

MAGAZINE SPRING / SUMMER 2020

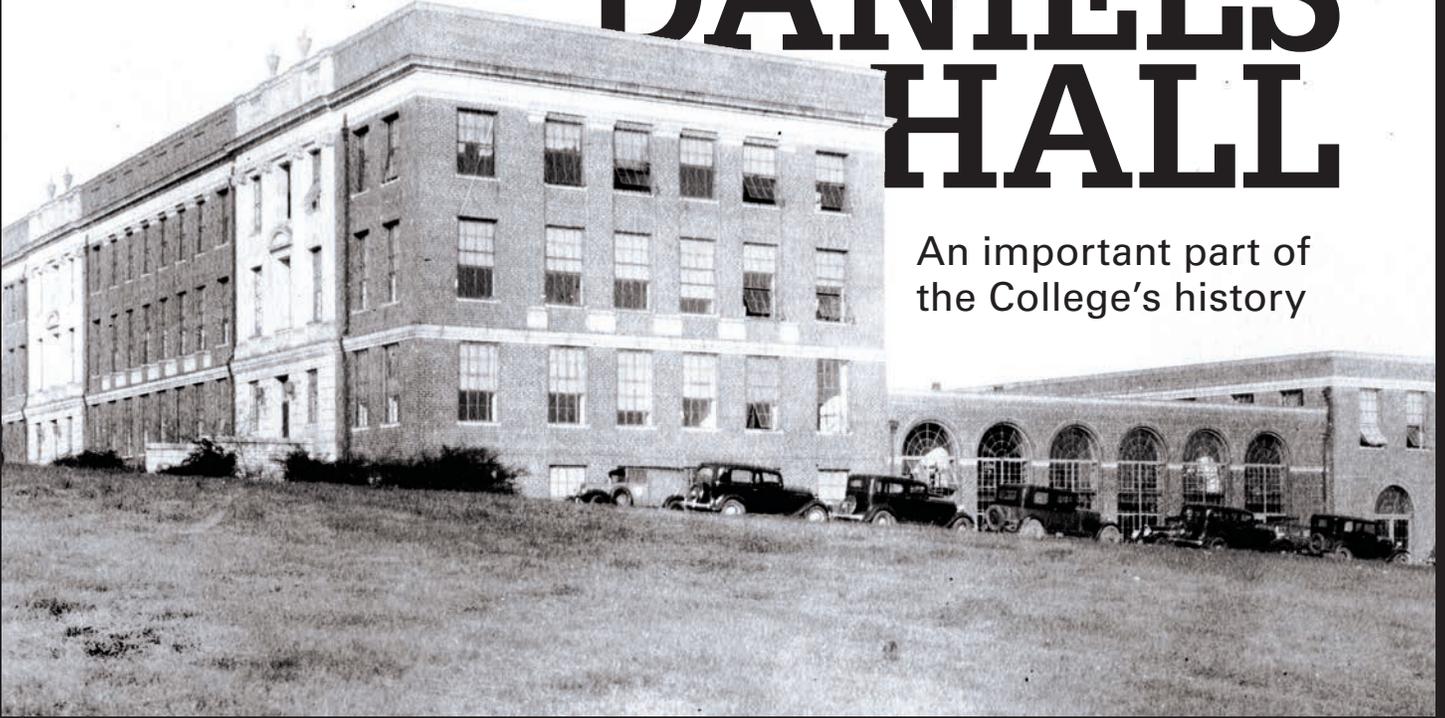


## OUT OF THIS WORLD

Engineering alumna Christina Koch completes a historic space mission

# DANIELS HALL

An important part of  
the College's history



There are nine academic departments within the College (and three affiliated engineering departments within other NC State colleges). Of those nine, four have called Daniels Hall home.

The Edward P. Fitts Department of Industrial and Systems Engineering (ISE) is the current occupant of the building at the corner of Katharine Stinson and Lampe Drives on NC State's North Campus. Over the years, the building has also been home to civil engineering, electrical engineering and computer science.

ISE will move out later this year and set up shop on NC State's Centennial Campus in the new Fitts-Woolard Hall, along with the Department of Civil, Construction, and Environmental Engineering (CCEE) and the dean of engineering's administrative offices.

The building opened in 1926 as the home of electrical engineering and physics and didn't receive its current

name until 1938. This photo, taken around 1934, shows quite a different version of Daniels than many are used to.

The two-story east wing shown in the photo opened in 1928 and was connected to the larger four-story structure by a single-story connector. Two floors were added to the east wing in 1953 to create the combined four-story structure that you see today.

Known for a long time simply as the Civil Engineering Building, the east wing first housed that department plus architectural engineering and the Engineering Experiment Station, established in 1923 as a research extension agency to address engineering issues of local, state and regional concern.

In 1956, the east wing was named for Carroll Lamb Mann, who served as head of the civil engineering department from 1916 to 1948. The name followed the

department to a new building in 1963, when it moved into its current home across Stinson Drive. "New" Mann Hall is still CCEE's home and will be until the move to Centennial Campus this summer.

Daniels Hall is named after Josephus Daniels (1862-1948), editor of the Raleigh News and Observer, a Secretary of the Navy and a U.S. ambassador to Mexico. Daniels Middle School on Oberlin Road in Raleigh, just a stone's throw from the NC State campus, also bears his name. Daniels was actively involved with the founding of NC State (the North Carolina College of Agriculture and Mechanic Arts to start with) as a member of the Watauga Club, and served as a trustee who participated in nearly all the public functions of the institution.

On **page 32**, learn more about Fitts-Woolard Hall, and how you can leave an indelible mark on NC State by supporting construction of this important facility. ■

## College continues to climb in *U.S. News* graduate rankings

The College is continuing its rise in the *U.S. News & World Report* rankings of the top graduate programs in engineering.

The 2020 report shows NC State's College of Engineering ranked 24<sup>th</sup> for the third straight year, but the College moved up from 12<sup>th</sup> to 11<sup>th</sup> among public institutions.

The College tied at 24<sup>th</sup> with the University of Wisconsin-Madison and the University of Washington.

The *U.S. News* rankings of graduate programs are released annually in March with updated grades for both colleges and departments. The rankings are one benchmark of success in academia.

The College's ranking of 24<sup>th</sup> nationally in 2018, 2019 and 2020 marks its highest spot in more than 15 years and is part of sustained growth in rankings, enrollment and research expenditures for NC State Engineering.

The College has finished in the top 10 nationally in research expenditures two years in a row, according to figures from the American Society for Engineering Education (ASEE), and is in the top 20 nationally in the number of annual bachelor's, master's and Ph.D. graduates in engineering, ASEE said.

In *U.S. News* rankings of engineering specialties at the graduate level, academic departments at NC State within the College of Engineering and in other colleges placed in the top 20 nationally in agricultural, industrial, materials and nuclear engineering.

The College also did well in *U.S. News* rankings of online graduate engineering programs, which were released for 2020 in January.

NC State's Engineering Online ranked seventh nationally on the list of Best Online Engineering Programs and 15<sup>th</sup> on the list of Best Computer Information Technology Programs. In rankings of online engineering specialties, the College landed in the top 10 in civil, mechanical, electrical and industrial engineering.

The online graduate engineering program was also ranked sixth on a list of Best Online Graduate Engineering Programs for Veterans. ■



Like all of you, we find ourselves in a new world this spring, trying to adjust to the reality of life during the COVID-19 pandemic in the United States. During these very difficult times please be assured that the number one priority of NC State and our College is first and foremost the safety and health of our students, faculty and staff as well as the academic, professional and personal success of our undergraduate and graduate students. That's why NC State has undertaken a number of measures with the well-being of the University community in mind. While the landscape is changing daily, as of this writing on March 23, 2020, NC State is functioning with minimal on-campus operations that include moving all instruction to fully online courses and limiting on-campus activities to only core operational functions.

In addition to elaborating more on these measures, our feature story in this issue will also highlight examples of the outstanding work that our faculty, students, and staff are doing in response to the urgent needs created by this pandemic. These efforts include the donation of needed protective materials by our Biomanufacturing Training and Education Center (BTEC) and Department of Materials Science and Engineering; the implementation of our 3D or additive manufacturing capabilities for the production of alternate materials, medical masks and related equipment; and various other efforts to help meet the rising and urgent demand for materials to protect our first responder health care professionals in North Carolina and nationwide.

The reputation our College has achieved as one of the leading and most preeminent Colleges of Engineering in our nation has been built, in large part, through our nationally and internationally recognized research, which has been marked more and more by interdisciplinary collaboration around big ideas. The complex problems our world faces in the 21<sup>st</sup> century require it. From improving the healthcare supply chain and harnessing the power of data to engineering the production of new medicines, our faculty, students and alumni are leaders in addressing major societal needs and challenges. I am confident that these efforts are also playing an important role in the development of the technologies and solutions needed to help the fight and ultimately conquer pandemics like the one we are currently living through.

While none of us really know how long this COVID-19 situation will persist, we are confident that it will be overcome and that we will all emerge wiser and more prepared for any future experience. This is neither the first time, nor will it be the last time, that the resilience of our state and nation will be tested.

I have never been prouder to be a part of NC State and our College of Engineering and I can promise you that we will always be up to addressing this challenge in ways that will make all of our alumni and friends truly proud.

Thank you again, more than ever, for the outstanding support you continue to provide "your" College of Engineering and I very much look forward to the moment when we can welcome you back to campus to thank you again in a more personal way.

Sincerely,

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

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Dr. Louis A. Martin-Vega

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## FEATURES

### 16 ENGINEERING ON THE FRONT LINES

The College is responding to the COVID-19 outbreak, moving to online instruction and working on solutions.

### 18 A SMARTER COLLAR

Wearable data collection systems being developed in the College are empowering guide dog trainers and making a costly, time-consuming process more efficient.

### 24 MATERIAL WORLD

The Data-Enabled Science of Engineering and Atomic Structure (SEAS) traineeship program is creating a new generation of data-driven scientists that will help develop smart materials.

### 28 CHECK-UP

Platforms developed in the Center for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST) allow for a wide range of health applications.

### 30 SECURE STATE

The Department of Computer Science is ramping up its research and education efforts in the area of cybersecurity to help meet a critical national need.



### ON THE COVER

NC State Engineering alumna Christina Koch took this photo of an NC State banner aboard the International Space Station. Read about the conclusion of Koch's historic mission on page 4.

# Q & A

## QUESTIONS FOR **GARY GILLESKIE**

*Dr. Gary Gilleskie is executive director of the Biomanufacturing Training and Education Center (BTEC), part of the College of Engineering and located on NC State's Centennial Campus.*

### **What is biomanufacturing?**

Biomanufacturing is the production of materials using biological systems. At BTEC, our product focus is biopharmaceuticals, which are medicines manufactured with the help of living organisms rather than by traditional chemical synthesis. Most of the top-selling medicines in the world today are biopharmaceuticals. Humira® is an example — it's an antibody produced in genetically engineered Chinese Hamster Ovary (CHO) cells and used to treat diseases such as arthritis and Crohn's disease. It's the largest-selling drug in the world.

### **What does BTEC do?**

As our name suggests, BTEC focuses on training and education related to biopharmaceutical manufacturing. We offer educational programs for NC State students as well as a very popular short-course program for professionals. We also work closely with industry and academic clients on a variety of biomanufacturing-related projects through our bioprocess and analytical services program. And we have a growing research program, including a number of projects with the National Institute for Innovation in Biopharmaceutical Manufacturing (NIIMBL) and a new program called Accelerated Innovation in Manufacturing Biologics (AIM-Bio) supported by the Novo Nordisk Foundation. These activities support our mission to develop skilled professionals for the biomanufacturing industry and to establish and conduct programs aimed at advancing bioprocessing.

### **What degree programs does BTEC offer for undergraduate and graduate students?**

Undergraduates can earn a minor in biomanufacturing at BTEC. We get students from a variety of departments, including Chemical Engineering, Food Science, Biochemistry, and Industrial and Systems Engineering. BTEC also has two programs that lead to a master's in biomanufacturing. About 350 students take our courses annually. We often hear from our industry partners that our students hit the ground running when they start a job.

### **What about professional development programs for those who are already working in the industry?**

As part of BTEC's industry training program, we offer more than 15 courses on various biomanufacturing topics. About 500 professionals attend our short courses annually. They come from biopharmaceutical manufacturers, vendors who sell equipment to the industry and the U.S. FDA. We also offer customized training, which tailors course content to an organization's needs. What makes our courses unique is their focus on hands-on experience.

### **How big is the biomanufacturing industry in the Research Triangle region and across North Carolina?**

It's large and growing. The NC Biotech Center estimates 5,000 new jobs in biopharmaceuticals will be created in NC in the next five years, which means our

students are in demand. Numerous biopharmaceutical companies located in the Research Triangle produce a variety of biopharmaceuticals including protein therapeutics, vaccines, gene therapies and cell therapies. Recent growth in the number of companies focusing on cell and gene therapies is particularly significant because these therapies hold immense promise for impacting human health.

### **What kinds of services does BTEC offer for corporate clients?**

Broadly speaking, we offer services in biomanufacturing process and technology development and analytical testing. BTEC's scientists and staff have industrial experience with some of the largest biotech companies in the world, and our labs are equipped with \$18 million worth of industry-standard equipment. ■



# Engineering alumna returns to Earth after historic flight

**TO BE HONEST**, it was about the worst thing **Christina Koch** could have said when she first looked out the tiny window of the Russian Soyuz MS-12 spacecraft that was hurtling away from home toward the International Space Station.

“Oh, my goodness ...”

The words had already escaped the three-time NC State graduate’s lips on March 14, 2019, when she realized it might create a bit of concern with her other two commuters, astronauts Aleksey Ovchinin and Nick Hague.

“Everything’s OK,” she assured them. “It’s just Earth.”

After a record-shattering 328 days, 13 hours and 58 minutes on the space station, with 5,248 orbits around the Earth and 139,053,992 miles traveled, Koch returned to her home planet on Feb. 6, a few days after celebrating her 41<sup>st</sup> birthday among the stars. She and her fellow astronauts landed in a remote part of Kazakhstan and returned to Houston’s Johnson Space Center later that same day.

She spent the next three days recovering in quarantine. On Feb. 9, 2020, she received clearance from her athletic trainer to enjoy a day at the beach with her husband, Robert, and their dog, LBD (Little Brown Dog), along with copious amounts

of chips and salsa, the culinary treat she missed the most while setting the record for the longest continuous spaceflight by a female astronaut.

During a media availability a few days later, Koch discussed her experiences, all the effects of spending nearly a year in microgravity some 250 miles above the Earth’s surface and the critical experiments she conducted on behalf of NASA and other scientists back home.

She talked about her training for such a mission, especially the long hours she spent at NC State’s Carmichael Gymnasium on the indoor climbing wall, the baby belay she needed to pursue her dream.

“My time at NC State was one of constant discovery,” Koch, who earned bachelor of science degrees in physics and electrical engineering in 2001 and a master’s degree in electrical engineering in 2002, said. “In particular, the thing that comes to mind is that is where I learned to rock climb and where I started pursuing that as a hobby.

“It turns out that it is a hobby that just lent itself to some of the challenges that I faced in learning to become an astronaut. It taught me to go out and achieve the things you think are achievable, to believe in

to space walking, which Koch did throughout her time at the space station. She not only participated in the first three all-female space walks in the history of human space travel with fellow American astronaut Jessica Meir, she spent 42 hours and 15 minutes total on her six scheduled spacewalks.

“NC State is where I discovered that great hobby of mine, as well as the teamwork that it took to do a lot of the projects that I took on as a physics student and an electrical engineering student,” she said. “Working together on a team of people to achieve a common purpose and a common goal was something that I relied on a lot.”

Koch worked on hundreds of experiments, from the mundane to the out-of-this-world. Some surprised her. Who knew growing protein crystals in microgravity could be of such great benefit to the international pharmaceutical industry?

She was constantly busy, if not growing mustard greens in a plant science experiment to share with her fellow space travelers, then taking pictures of the universe from an astronaut’s perspective. She saw a hurricane over her hometown, wildfires in Australia and unbelievable cloud formations on a planetary level.

“I’m an electrical engineer and physicist, so I love that there’s a lot of physical science things,” said Koch. “I also love computer programming. So, I like the idea that in microgravity we can study things without what we might consider the boundary conditions of 1G.

yourself and learn the important aspects of teamwork. I constantly relied on that.”

As it turns out, rock climbing is quite similar

“Live according to your own passions...”

**CHRISTINA KOCH**



“Things like capillary action that really allow us and the people investigating those things to kind of gain an edge in the industrial environment where we’re really pushing the limits of how we can be efficient in manufacturing. I love all those experiments as well.”

Going to space fulfilled a dream Koch has had since she was 5 years old, back when she and her family still lived in Grand Rapids, Mich., before they moved to Jacksonville, NC, and before she ever attended the North Carolina School of Science and Math and NC State.

She learned during a trip to Space Camp to push her boundaries and not be scared of risks, no matter how life-threatening.

“I was confident early on that I wanted to be an astronaut,” she said. “I also knew the chances were really, really low... But I knew that I was going to live according to my own passions.”

She remembered when she quit a near-dream job as a NASA engineer to become a research assistant for three-and-a-half years, going between the South Pole and both Arctic and Antarctic extremes.

“That turned out to be one of the greatest experiences I ever had,” she said. “So, live according to your own passions and let those guide you.” ■





## New center will focus on traffic congestion and mobility

**INCREASES IN POPULATION** and aging physical infrastructure across the U.S. have led to a broad increase in traffic congestion. Americans rely heavily on automotive vehicles due to a variety of reasons that include lack of access in many areas to public transportation, and the convenience, speed and comfort of personal vehicles.

The NC Department of Transportation recognizes that in

A&T State University and UNC-Chapel Hill. Researchers at each of these universities will serve as center associate directors. “We’re excited to work with our NCDOT partners and top university researchers from across North Carolina to enable improvements to our transportation systems that will provide access for all citizens to mobility options that minimize travel delay,” Williams said.

order to take advantage of available data to more efficiently route traffic and improve infrastructure, the area’s strong university community is the state’s best bet to discover novel and cutting-edge solutions that can be applied both regionally and nationally. In order to achieve that lofty goal, the department is funding the creation of three University Research Centers of Excellence.

One of the three multi-disciplinary centers is focused on the reduction of congestion and improvement in mobility and will be led by **Dr. Billy Williams**, in conjunction with his role as director of NC State’s Institute for Transportation Research and Education (ITRE).

NC State will serve as the lead on this initiative, but will work closely with research leaders at Duke University, Fayetteville State University, NC

The research that comes out of the North Carolina Center of Excellence for Enhancing Mobility and Reducing Congestion will focus on three projects, each led by a principal investigator (PI) from a different North Carolina university.

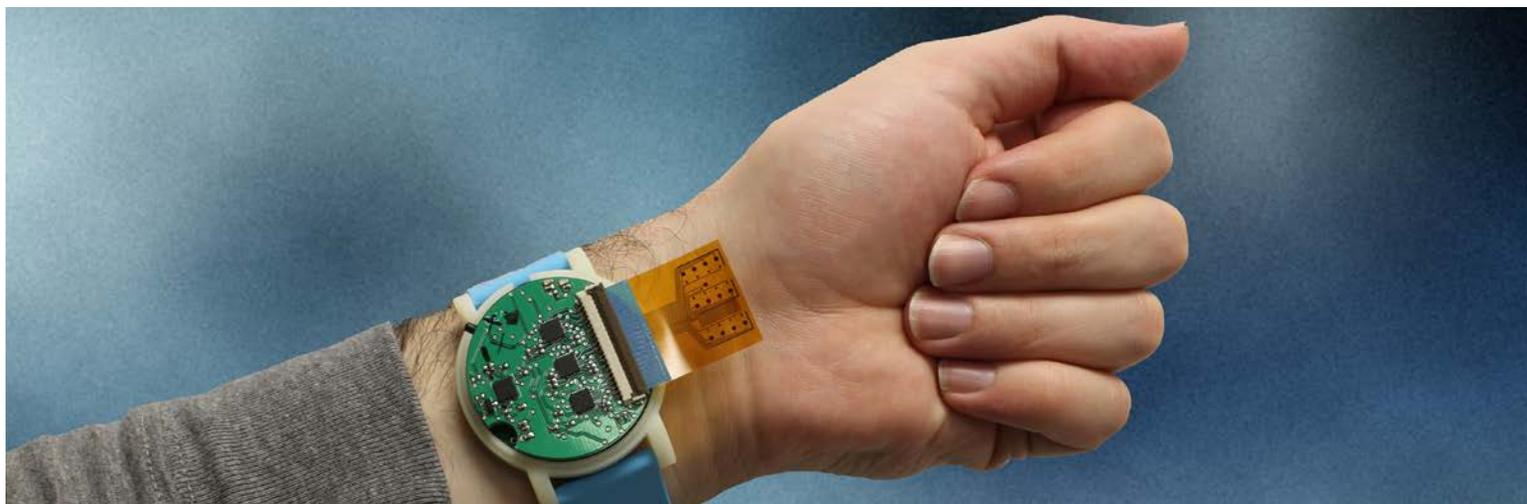
They are:

- **Deep Learning Software for Traffic State Prediction**, led by *Dr. Sambit Bhattacharya*, Fayetteville State University
- **Smart Connected and Automated Vehicle Fleet Management: Developing Regional Dispatch Decision Support for Congestion Mitigation**, led by *Dr. Mary (Missy) Cummings*, Duke University
- **First Mile to Health: Improving Healthcare Access in North Carolina**, led by *Kai Monast*, an ITRE researcher

“Rural areas and underserved populations experience many healthcare barriers which make it more difficult to live active, healthy lives. Affordable, reliable and convenient transportation helps to remove one of these barriers,” Monast said. “Because of the many recent changes in transportation and healthcare policy, we are going to explore how people access healthcare today and develop tools that help us build mobility networks for the future that focus on the needs of the individual.”

Co-PIs on the project include faculty members from NC State’s Department of Civil, Construction, and Environmental Engineering and Department of Business Management. ■

# ‘Wristwatch’ monitors body chemistry to boost athletic performance, prevent injury



**NC STATE RESEARCHERS** have developed a device the size of a wristwatch that can monitor an individual's body chemistry to help improve athletic performance and identify potential health problems. The device can be used for everything from detecting dehydration to tracking athletic recovery, with applications ranging from military training to competitive sports.

"This technology allows us to test for a wide range of metabolites in almost real time," says **Dr. Michael Daniele**, co-corresponding author of a paper on the work and an assistant professor of electrical and computer engineering and in the Joint Department of Biomedical Engineering (BME) at NC State and UNC-Chapel Hill.

Metabolites are markers that can be monitored to assess an individual's metabolism. So, if someone's metabolite levels are outside of normal parameters, it could let trainers or health professionals know that something's

wrong. For athletes, it could also be used to help tailor training efforts to improve physical performance.

"For this proof-of-concept study, we tested sweat from human participants and monitored for glucose, lactate, pH and temperature," Daniele says.

A replaceable strip on the back of the device is embedded with chemical sensors. That strip rests against a user's skin, where it comes into contact with the user's sweat. Data from the sensors in the strip are interpreted by hardware inside the device, which then records the results and relays them to a user's smartphone or smartwatch.

"The device is the size of an average watch, but contains analytical equipment equivalent to four of the bulky electrochemistry devices currently used to measure metabolite levels in the lab," Daniele says. "We've made something that is truly portable, so that it can be used in the field."

While the work for this paper

focused on measuring glucose, lactate and pH, the sensor strips could be customized to monitor for other substances that can be markers for health and athletic performance — such as electrolytes.

"We're optimistic that this hardware could enable new technologies to reduce casualties during military or athletic training, by spotting health problems before they become critical," Daniele says. "It could also improve training by allowing users to track their performance over time. For example, what combination of diet and other variables improves a user's ability to perform?"

First author of the paper is **Murat Yokus**, a Ph.D. student at NC State. Co-corresponding author of the paper is **Dr. Alper Bozkurt**, a professor of electrical and computer engineering. The paper was co-authored by **Tanner Songkakul**, a Ph.D. student at NC State, and **Vladimir Pozdin**, a post-doctoral researcher in BME. ■

# Departmental ambassador programs promote leadership, strengthen communication skills

**IN AN EFFORT** to create more peer-to-peer representation, each of the College’s nine academic departments have established student ambassador programs.

“We wanted a diverse and dynamic group of students to represent the department to prospective students and their families, industry representatives and the community at large,” said **Elizabeth New**, undergraduate student services coordinator for the Department of Electrical and Computer Engineering (ECE) and advisor to the ECE Ambassadors.

The newest program began in fall 2019 in the Department of Chemical and Biomolecular Engineering (CBE), thanks to an endowment by CBE alumnus **Quint Barefoot**, ‘85.

These student ambassadors host and participate in various events for their home departments, ranging from lab tours and Engineering Open House to professional development events, social and networking opportunities and more.

Each department has its own list of qualifications and duties — but across the board, each department

shares that students who become ambassadors are given an opportunity to enhance their leadership, organizational and public speaking skills, as well as develop and strengthen their professional networks.

“These well-rounded students go above and beyond what is expected in the classroom and are engaged in various other activities in the department, on campus, and in the local and global community,” said New.

For each department, the ambassador program is a way to not only interact with students who are on campus within their departments, but also with prospective ones.

“For prospective students, we want to provide a clear vision of how they would fit within the department, as well as a roadmap to how they can achieve their personal and academic goals by leveraging the department’s resources and relationships,” said **Dr. Kanton Reynolds**, director of undergraduate programs, and an associate teaching professor in the Edward P. Fitts Department of

Industrial and Systems Engineering (ISE), and co-advisor to the department’s ambassadors. “For current students, we want the ambassadors to serve as mentors and role models by providing timely advice and assistance in how to become their best selves in the context of our department and their intellectual pursuits and interests. We purposefully select a broad cross-section of students including transfers, students from rural areas and students who started out in a different major, so that we can capture all of the possible experiences our students may bring to the table.”

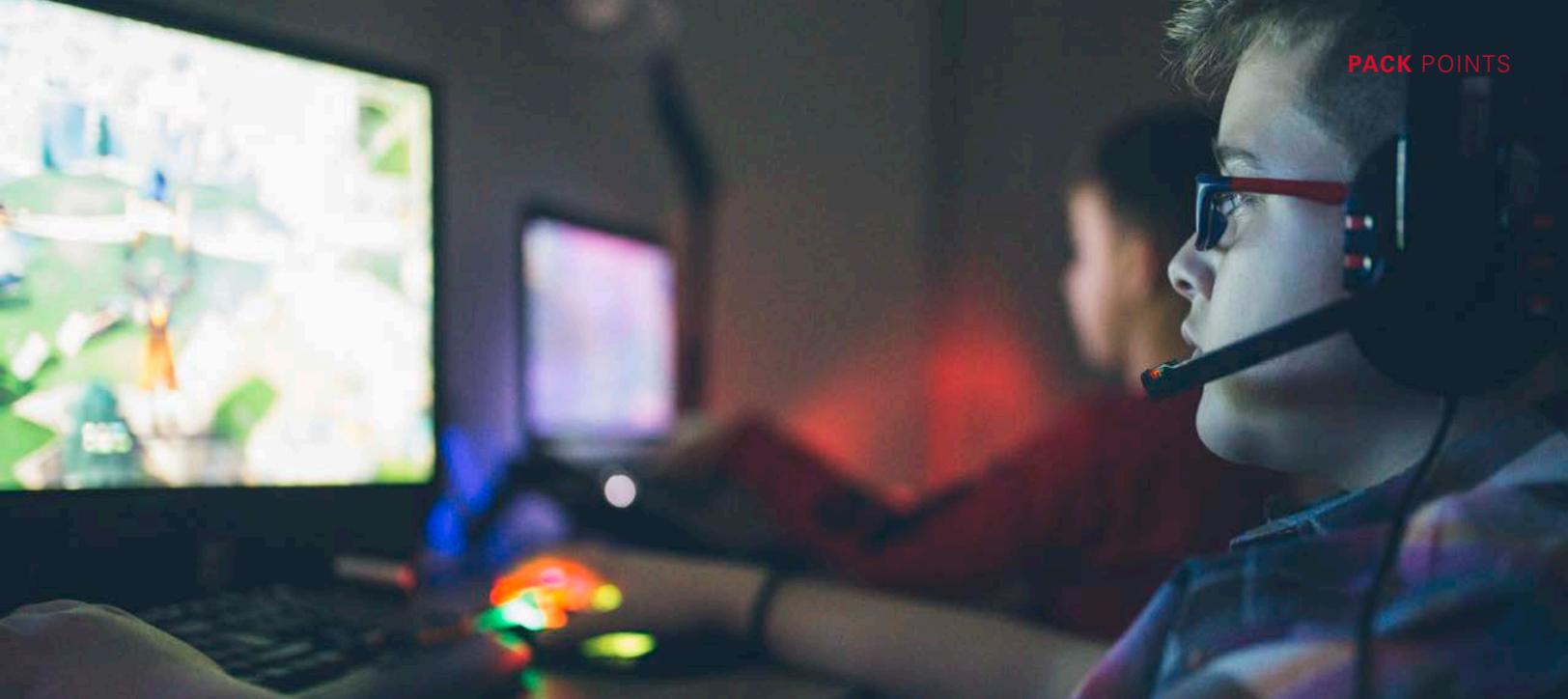
For ISE senior **Jasmine Cooper**, being an ambassador has given her many takeaways from the experience.

“I have a deeper understanding of how to work with different people, how you need to work with them to meet their needs,” said Cooper. “For me, being an ambassador has been a rewarding experience because I am able to help my peers to be the most successful students they can be.” ■

“These well-rounded students go above and beyond what is expected...”

ELIZABETH NEW





## Improving AI's ability to identify students who need help

### RESEARCHERS HAVE DESIGNED

an artificial intelligence (AI) model that is better able to predict how much students are learning in educational games. The improved model makes use of an AI training concept called multi-task learning, and could be used to improve both instruction and learning outcomes.

Multi-task learning is an approach in which one model is asked to perform multiple tasks.

"In our case, we wanted the model to be able to predict whether a student would answer each question on a test correctly, based on the student's behavior while playing an educational game called Crystal Island," says **Dr. Jonathan Rowe**, co-author of a paper on the work and a research scientist in NC State's Center for Educational Informatics (CEI).

"The standard approach for solving this problem looks only at overall test score, viewing the test as one task," Rowe says. "In the context of our multi-task learning

framework, the model has 17 tasks — because the test has 17 questions."

The researchers had gameplay and testing data from 181 students. The AI could look at each student's gameplay and at how each student answered Question 1 on the test. By identifying common behaviors of students who answered Question 1 correctly, and common behaviors of students who got Question 1 wrong, the AI could determine how a new student would answer Question 1.

This function is performed for every question at the same time; the gameplay being reviewed for a given student is the same, but the AI looks at that behavior in the context of Question 2, Question 3, and so on.

And this multi-task approach made a difference. The researchers found that the multi-task model was about 10 percent more accurate than other models that relied on conventional AI training methods.

"We envision this type of model being used in a couple of ways that can benefit students," says **Dr. Michael Geden**, first author of the paper and a postdoctoral researcher at NC State. "It could be used to notify teachers when a student's gameplay suggests the student may need additional instruction. It could also be used to facilitate adaptive gameplay features in the game itself. For example, altering a storyline in order to revisit the concepts that a student is struggling with.

"Psychology has long recognized that different questions have different values," Geden says. "Our work here takes an interdisciplinary approach that marries this aspect of psychology with deep learning and machine learning approaches to AI."

The paper was co-authored by **Dr. James Lester**, Distinguished University Professor of Computer Science and director of CEI, and **Andrew Emerson**, a Ph.D. student at NC State. ■

# Next generation of greenhouses may be fully solar powered



## MANY GREENHOUSES COULD

become energy neutral by using see-through solar panels to harvest energy — primarily from the wavelengths of light that plants don't use for photosynthesis. Those are the findings of a new modeling study conducted by engineering, plant biology and physics researchers at NC State.

"Plants only use some wavelengths of light for photosynthesis, and the idea is to create greenhouses that make energy from that unused light while allowing most of the photosynthetic band of light to pass through," says **Dr. Brendan O'Connor**, corresponding author of the study and an associate professor of mechanical and aerospace engineering. "We're able to do this by using organic

solar cells, because they allow us to tune the spectrum of light that the solar cell absorbs — so we can focus on using mostly wavelengths of light that plants don't use. However, until now it wasn't clear how much energy a greenhouse could capture if it was using these semitransparent, wavelength selective, organic solar cells."

To address that question, researchers used a computational model to estimate how much energy a greenhouse could produce if it had semitransparent organic solar cells on its roof — and whether that would be enough energy to offset the amount of energy the greenhouse required to operate effectively. The model was developed to estimate energy use for greenhouses growing tomatoes at locations in Arizona, North Carolina and Wisconsin.

"A lot of the energy use in greenhouses comes from heating and cooling, so our model focused on calculating the energy load needed to maintain the optimal temperature range for tomato growth," O'Connor says. "The model also calculated the amount of energy a greenhouse would produce at each location when solar cells were placed on its roof."

The modeling is complex because there's a complicated trade-off between the amount of power the solar cells generate and the amount of light in the photosynthetic band that they allow to pass through. Basically, if growers are willing to sacrifice larger amounts of photosynthetic growth, they can generate more power.

What's more, the solar cells used for this analysis are effective insulators, because they reflect infrared light. This helps to keep greenhouses cooler in the summer, while trapping more warmth in the winter.

The end result is that, for many greenhouse operators, the trade-off could be a small one. Particularly for greenhouses in warm or temperate climates.

First author of the paper is **Eshwar Ravishankar**, a Ph.D. student at NC State. The paper was co-authored by **Ronald Booth**, a Ph.D. student at NC State; **Dr. Carole Saravitz**, director of NC State's Phytotron; **Dr. Heike Sederoff**, professor of plant and microbial biology; and **Dr. Harald Ade**, Goodnight Innovation Distinguished Professor of Physics. ■



## Study finds flooding damage to levees is cumulative — and often invisible

**RECENT RESEARCH FINDS** that repeated flooding events have a cumulative effect on the structural integrity of earthen levees, suggesting that the increase in extreme weather events associated with climate change could pose significant challenges for the nation's aging levee system.

"Traditionally, levee safety inspections are based on visible signs of distress on the surface," says **Rowshon Jadid**, a Ph.D. candidate at NC State and first author of a paper describing the research. "What we've found is that as a levee goes through repeated flood events, it gets weaker — but the damage may be invisible to the naked eye."

"This is particularly relevant now, since we're seeing severe flooding more often," says **Dr. Brina Montoya**, co-author of the paper and an associate professor in the Department of Civil, Construction, and Environmental Engineering at NC State.

The study draws on data from

the Princeville levee in North Carolina, as well as flooding associated with hurricanes Floyd and Matthew. Princeville is a town in Edgecombe County, and is the oldest town incorporated by African Americans in the United States. The community experienced severe flooding in September 1999 with Hurricane Floyd and in October 2016 with Hurricane Matthew.

Levees are earth embankments that protect against flooding — and there are a lot of them. According to the U.S. Army Corps of Engineers, there are 45,703 levee structures in the United States, stretching for 27,881 miles. On average, they're 56 years old.

"Because these levees are aging, and we have limited resources available to maintain them, we need to determine which levees should be prioritized for rehabilitation efforts that will reduce their risk of failure," Jadid says.

"There are inspection regimes in place, where officials look for

signs of distress and structural damage," says **Dr. Mohammed Gabr**, co-author of the paper and Distinguished Professor of Civil Engineering and Construction at NC State. "However, some of these visual signs can be missed and, in many cases, by the time we can see the problem, it's either too late or too expensive to fix."

"The work we've published here demonstrates the increased risk of levee failure with the repeated flooding cycles and serves to help the profession with identifying levees with the highest risk of failure before signs of distress are visually observed."

Researchers are in the process of using this study's findings, as well as additional data, to develop tools that can facilitate more accurate identification of levee damage and the development of more accurate failure criteria.

The research was done with support from the Coastal Resilience Center, which is funded by the U.S. Department of Homeland Security. ■

## Professor reflects on L-E-S-S-O-N-S learned from 1975 National Spelling Bee



**TODAY**, Dr. Richard Spontak is a Distinguished Professor of Chemical and Biomolecular Engineering at NC State. Internationally known for his award-winning research in the field of soft materials, he focuses on developing and modifying recyclable elastomers — soft stretchy polymers — for a variety of applications, from infection prevention to wearable technologies and robotics.

But 45 years ago, long before he mastered the fundamentals of polymer science and the use of an electron microscope, Spontak was just a smart kid growing up in a small working-class borough in Schuylkill County, Penn., where athletics reigned supreme.

And then he found himself in the throes of competition, in a spelling bee.

Though it sounds mundane, it turned out to be a pivotal moment in his young life.

He'd won his school spelldown and had advanced to the regional competition, which even to this day conjures up vivid memories.

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*“I hungered for scholarly competition throughout college and that ultimately drove me into undergraduate research.”*

**DR. RICHARD SPONTAK**

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“When I close my eyes, I can still picture the crowd in the auditorium and recall how my legs got tense and my palms became sweaty. I was competing against a fellow student from a local Catholic school, which was my public school’s biggest athletic competitor. I remember my opponent missing his word and feeling confident that I knew how to spell it. When I did and correctly spelled the next word (‘roulette’), I simply could not comprehend that I had won. I showed the students, faculty and administrators that students in my tiny public school could compete in scholarship, as well as on the court and field.”

With that victory, Spontak — then a 14-year-old eighth grader from Saint Clair, Penn. — was one of 79 students from around the country to earn their way to Washington, D.C., for a seat in the 48<sup>th</sup> National Spelling Bee in 1975. It was two days of oral spelling sandwiched into a week of sightseeing and parties for the youngsters and their families. (By comparison, the 2020 National Spelling Bee, which was to be held May 24-29, 2020, but has been postponed, would have drawn about 400 competitors. After a written

competition whittles the field down, the finalists would go head-to-head in a spelldown broadcast live on ESPN).

Spontak lasted about halfway through the national bee, tripping on the word “replevin,” which is a legal action allowing the recovery of personal property. He spelled it r-i-p-l-e-v-i-n.

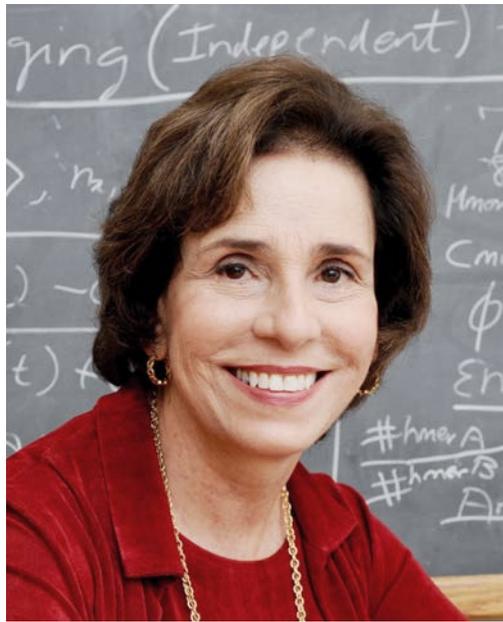
“It’s burned into my memory forever,” he said.

Actually, what Spontak remembers most about the National Spelling Bee is that it offered him a host of new experiences: “It was my first time in Washington, D.C., my first time to compete at the national level. It was the first time that my school district had a spelling bee contender. It was the first time I felt the pressure of scholarly competition. And it was the first time I traveled without my father, since he just had a heart attack and couldn’t be exposed to such excitement.”

The National Spelling Bee experience made Spontak realize that being smart was not a bad thing. He was treated differently when he returned home. He’d found his niche.

“In my school district, the only way to gain notoriety was through





## Three receive NSF CAREER Awards

Three faculty members in the College have been chosen to receive Faculty Early Career Development (CAREER) awards from the National Science Foundation (NSF).

The NSF CAREER award is one of the most prestigious awards in support of junior faculty members who exemplify the role of teacher-scholars through outstanding research, excellent education and the integration of education and research within the context of the mission of their organizations.

NSF will provide \$558,779 in funding over five years to **Dr. Milad Abolhasani**, assistant professor in the Department of Chemical and Biomolecular Engineering (CBE), for the project, "Intelligent Synthesis of Colloidal Nanocrystals Enabled by Microreaction Engineering in Flow."

NSF will provide \$500,000 in funding over five years to **Dr. Chris Martens**, assistant

TOP, LEFT TO RIGHT, DRS. MILAD ABOLHASANI, LAURA BOTTOMLEY, JAN GENZER, CAROL HALL, CHRIS MARTENS, AND QINGSHAN WEI.

# FACULTY HIGHLIGHTS

professor in the Department of Computer Science, for the project, "Explorable Formal Models of Privacy Policies and Regulations."

NSF will provide \$500,000 in funding over five years to support **Dr. Qingshan Wei**, assistant professor in CBE, for the project, "Smartphone-Based CRISPR Biosensor for Point-of-Care HIV Viral Load Testing." ■

## Genzer receives R.J. Reynolds Award

**Dr. Jan Genzer**, S. Frank and Doris Culberson Distinguished Professor in the Department of Chemical and Biomolecular Engineering, is the thirty-fifth recipient of the R.J. Reynolds Tobacco Company Award for Excellence in Teaching, Research and Extension.

The annual award was established in 1981 to honor a College of Engineering faculty member who has demonstrated superiority in several areas of activity that relate to NC State's three-fold mission of teaching, research and extension. The recipient is given a \$25,000 prize distributed over five years.

Internationally recognized

for his research in the area of soft materials, Genzer is a leading scholar in the area of polymer physics and interfacial phenomena, a prolific publisher of scholarly papers, a dedicated and innovative teacher and an enthusiastic organizer of scientific events in the Research Triangle area.

Among his many honors, he is a recipient of the National Science Foundation (NSF) CAREER Award, the John H. Dillon Medal of the American Physical Society, the NSF Special Creativity Award, the NC State Outstanding Teacher Award, the NC State Alumni Outstanding Research Award, the Alcoa Foundation Distinguished Engineering Research Award and a Fellowship of the American Physical Society. ■

## Hall named AAAS Fellow

**Dr. Carol Hall**, Camille Dreyfus Distinguished University Professor in the Department of Chemical and Biomolecular Engineering, has been elected as a Fellow of the American Association for Advancement of Science (AAAS), the world's largest scientific society and publisher of journal science.

AAAS Fellows are elected by their peers who serve on

the Council of AAAS, the organization's member-run governing body, for having shown "scientifically or socially distinguished efforts to advance science or its applications."

Hall was elected for her distinguished contributions to the field of thermodynamics using statistical methods and computer simulation methods to solve engineering problems involving macromolecules and complex fluids.

She joined the NC State faculty in 1985 and was one of the first women to be appointed to a chemical engineering faculty in the United States. Hall is a member of the National Academy of Engineering, and a Fellow of AIChE and the American Physical Society.

With her appointment, the College has nine active faculty members who are AAAS Fellows. ■

## Bottomley named Tech Educator of the Year

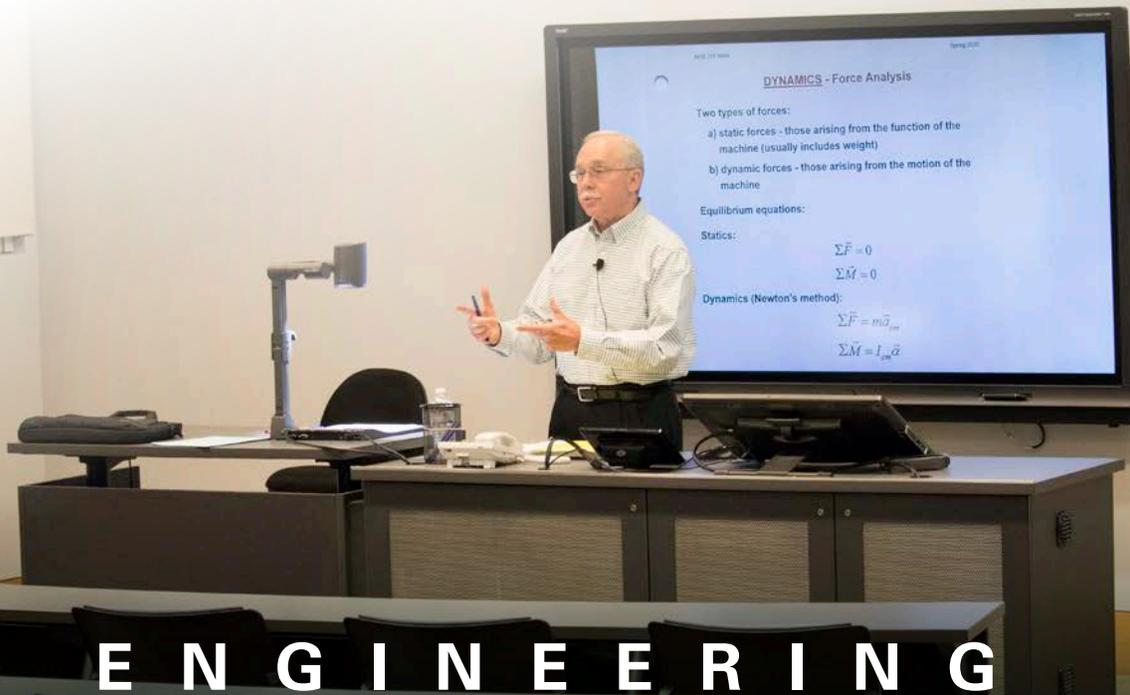
**Dr. Laura Bottomley**, director of The Engineering Place and the Women in Engineering program within the College, was named Tech Educator of

the Year during the NC TECH Association's annual NC TECH Awards program in November.

The award honors "an individual (e.g. teacher, administrator, counselor, etc.) that has demonstrated innovation and effectiveness in the use of technology to educate students, and / or has been effective in driving interest among students in pursuing technology fields."

Bottomley founded the K-12 outreach program The Engineering Place in 1999, and is responsible for its oversight and strategic operations. She is also a frequent creative contributor to program content and holds primary responsibility for funding, operation and personnel. Along with directing the Women in Engineering program, she advises students and teaches the E 101 Introduction to Engineering and Problem-Solving class for first-year students in the College.

In 2000, she was among the College's representatives as it received a Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring (PAESMEM). In 2009, she received an individual PAESMEM for her mentoring and outreach efforts with the Women in Engineering and K-12 Outreach Programs. She is a Fellow of IEEE and the American Society for Engineering Education. ■



# ENGINEERING ON THE FRONT LINES

The College of Engineering adjusts to a changing landscape

DR. RICHARD KELTIE RECORDS A LECTURE IN A VACANT CLASSROOM.



MASTER'S STUDENT HARRY SCHRICKX CUTS PLASTIC SHEETING TO MAKE MEDICAL FACE SHIELDS.

**Dr. Richard Keltie** stands at the front of a classroom in Engineering Building III, slides for his MAE 315 Dynamics of Machines class projected behind him.

"Hello students," he says, by way of beginning. "I guess you'll be seeing these lectures in a few days. I'm getting used to teaching in front of nobody. I hope that everybody is doing OK."

Keltie, a longtime professor in NC State's Department of Mechanical and Aerospace Engineering (MAE), is the only person in the room. The lecture, being recorded by staff members from NC State's Engineering Online distance

education program, will be shown to undergraduate students who were ordered to leave campus because of an outbreak of the COVID-19 respiratory disease that struck the United States in spring 2020.

Like their colleagues at colleges and universities across the country, faculty and staff members within the College saw unprecedented disruption to the spring 2020 academic semester.

While the landscape is changing daily, as of the last week in March, the University was functioning with minimal on-campus operations that included the following measures:

- Most students who live on campus had been asked to return to their permanent residence unless given a hardship exception
- All instruction was moving fully to online courses
- Remote or alternative work arrangements were required for the majority of employees
- With minimal exceptions, almost all research laboratories and facilities were asked to cease operations and core services and facilities were being closed or significantly limited

- All in-person NC State and College campus events and meetings had been cancelled or postponed indefinitely
- All employee travel with state funding had been curtailed
- Spring 2020 University commencement exercises and alumni-focused events like Day of Giving and the annual Endowment Dinner were postponed

The College has taken up the challenge and is helping to engineer a front-line response. Faculty members and students have begun using their equipment and expertise to help get local medical providers in the Research Triangle area of North Carolina the supplies they desperately need to combat the pandemic.

At the same time, faculty and staff members are moving to online instruction and utilizing remote working capabilities to continue operations, communicate with students about their concerns and provide online instruction and individual communication.

Fortunately, the College has extensive experience with distance learning. Engineering Online offers master's and certificate programs remotely. Having that infrastructure in place, plus the experience that so many faculty members in the College have with it, should help make the transition easier.

## READY TO HELP

As the crisis deepened, healthcare systems in Raleigh and around the country faced the same problem: how would they access enough personal protective equipment (PPE) to ensure that front-line providers would be able to stay healthy while treating the sick. The UNC Health system, which serves the area, asked the public for donations of critical supplies.

By the last week in March, several efforts within the College to help meet that need had gotten under way.

Faculty members began working with colleagues in the Wilson College of Textiles' Nonwovens Institute on a production line to create a nonwoven material that could be sent to industry partners for reusable surgical masks.

MAE faculty members began using laser cutters to produce plastic face shields. **Drs. Landon Grace** and **Tim Horn** in MAE were looking into whether 3D printers on campus and in the community could be used to create needed components like ventilator valves (with FDA approval) and assembling a network of available printer capacity.

Staff members in the Biomanufacturing Training and Education Center (BTEC), part of the College, were making preparations to begin producing hand sanitizer for use on campus and in medical facilities as needed. BTEC also donated lab supplies to UNC Health.

In the Department of Materials Science and Engineering (MSE), faculty and staff members gathered up pallets of supplies that are used in the department's labs but could also be utilized by healthcare workers, including masks, safety glasses, face shields

and disposable coats. **Joseph Matthews**, research operations manager in MSE, delivered the supplies to REX Hospital in Raleigh, part of UNC Health.

"It made me proud to do it," Matthews said. "Those people need all the help they can get."

## ON-CAMPUS STUDENTS BECOME DISTANCE STUDENTS

Engineering Online offers 16 online graduate degree and certificate programs. EOnline began in 1978 with videotapes of lectures sent in the mail, but today's students receive all class instruction and complete any other interactions with faculty members online.

**Dr. Linda Krute**, the program's director, said that nearly 200 faculty members within the College have taught for the program, using studios and camera-enabled classrooms on campus maintained by EOnline and the University's Distance Education and Learning Technology Applications (DELTA) program.

"This is the blessing that we have in the College, that so many faculty have said to us, 'I'm so glad that I've taught distance ed,'" she said.

Many faculty members, including Keltie, were taking advantage of EOnline capabilities to record lectures for on-campus students to watch remotely. Others who had taught distance classes were able to take advantage of master's level lectures they had recorded during previous semesters.

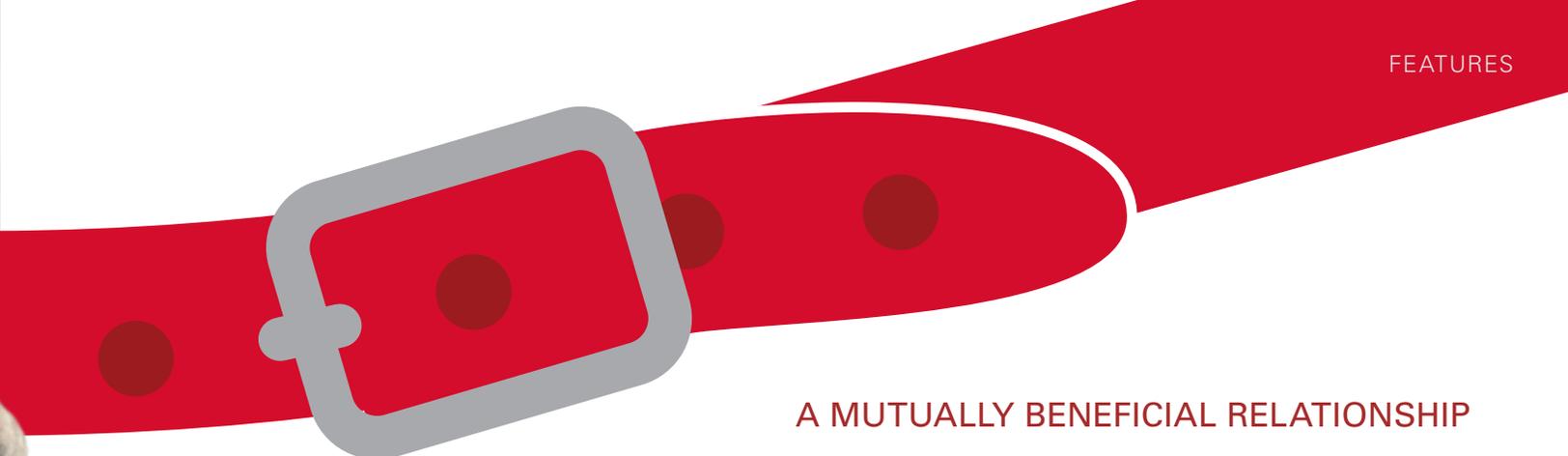
For Krute's program, online instruction and homework assignment and completion continued mostly as usual as the pandemic took hold. The issue that was being discussed for online master's students — and for other students within the College who suddenly found themselves switching from on-campus to distance learning — is how exams will be given. For EOnline students, exams can be taken on the NC State campus if they live nearby or can be given by a network of proctors available at other colleges and universities or companies that employ NC State engineering distance students. That option will be taken away with most of the country in isolation during the spring 2020 semester.

During the week of March 23<sup>rd</sup> (the first week in which all instruction at NC State moved online) faculty members were conferring with students in online departmental town halls and holding virtual meetings of the College's leadership team to work out potential issues. Along with the question of how to maintain the integrity of exams, they discussed potential issues with network bandwidth when an entire class tries to watch a lecture on the same platform and whether all students have access to computers and broadband in rural parts of the state. Other issues being examined included potential effects on financial support for graduate students sponsored by a company or government agency and whether senior design teams within the College would be able to complete their work. ■

# A SMARTER COLLAR

Researchers use wearable data collection systems to empower guide dog trainers





Lorraine Trapani’s husband, Michael, was a hard-charging, happy person. So, when he became partially blind, he worked to live with it, learning a scanning technique that made the most of the vision that remained.

“He said the hardest thing was not being able to see my face,” Lorraine Trapani remembers.

Seventeen years after his death, Trapani honors her husband’s memory as a volunteer puppy raiser, providing a loving home and teaching foundational skills to puppies who will one day provide their recipients with independence, safety and companionship.

“I want to raise an army of guide dogs in honor of Michael,” said Trapani, who was paired with her seventh puppy trainee, Jackie, in 2019.

As a volunteer for the nonprofit guide dog school Guiding Eyes for the Blind, Trapani will take a puppy for about 16 months. During that time, she’ll keep the animal with her at all times, exposing her to different social situations and constantly observing how she reacts.

Not every puppy is cut out for this type of work.

The best guide dogs can make hundreds of snap decisions a day while remaining calm in environments that can be noisy and stressful. Guiding Eyes can invest \$50,000 and two years in a dog, whether the animal is ultimately trained and placed with a blind person or not.

Fifty to 75 percent of puppies that start the training don’t complete it, so the earlier they can determine whether a dog is cut out for the work, the more resources can be put toward training the right dogs and placing them in a position to help.

Technology developed at NC State, combined with Watson artificial intelligence applied to data collected and stored on the IBM Cloud, has led to a smart collar that gathers valuable insights during Jackie’s training period that will help determine if life as a guide dog is the right path.

It’s a tool that will help improve the training process, giving volunteers like Lorraine Trapani a chance to train that army of dogs in memory of her husband.

## A MUTUALLY BENEFICIAL RELATIONSHIP

Candidate dogs begin evaluations as young as 7½ weeks and are scored on a number of traits, including fear of strangers, separation anxiety and excitableness.

The drawbacks are that it takes years of experience for a trainer to be able to score an animal accurately, and it requires a high level of time and attention for volunteers.

Collecting that data on dozens of dogs with smart collars and using Watson AI technology to predict what it means, Guiding Eyes will be able to tell earlier on which animals are fit to continue training as guide dogs. The data could also offer valuable information for the organization’s genetics program by helping to estimate the heritability of temperament traits between generations of dogs.

In a 2019 paper, researchers from NC State’s Departments of Computer Science (CSC) and Electrical and Computer Engineering (ECE) showed that by outfitting dogs with a data collection system that records electrocardiography and other measurements, they could predict 29 behavioral scores with approximately 92 percent accuracy over 11 distinct tasks.

The research is part of a long partnership between **Dr. Alper Bozkurt**, professor in ECE, and **Dr. David Roberts**, associate professor in CSC. The two met in a faculty orientation workshop after arriving at NC State and have collaborated on several projects involving animals, sensors and artificial intelligence, including work on an interactive harness for search and rescue dogs that monitors their health and allows them to communicate with handlers in a disaster zone.

Projects in Roberts’ Canine Instruction with Instrumented Gadgets Administering Rewards (CIGAAR) Lab study how to improve upon the centuries-old mutually beneficial relationship between man and his best friend.

The CIGAAR Lab smart handle project focuses on the non-visual communication of canine heart and respiratory rates. The main goal is to communicate canine physiological data to a blind handler in real time to give him or her a better idea of the animal’s current physical and emotional state. A scent discrimination project collects physiological and behavioral data from a dog during scent-detection tasks to identify patterns



that correlate to the presence of a target odor; it can be used to develop an automated training system that can capture and reinforce a desirable behavioral response upon detection of scents.

Bozkurt's research involves using engineering to better understand biological systems, be they human, animal or plant.

In work with the National Science Foundation Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST) Engineering Research Center led by NC State, he is helping develop wearable, self-powered systems that track a patient's health data and environmental exposure.

Bozkurt has studied the potential for turning Madagascar hissing cockroaches into cyborgs for use in disaster zones and, in collaboration with the Plant Sciences Initiative in the College of Agriculture and Life Sciences at NC State, is looking at how sensors can be used to improve plant health for agriculture applications.

"We have been working on wearable technologies for dogs for the last 10 years," Bozkurt said. "We are now very glad to see that our technologies are creating impact in real life applications for two critical populations in this case: guide dogs and their humans."

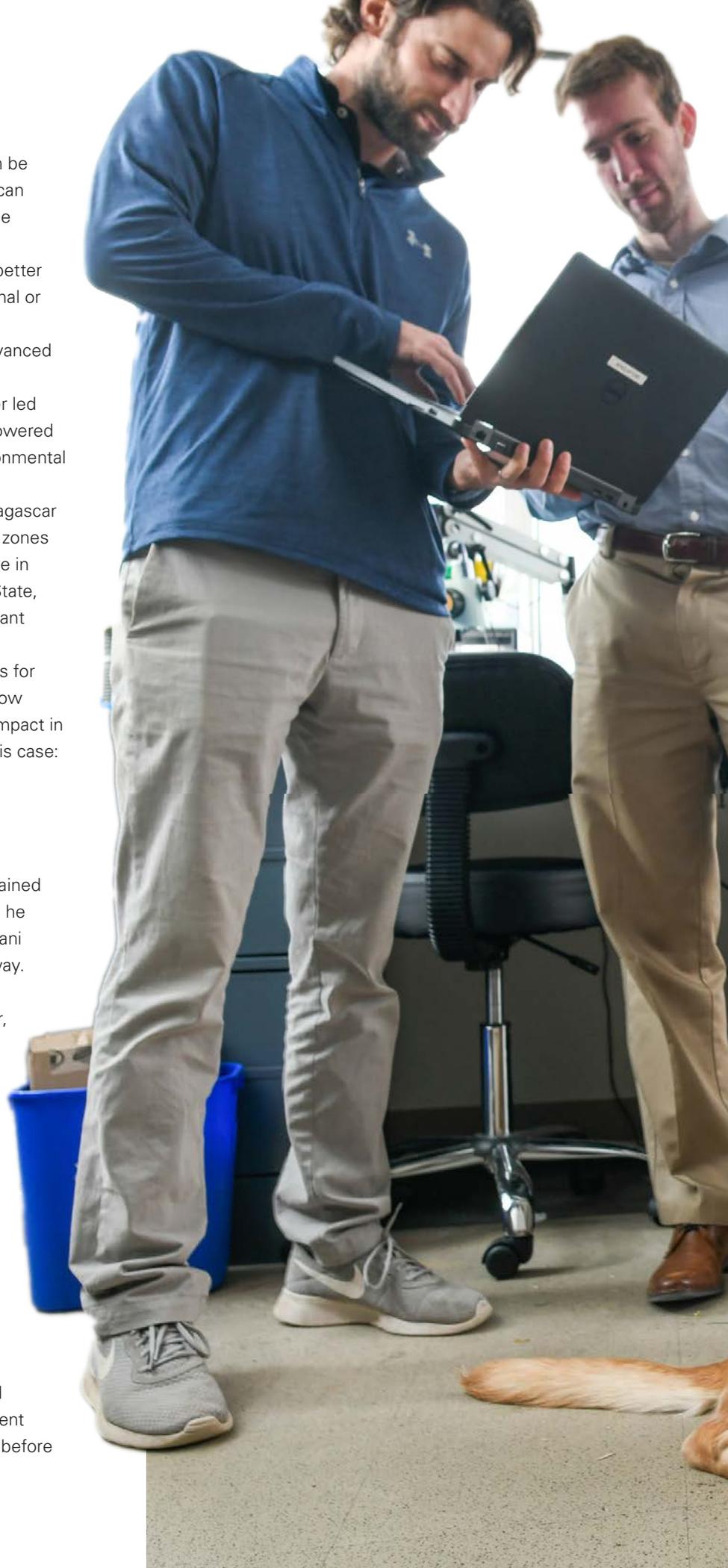
## TECH FOR GOOD

Trapani's first puppy, Merrick, was successfully trained and placed, but even before he became a guide dog he served as a therapy dog. He was the first thing Trapani allowed herself to love after her husband passed away. Her second puppy completed training and was matched with a partner. Before graduating, however, he was released, as the stress of actual guide work was too much for him.

The setback made her want to work harder and wonder what could be done to ensure more successful trainings and placements.

Guiding Eyes has been collecting data on its dogs since 1995 and had begun using IBM Cloud to store it, then Watson to help predict whether a dog in training would ultimately make a good guide dog. The company learned about the research going on at NC State from a paper that Roberts and Bozkurt had published together.

An IBM donation is putting smart collars on 350 puppy trainees and is sponsoring dogs being trained by Trapani, who works for the company in Government and Regulatory Affairs. The puppy she worked with before



Jackie was named TJ after Thomas J. Watson, a former IBM CEO and the company's AI platform's namesake.

Trapani's work includes frequent trips to Washington, D.C., and her trainees tag along. She's constantly watching for a calm emotional state, smooth movements and as little barking as possible.

Learning when it's appropriate to eliminate is also part of the process, especially not when in a senator's office.

"Jackie is walking the halls of Congress with me, advocating for the potential of AI to benefit society," she said. ■

**"Our technologies are creating impact in real life applications, for two critical populations in this case: guide dogs and their humans."**

**DR. ALPER BOZKURT**



# OUR CHALLENGES, OUR IDEAS

## SECURITY AND SAFETY

### Research areas

- Restore and improve civil infrastructure
- Prevent nuclear proliferation
- Secure cyberspace

### Center for Nuclear Energy Facilities and Structures

CNEFS performs research on innovative but rigorous solutions to problems in nuclear energy-related facilities, reducing uncertainty, increasing safety and curtailing the cost of operating existing plants and of building new ones.

### Center for Nonproliferation Enabling Capabilities

With funding from the National Nuclear Security Administration, CNEC is developing the next generation of leaders with practical experience in technical fields relevant to nuclear nonproliferation.

### Institute for Transportation Research and Extension

ITRE is committed to leadership in the study of transportation issues through fostering analytical thinking, integrating technology in education and research and serving as a catalyst for problem solving.

### Secure Computing Institute

SCI is enhancing the security and privacy of computing systems for the betterment of society through performing basic and applied research and advancing and delivering cybersecurity education.

## HEALTH AND WELL BEING

### Research areas

- Advanced health informatics
- Health monitoring
- Engineering better medicines
- Rehabilitation engineering

### Accelerated Innovation in Manufacturing Biologics

With funding from Novo Nordisk Foundation, AIM BIO will help accelerate the next generation of biotherapeutics to treat a range of chronic and potentially lethal diseases.

### Center for Advanced Self-Powered Systems of Integrated Sensors and Technologies

NSF ASSIST Engineering Research Center is developing leading-edge systems for high-value applications such as healthcare and Internet of Things by integrating fundamental advances in energy harvesting, low-power electronics and sensors.

### Health Systems Engineering Program

Faculty members in the Edward P. Fitts Department of Industrial and Systems Engineering are improving the effectiveness and quality of healthcare by focusing on the entire patient care cycle.

### Closed-Loop Engineering for Advanced Rehabilitation Core

CLEAR Core faculty members are improving the lives of individuals with disabilities by studying basic science in neuromechanics, sensorimotor integration and tissue biomechanics.



## SUSTAINABILITY

### Research areas

- Energy and the environment
- Materials and manufacturing
- Plant growth and monitoring

### Center for Additive Manufacturing and Logistics

CAMAL research is helping to drive a U.S. manufacturing renaissance by increasing efficiency in existing systems and developing new techniques to build products from the ground up in areas that range from biomedical to aerospace and automotive.

### Consortium for Advanced Simulation of Light Water Reactors

CASL's goal is to predict the performance of existing and next-generation commercial nuclear reactors to help lower costs, improve efficiency, enhance safety and extend the life of existing facilities.

### Future Renewable Electric Energy Delivery and Management Systems Center

The NSF FREEDM Center is building the next generation electric power grid that is more efficient and allows bidirectional power flow and seamless integration of renewable resources.

### Plant Sciences Initiative

As part of the initiative within NC State's College of Agriculture and Life Sciences, engineering researchers are collaborating on projects that make plant science more data-driven, helping ensure that we can feed a growing population.

### PowerAmerica

This National Manufacturing Innovation Institute is driving development and implementation of the next generation of wide bandgap semiconductor-based power electronics.

### Research areas

- Energy and the environment
- Materials and manufacturing
- Plant growth and monitoring

### Aerial Experimentation and Research Platform for Advanced Wireless

Part of NSF's Platforms for Advanced Wireless Research, AERPAW includes partners across the Research Triangle region of North Carolina and will study the convergence of 5G technology and autonomous drones.

### Center for Educational Informatics

CEI's mission is to design, develop and investigate next-generation learning technologies; with a focus on personalized learning for K-12 STEM education, the center creates adaptive learning technologies for classrooms, homes and museums.

### Quantum Computing Hub

The hub is a university-level, cross-disciplinary center that provides supported remote access to commercial IBM Q computation resources via IBM Cloud attached to conventional laptops, desktops and servers.



**With its Grand Challenges for Engineering in the 21<sup>st</sup> century and its 10 Big Ideas, the National Academy of Engineering and National Science Foundation (NSF), respectively, have asked engineers to **think about the broad topics that will drive human progress for decades to come.****

**Working across disciplines, the College's faculty members and students are collaborating to make progress in many of these vital areas.**

Learn more at; [engineeringchallenges.org](http://engineeringchallenges.org) and [nsf.gov/news/special\\_reports/big\\_ideas](http://nsf.gov/news/special_reports/big_ideas).

# material1 w0r1d

SEAS traineeship creates a new generation  
of data-driven materials scientists

Materials matter.

As **Dr. Yaroslava Yingling**, professor in NC State's Department of Materials Science and Engineering (MSE), points out, breakthroughs across engineering disciplines that create smart infrastructure, new consumer electronics or better drug delivery methods are enabled by new and better materials.

"A discovery of novel material often precedes and stimulates technological innovations," Yingling said. "Until we discover new materials, we can't do the rest of the engineering."

Like many scientific and engineering disciplines, materials science is being impacted today by tremendous growth in available data, cheaper ways to store it and machine learning methods that help researchers interpret data and look for patterns. The processed and analyzed data patterns can help speed up development and deployment of new materials, leading to high demand by industry for graduates trained in both materials engineering and data science.

MSE research teams traveling to Argonne, Brookhaven and Oak Ridge National Laboratories to use advanced scattering microscopy resources return with terabytes of data to sort through and interpret, said **Dr. Elizabeth Dickey**, Distinguished Professor in MSE.

It's causing engineers and scientists to rethink some assumptions. Yingling

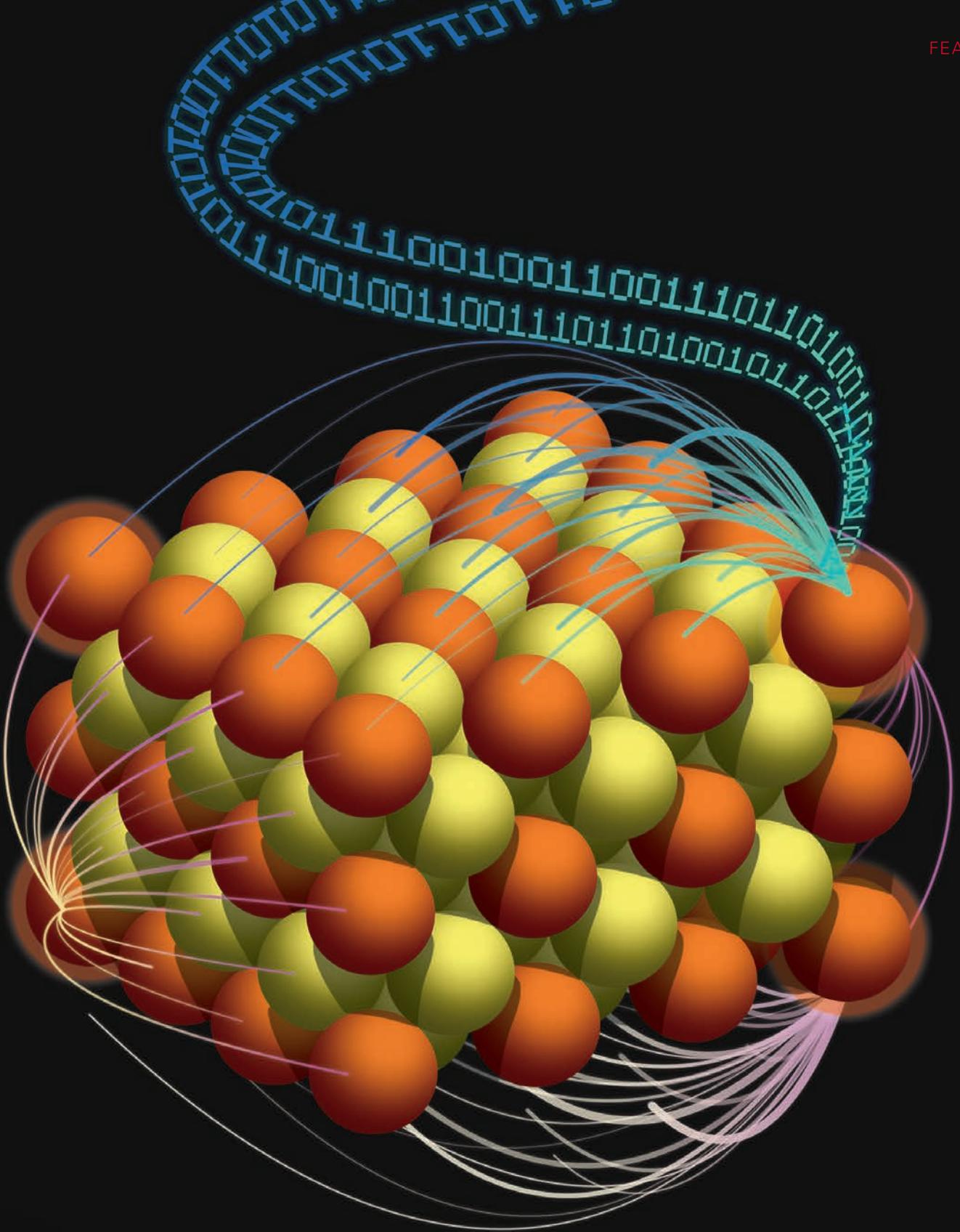
explains that, for years, data from experiments that were not part of patent or publication was tossed aside. With more capacity for data capture and storage, the results from those experiments now can and should be kept.

"We need to change students' understanding of how to collect the data, how to keep the data, what data to keep and how to use this data for machine learning to speed up materials discovery," she said.

That's the idea behind Data-Enabled Science of Engineering and Atomic Structure (SEAS), a National Science Foundation Research Traineeship at NC State and NC Central University (NCCU).

The program allows graduate students in materials science and engineering, statistics and other fields to receive additional training and instruction in areas beyond their discipline. The program also includes a broad mix of laboratory rotations, interdisciplinary research group activities, external internships, leadership-training activities and more.

The program's Bridge-to-Ph.D. component allows master's students in math, physics and chemistry at NCCU to participate in SEAS activities at NC State, helping those students on the path to pursuing a Ph.D. in a STEM-related field and addressing the challenges of diversity within doctoral programs.



“You have a unique opportunity to take an interdisciplinary route to your graduate education which, in my opinion, makes students more marketable whenever they’re looking for jobs,” said **Dr. Ashleigh Wright**, SEAS program coordinator. “You still gain expertise in a particular field, but you also develop a working knowledge of another area that really enhances the way that you do research, the way that you think about approaching problems.”

## meeting a need

SEAS trainees are required to take nine credit hours of core coursework in materials science and engineering, mathematics and statistics, and at least three credit hours in elective coursework outside of their home discipline. The coursework comprises a new Graduate Certificate in Materials Informatics that will be offered in fall 2020, further filling the need of data-driven scientists in the workforce. As director of the undergraduate program in MSE, Yingling hopes to also establish an undergraduate level class in materials informatics and eventually an undergraduate materials informatics concentration.

“Students in math and statistics would not normally be taking an atomic crystallography course or a materials informatics course and vice versa,” Wright said. “Prior to this program there was not much overlap in these particular fields.”

Yingling said that additional training in data science affords materials science and engineering students a significant hiring advantage and a higher starting salary. **Nicole Creange**, a fifth-year MSE Ph.D. student, came to NC State after earning a bachelor’s degree in physics from James Madison University. Under the mentorship of Dickey, who serves as director of SEAS, she started as a Fellow in 2016 and has developed her research to incorporate statistical methods into the analysis of atomic structure-generated data and is completing an internship at Oak Ridge. Creange, who hopes to secure a position in industry or with a national laboratory, said her SEAS training in data science has made her much more prepared for opportunities after graduation.

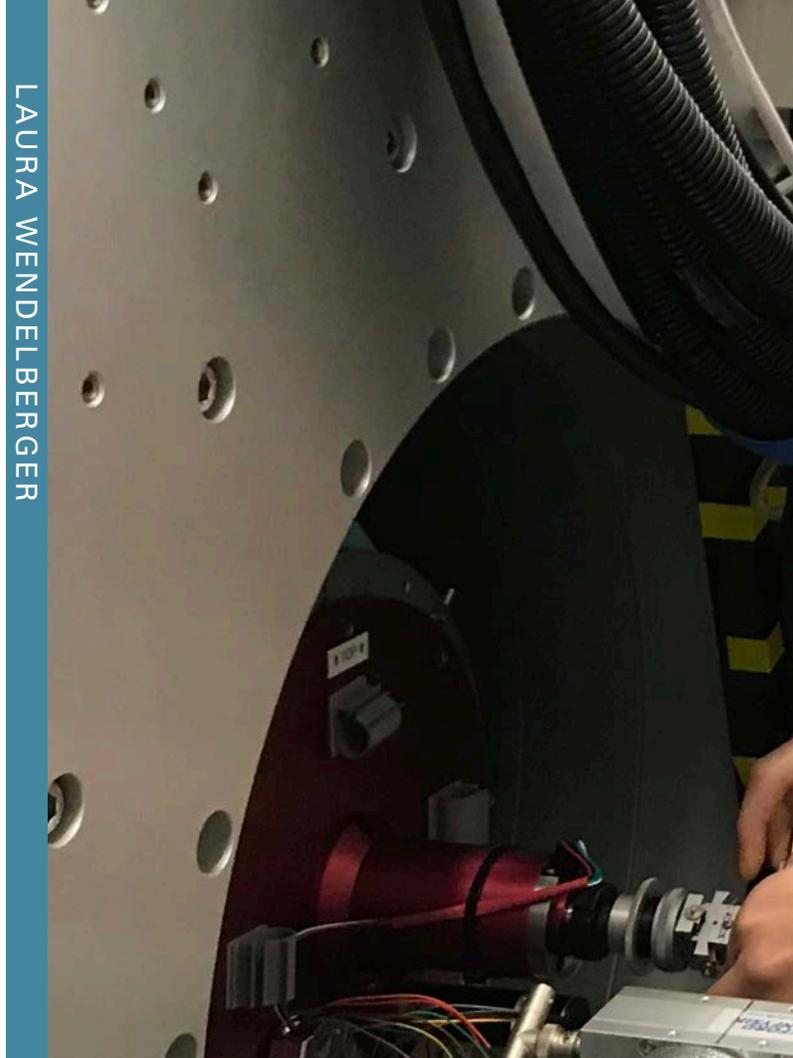
“It’s opened more doors, especially at Oak Ridge, for future jobs,” Creange said.

SEAS graduates have secured positions as data analyst at Johns Hopkins Applied Research Lab, data scientist at Citrine Informatics and postdoctoral researcher at the University of Sydney.

Dickey said members of SEAS’ industrial advisory board have emphasized the need for materials engineers to have a working knowledge of using data in order to hit the ground running after graduation.

“They definitely sent a clear message that these skill sets are now an expectation.”

LAURA WENDELBERGER



## charting a path

SEAS is one of a suite of efforts being undertaken at NCCU to help smooth the transition from bachelor’s and master’s studies in the sciences at an HBCU to a Ph.D. program at a research-intensive university. For example, NCCU’s NSF-funded DREAM STEM project works to attract, retain and train undergraduates from underrepresented groups to science degree programs. Also, NCCU participates in a 3+2 program with the College of Engineering at NC State; the program allows students to earn a dual B.S. in math or physics from NCCU and in electrical engineering from NC State.

Dr. Caesar Jackson, professor, and Dr. Kimberly Weems, associate professor, in NCCU’s Department of Mathematics and Physics coordinate the SEAS program in conjunction with Wright. They spend a lot of time recruiting at events held by the National Society of Black Engineers, National Society of Black Physicists, Math Alliance and other professional organizations.

Weems says that SEAS provides NCCU students with important support structures like writing workshops and GRE preparation that enhance their academic training. Exposing the students to research and the culture of a Ph.D. program is



important to overcoming impostor syndrome, a feeling of inadequacy that often affects high-achieving students from underrepresented groups. “Our goal is to encourage students to pursue Ph.D.s in STEM fields,” she said. “SEAS is a way of doing this, and, so far, we’ve been very successful.”

NC Central master’s graduates who have participated as SEAS Fellows have gone on to Ph.D. programs in mathematics at NC State and Howard University. After completing a master’s degree in applied mathematics, **Shana McDowell** accepted a position as a senior data technician in Duke University’s Structural Biology and Biophysics Program, an offer that resulted from a summer internship for which she was competitive because of her data science knowledge and training. “My main motivation for joining the SEAS program was gaining experience in quantitative research,” she said.

McDowell was accepted into the biostatistics Ph.D. program at the University of Alabama at Birmingham in 2019. She is currently looking to expand her graduate school opportunities and plans to begin her Ph.D. studies this fall. ■



NICOLE CREANGE



SHANA MCDOWELL

ASSIST platforms allow for a wide range of **health applications**

# CHECK-UP

When engineering researchers were tasked by the **National Science Foundation (NSF)** with creating wearable, self-powered health monitoring devices to help patients suffering from chronic diseases, a couple of uses came to mind early on.

The team behind the **Center for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST)** first looked at systems that can monitor heart rate or help an asthmatic head off an attack by monitoring both his respiratory rate and the condition of the air around him. Researchers in the NSF **Engineering Research Center (ERC)** led by **NC State**, have developed research that could lead to wearables that help with wound healing, diet management for pre-diabetics and even medication compliance.

And once ASSIST platforms are built and made available for physicians and their patients, the use scenarios could continue to grow.

While wearable devices that count steps or even take a heart reading are popular and available on the market, the ASSIST vision dramatically increases the amount of useful health data collected and does it without forcing a patient to change batteries or recharge the device by utilizing power created by the human body. An always-on ASSIST device will produce valuable data on chronic medical conditions that will benefit not only an individual patient's doctor but, when combined with the data from thousands of patients, physicians treating the same illnesses around the globe.

"This can be a real disruption in health monitoring," said **Dr. Veena Misra**, director of ASSIST and Distinguished Professor in the Department of Electrical and Computer Engineering (ECE) at NC State. "There's nothing like that out there right now."

## DUAL-PLATFORM APPROACH

NSF awarded the ASSIST ERC in 2012 to a team that includes collaborators from Florida International University, Penn State University and the universities of Michigan, Notre Dame, Virginia, Utah and North Carolina. With the award, NC State became just the second university to lead two ERCs at once and one of just two universities to ever take the lead role in three.

Over seven years, ASSIST has developed two platforms — a health and environmental tracker (HET) that measures vital signs and environmental exposures running on a long-lasting battery and a self-powered, adaptive sensing platform (SAP) that takes electrocardiogram readings and is powered by energy harvested from the human body. Along the way, research projects have broken new ground both in how much power can be pulled from the human body and in how little power sensors and radios that transmit data from a wearable to a cell phone can use to operate. One breakthrough was in using liquid metal to fabricate flexible thermoelectric devices that can pull energy from the body more efficiently.

Other research thrusts within ASSIST are working on how to make devices comfortable to wear and how to crunch all the data that will be produced from patient monitoring.

As the center moves forward, all of that work is being integrated together into these platforms that drive multiple sensors and operate in a self-powered mode.

Then the types of health monitoring cases available can grow. ASSIST researchers are also looking at what information can be drawn from sweat or interstitial fluid from just beneath the skin. With that type of data, physicians might be able to tell whether a diabetic patient is following dietary guidelines or whether the person wearing the device is taking her medication on schedule.

## OUT OF THE LAB

ERCs receive funding from NSF for 10 years. With year eight on the horizon, ASSIST's leadership team is already looking toward funding that would keep the center going past a decade and what its vision would be.

During a site visit with NSF officials in 2019, ASSIST successfully demonstrated a self-powered electrocardiogram wearable that is built into a shirt.

"We are going to focus in year eight on maturing it, working with external partners to scale it and reliably test it and then, hopefully, commercialize it," Misra said. Other versions of an ASSIST platform could take the form of a wristband or even a device worn under the skin.

Finding an industry partner to produce an ASSIST device is an ultimate goal, but some of the center's technology may find uses elsewhere. The energy harvesting advances, for instance, could help industrial machines make use of the heat they produce for devices that sense temperature, humidity or vibration.

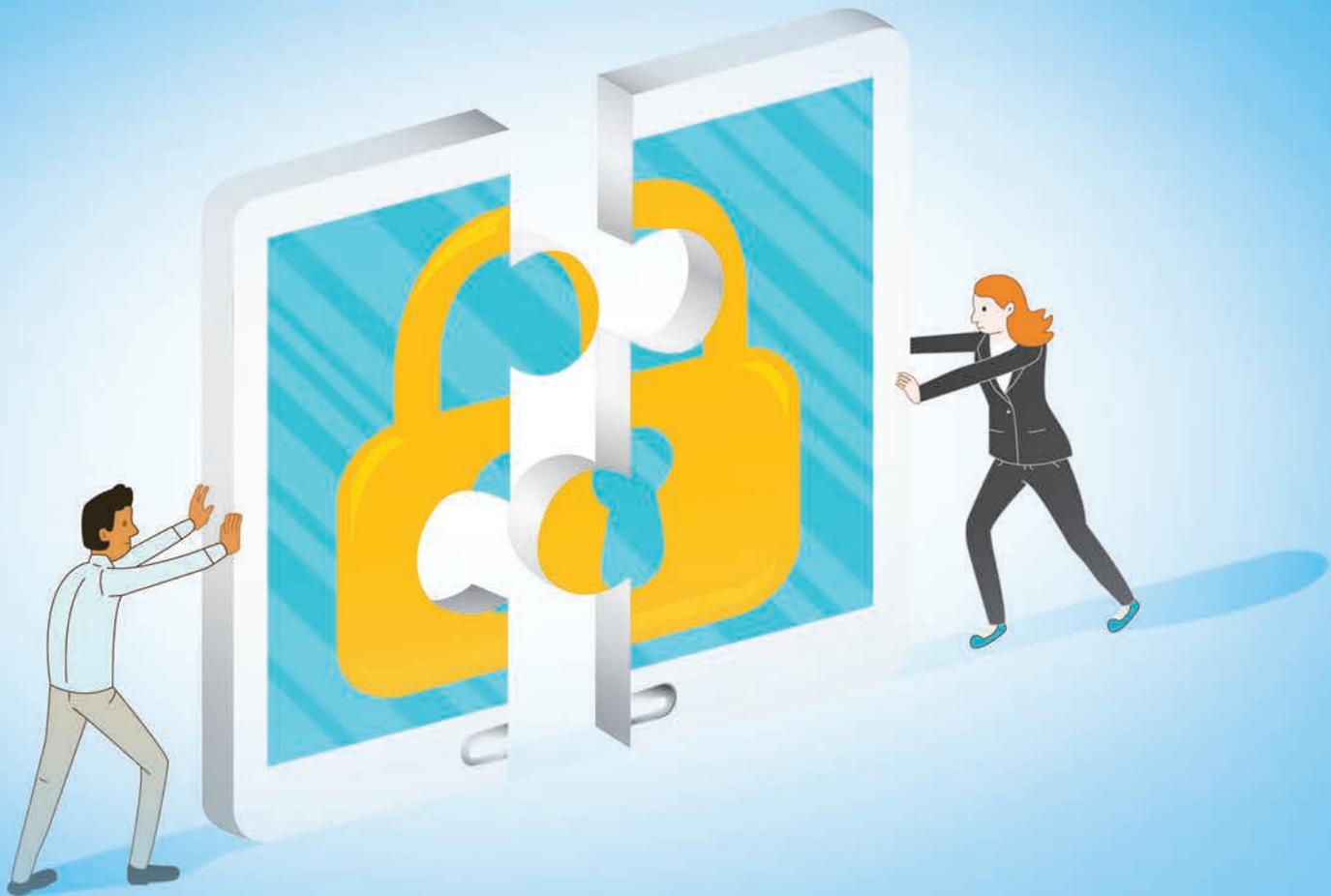
For now, ASSIST's work is being put through small-scale clinical trials at the School of Medicine at UNC-Chapel Hill to test their usefulness for physicians.

"I think success for ASSIST will be putting together systems that work and that can be used in small-scale medical studies to prove the concept," said **Dr. Mehmet Ozturk**, ASSIST deputy director and professor in ECE. "I think we need the doctors' word that yes, indeed these devices are useful for monitoring these conditions." ■

"This can be a real disruption in health monitoring... There's nothing like that out there right now."

**DR. VEENA MISRA**





# Secure State

In 30 years of teaching and research in the area of network and software security, **Dr. Douglas Reeves** has seen the landscape change drastically.

Hackers were once interested mostly in the notoriety, proving that they could break the most impenetrable systems, said Reeves, a professor in the Department of Computer Science (CSC). That changed in the mid-2000s, when organized crime saw the potential for profit and became very interested in cyberattacks.

“The motive for attacks has changed significantly over the last 20 years,” Reeves, who is also the College’s associate dean of graduate and international programs, said. “It’s much higher stakes.”

The CSC department is enhancing its research and education efforts with expanded offerings for undergraduate students, scholarship opportunities and a new cybersecurity research center.

The move will help meet a growing need for

research that leads to more secure systems and for trained professionals to work in the industry. Cyber Seek, a website that provides data about supply and demand in the cybersecurity job market, reported that in North Carolina alone, 34,379 people are employed in the field and 19,657 job openings were listed between October 2018 and September 2019.

“The good news for students, of course, is that there are just unlimited opportunities,” Reeves said.

## FROM EDUCATION TO RESEARCH

The department launched a master’s track in security in 2017 and an undergraduate track in 2019. At the same time, CSC has received a \$2.75 million award from the National Science Foundation (NSF) to launch a CyberCorps Scholarships for Service program that is available to undergrad and graduate students specializing in cybersecurity. Five scholarships will be awarded annually.

“

In order to know what defense to play you need to know how the attackers play.

DR. ALEXANDROS KAPRAVELOLOS

”

In addition to full tuition, the two-year scholarships provide a generous stipend, health insurance and an allowance for other professional expenses. In return, students agree to work after graduation with a federal, executive-branch government agency for an equal period of time. A newly created director of cybersecurity education position will oversee the undergraduate concentration and the scholarship program.

On the research side, the Secure Computing Institute (SCI) created in 2019 will pull together much of the work and funding already in place in CSC and other parts of the University. Chief among them is NC State’s Science of Security Lablet, a National Security Agency program that has brought \$19 million in research to NC State since it was established in 2012. Science of Security Lablets are multi-disciplinary labs at a handful of leading U.S. research institutions that promote security and privacy science as a recognized field of research and encourages rigorous research methodologies.

The institute and undergrad concentration will both include a strong industry component, enabling partner companies that work in cybersecurity or need more of it to benefit from research collaborations and have mutually beneficial interactions with students.

The department has eight faculty members in security and privacy, in areas ranging from cryptography to the security and privacy risks of sensors embedded in modern smart electronics, telephone networks and Internet of Things-enabled devices.

“We’ve worked very hard to create a really rounded-out security group that complements each other well,” said **Dr. William Enck**, associate professor in the department and co-director of SCI.

## THE BEST DEFENSE IS A GOOD OFFENSE

In order to teach students to be good defenders, **Dr. Alexandros Kapravelos** teaches them to be attackers.

As part of his undergraduate and graduate security classes, Kapravelos, an assistant professor of computer science, introduces his students to common cyber-attacks and has the

students try them out in a test environment. It’s the same idea behind HackPack, a student organization interested in cybersecurity that Kapravelos advises. Each spring, the group holds a Capture the Flag event that involves teams competing to solve security challenges.

“Fundamentally, in order to know what defense to play you need to know how the attackers play,” Kapravelos said. “So, hopefully when they build software for a company, they will be more aware of the security problems that may be introduced.”

Today’s cybersecurity landscape includes thieves looking to empty your bank account, but also governments that want to gain access to other countries’ infrastructure and companies trying to steal intellectual property from competitors.

Enck says that, despite all of the headlines about hacks that steal our data or threaten the U.S. energy grid, our systems are better prepared today than decades ago.

“Systems are more secure, but there are more attackers and they are better equipped. Both are true.”

And we have more to lose. Kapravelos points out that when hacking was mostly done to prove a point, there wasn’t much to gain. Today, our bank accounts and so much of our valuable personal data are online.

Most successful attacks, **Dr. Laurie Williams**, Distinguished Professor of Computer Science, says, fall under what she calls social engineering, relying on a human mistake instead of a hole in a system. An email disguised as a message from a friend tricks you into sharing important information. Someone claiming to be an IT technician for your company hands you a USB drive that you plug into your computer.

Security risks are everywhere, from airplanes to self-driving cars. That’s why, instead of offering a degree program that would focus solely on cybersecurity (the route that some universities have chosen), NC State CSC’s intention is to give students a broad knowledge base that includes security concepts for whatever platform they are working on, said Williams, who is also a co-director of SCI.

“We’re trying to create computer scientists who are also experts in security,” she said. “You need that domain expertise, plus security.” ■

## Making a mark

### You can establish a legacy in Fitts-Woolard Hall

Tours of Fitts-Woolard Hall are in high demand.

Groups of alumni, faculty members and students are lining up to get a closer look at the College's newest building on NC State's Centennial Campus. And even though work on the innovative new building isn't complete, it's easy for visitors to see how remarkable it will be.

The new home of the Edward P. Fitts Department of Industrial and Systems Engineering (ISE); the Department of Civil, Construction, and Environmental Engineering (CCEE); and the dean's administrative offices is scheduled to open this summer and will hopefully be ready when students return to campus for the fall 2020 semester.

The building is organized around the theme of "engineering on display," placing laboratories of the two departments in prominent spots so that visitors can understand the important work going on inside.

In these labs, faculty members and students in CCEE and ISE will work to make manufacturing and infrastructure smarter and to make our environment cleaner and our healthcare more efficient. Alumni who are supporting the construction of Fitts-Woolard Hall are able to choose a space of personal meaning to name. Many donors have named spaces in honor or memory of someone who was important to their



education, or selected a lab because they value this aspect of the academic experience. *(You can meet some of these alumni donors and learn why supporting the project is so important on page 34).*

Fitts-Woolard Hall is a vital next step for the College as it continues to grow in both size and national prominence. With this new facility in place, and more of the College moved to Centennial Campus, NC State Engineering can continue its upward trajectory as it moves toward a goal of being one of the most preeminent public colleges of engineering in the United States.

"You can't really attract, retain and develop the people, the outstanding students and the promising young faculty members, that you need to reach that goal if you don't have the best world-class infrastructure to support them," said **Dr. Louis Martin-Vega**, dean of the College.

### A CONSTANT CHALLENGE

Fitts-Woolard Hall represents a new public-private model for funding construction, a first for a campus building in the University of North Carolina System.

The \$154 million project received \$75 million from the voters of North Carolina through a 2016 bond

#### HELP FILL THE GAP

Contact Erica Fuller with the NC State Engineering Foundation at [eacinder@ncsu.edu](mailto:eacinder@ncsu.edu) or **919.515.9958** to learn more about how you can contribute to the fundraising effort for Fitts-Woolard Hall.





referendum. The NC Legislature provided an additional \$2 million in design funding and the University is providing \$17 million for support infrastructure. The College pledged to contribute \$60 million through private philanthropy and currently has commitments of over \$48 million, thanks to the generosity of more than 300 alumni donors and a lead gift of \$25 million from industrial engineering alumni Edward P. Fitts and Edgar S. Woolard.

With its opening, eight of the nine academic departments within the College will have relocated to Centennial. ISE and CCEE will leave behind facilities on North Campus built more than 50 years ago that currently make both teaching and research challenging.

Being on Centennial Campus puts the College on one of the country's most innovative campuses, where students and faculty members are in proximity to leading companies and government agencies, enabling enhanced interdisciplinary and industrial collaborations.

Over more than a decade, the College has staked its claim as one of the preeminent public colleges of engineering in the United States by growing its research infrastructure and successfully competing with peer institutions to recruit the best faculty members and students. The transition to Centennial has been a major part of this leap forward.

At the same time, no one is standing still; universities around the country are making substantial investments in engineering education and research.

"We are in pretty elite territory and it hasn't been easy to get there," Martin-Vega said of the College's stature. "We're delighted that we're there. It's a constant challenge to stay there."

Though Fitts-Woolard Hall will soon be a reality, how the project will ultimately be paid for isn't fully known. With more than \$11 million of the College's commitment left to be raised, it's important for alumni donors to step up and help fill the gap. The alternative — for the College to take on debt to finish construction — would mean a financial burden that negatively impacts students and faculty members.

"We hope alumni will continue to step forward with support at any gift level," said **Griffin Lamb**, assistant dean for development and college relations and executive director of the NC State Engineering Foundation. "This fundraising project is unique in its visibility and potential to demonstrate the collective power of our donor community. That philanthropy is literally on display in this building not only syncs with our engineering on display theme but also models the role of philanthropy to our students." ■

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**"Philanthropy is literally on display in this building..."**

**GRIFFIN LAMB**

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## Alumni donors know that Fitts-Woolard Hall is more than a building

Fitts-Woolard Hall, the College's newest building on NC State's Centennial Campus, will open this summer and with a goal of being ready for the arrival of students back to campus for the fall 2020 semester.

The new home of the Department of Civil, Construction, and Environmental Engineering; the Edward P. Fitts Department of Industrial and Systems Engineering; and the dean's administrative offices represents a pivotal moment in the history of the College.

Taking another big step toward finishing the move to Centennial will continue NC State Engineering's climb to a leading spot among public colleges of engineering in the United States.

More than 300 alumni donors have supported the College in its effort to raise \$60 million in private donations to help fund construction. Meet two couples who have made support of the project a priority and learn why they decided to give.

### SCOTT AND BETH STABLER

As a high school senior in Delaware, **Scott Stabler** visited the University of Delaware, Virginia Tech and NC State before deciding to come to school in Raleigh.

"It just felt right," Stabler remembers.

Next came a major. Stabler, whose parents both worked for DuPont, first looked at chemical engineering. But he soon found that mechanical engineering was a better fit.

NC State was a good fit, too. He joined a fraternity, Sigma Chi, and made lifelong friends. Several students in the house were also engineering students, and it was an important connection for a student from out of state.

Stabler met his wife, **Beth**, a native of Williamsburg, Va., who was studying nearby at Meredith College. The couple still loves to return to Raleigh for football games and alumni events at NC State and Meredith.

He started his career at the Naval Weapons Station in Yorktown, Va. Then a roommate who worked at Newport News Shipbuilding (NNS) invited Stabler to come take a look. It was the start of a 35-year-career at NNS and its parent company, Huntington Ingalls Industries.

Stabler, who is now the executive vice president and chief transformation officer for Huntington Ingalls, has worked in engineering, purchasing, business development and program management over his career. He went on to earn a master's degree in business administration from the College of William and Mary.

FROM LEFT, SCOTT STABLER, MAE '82, WITH WIFE, BETH AND GERALD WHITE, MSE '60, WITH WIFE, NANCY.

From 2001 to 2009, he was directly responsible for program management and construction of the last Nimitz-class aircraft carrier, USS George H.W. Bush, and points to the time as a career highlight.

"That was absolutely my marquee work experience inside the shipyard," he said.

Stabler shares that his NC State engineering degree set him up well for his career.

"It gives you a calling card," he said. "It gives you a door opener to a lot of things. You've got to prove it once you get into the door, but it does open a lot of doors."

He has stayed involved with the University as a member of the Wolfpack Club and has served on the advisory board for the Department of Mechanical and Aerospace Engineering (MAE) and the NC State Engineering Foundation board of directors. In 2013, he was selected for the inaugural class of MAE's hall of fame.

So, when the Stablers heard the College's call for help supporting the construction of Fitts-Woolard Hall, they knew that the investment as Dean's Oval Club members would be worth it. "We're grateful for the foresight of those who made these investments and we're glad to help make a difference for the generations that are coming after us," Beth Stabler said.

## GERALD AND NANCY WHITE

When he heard Dean Louis Martin-Vega speak in Charlotte about the College's plans to raise \$60 million to help fund construction of Fitts-Woolard Hall (FWH), **Gerald White** was already a generous donor to the College.

White and his wife, **Nancy**, established the Gerald M. and Nancy A. White Scholarship. In partnership with his nephew **David White**, the couple had also established the Dr. William Austin Fellowship to honor

a former department head in what was then NC State's Department of Mineral Industries.

"(Martin-Vega) stepped forward and put his view on it that the alumni and friends of the University ought to take the lead in funding for the project," said White, who earned his bachelor's degree in metallurgical engineering in 1960.

"I thought that I had to contribute."

After graduating with his bachelor's degree, Gerald White worked at Douglas Aircraft in Charlotte in the metallurgical lab. He then went on to work at Industrial Piping Inc. as a fabrication engineer. In 1984, his friend John Ward offered him a partnership in Ward Tank & Heat Exchanger Company — a company that designs and fabricates custom shell and tube heat exchangers and pressure vessels. Gerald White retired in 2007 but remained a partner in the company and a member of its board of directors for several years.

Both Gerald and David White, who earned a bachelor's degree in materials engineering in 1973 and a master's degree in 1980, attribute their successful careers to NC State and to Austin's support and encouragement. The Austin Fellowship supports graduate students in today's Department of Materials Science and Engineering (MSE) and the White Scholarship goes to MSE undergraduates.

"He was the epitome of a Southern gentleman and a great teacher," Gerald White said of Austin.

The Whites became reconnected with the University about eight years ago and began thinking about supporting Gerald White's home department.

When the College began talking to alumni about Fitts-Woolard Hall, Gerald White was particularly impressed with Martin-Vega's contribution to the project. Martin-Vega and his wife, Maggie, made a lead gift to establish the Dean's Oval Club for FWH donors of \$50,000 to \$99,999.

"If he can do it, maybe the rest of us ought to really get behind him," White remembers thinking.

Gerald White hopes that many more alumni of the College will follow their lead.

"There's still a big need and an opportunity for everyone else to contribute. This, to me, is kind of an historic event." ■

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"We're glad to help make a difference for the generations that are coming after us."

**BETH STABLER**

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NC STATE

# THINK AND DO THE EXTRAORDINARY



The Campaign for NC State

# \$1,617,927

## College closes in on campaign goal

In November 2019, Chancellor **Randy Woodson** announced that Think and Do the Extraordinary: The Campaign for NC State had met its overall fundraising goal of \$1.6 billion two years ahead of schedule.

The College of Engineering established its own goal during the campaign to raise \$230 million. **Griffin Lamb**, assistant dean for development and college relations and executive director of the NC State Engineering Foundation, said that the College, like some other units on campus, is still working to meet its goal, but is close with roughly \$15.4 million left to raise.

"We in engineering have seen an incredible response to the areas of greatest need like Fitts-Woolard Hall, but we still have a gap," Lamb said.

The College's campaign fundraising priorities include student scholarships, professorships, the construction of Fitts-Woolard Hall and many more areas requiring private, programmatic support, such as the College's Women and Minority Engineering Programs (WMEP).

With the campaign under way, the University broke ground on the new building in April 2018. Fundraising efforts for the building benefitted from a \$25 million gift from alumni **Edward P. Fitts, Jr.** and **Edgar S. Woolard, Jr.** It will be home to the Department of Civil, Construction, and Environmental Engineering (CCEE); the Edward P. Fitts Department of Industrial and Systems Engineering (ISE); and the dean's administrative offices, unifying the College on Centennial Campus.

"I've been a strong proponent for a number of years of having Centennial Campus completed," said **S. Frank Culberson**, the College's campaign chair. "I am

really pleased at where we are; I think we'll raise the remaining money in due time."

Lamb agreed, pointing out that continued support can help the College reach its goal ahead of the official end to the Think and Do the Extraordinary Campaign in December 2021.

"A campaign is about coming together, and so is our move to Centennial Campus," Lamb said. "Together as one community we'll forge ahead to finish the building, and to finish our campaign goal of \$230 million."

### Success so far

The College's success to this point has been about its people. Lamb said the College has seen people step forward with first-time large leadership gifts, as well as many first-time contributors.

At the same time **Deborah Young**, vice president of the Foundation's board of directors and an advocate for inclusion of all people at any level of support, said a push for increased openness and transparency brought more people on board during the campaign.

"When people have more knowledge, they have more passion," she said. "The success of your College includes your entire College — whether it's \$1 or \$1 million, if we all work together we'll be more successful."

With the fundraising success will come even greater student success. The University announced that support from the campaign means students will benefit from:

- 656 new scholarships and fellowships

"The success of your College includes your entire College... if we all work together we'll be more successful."

DEBORAH YOUNG



ABOVE, FROM TOP, FRANK CULBERSON, CHE '60, GRIFFIN LAMB, NELSON PEELER, EE '88, DEBORAH YOUNG, CE '77.

- 89 distinguished faculty positions, which support outstanding professors and foster excellence in teaching, learning and research
- 2,200 newly established funds that will enhance campus programs; nearly half of these are already endowed

### Taking the College over the finish line

Within the College, Lamb called the completion of Fitts-Woolard Hall an all-hands-on-deck situation. Though it houses CCEE and ISE, the alumni base as a whole can come together to support the new building, she said. Those who support Fitts-Woolard Hall can choose to receive recognition in their home department's own building if they prefer.

With less support coming from the state of North Carolina, Lamb said philanthropy has become increasingly important. Everyone is asked to consider giving at a level of personal leadership, Lamb said.

"Sometimes when you have such a large goal, we know it can't all be on the shoulders of one person," she said. "Campaigns are never about one person — they are about what we can achieve together to make our College community a stronger academic community."

It's important, too, to remember that the effects will be felt beyond NC State, said Nelson Peeler, president of the Foundation board. For Peeler, it's become a personal passion project for him to see the school succeed and the results it has for the state of North Carolina.

"The business I work in is very engineering intensive; we have a lot of interaction with the University, both from the student standpoint and the University's research," said Peeler, who is senior vice president and chief transmission officer for Duke Energy. "We have a stake in the University being successful."

"For businesses and the state of North Carolina, the College of Engineering is a big economic driver," he said.

### Making NC State even more accessible to all

NC State may have met its overall goal, but the University is not done yet — recently reaffirming its commitment to make NC State more accessible for all students.

Currently, more than 72 percent of undergraduates apply for financial aid, and the average need is \$16,431. Though it is recognized as a top value in education, the University continues to lose motivated and promising low- to middle-income students to institutions that are better positioned to meet their financial needs.

NC State is asking supporters to answer the call for continued support to aid students, no matter their family background or what corner of the state they call home, in having the opportunity to enroll at NC State.

"We've reset our goals to be more inclusive and more effective, to give support to those who really need it," Culberson said. "We've already got some strong scholarships going, we just need more people to step up to the plate." ■

## Alumni return to campus for homecoming

“This is more than bricks and mortar...”

**DEAN LOUIS MARTIN-VEGA**



**Dr. Richard Nance** earned his bachelor’s and master’s degrees in industrial engineering from NC State in the 1960s.

Nance has been to campus several times since, to interact with faculty colleagues, for induction into the Edward P. Fitts Department of Industrial and Systems Engineering’s (ISE) first Alumni Hall of Fame class in 2006 and to serve on the advisory committee for the Computer Simulation Archives housed in the NC State Libraries. He and his wife, Barbara Page Nance, were back again for the College’s 2019 homecoming event, held in early November.

The College’s homecoming activities held on Nov. 7-8, 2019 included a barbecue lunch, tours of the new Fitts-Woolard Hall and a young alumni social.

After earning a Ph.D. at Purdue, Nance held faculty positions at Southern Methodist University and then Virginia Tech, where he served as the computer science department head (1973-79). The Raleigh native grew up watching NC State men’s basketball under legendary head coach Everett Case.

“NC State was, for me, the place to come,” he said.

Homecoming gave the Nances a chance to check out the growing Centennial Campus, including its newest showpiece, Fitts-Woolard Hall.

The new home of ISE; the Department of Civil, Construction and Environmental Engineering; and the dean’s administration is scheduled to open in summer 2020.

Visiting alumni were invited to take tours of the building and see where innovative labs and teaching

spaces will offer students an interdisciplinary engineering education that is second to none.

The College has pledged to raise \$60 million in private funding to support construction of Fitts-Woolard Hall, and alumni learned about naming opportunities available within the building or the existing engineering buildings on Centennial that offer an opportunity to leave a permanent legacy at NC State. The College still needs \$11.8 million in commitments to avoid taking on debt service to complete the building.

**Dr. Louis Martin-Vega**, dean of the College, told alumni during a lunch presentation that completing the new building is essential to continuing the College’s growth as one of the nation’s top public colleges of engineering. Over the last decade, the College has made tremendous strides in national rankings, increasing research infrastructure and the number of women faculty members.

With the opening of Fitts-Woolard Hall, eight of the College’s nine academic departments will have relocated to Centennial. Making the move is essential to the College’s continued development.

“This is more than bricks and mortar,” Martin-Vega said. “This is what underpins the success of the faculty and the success of the students.”

**Griffin Lamb**, assistant dean for development and college relations and executive director of the NC State Engineering Foundation, said that, along with making a contribution toward Fitts-Woolard Hall, there are many ways for alumni to become involved with the College and lend support.

They can endow a scholarship or make a donation during NC State’s next Day of Giving. Acting as a mentor to a current student, serving on an advisory board or attending an event are also great opportunities.

“Please don’t wait until the homecoming to return again,” Lamb said. “This is your campus.” ■



FROM LEFT, JOHN C. BRANTLEY, III, CE '64; STEFFANIE B. EASTER, CHE '85; AND JACOB T. "JAKE" HOOKS, MSE '78.

## Brantley, Easter and Hooks receive DEA awards

The College bestowed the Distinguished Engineering Alumnus (DEA) award on **John C. Brantley, III**, **Steffanie B. Easter** and **Jacob T. "Jake" Hooks**. **Dr. Louis Martin-Vega**, dean of the College, recognized the three distinguished graduates at a banquet on Nov. 6. Brantley could not attend the ceremony.

Brantley earned his bachelor's degree in civil engineering in 1964. After working with the Federal Aviation Agency and a private engineering firm, he founded an airport planning and design consultancy. He joined the Raleigh-Durham Airport Authority in 1977 as an airport contractor and in 1982 became the airport director, a position he held for 29 years. From 1982 to 2016, he taught / co-taught a biannual course in airport planning and design in the Department of Civil, Construction, and Environmental Engineering (CCEE) at NC State as an adjunct assistant professor of civil engineering (later adjunct professor of the practice). He also helped create an advisory board for the department and served on the board for five years.

He and his wife, Marilyn, established the John C. Brantley, IV Alumni Memorial Scholarship in Civil / Construction Engineering in memory of their eldest son, who passed away three months after graduating from NC State. In 2012, they established the Bruce E. Matthews Memorial Scholarship in Civil / Transportation Engineering in memory of Matthews, with whom Brantley co-taught the CCEE course.

Easter earned her bachelor's degree in chemical engineering in 1985 and received a master's degree in engineering from the Catholic University of America. As director navy staff, she serves as the senior chief naval operations (OPNAV) civilian and coordinates enterprise-level efforts across the entire OPNAV staff.

In this role, she ensures alignment of more than 400 flag officers and senior executives, providing indispensable advice and support to the Chief of Naval Operations and the Secretary of the Navy. Previously, she served as acting assistant secretary of the Army for acquisition, logistics and technology.

She has received the Army Exceptional Civilian Service Award, the Meritorious Executive Presidential Rank Award, the Secretary of Defense Meritorious Civilian Service Award, the Secretary of the Navy Distinguished Civilian Service Award, the Navy Superior Civilian Service Award and the Navy Meritorious Civilian Service Award.

Hooks earned his bachelor's degree in materials science and engineering in 1978. After a 35-year career at Eaton Corporation, he retired as president of Automotive North America and is a former member of the Nittan Valve Co. Ltd. Board of Directors. He is a graduate of the University of Michigan's Executive Program and completed the Global Leadership 2020 program at Dartmouth College's Amos Tuck School of Business. Hooks serves as development chair for the NC State Engineering Foundation, has served on the Park Scholars Selection Committee and is on the NC State Foundation Board.

He and his wife, Jennifer, established the Jacob T. Hooks, Sr. Scholarship in Materials Science and Engineering (MSE) in honor of his father, who also studied at NC State. They have also established a planned gift that will create a distinguished professorship in MSE and are Cornerstone donors for Fitts-Woolard Hall. Hooks is a lifetime member of the Alumni Association, a member of the R.S. Pullen Society and a member of the W.C. Riddick Society. ■

# THE IMPACT OF DAY OF GIVING

## A look back at 2019

### ON MARCH 27, 2019,

NC State University hosted its inaugural Day of Giving — a 24-hour fundraising campaign to maximize support for the University, College and other units on campus. Thanks to the College of Engineering's students, alumni and friends, \$2,171,468 was raised from 1,568 gifts — more gifts received on the day than any other college or program and the second-most dollars raised overall. The gifts received help support innovative research, scholarships, study abroad and other education programs for the College's students.

Highlights from the day include:



**\$1 million**

largest single gift of the day



**Singapore**

furthest donor from campus



**1,081 gifts**

of 1,568 gifts were made by College alumni



**449**

new donors making first-time gifts

### ONE OF THOSE FIRST-TIME DONORS

was NC State Engineering alumna **Jiyoung Shin**. She is a 2016 chemical engineering graduate who is part of the Engineering Foundation Young Alumni Advisory Board and is currently a quality engineer at Polyzen.

For Shin, she felt Day of Giving was the perfect opportunity to give back to the University that gave her so much.

"NC State has provided me with valuable resources and high quality education for me to be where I am today. As a proud NC State alumna, I wanted to give back to my alma mater so that my contribution can make a difference in the student life. I wanted to give back what I have received from the previous NC State alumni."

When thinking about what she would tell other alumni who are considering donating, she shared that she hopes they do.

"Your donation will make a difference in the education of developing future leaders. The amount you donate doesn't really matter. What truly matters is that you care about the growth of future generations and the place you can always call 'home.'"



JIYOUNG SHIN, CHE '16

### DAY OF GIVING 2020

was originally scheduled for March 25, 2020 — but in an effort to limit the spread of COVID-19 and to prioritize the health and safety of the community, the event has been postponed. A new date had not been selected at the time of publication.

The impact of COVID-19 is being felt by students in the University, from those that are under resourced, in need of emergency housing / travel funds, those who are unable to work or do not know when their next paycheck will be and those that lack the resources to participate in online instruction. To help these students, donations can be made to NC State's Student Emergency Fund. If you are interested in donating to help alleviate some of these students' financial burdens, please contact **Nicole Peterson**, executive director of development for the Division of Academic and Student Affairs, at [napeters@ncsu.edu](mailto:napeters@ncsu.edu) or online at: [go.ncsu.edu/sef](http://go.ncsu.edu/sef). ■

"What truly matters is that you care about the growth of future generations and the place you can always call 'home.'"

JIYOUNG SHIN



THE MADREN FAMILY, FROM LEFT: DR. ERIC MADREN, DR. LISA MADREN, BEN MADREN, LIBBY MADREN, JO ANN MADREN, FRANK MADREN, BRONTE BEDIN, COOPER BEDIN, CAROL BEDIN, DAYTON BEDIN AND MATT BEDIN.

## Endowment honors alumnus who valued education and knew the importance of scholarships



Alumnus **Frank Madren's** love of electrical engineering and computer science was surpassed only by his love for his wife of 55 years, Jo Ann Madren.

Three years after Frank Madren passed away in 2015, Jo Ann Madren honored his memory by endowing a merit-based scholarship at NC State in his name. The Frank Simpson Madren Scholarship Endowment is for undergraduate students in the College of Engineering with preference given to those with demonstrated financial need.

Both of the Madrens grew up on farms in Alamance County, NC, and attended Altamahaw-Ossipee High School, where they began dating. Their relationship flourished on a school bus, a bus he rode his bike through the woods to take because he liked to sleep longer.

Jo Ann Madren said, "My bus was full by the time he got on, so he would stand at the front. I was at the front because I was one of the first people on. He would stand over me and started talking to me."

They continued dating while he attended NC State and she attended Elon College, now Elon University. They were married in his last year of school.

Frank Madren was president of the Engineers' Council as a senior and graduated in 1961 with a B.S. in electrical engineering. He worked for two years at Procter & Gamble as an electrical engineer and then attended Harvard Business School, receiving his M.B.A. in 1965.

His love of computer science and technology took him back to work in North Carolina, where his daughter, Carol, and son, Eric, were born, and then on to Massachusetts.

The family moved to Los Gatos, Calif., in 1981. He had a successful business career there, working for several start-ups and eventually owning and building up his own, GarrettCom, a company that designs, manufactures and sells industrial networking products.

In 2010, Frank Madren sold GarrettCom to Belden Solutions. Afterwards, he traveled, spent time with family and was on several boards in Silicon Valley.

Jo Ann Madren explained why she chose to honor his memory with the scholarship endowment: "He really believed in education. I think there are a lot of young people who could use the help."

She said that he valued what scholarships could mean to an individual's life when they are trying to get ahead. The Aubrey Lee Brooks Scholarship paid for his education at NC State, and he received the J. Spencer Love Fellowship at Harvard.

Three of five grandchildren are now in college. Cooper Bedin is in his second year at the University of California, Berkeley, studying linguistics and computer science, and Ben Madren is a senior at the University of Mary Washington studying math. Libby Madren is in her first year at NC State in computer science, loving the discipline as her grandfather did and carrying on his legacy at NC State.

Frank Madren would be proud.

"He was a good guy," Jo Ann Madren said. "It has been a wonderful life." ■

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**"He was a good guy. It has been a wonderful life."**

**JO ANN MADREN,**  
*Wife of Frank Madren*

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## ANNUAL GIVING ENGINEERING FOUNDATION

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

Gifts from alumni like you keep the College moving forward by supporting faculty and student recruitment and retention efforts. Your donation is a great way to make sure the opportunity that meant so much to you is there for students today.

If you would like to include the College of Engineering in your yearly charitable donations, here are some options for giving back.

If you have already made your 2019-20 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 Erica Fuller at 919.515.9958 or [eacinder@ncsu.edu](mailto:eacinder@ncsu.edu).

### WAYS TO GIVE

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

### JOIN THE DEAN'S CIRCLE

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

### INCREASE YOUR IMPACT

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

**HOMETOWN**

Johnstown, Penn.

**GRADUATION YEAR**

2017

**DEGREE**

B.S., Biomedical Engineering

**CURRENT JOB TITLE**

Pharmaceutical Sciences, Ph.D. candidate at UNC-Chapel Hill

**YOUNG ALUMNI ADVISORY BOARD (YAAB)**

2018 — present

## HUNTER BOMBA

Once **Hunter Bomba** decided that she wanted to pursue a degree in engineering, she knew NC State was where she wanted to attend.

“Touring NC State was what solidified my decision. The information session hosted by the Engineering Ambassadors and **Brian Koehler** (the College’s director of student engagement) helped me visualize myself as part of the NC State community, and it was reassuring to hear the positive and inspiring stories from current students,” said Bomba. “Also, coming from the mountains in Pennsylvania, the thought of more warm, sunny days was also very enticing.”

Post-graduation, Bomba is a pharmaceutical sciences Ph.D. candidate at UNC-Chapel Hill. It is here that she works with a variety of physicians, scientists and engineers on collaborative research that she hopes will leave a lasting impact on patients in the future.

Though she is no longer at NC State, her ties to the University can be found in collaboration with the Nonwovens Institute in the Wilson College of Textiles as well as her most recent lab project with the College of Veterinary Medicine that looked at the safety and efficacy of stem cell therapy in a large-animal model. According to Bomba, this is a crucial step in pharmaceutical research before entering clinical trials.

“It was a huge undertaking for me as one of the newest members of the lab; however, it helped me enhance my project management and leadership skills. The best part about this project was collaborating with the College of Veterinary Medicine at NC State.”

Bomba shares that the skills and knowledge she gained at NC State continue to help her every day in graduate school. “From skills such as critical thinking and problem solving, to knowledge on biomaterials and equipment to evaluate mechanical properties, my education at NC State has helped me tremendously.”

Another big takeaway for her was working with students as a teaching assistant for E 101 and BME 204 courses. She is looking forward to continued mentoring of students in graduate school and has already had the opportunity to work with several students. “I’ve really enjoyed ‘paying it forward’ to the next generation of scientists and engineers.”

Outside of her studies, she and her dog Willis, a two-year-old mini golden doodle (@willis\_doodle on Instagram), are a registered therapy animal team. Currently, they visit the School of Pharmacy at UNC-Chapel Hill and are hoping to visit NC State’s campus soon. ■

For more information about the YAAB, please contact Erica A. Fuller, assistant director of development for the NC State Engineering Foundation, Inc., at **919.515.9958** or **eacinder@ncsu.edu**.



## Ways to give to the NC State Engineering Foundation

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

**ANNUAL GIVING:** Annual gifts to the College are generally for an unrestricted purpose. Gifts of more than \$1,000 qualify for membership in the Dean's Circle. Annual gifts from alumni are measured as "participation rate" and directly affect national rankings.

**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 "bricks and mortar" projects. Donors are given "naming opportunities." Opportunities include Fitts-Woolard Hall and other engineering buildings on Centennial Campus.

**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 as directed and approved by the dean of engineering. ■

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## MAN'S BEST FRIEND OFFERS EXAM STRESS RELIEF

Alumni may remember that finals week means long nights and a lot of stress. It's no different for today's students.

That's why two student ambassadors in the Department of Electrical and Computer Engineering (ECE) started a program in fall 2017 that brought dogs to campus for students to interact with and take a break from studying. Now called Mini Wolves of ECE, the program continues under the direction of current ECE ambassadors during both spring and fall exams.

On Reading Day — Wednesday, Dec. 11, for the fall 2019 semester — ECE's lobby in Engineering Building II (EB II) on NC State's Centennial Campus was a bustle with students waiting for a chance to spend 10 minutes in a scrum with puppies and adult dogs brought to campus by Peak Labs Rescue, a rescue group based in Apex, NC, that



works with Labrador retrievers and other breeds.

In the front of the lobby, couches were repositioned to form an impromptu dog pen.

"It's always hectic because puppies try to escape. That's why we have our ambassadors here," said **Leyla Muse**, a senior in ECE who will graduate in May and president of the group.

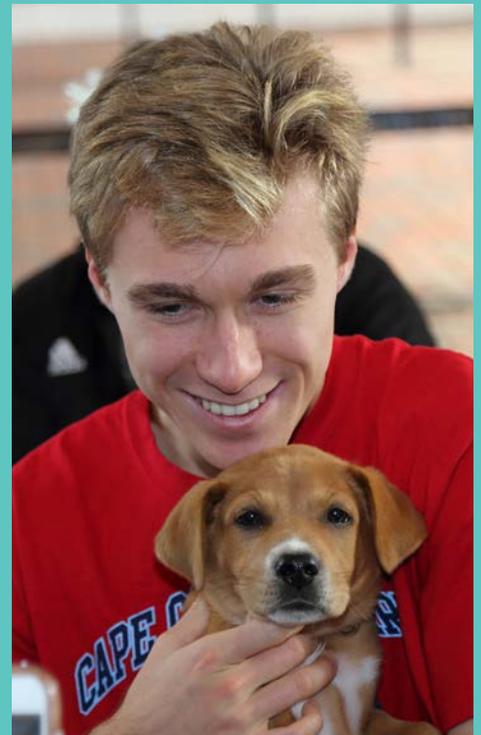
The ambassadors communicate with students by email and usually draw a large crowd. The event is always held sometime around finals or the last day of class. At the end of the spring semester, students and the dogs move outside to play in the grassy oval on Centennial that is ringed by engineering buildings.

Students were asked to make at least a \$1 donation to Peak Labs Rescue. After navigating a line so long that it climbed up the steps in the EB II lobby, groups of about 20 students were given 10 to 15 minutes to sit on the floor and snuggle with dogs that ranged in age from puppy to adult. Word has spread around campus, and students from other engineering departments and other colleges at NC State find their way over to take part.

Peak Labs Rescue has participated in the event several times, and Mini Wolves in ECE has even led to some adoptions, said **Ashley Robbins** an ECE senior who is the ambassadors' secretary and co-chair of the group's events committee.

**Kasyap Pasumarthy**, an ECE graduate student, finished his time with the dogs and immediately headed to the back of the line for another session. "I just pulled an all-nighter," Pasumarthy said. "It helps."

Electrical engineering junior **Laura Walker**



was joined by her friend **Emma Harrell**, a freshman who is majoring in human biology.

The two pointed out that many students have dogs at home that they weren't able to bring to campus and connecting with other dogs is therapeutic in many ways.

"Of course," Walker said, when asked if their time with the animals helped.

"They're dogs," Harrell added. ■

# Leaders Needed

Donors who support the College's Fitts-Woolard Hall project receive recognition and exclusive benefits as part of their important gift. Along with recognition in this iconic new engineering building, members will receive regular insider updates on the construction and will be invited to exclusive events, including hard hat tours of the space and the building dedication.



## Cornerstone Society

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*For gifts of \$50,000 to \$99,999*

You will receive permanent recognition with a donor profile in a central location in Fitts-Woolard Hall.



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*For gifts of \$25,000 over five years by young alumni up to 15 years after graduation*

You will receive permanent recognition with a donor profile in a central location in Fitts-Woolard Hall.

To learn more about how you can support Fitts-Woolard Hall and about membership in these groups, contact Erica Fuller with the NC State Engineering Foundation, Inc. at [ecacinder@ncsu.edu](mailto:ecacinder@ncsu.edu) or 919.515.9958.

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