respondents' survey results.



64% interned while students at NC State.



35% were employed full-time by a company they interned with as students, currently or at one point in their careers.



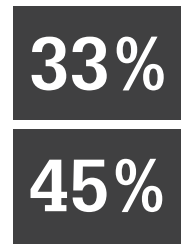
66% of respondents who received their undergraduate degree from NC State have not attended graduate school.



Hybrid work and flex hours are most important in terms of where, when and how often they work.

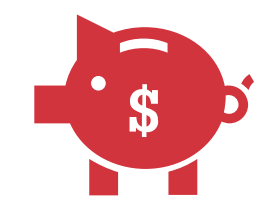


55% of respondents live outside of North Carolina, with 18% of those who live outside of NC reporting California as their current location.

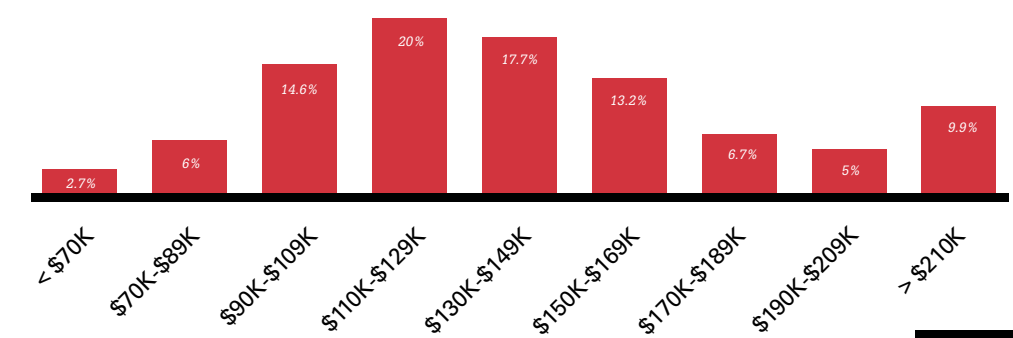


33% have made a gift to the College of Engineering
45% of those who have given said they donated on Day of Giving

- Overall, young alumni indicated good work-life balance and satisfaction in their jobs.
- **85%** of respondents said they were somewhat satisfied or extremely satisfied in their current roles.
- **50%** of respondents work 40-44 hours per week.



43% reported a starting base salary of \$50-69K. But their current base salaries are higher.



Current Base Salary Ranges
(4.2% selected prefer not to answer)

Please contact Molly Andrews, Assistant Director of Philanthropy, at meandre2@ncsu.edu for more information.

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 aeoperations.ofa.ncsu.edu/nc-state-engineering-foundation-inc.

Ways to give to the NC State Engineering Foundation

- **ANNUAL GIVING:** Gifts of more than \$1,000 to any of our college enhancement funds make you a part of the Dean's Circle. Annual gifts from alumni are measured as participation rate and directly affect national rankings. These gifts help faculty members and leaders meet their most urgent needs.
- **ENDOWMENT:** An endowment is a fund held in perpetuity that benefits a specific purpose. Most endowments held by the Engineering Foundation are either for scholarships or endowed faculty positions.
- **PLANNED GIVING:** Planned gifts can be as simple as a bequest (including us in your estate plans). Other options include trust vehicles and annuities, which have the potential to provide an income stream and significant tax benefits.
- **CAPITAL GIFTS:** These gifts go toward brick-and-mortar projects. Donors are given naming opportunities within a project.
- **IN-KIND GIFTS:** These are gifts of goods or services to the College at a discount or no cost.
- **SPECIAL GIFTS:** These gifts are directed to unique projects, centers or initiatives and approved by the dean. ■

GG WITH DEAN PFAENDTNER



JAIR VALENZUELA, LEFT, PLAYS SUPER SMASH BROTHERS ULTIMATE AGAINST DEAN JIM PFAENDTNER AND KALEB DECKER IN THE NEW ESPORTS LAB.

only to explore the space because it's new and fresh, and I think it's a really great way to bring community together, but also to rub shoulders with the dean and say hi and kind of destroy him in *Super Smash Bros*," he said.

Emma Grace Johnson, a biomedical engineering student who played as Baby Toad in *Mario Kart*, felt the pressure to play well due to the livestream.

"The dean was super interactive, so it was fun playing with him," she said.

Prior to heading up to the Esports Lab, Pfaendtner spoke to students about his experience with depression and encouraged students to reach out to him or other leaders in the College at any time.

"... Know that you're not alone," he said. "You have a dean who understands mental illness and cares deeply about your success and wellbeing. Among the many resources we want to provide you with here in the College are authentic examples of professional engineers who are not just surviving but thriving with mental illness so that if you or someone you know is struggling with those symptoms, just know that it's available for you, too."

The Wellness Day also included yard games and Cocoa & Crafts, an ODEI event for students to connect over hot drinks and a craft. For the Lunar New Year, students made their own fortune cookies out of paper, writing fortunes like "Everything happens for good."

"It's been a tough semester," said **Pankaj Mancharlal Thakur**, a graduate student in the Department of Computer Science. "So, I was focusing on not doing anything ... to just have this day to relax and enjoy." ■

For many College of Engineering (COE) students, playing video games is a popular way to unwind. It's also a favorite pastime of **Jim Pfaendtner**, Louis Martin-Vega Dean of Engineering.

During the spring semester's Wellness Day on Feb. 13, students took on the dean in *Mario Kart* and *Super Smash Brothers Ultimate* through an event put on by the COE Office for Diversity, Equity and Inclusion (ODEI). NC State has scheduled a Wellness Day each semester to encourage students to unplug from academics.

There were GGs (gaming lingo for "good game") all around as the event was livestreamed from the new Esports Lab in the James B. Hunt Jr. Library. But there were a few hiccups when changing games and switching players.

"Once he figured out what character he was, yes, he was actually pretty good," joked **Kaleb Decker**, a Ph.D. student in the Department of Chemical and Biomolecular Engineering, after playing two rounds of *Super Smash Brothers Ultimate* against the dean.

"And I take full responsibility for that," laughed **Jair Valenzuela**, Ph.D. student in the Joint Department of Biomedical Engineering at NC State University and the University of North Carolina at Chapel Hill. "I could've sworn he was player four, and he was actually player two, and he was very confused. I'm so sorry Dean Pfaendtner. It's on the record."

Decker has known Pfaendtner since they were both at the University of Washington.

"I thought it'd be a cool chance not

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SAVE THE DATE

RED AND WHITE WEEK is Oct. 27 to Nov. 3.

Reconnect with the Pack and all the things you love about NC State.
Stay tuned for the College of Engineering's Red and White Week plans for 2024.

