

NC STATE

Engineering

FALL / WINTER 2019

RESEARCH AS RECRUITMENT

Summer research experiences help with student skills



RICHARDSON WAS COLLEGE'S FIRST WOMAN FACULTY MEMBER

Plans to build the first nuclear reactor on a university campus brought Frances Marian (Billie) Richardson to NC State in 1951. She ended up staying for 41 years. Richardson came to NC State as a research associate professor in the Department of Engineering Research and was the first woman faculty member in the School of Engineering. She retired from NC State in 1992 as an emeritus faculty member in the Department of Biological and Agricultural Engineering (BAE) and passed away in Raleigh in April 2018.

Fresh off graduate studies at Columbia University, Richardson was drawn to the reactor program because of her interest in nuclear chemistry. Her research and publications focused on the areas of fluid mechanics

and infrared imaging thermography, as well as respiratory physiology and tracing the flow of non-Newtonian fluids using radioactive tracer displacement techniques.

Born in Roanoke, Va., in 1922, she received a B.S. in chemistry from Roanoke College in 1943 and an M.S. in chemistry from the University of Cincinnati in 1947. From 1951 to 1980, she continued as a research associate professor in Engineering Research. From 1980 to 1983, she was associate director of the Engineering Operations Program. She then became associate professor of chemical engineering from 1983 to 1990 before joining the faculty of the BAE department until she retired.

Richardson and the late Professor Kenneth O. Beatty were lifelong professional collaborators in chemical engineering, including the development of the first biomedical engineering course at NC State, which she taught. In BAE, she helped undergird the developing biomedical engineering concentration and set the stage for the first ABET-accredited biomedical engineering program in the University of North Carolina System.

She received the Sigma Xi Research Award in 1959 and the Roanoke College Alumni Distinguished Service Award in 1970. She was also elected a Fellow of the American Institute of Chemists in 1969, and that same year she was a visiting professor of biomedical engineering at Case Western Reserve University. Richardson was elected the first president of the North Carolina Society of Women Engineers in 1979 and, in 1980, the society named her Outstanding Woman Engineer.

Through the years, her love of engineering was expressed through mentoring many women in engineering programs at NC State and in founding the Student Section of the Society of Women Engineers at NC State.

"It has always been important to me to see more women enjoy the engineering sciences, just as I have, and I believe strongly that mentoring and supporting women is one way to do this," she said in a 2003 interview. On page 18, learn more about the work of today's women faculty members in the College and the efforts being made to increase their presence on campus.

contents

FALL / WINTER 2019

FEATURES



16 IN OUR LABS

Explore the spaces where our engineering faculty members work. In this issue, visit the Virtual and Augmented Reality Lab in the Edward P. Fitts Department of Industrial and Systems Engineering.

18 MAJOR IMPACT

The College has increased the number of women faculty members over the last decade and promoted them to leadership positions in departments and centers.

24 BREWING UP A SUSTAINABLE COFFEE CUP

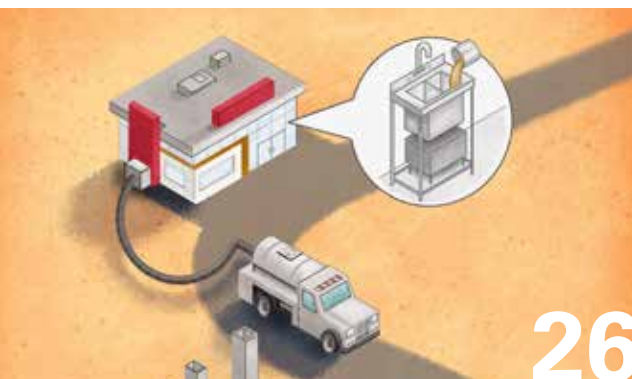
A student team develops a coffee filtration system that processes wastewater into clean water and fertilizer and is recognized in a global engineering competition.

26 FOG ALERT

Researchers in the Department of Civil, Construction, and Environmental Engineering are leading research on the impact of fats, oils and grease.

30 RESEARCH AS RECRUITMENT

Summer research experiences held on campus help strengthen student skills. They also serve as a way for faculty members to recruit top graduate students.



DEAN Dr. Louis A. Martin-Vega

ADVISORY BOARD

Dr. John Gilligan, Executive Associate Dean of Engineering

Griffin Lamb, Assistant Dean for Development and College Relations, Executive Director of the NC State Engineering Foundation, Inc.

Suzanne S. Gordon (BSCSC / MA '75, MSST '80) President, Board of Directors, NC State Engineering Foundation, Inc.

Michael Walsh, Interim Executive Director of Major Gifts and Campaign Planning, NC State Engineering Foundation, Inc.

EDITOR Brent Lancaster

ASSISTANT EDITOR Darsee Heath

MAGAZINE DESIGN DIRECTOR Candice Wallace

ASSISTANT GRAPHIC DESIGNER Jacob Fremdeman

CONTRIBUTING WRITERS Nora Brodsky, Lea Hart, Danielle Herman, Kathi McBlief, Matt Shipman

IMAGES Milad Abolhasani; Ralph Edwards; Marc Hall; iStock; Joy Johnson; Rebecca Kirkland; Robert Lasson; NC State High-Powered Rocketry Club; Stuart Nisbet; Stuart Phoenix; Richard Rohrbaugh; Skanska USA; Special Collections Research Center, North Carolina State University Libraries; Strata Solar; Alex Stone; U.S. Army.

ILLUSTRATIONS Jie Sun, Dameon Williams

OFFICE OF THE DEAN

College of Engineering
Campus Box 7901, NC State University
Raleigh, NC 27695-7901
919.515.2311
www.engr.ncsu.edu

NC STATE ENGINEERING FOUNDATION, INC.

Campus Box 7901, NC State University
Raleigh, NC 27695-7901
919.515.7458
www.engr.ncsu.edu/alumni-and-giving/ncsef

CHANGE OF ADDRESS? Send address corrections to alumnianddonor_records@ncsu.edu; or call **919.515.7458**, toll free: **866.316.4057**.

NC State University is an equal opportunity and affirmative action employer and is dedicated to equality of opportunity within its community. Accordingly, NC State University does not practice or condone discrimination, in any form, against students, employees, or applicants on the grounds of race, color, national origin, religion, sex, sexual orientation, age, veteran status, or disability. NC State University commits itself to positive action to secure equal opportunity regardless of those characteristics.

© 2019. This document was produced by the NC State Engineering Foundation, Inc. and Engineering Communications. No state funds were used; 65,000 copies of this document were printed at a cost of \$40,453 on recycled paper.

Q&A

QUESTIONS FOR **GRIFFIN LAMB**

Griffin Lamb joined the College in May as assistant dean for development and college relations and executive director of the NC State Engineering Foundation.

Please tell us about your background in higher-education development.

I started my first job as reunion coordinator at my alma mater, Davidson College, in July 2000. This role provided the opportunity to work with a variety of alumni, from the fifth reunion to the 50th, and to begin learning how to coordinate with leaders across campus in order to plan the reunion programming. I did everything from buy blenders at Target for a fifth reunion Fiesta party to proof the Memorial Service program for the 50th reunion to write instructions for the event the vice president of college relations needed to attend. Best of all, I got my own golf cart for reunion weekend! After Davidson, I held roles in annual and reunion giving at the Harvard College Fund. From there, I returned to my home state and learned about the UNC system during four-and-half years as associate vice chancellor for development at East Carolina University in Greenville.

What interested you in a position within the College of Engineering?

First and foremost, the fact that it is about engineering. I was not looking to move, but the job description caught my eye immediately: a chance to scale a fascinating learning curve while continuing to serve my home state. I wanted to apply the fundraising fundamentals I've learned over the last two decades in a new setting with endless storytelling possibilities. It was a win-win.

What are the Foundation's current priorities?

We are working hard to cross the finish line of \$60 million raised for Fitts-Woolard Hall. To paraphrase Dean Martin-Vega, this project is about providing faculty and staff with the tools they need to be successful. When not focused on Fitts-Woolard, we talk to donors about scholarships, professorships, graduate support, study abroad support and much more. While we have clear priorities to share on behalf of the College, we always begin a gift conversation by asking a donor about his or her interests.

The University launched the Think and Do the Extraordinary capital campaign in 2013.

Where does that effort stand?

As of June 30, we have raised \$182,108,859 toward our total COE goal of \$230,000,000. With these gifts as our momentum heading into the next two years and many more alumni and friends to speak to about their support, we have what we need to be successful.

What can alumni and friends of the College do to become more involved?

There is no shortage of ways to help: make an annual gift, return to campus during Red and White Week, provide an internship for a student, mentor a young alumnus/a in your field, serve on your departmental advisory board, or, best of all, meet with a staff member to tailor your involvement.

As you have learned more about the College, has anything surprised you?

I'm in awe of Centennial Campus. The vision required to see how NC State could expand and what the College could be with the right tools (space, people and partnerships with business) astounds me. ■



FROM THE DEAN



LOUIS A. MARTIN-VEGA

Welcome to the fall 2019 issue of *NC State Engineering* magazine. Your College continues to be one of the **largest producers of engineering graduates in the United States**. NC State engineers are helping to drive the economy in the Research Triangle Park, across North Carolina and around the nation, thanks to the ability to solve problems and work collaboratively, a skill that they learned during their time on campus.

The latest American Society for Engineering Education (ASEE) figures released this summer show that we continue to rank in the **top 20 nationally** in the number of annual bachelor's, master's and Ph.D. engineering graduates. As the fall semester begins, we are welcoming our **largest first year and transfer class ever**, with 1,752 new undergraduate students. We have also set a new record for new Ph.D. students, reaching 261 this fall.

More than 12 percent of the newly arrived first-year engineering students come from underrepresented groups, and the class is **more than 30 percent women**, both new records for the College. The 2019-20 first-year class across the University is **more than 50 percent women for the first time in NC State's history**.

In this issue, you will be able to read about our efforts to not only recruit and retain more women faculty members, but also the leadership roles they have attained in our College. They are some of our most prominent teachers and researchers as well as leaders of our academic departments and nationally recognized research centers. They are also outstanding role models who are making a significant impact on the increase in female student enrollment that we have been experiencing.

As we continue to grow, it's important that we continue to recruit a broad cross section of students that includes not only women, but more students from groups that are historically underrepresented in engineering. This continues to be a foremost priority for the College.

With this in mind, we are very proud to share with you that our College recently received national recognition by ASEE for our efforts to increase diversity in engineering education. NC State was one of 29 universities to be recognized as an "exemplar" recipient of the Bronze Award for the inaugural ASEE Diversity Recognition Program.

Recipients had to meet several stringent criteria related to our diversity efforts including infrastructure to support diverse populations, K-12 community college pipeline activity and many other initiatives. The impact of our Minority Engineering and Women in Engineering programs also played a major role in our College receiving the highest level of recognition that this ASEE program provides at this moment.

We trust that these efforts, as well as the many other initiatives shared in this issue, will offer many reasons for you to be proud as an alumni or friend of NC State's College of Engineering. Thank you for your continuing support.

A handwritten signature in black ink, appearing to read 'Louis A. Martin-Vega'.

Louis A. Martin-Vega, Ph.D.

Dean

College lands two major research projects

Engineering faculty members continue to attract new major research funding, with new projects that will advance 5G wireless networking and production of new biotherapeutics.

The Norvo Nordisk Foundation will fund the Accelerated Innovation in Manufacturing Biologics (AIM-Bio) effort to accelerate the next generation of biopharmaceutical manufacturing, granting global access to powerful new biotherapeutics for treating a wide range of chronic and potentially lethal diseases.

NC State will administer AIM-Bio in collaboration with the Technical University of Denmark (DTU) in Copenhagen and will receive \$18 million of the \$27 million in funding.

The Biomanufacturing Training and Education Center, part of the College, will develop and offer new courses to train the biopharmaceutical workers of tomorrow.

Dr. Ruben Carbonell, Frank Hawkins Kenan Distinguished Professor in the Department of Chemical and Biomolecular Engineering (CBE), is the principal investigator on the grant. Dr. Stefano Menegatti, assistant professor in CBE, is a co-PI.

With \$24 million in funding from the National Science Foundation (NSF), NC State will lead a seven-year effort to build a specialized wireless network covering North Carolina's Research Triangle region so researchers can test new ways of increasing wireless speed and capacity.

It's the third testing platform established by NSF as part of an initiative to ensure U.S. dominance in Fifth Generation (5G) wireless networks.

Dr. Ismail Guvenc, associate professor in the Department of Electrical and Computer Engineering (ECE), is the PI on the project. Co-PIs include Dr. Rudra Dutta, professor in the Department of Computer Science; and Drs. Brian Floyd and Mihail Sichitiu, professors in ECE. ■



SUMMER GAMING PROGRAM HELPS CAMPERS REALIZE THEIR POTENTIAL

LEAD COUNSELOR NASIR JONES

stands at the front of the class, guiding the campers through coding exercises that are part of SNAP, a visual programming language. Three other counselors move among them answering questions.

The 12 campers are participating in the Bridge to Computing summer camp program for underserved 12- to 15-year-old boys held in the Department of Computer Science (CSC) at NC State.

According to Dr. Tiffany Barnes, a professor in the department who is in charge of the program, the very first camp was held in 2017. She said

numerous groups have joined forces to keep this camp viable, including the partnering Raleigh Police Department (RPD) and Ronneil Robinson's Give Back Organization (GBO). Cisco largely funded the program this year.

Lt. Barbara Cojocar is with the RPD's Southeast District and oversees the department's involvement with the camp. She described how the idea for a computer gaming camp came about.

"Knowing that there were underserved children in the district and wanting to make sure they had productive activity during the summer to help them not be recruited into gang activity, we thought,

what can we do that would be of interest to them," she said.

She explained that former police sergeant James Kryskowiak and Ronneil Robinson came up with the idea of a computer gaming camp originally called Games Over Gangs. The RPD eventually enlisted NC State as the camp venue.

The first year, RPD officers identified children and talked to parents, transported the children back and forth to camp, mentored them and picked up food for them provided by GBO through donors and volunteers. Now, they are out of the food loop but still select the children, transport them, chat and play football with them. Always they mentor them, focusing on values such as courage, fairness and integrity.

Barnes said that she saw the camp as an opportunity to reach out to

children who don't typically think about computing as something they can do.

Growing up in a poor neighborhood, she said, "I always saw education as a way of not being poor... When I took a computer science class in high school, which was required, I was really good at it, and I was like, 'I can do this,' but if I hadn't had that class, I don't know what I would be doing now."

Barnes said that the curriculum has evolved each year to provide the best possible experience for the campers. Barnes also realized that the campers related better to counselors closer in age from similar neighborhoods.

Jones comes from such a neighborhood in Greenville, N.C. Marnie Hill, who taught computer science to Jones at J.H. Rose High School in Greenville and now works for Barnes as the program manager of a workshop for teachers, told Barnes about the great job Jones did in her classes.

Jones worked as a camp counselor last year and is this year's lead counselor. He's in his second year at North Carolina A&T State University (NC A&T) and plans to come to NC State as a graduate student in computer science. He had a large role in making this year's lesson plans and recruited the other counselors.

Two of the three other counselors also attend NC A&T: Kalya Robertson is a sophomore majoring in supply chain management and Nelson Lee is a junior majoring in psychology. Arquavion Page, also taught by Hill, is now in his first year at Pitt Community College majoring in computer science with a full scholarship. Hill mentored the four counselors.

The three-week camps are made up of a variety of activities from basic typing to leadership activities. The lessons center around computer science, sometimes in the form of games, but there are also field trips, speakers and breaks for football.

The campers build their skills so that by the end of camp they have produced projects with SNAP. They present the projects on the last day to an audience that includes their parents.

The counselors, in addition to keeping the campers on task with their lessons, take advantage of teachable moments.

Lee gave an example. During some free time, the campers were playing a song by YNW Melly called "Mama Cry." Robertson asked how the so-called thug lifestyle appeals to them through music. Some thought it seemed cool because of the money, cars, girls and friends. The counselors asked them to pay attention to lyrics — not just the beat — because they often reveal the harsh reality of the lifestyle.

These camp counselors, RPD officers, Ronnell Robinson, donors, Barnes, Hill and more say they care deeply about the success of this program and are committed to helping these young men realize their full potential. ■

How did two campers enjoy the experience?

"I really like how they put us at NC State. They could have put us somewhere else. We can go outside to play and go to lunch, so this is a very good place to have camp."

JONATHAN PITTMAN, 13,
Martin Middle School

"(The counselors) lighten the mood. They work with us when we're doing coding."

JAMARI AVERY, 14,
Enloe High School

Both expressed an interest in coding as a profession. Pittman has already started his own game.



RESEARCH OVERCOMES KEY OBSTACLES TO SCALING UP DNA DATA STORAGE

NC STATE RESEARCHERS have developed new techniques for labeling and retrieving data files in DNA-based information storage systems, addressing two of the key obstacles to widespread adoption of DNA data storage technologies.

"DNA systems are attractive because of their potential information storage density; they could theoretically store a billion times the amount of data stored in a conventional electronic device of comparable size," says Dr. James Tuck, co-corresponding author of a paper on the work and an associate professor of electrical and computer engineering.

"But two of the big challenges here are, how do you identify the strands of DNA that contain the file you are looking for? And once you identify those strands, how do you remove them so that they can be read — and do so without destroying the strands?"

"Previous work had come up with a system that appends short, 20-monomer long sequences of DNA called primer-binding sequences to the ends of DNA strands that are storing information," says Dr. Albert Keung, co-corresponding author of the paper and an assistant professor in the Department of Chemical and Biomolecular Engineering. "You could use a small DNA primer that matches the corresponding primer-binding sequence to identify the appropriate strands that comprise your desired file. However, there are only

an estimated 30,000 of these binding sequences available, which is insufficient for practical use. We wanted to find a way to overcome this limitation."

To address these problems, the researchers developed two techniques that, taken together, they call DNA Enrichment and Nested Separation, or DENSe.

The researchers tackled the file identification challenge by using two, nested primer-binding sequences. The system first identifies all of the strands containing the initial binder sequence. It then conducts a second "search" of that subset of strands to single out those strands that contain the second binder sequence.

"This increases the number of estimated file names from approximately

30,000 to approximately 900 million," Tuck says.

Once identified, the file still needs to be extracted. Existing techniques use polymerase chain reaction (PCR) to make lots (and lots) of copies of the relevant DNA strands, then sequence the entire sample. Because there are so many copies of the targeted DNA strands, their signal overwhelms the rest of the strands in the sample, making it possible to identify the targeted DNA sequence and read the file.

Co-lead author of the paper is Kevin Volkel, a Ph.D. student at NC State. The paper was co-authored by Alexander Simpson, a former graduate student at NC State; and Austin Hass and Elaine Indermaur, both undergraduates at NC State. ■





ULTRASOUND ALIGNS LIVING CELLS IN BIOPRINTED TISSUES

COE RESEARCHERS have developed a technique to improve the characteristics of engineered tissues by using ultrasound to align living cells during the biofabrication process.

"We've reached the point where we are able to create medical products, such as knee implants, by printing living cells," says Dr. Rohan Shirwaiker, corresponding author of a paper on the work and an associate professor in the Edward P. Fitts Department of Industrial and Systems Engineering. "But one challenge has been organizing the cells that are being printed, so that the engineered tissue more closely mimics natural tissues.

"We've now developed a technique, called ultrasound-assisted biofabrication (UAB), which allows us to align cells in a three-dimensional matrix during the

bioprinting process. This allows us to create a knee meniscus, for example, that is more similar to a patient's original meniscus. To date, we've been able to align cells for a range of engineered musculoskeletal tissues."

To align the cells, the researchers built an ultrasound chamber that allows ultrasonic waves to travel across the area where a bioprinter prints living cells. These ultrasonic waves travel in one direction and are then reflected back to their source, creating a "standing ultrasound wave." The soundwaves effectively herd the cells into rows, which align with areas where the ultrasound waves and the reflected waves cross each other.

"We can control the alignment characteristics of the cells by controlling the parameters of the ultrasound, such

"This is important, because it gives us a clear understanding of both what we can do to improve tissue performance and what we need to avoid in order to preserve living cells."

DR. ROHAN SHIRWAIKER

as frequency and amplitude," Shirwaiker says.

To demonstrate the viability of the UAB technique, the researchers created a knee meniscus, with the cells aligned in a semilunar arc — just as they are in a natural meniscus.

"We were able to control the alignment of the cells as they were printed, layer by layer, throughout the tissue," Shirwaiker says. "We've also shown the ability to align cells in ways that are particularly important for other orthopedic soft tissues, such as ligaments and tendons."

The researchers also found that some combinations of ultrasound parameters led to cell death.

"This is important, because it gives us a clear understanding of both what we can do to improve tissue performance and what we need to avoid in order to preserve living cells," Shirwaiker says.

To that end, the researchers have created computational models that allow users to predict the performance of any given set of parameters before beginning the biofabrication process.

First author of the paper is Parth Chansoria, a Ph.D. student and Provost Doctoral Fellow at NC State. The paper was co-authored by Lokesh Karthik Narayanan and Karl Schuchard, who are Ph.D. students at NC State. ■

NEW FRAMEWORK IMPROVES PERFORMANCE OF DEEP NEURAL NETWORKS

RESEARCHERS IN THE

DEPARTMENT of Electrical and Computer Engineering (ECE) have developed a new framework for building deep neural networks via grammar-guided network generators. In experimental testing, the new networks — called AOGNets — have outperformed existing state-of-the-art frameworks, including the widely used ResNet and DenseNet systems, in visual recognition tasks.

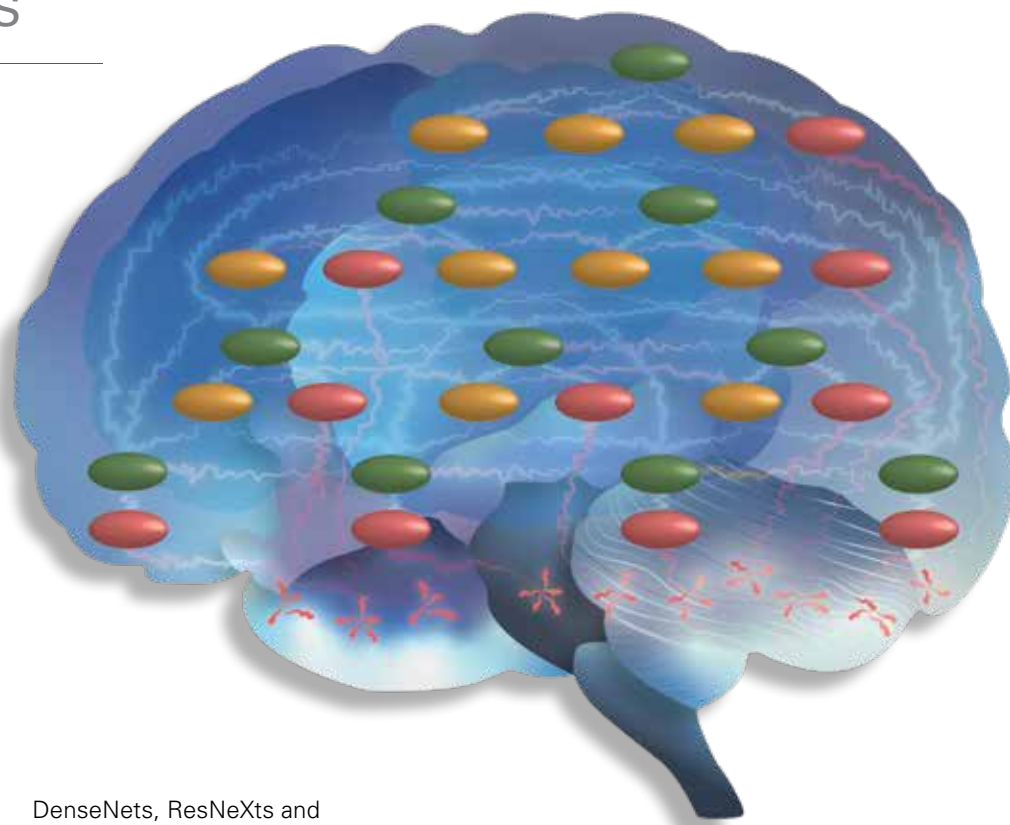
“AOGNets have better prediction accuracy than any of the networks we’ve compared it to,” says Dr. Tianfu Wu, an assistant professor in ECE and corresponding author of a paper on the work. “AOGNets are also more interpretable, meaning users can see how the system reaches its conclusions.”

The new framework uses a compositional grammar approach to system architecture that draws on best practices from previous network systems to more effectively extract useful information from raw data.

“We found that hierarchical and compositional grammar gave us a simple, elegant way to unify the approaches taken by previous system architectures, and to our best knowledge, it is the first work that makes use of grammar for network generation,” Wu says.

To test their new framework, the researchers developed AOGNets and tested them against three image classification benchmarks: CIFAR-10, CIFAR-100 and ImageNet-1K.

“AOGNets obtained significantly better performance than all of the state-of-the-art networks under fair comparisons, including ResNets,



DenseNets, ResNeXts and DualPathNets,” Wu says. “AOGNets also obtained the best model interpretability score using the network dissection metric in ImageNet. AOGNets further show great potential in adversarial defense and platform-agnostic deployment (mobile vs. cloud).”

The researchers also tested the performance of AOGNets in object detection and instance semantic segmentation, on the Microsoft COCO benchmark, using the vanilla Mask R-CNN system.

“AOGNets obtained better results than the ResNet and ResNeXt backbones with smaller model sizes and similar or slightly better inference time,” Wu says. “The results show the effectiveness of AOGNets learning better features in object detection and segmentation tasks.”

These tests are relevant because image classification is one of the core basic tasks in visual recognition, and

ImageNet is the standard large-scale classification benchmark. Similarly, object detection and segmentation are two core high-level vision tasks, and MS-COCO is one of the most widely used benchmarks.

“To evaluate new network architectures for deep learning in visual recognition, they are the golden testbeds,” Wu says. “AOGNets are developed under a principled grammar framework and obtain significant improvement in both ImageNet and MS-COCO, thus showing potentially broad and deep impacts for representation learning in numerous practical applications.

First author of the paper is Xilai Li, a Ph.D. student in ECE. A patent application is submitted for the work. The authors are interested in collaborating with potential academic and industry partners. ■

NEW TOOL TACKLES UNCERTAINTY IN MILITARY LOGISTICS PLANNING

MILITARY DEPLOYMENTS to austere environments — whether humanitarian missions or combat operations — involve extensive logistical planning, which is often complicated by unforeseen events. New research has created a model to help military leaders better account for logistical risk and uncertainty during operational planning and execution.

“Every branch of the military now uses an enterprise resource planning (ERP) system that handles everything from requisitions to shipment of supplies to inventory tracking,” says Brandon McConnell, corresponding author of a paper on the new model and a research assistant professor in the Edward P. Fitts Department of Industrial and Systems Engineering (ISE). “These ERP systems make it possible to create computational models that can be used to identify the most efficient means of meeting the military’s logistical needs.

“These models would be particularly valuable during expeditionary operations, in which the military is seeking to establish its presence — and its supply chain — in an environment that is subject to a fair amount of uncertainty.

“The model that we’ve developed can not only facilitate the military’s ability to efficiently determine what will be needed where, but can also assess risk in near real time in order to account for uncertainty,” says McConnell, a former infantry captain in the U.S. Army who served two tours in Iraq.

The new model, called the Military Logistics Network Planning System (MLNPS), draws on three sources of information. First is logistical data from the ERP system. Second is operational data, such as an operation’s mission, organization and timeline. Third is data on “mission specific demand,” meaning logistical requirements that are particular

to a given mission and its environment. For example, a combat operation being conducted in a cold, damp environment would have different requirements than a humanitarian mission being conducted in a hot, dry environment.

The MLNPS also uses two factors to assess risk and determine how risk might affect military capacities. The first factor is the likelihood that an event will happen; the second factor is what the consequences of that event will be. For example, if the likelihood of two events is identical, the model would give more weight to the event that could have a greater adverse impact on military personnel and mission performance.

The paper was co-authored by Drs. Thom Hodgson and James Wilson, professors emeriti in ISE; Drs. Michael Kay and Yunan Liu, associate professors in ISE; Dr. Russell King, the Henry Armfield Foscoe Distinguished Professor in ISE; Greg H. Parlier, adjunct professor in the department; and Kristin Thoney-Barletta, associate professor of textile and apparel, technology and management in NC State’s Wilson College of Textiles. ■



NANOCRYSTAL 'FACTORY' COULD REVOLUTIONIZE QUANTUM DOT MANUFACTURING

A MULTIDISCIPLINARY TEAM of NC State researchers has developed a microfluidic system for synthesizing perovskite quantum dots across the entire spectrum of visible light. The system drastically reduces manufacturing costs, can be tuned on demand to any color and allows for real-time process monitoring to ensure quality control.

Over the last two decades, colloidal semiconductor nanocrystals, known as quantum dots (QDs), have emerged as novel materials for applications ranging from biological sensing and imaging to LED displays and solar energy harvesting. The new system can be used to continuously manufacture high-quality QDs for use in these applications.

"We call this system the Nanocrystal (NC) Factory, and it builds on the NanoRobo microfluidic platform that we unveiled in 2017," says Dr. Milad Abolhasani, an assistant professor in the Department of Chemical and Biomolecular Engineering (CBE) and corresponding author of a paper on the work.

"Not only can we create the QDs in any color using a continuous manufacturing approach, but the NC Factory system is highly modular," Abolhasani says. "This means that, coupled with continuous process monitoring, the system allows modifications to be made as needed to eliminate the batch-to-batch variation that can be a significant problem for conventional QD

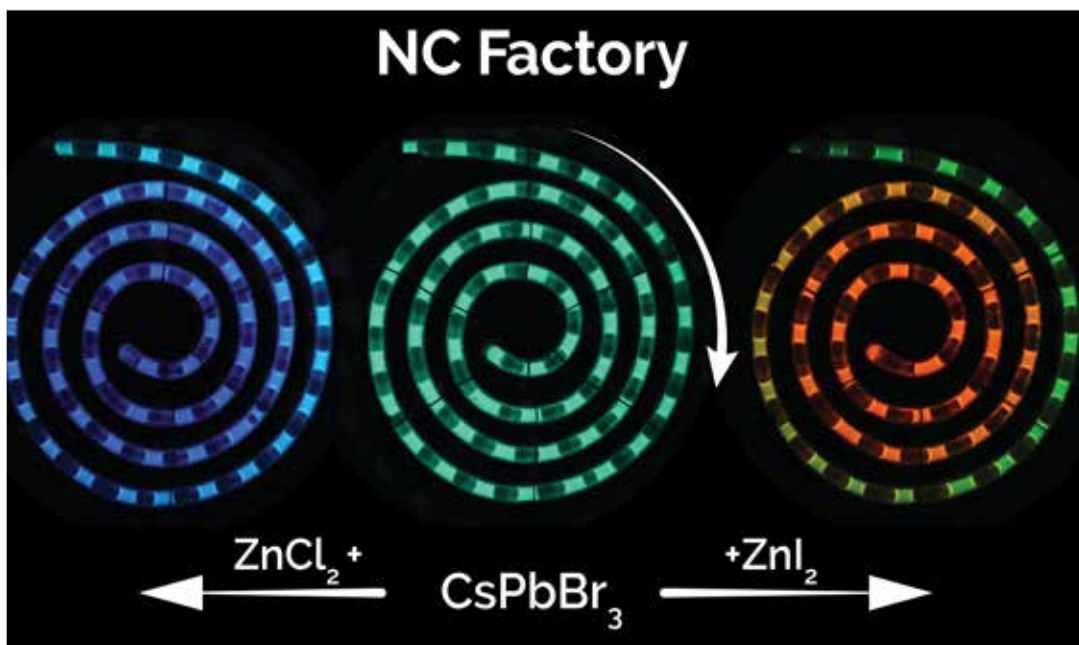
manufacturing techniques. Additionally, the chemistry we have developed in this work allows the perovskite QD processing to take place at room temperature."

The fluorescence color of QDs is a result of the chemical composition, the size, and the way the nanocrystals are processed. The original QD synthesis strategy utilized in the NanoRobo system allowed for the room temperature synthesis of green-emitting perovskite QDs, which are made using cesium lead bromide. NC Factory starts with cesium lead bromide perovskite quantum dots, but then introduces various halide salts to precisely tune their fluorescence color across the entire spectrum of visible light. Anions in these salts replace the bromine atoms in the green-emitting dots with either iodine atoms (to move toward the red end of the spectrum) or chlorine atoms (to move toward blue).

"Because the NC Factory can precisely control both chemical composition and processing parameters, it can be used to continuously manufacture perovskite quantum dots in any color with the highest quality," Abolhasani says.

The NC Factory system consists of three "plug and play" modules. The researchers developed a pre-mixing module to expedite the mixing of halide salts and quantum dots, in order to improve product quality.

Co-first authors on the paper are Kameel Abdel-Latif and Robert Epps, Ph.D. students in CBE. The paper was co-authored by Corwin Kerr, an undergraduate student at NC State; Christopher Papa, a Ph.D. student in chemistry at NC State; and Dr. Felix Castellano, the Goodnight Innovation Distinguished Chair of Chemistry at NC State. ■



STUDENTS INTERACT WITH NC STATE ASTRONAUT THROUGH LIVE DOWNLINK



ASKED BY A STUDENT ON EARTH

about the hardest things for her to do on the International Space Station (ISS), NC State engineering alumna and NASA astronaut Christina Koch decided to demonstrate.

Koch, who was participating in a live downlink from orbit, showed an audience assembled in the Talley Student Union on campus and watching live online how easy it is to lose items that you need when you try to set something down for a second and soon realize that it has floated away. She talked about how astronauts drink liquids and where they sleep. Then there was something else.

"And then finally, the one thing that I find challenging is moving around in microgravity," Koch said. "So let me show you an example of that."

And with that, Koch floated up and out of the view of the video feed as students from NC State, the North Carolina School of Science and Math (NCSSM) and other schools around NC State's Raleigh campus cheered.

Koch blasted off for the International Space Station on March 14, 2019. It was the culmination of a journey that began with dreams of space growing up in Jacksonville, NC, and studying at NCSSM; bachelor's and master's degrees in electrical engineering and a bachelor's degree in physics from NC State; and nearly six years of astronaut training.

During the 19-minute downlink, she answered questions including how hard it will be to return to the moon, lesser known skills or abilities that are common among astronauts, which women

inspired her to pursue her dreams in STEM and her favorite pastimes on board the ISS.

The event, held on August 30, 2019, and co-hosted by NCSSM, included a panel discussion with engineering and sciences faculty members, a keynote address and student exhibits.

When asked by a student about the biggest challenge to the future of space exploration, Koch mentioned NASA's Artemis program, which is building toward a return trip to the moon and laying the groundwork for a mission to Mars.

"I'm so excited about the Mars mission because I think not only is it a great example of human exploration and pushing the frontiers, but it also gives us a chance to answer a question that I think is hugely important philosophically and for the question of our age really," she said. "And that is, 'are we alone?' And I think going to Mars with people can answer that question."

Asked about being a role model for young women interested in STEM, Koch pointed to the inspiration that she received from women in her family and leaders of the civil rights movement.

"I look around at basically any woman who was strong that believed in themselves and that wasn't afraid to take on their own dreams full speed ahead. Those are the types of people that really inspired me," Koch said. ■

ARE E-SCOOTERS POLLUTERS?

PEOPLE THINK OF ELECTRIC

SCOOTERS, or e-scooters, as environmentally friendly ways to get around town. But a new study from an environmental engineering faculty member finds it's not that simple: Shared e-scooters may be greener than most cars, but they can be less green than several other options.

"E-scooter companies tout themselves as having little or no carbon footprint, which is a bold statement," says Dr. Jeremiah Johnson, corresponding author of the study and an associate professor in the Department of Civil, Construction, and

Environmental Engineering (CCEE). "We wanted to look broadly at the environmental impacts of shared e-scooters — and how that compares to other local transportation options."

To capture the impact of e-scooters, researchers looked at emissions associated with four aspects of each scooter's life cycle: the production of the materials and components that go into each scooter; the manufacturing process; shipping the scooter from the manufacturer to its city of use; and collecting, charging and redistributing the scooters.

The researchers also conducted a small-scale survey of e-scooter riders to see what modes of transportation they would have used if they hadn't used an e-scooter. The researchers found that 49 percent of riders would have biked or walked; 34 percent would have used a

car; 11 percent would have taken a bus; and seven percent wouldn't have taken the trip at all. These results were similar to those of a larger survey done by the city of Portland, Ore.

In order to compare the impact of e-scooters to that of other transport options, the researchers looked at previously published life cycle analyses of cars, buses, electric mopeds and bicycles. Researchers looked at four types of pollution and environmental impact: climate change impact, nutrient loading in water, respiratory health impacts related to air pollution and acidification. The performance results were similar for all four types of pollution.

"A lot of what we found is pretty complicated, but a few things were clear," Johnson says. "Biking — even with an electric bike — is almost always more environmentally friendly than using a shared e-scooter. The sole possible exception is for people who use pay-to-ride bike-share programs. Those companies use cars and trucks to redistribute the bicycles in their service area, which can sometimes make them less environmentally friendly than using an e-scooter."

By the same token, the study found that driving a car is almost always less environmentally friendly than using an e-scooter. But some results may surprise you. For example, taking the bus on a route with high ridership is usually more environmentally friendly than an e-scooter.

First author of the paper is Joseph Hollingsworth, a former graduate student in CCEE. The paper was co-authored by Brenna Copeland, an undergraduate in the department. ■





FREEDM RESEARCHERS RECEIVE FUNDING FOR WORK ON GRID RESILIENCE TOOLS

RESEARCHERS IN THE FREEDM SYSTEMS CENTER led by NC State have received a \$3.1-million research award from the U.S. Department of Energy Solar Energy Technologies Office (SETO) to advance solar energy's role in strengthening the resilience of the U.S. electricity grid.

The project will develop a Photovoltaic (PV) Analysis and Response Support (PARS) platform to provide real-time situational awareness and optimal response plan selection for electric utilities.

Grid management is becoming more complex with the addition of distributed renewable energy resources, and electric utilities require new tools to optimize a more complex system. In addition, extreme weather events and malicious cyber-attacks are becoming more frequent. PARS will allow hybrid PV systems to operate similarly to conventional generation resources in terms of visibility, dispatchability, security and reliability. A team of researchers and faculty members from the FREEDM Systems Center, a National Science Foundation (NSF) Engineering Research

Center on the campus of NC State, will partner with the NC Cleantech Center, Pacific Northwest Laboratory, OPAL-RT Corporation, Strata Solar, New York Power Authority, Electricities of North Carolina and the City of Wilson — Wilson Energy and Roanoke Electric Cooperative to develop grid management tools to enhance power system resilience.

"PARS can be used to develop optimal response plans for hybrid PV systems located at the transmission or distribution levels," says Dr. Ning Lu, principal investigator for the project. "And when running off-line using historical data, it will be a planning tool to design and test PV-based grid support functions and perform cost-benefit studies."

PARS will use a new approach to complex grid management by linking steady state and dynamic elements together and performing real-time simulations and faster-than-real-time simulations in the same environment. The platform will also incorporate PV systems at any level of the grid in both normal and emergency operating scenarios.

The team will develop and deploy

several tools on the PARS platform, including:

- An operations modeling tool that will incorporate new grid support functions
- A model parameterization tool to update power grid operation models
- A real-time situational awareness tool
- An optimal response tool that incorporates distributed energy resources like PV and customer storage
- A cost benefit tool for addressing the value proposition of the newly developed grid support functions.

Linking these tools creates a seamless interface for users with multiple benefits. Real-time situational awareness that includes prediction of future operation allows for early detection of anomalous behavior like that seen during a cyber-attack. Optimal response selection allows utilities to include distributed resources to participate in grid restoration.

Additional project team members include Dr. Mesut Baran, Dr. David Lubkeman and Dr. Wenyan Tang, all faculty members in the Department of Electrical and Computer Engineering. ■

FACULTY HIGHLIGHTS

Huang receives award for young scientists and engineers

Dr. Hsiao-Ying Shadow Huang, associate professor in the Department of Mechanical and Aerospace Engineering, has been named a recipient of the 2019 Presidential Early Career Award for Scientists and Engineers (PECASE).

The PECASE acknowledges the contributions made by scientists and engineers to the advancement of science, technology, engineering and

mathematics education and to the community through scientific leadership, education and community outreach.

Huang is the fourth faculty member in the College to receive the award.

Her research focuses on investigating degradation mechanisms in lithium battery materials via experimental, theoretical and computational approaches. ■



DR. HSIAO-YING SHADOW HUANG

Bourham, DeCarolus and Montoya named Outstanding Teachers



DR. MOHAMED BOURHAM



DR. JOSEPH DECAROLIS



DR. BRINA MONTOYA

Three faculty members in the College were recognized with Outstanding Teacher Awards for 2018-19.

Dr. Mohamed Bourham is an Alumni

Distinguished Graduate Professor of Nuclear Engineering; **Dr. Joseph DeCarolus** is an associate professor in the Department of Civil, Construction,

and Environmental Engineering (CCEE); and **Dr. Brina Montoya** is an assistant professor in CCEE.

The award recognizes excellence in teaching at all levels and is a prerequisite for being considered for the Board of Governors Award for Excellence in Teaching and the Alumni Distinguished

Professor Award. Recipients become members of the Academy of Outstanding Teachers for as long as they are NC State faculty members. ■

Martin-Vega named AAAS Fellow

Dr. Louis A. Martin-Vega, dean of the College, has been elected as a Fellow of the American Association for Advancement of Science (AAAS).

Fellows are nominated by their peers and are elected by the AAAS council, a policymaking body of the society, and elected for having shown "scientifically or socially distinguished efforts to advance science or its applications."

Martin-Vega was recognized for his outstanding contributions to industrial and systems engineering, manufacturing, industrial innovation and engineering education, and for unconditional support for the advancement of Hispanic professionals.

He is one of eight active faculty members in the College who are AAAS Fellows. ■



DR. LOUIS A. MARTIN-VEGA

Rabiei, Williams receive 2019 Alcoa Foundation Awards

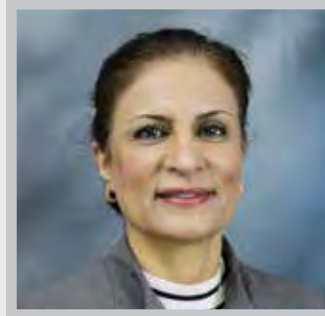
The 2019 Alcoa Foundation Engineering Research Awards were presented to **Dr. Afsaneh Rabiei**, professor in the Department of Mechanical and Aerospace Engineering, and **Dr. Cranos Williams**, associate professor in the Department of Electrical and Computer Engineering. Rabiei received the Alcoa Foundation Distinguished Engineering Research Award, made to a senior faculty member for research achievements over a period of at least five years at NC State. Williams was awarded the Alcoa Foundation Engineering Research Achievement Award, which recognizes young faculty members who have accomplished outstanding research achievements during the preceding three years.

Rabiei is known internationally as a leader of research on composite metal

foams, which as a lightweight material capable of high energy absorption has outstanding properties as armors, car bumpers and biomedical implants.

Additionally, she has made unique contributions to her field through the development of multiple novel materials such as metallic bubble wraps and smart coatings for biomedical implants.

Williams is leading an interdisciplinary research effort merging plant sciences and engineering, single-handedly creating a new research discipline.



DR. AFSANEH RABIEI



DR. CRANOS WILLIAMS

His breakthrough research has led to the development of computational approaches that use high-throughput data to identify regulators of plant stress responses. His contributions have improved understanding of the interactions of biomolecular, physiological and structural processes that affect plant growth, development and adaptation. ■

Bitzer, Kim win Holladay Medal



DR. DONALD BITZER



DR. RICHARD KIM

Dr. Donald Bitzer, Distinguished University Professor in the Department of Computer Science, and **Dr. Youngsoo (Richard) Kim**, Jimmy D. Clark Distinguished University Professor in the Department of Civil, Construction, and Environmental

Engineering, received the Alexander Quarles Holladay Medal for Excellence. Named for NC State's first professor of history and its first president, the medal is the highest honor bestowed by NC State and the University's Board of Trustees.

Bitzer's scholarship focuses on computer systems, computer displays, data communications, voice analysis and genetics to amplify protein

production. He is the inventor of plasma panel displays used for flat panel televisions. A member of the National Academy of Engineering, Bitzer received the National Academy of Television Arts and Sciences Emmy for Scientific Development and Technical Achievement for the development of plasma displays.

Kim's research interests include the laboratory and field aspects of the performance evaluation of asphalt materials and pavements. He has received more than \$18 million in research funding from national and international agencies and has published more than 300 papers in technical journals and proceedings. ■

IN OUR LABS

THESE ARE THE SPACES THAT ENABLE
GROUNDBREAKING RESEARCH

VIRTUAL AND AUGMENTED REALITY LAB

EDWARD P. FITTS DEPARTMENT OF INDUSTRIAL AND SYSTEMS ENGINEERING

DR. KAREN BORU CHEN'S WORK in the field of human factors engineering explores how people interact with different types of systems — and how to make those systems safer and more efficient.

"I really have a passion for studying and helping humans from a healthcare and safety perspective," Chen said.

Her Ph.D. work in biomedical engineering at the University of Wisconsin-Madison aligned with an emergence of interest in virtual reality (VR) systems, based in part on advances in processing speed and screen resolution in commercially available systems.

Today Chen, an assistant professor in the Fitts Department of Industrial and Systems Engineering, is studying how VR can provide expanded access to healthcare services and workplace training.

Chen's CAVE (that's Cave Automatic Virtual Environment) is a four-sided (that's three walls and a floor) screened enclosure with a digital projection system that creates an immersive virtual environment with the capability for a researcher to track a participant's movements.

Markers on 3-D glasses worn by a research participant allow cameras lining the structure to track the

participant. The CAVE uses a rear-projection system with mirrors so that the research participant does not see shadows cast over the visuals in the virtual environment.



CHEN SEES THE FIELD in two categories — VR systems that are entirely contained in a device that goes over a patient's head or larger systems like a CAVE. While a CAVE might help a researcher draw more data on face-to-face interactions and collaborations, using an over-the-head device like the commercially available Oculus Rift headset is more cost-effective and accessible.

Chen has used a headset to conduct research in a large-scale research clinic with patients undergoing physical therapy for neck pain.

"It made more sense to bring the equipment to a clinic," she said. "It doesn't make sense to bring a CAVE to an office or to ask these patients who are already in pain to come to my lab."



IN THE FUTURE, VR could allow patients to perform therapeutic exercises at home rather than in a medical facility. The hope is that this will provide a more cost-effective treatment and expand access to patients who have trouble traveling to an office because of mobility issues or inconvenient office locations. The same technology can be used to provide job-related training or serve as a fill-in virtual personal trainer for patients who need to exercise.

The technologies aren't intended to replace one-on-one interactions with a human professional, Chen said, but rather to supplement it. Patients who need physical rehabilitation are often sent home with a sheet of paper listing exercises. The hope is that a virtual program could motivate them to push further by making the movements more engaging, similar to a kind of game. The 3-D environment also can give a patient a better sense of whether the movements are being done correctly. And because a patient at home using a headset system relies on a virtual avatar to see what she is doing, the feedback may be altered slightly to make that patient think she is doing less movement than she really is in order to push her a little further or help overcome fear of more injury.

But first, baseline research that compares how research participants perform in a virtual world compared to the physical world must be conducted to evaluate VR-based therapy's feasibility.

One of Chen's graduate students is using the CAVE to conduct research that compares how first responders perform a lifting task using virtual weights with how they make the same lift using an object in the real world. ■

MAJOR IMPACT



Dr. Christine Grant



Dr. Laurie Williams



Dr. Veena Misra



Dr. Nancy Allbritton

The College has made important strides in recruiting **outstanding women** faculty members



Dr. Julie Swann

IN THE LAST 10-PLUS YEARS, hiring and retaining the best women faculty members and enabling their success has been a major priority for the College.

When Dean Louis Martin-Vega joined the College in 2006, there were but a handful of women tenured or tenure-track faculty members, no women department heads and even academic departments that had no women faculty members at all.

While it was clear that the College would never be a preeminent engineering leader unless it markedly increased the number of women faculty members, this effort was also motivated by the need to gain different perspectives and viewpoints from a group that has often been underrepresented in engineering.

Currently, there are more than 61 tenured or tenure-track women faculty

members in the College as well as more than 20 non-tenure track women teaching and research faculty members. They are some of the College's most prominent teachers and researchers as well as leaders of the College's academic departments and nationally recognized centers. They are also outstanding role models who have made a significant impact on the increase in female student enrollment that the College has been experiencing.

The College took its first step in 2006 by ensuring that women faculty members were part of the search process for new faculty hires, even if they were not part of that academic department. Dr. **Christine Grant** — the first African-American female faculty member hired by the College, in December 1989 — was the first person Martin-Vega asked to be part

of the search committee process. She often met with faculty candidates during campus visits, providing insights to the importance of broadening participation in the faculty realm.

When Grant, who is now the associate dean for faculty advancement for the College and professor in the Department of Chemical and Biomolecular Engineering, agreed to serve as a resource for the committees, it helped solidify that hiring and enrolling more women was a high priority. Additionally, Grant has served as a leader for three grants awarded to NC State by the National Science Foundation's (NSF) ADVANCE program — which included the NSF ADVANCE Women of Color Engineering Faculty Peer Mentoring Summits.

"It is about institutional change," shared Grant. "Initiatives such as the



INDUSTRIAL AND SYSTEMS ENGINEERING GRADUATE STUDENTS KIMIA VAHDAT, LEFT, AND PRISCILLE KOUTOUAN ARE PART OF AN EFFORT TO ATTRACT MORE WOMEN STUDENTS TO THE DEPARTMENT.

“You want the faculty to be familiar to the student population not only in appearance, but in background — students like to see someone like themselves and see where they can be in years’ time.”

DR. LAURIE WILLIAMS

NSF ADVANCE program that were supported by the dean and provost’s office were and continue to be instrumental to the College.”

Grant asserts that having a more diverse faculty available for students helps prepare them to work in a more diverse engineering setting in the future. “They can learn different perspectives, and the faculty incorporate different experiences into their interactions with the students.”

In the first year of this priority action, eight new women faculty members were hired, representing one-third of the total faculty hires that year. “It was a great start — but still well below where we needed to be,” said Martin-Vega.

MOVING TOWARD FULL REPRESENTATION

Dr. **Laurie Williams**, Distinguished Professor and previous interim head of the Department of Computer Science (CSC) was the third female hire in the department. Since she joined the faculty in 2000, she has seen a huge change in environment and attributes that success to the efforts of Martin-Vega and to Dr. Mladen Vouk, former CSC department head.

According to 2018 American Society for Engineering Education (ASEE) figures, the department is now ranked first nationally in female tenure / tenure track faculty members among

departments of computer science.

Williams, who is also the co-principal investigator of the National Security Administration Science of Security Lablet at NC State, finds that having a diverse faculty provides students with role models.

“You want the faculty to be familiar to the student population not only in appearance, but in background — students like to see someone like themselves and see where they can be in years’ time,” she said.

The women faculty members in the College are a diverse and distinguished group that includes two National Academy of Engineering members, a National Inventors Hall of Fame inductee, distinguished professors, fellows of professional societies and department heads. Dr. **Veena Misra**, Distinguished Professor in the Department of Electrical and Computer Engineering, is director of the Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST) Center, a National Science Foundation Engineering Research Center led by NC State.

Two of the College’s nine academic departments are led by women — the UNC / NC State Joint Department of Biomedical Engineering (BME) led by Dr. **Nancy Allbritton**, Kenan Distinguished Professor of Biomedical Engineering and Chemistry, who will leave in fall 2019 to be the dean of engineering at the University of Washington, and the Edward P. Fitts Department of Industrial and Systems Engineering (ISE) led by Dr. **Julie Swann**, A. Doug Allison Distinguished Professor.

Swann, the first woman department head in ISE, feels that recruiting,

retaining and promoting women in the faculty plays a critical role in enrolling more female undergraduate and graduate students. “Making sure that women and other minorities have sufficient mentors and champions is important because their social networks may be smaller in a STEM field,” Swann said.

Dr. Morton Barlaz, Distinguished University Professor and head of the Department of Civil, Construction, and Environmental Engineering (CCEE), has made increasing faculty diversity a priority. Seven women faculty members have been hired in the 10 years in which he has led CCEE.

Barlaz said that he believes every faculty member to be a unique person with individual needs and it is important to help them navigate the early years in their career to help them succeed.

“In recruiting and retaining women faculty, I believe it’s about conveying excellence, highlighting the department, the atmosphere of the College and working with everyone individually,” Barlaz said. “Everyone has a unique situation — it could be a spouse / partner who needs assistance looking for a job, the need for the candidate to defer until they complete a post-doc, or perhaps waiting to move to NC State until a child finishes the school year. Exhibiting flexibility is important and helps set a tone.”

MEASURING THE IMPACT

The impact of the College’s efforts can be seen in current rankings and the number of female students in the College. The College ranks 18th in bachelor’s degrees, 21st in master’s

degrees and 14th in Ph.D. degrees awarded to women, according to ASEE figures. The College’s fall 2019 first-year class is 30 percent female, an increase from 12 percent in 2004.

In BME, the undergraduate student body is 48 percent women and 43 percent women at the graduate level. In ISE, the fall 2019 class Ph.D. class is 50 percent women.

“We did this by encouraging women to apply who had not thought about doing it or who needed a little extra nudging or encouragement,” Swann said.

Priscille Koutouan in ISE is one of those graduate students who noticed the efforts being made by the College and department to recruit women into their programs.

“I was a part of a group that came for a visit and got to talk to some of the amazing women faculty members. I had heard of many of them before joining the department, and these brilliant researchers played a key role in me deciding on NC State for my graduate work.”

As the College continues to grow, Martin-Vega is optimistic that the number of women in the faculty will also increase. He sees no reason why half of the College’s faculty couldn’t be women.

“I think that our College and the University has been greatly enriched by the fact that we now have a much stronger representation of women on our faculty. Our College in particular is a much better college because of it,” he said. “The environment that we have for students — and in particular women students — is providing more women mentors for our students, and the work that is being done by these faculty members is extraordinary.” ■

NC State, Duke and UNC-Chapel Hill may be fierce rivals on the basketball court, but the three universities are partners in an effort to enable innovative nanoscience and nanotechnology research, discovery, workforce development and education.



RESEARCH TRIANGLE NANOTECHNOLOGY NETWORK



PROGRAM HIGHLIGHTS

The **Kickstarter Program** supports initial use of the facilities by new, non-traditional users by providing access to facilities for work valued at up to **\$1,000** in RTNN member facilities. To date, **64 projects** have participated in the program, equating to **>1,000 hours** in free facility access.

Nanotechnology, A Maker's Course, a free online course hosted on Coursera, gives an overview of nanotechnology tools and techniques and shows demonstrations within RTNN facilities. Since the course launch, more than **56,000** people have visited the course website, more than **12,600** have enrolled and more than **1,600** have completed all course components.

The RTNN's **Community Engagement Programs** include immersive lab experiences, where students work in RTNN facilities, and portable scanning electron microscopes at schools, libraries, and museums. Through these types of activities, the RTNN has engaged more than **8,000 people**.

ABOUT RTNN

To support and expand the growth of nanotechnology, the National Science Foundation (NSF) established the National Nanotechnology Coordinated Infrastructure (NNCI) in 2015, a network of 16 sites across the U.S. The RTNN is one of these sites and a dynamic project involving NC State, Duke and UNC-Chapel Hill. Collectively, these institutions house nine core nanotechnology fabrication and characterization facilities and more than 100 principal faculty members whose research encompasses broad aspects of nanotechnology. The RTNN aims to be a national focal point for enabling innovative nanoscience and nanotechnology research.

Learn more at rtnn.org

BY THE NUMBERS



More than **230** major fabrication and characterization tools



More than **65** technical staff members



>1,300 unique users access facilities annually



More than **55,000** annual hours of collective use



Through all programs **>10,000** people reached annually



SILVANA ALFIERI



BREWING UP A SUSTAINABLE CUP

Students' **coffee filtration system** earns second-place finish in global competition

ON TOP OF CLASSES, extracurriculars and day-to-day student life, it would be difficult to find time to develop a business plan and create a product design in just two months — with the added stress of vying for a chance to represent the United States at an international competition.

But five engineering students made it happen, creating the start-up Peak Coffee Processing and developing a filtration system for coffee production wastewater. They presented their business plan in April in Washington, D.C., along with more than 30 other student teams and earned one of six spots to represent the U.S. in September in London at the 2019 Global Grand Challenges Summit, which is hosted by the U.S., U.K. and Chinese academies of engineering.

The students — Silvana Alfieri, a senior double-majoring in environmental

engineering and environmental policy; Kevin Duke, a junior majoring in civil engineering; Rachel Figard, a junior majoring in industrial and systems engineering; Grant Jordan, a junior majoring in industrial and systems engineering; and Pippin Payne, a senior double-majoring in mechanical engineering and religious studies — didn't know each other well prior to the project, but in the time they've spent brainstorming, developing and practicing, they've become a cohesive unit.

"I think we've all become really close, and that has contributed to it not feeling like work because we all share this vision, and we share the same goals," Alfieri said.

The NC State team finished **second overall in London and first among teams from the United States**,

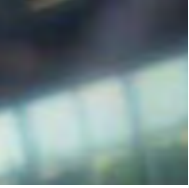
receiving a £7,500 prize. Other U.S. teams were from Dartmouth University, Oklahoma State University, UC San Diego, University of Southern California and University of Rochester.

Even before the students knew they'd go to London, they decided together that they wanted to continue growing Peak Coffee Processing.

All five are members of the National Academy of Engineering (NAE) Grand Challenges Scholars Program at NC State, a curricular and extra-curricular program that helps prepare students to solve the NAE's 14 Grand Challenges for Engineering in the 21st century. Their mentor, Dr. David Parish, assistant dean of academic affairs, sent out the call for an NC State team to go to D.C.

With a wide range of disciplines both within and outside of engineering, the group approached sustainability by trying to find a solution that would benefit both the individual and society. They researched water, food and energy, each coming to the table with their own ideas, before settling on coffee.

"By narrowing the scope, we found ways to combine our talents and perspectives for a project that is not only impactful to others but very feasible as well," Figard said.



PIPPIN PAYNE



KEVIN DUKE



GRANT JORDAN



RACHEL FIGARD

Coffee is the second most traded commodity in the world, surpassed only by oil. Coffee beans grow inside a small fruit similar to a cherry, and are processed using either the dry or wet method. Peak Coffee Processing's filtration system is designed for wet processing, which starts with using water to sort the coffee cherries by density. The denser coffee cherries sink to the bottom, and the cherry is removed from the bean in a process known as de-pulping. The bean is then fermented in water. The process creates large amounts of wastewater that contains solid particles and has a low pH, which is harmful to environmental and human health when released into local

waterways. It can also infiltrate drinking water, and according to some studies, up to 90 percent of people living in areas near coffee-producing areas experience health problems.

To decrease the amount of harmful waste, Alfieri explained, the students developed a filtration system that outputs clean water that can be reused in the coffee production process or can be released into the environment without causing harmful effects. This system leads to a cleaner and safer environment while also allowing coffee producers to produce more coffee, as it generates a fertilizer that increases crop yields and improves the density of the coffee bean,

which makes better-tasting coffee. The team is applying for an international patent for their filtration system, which they currently estimate would cost about \$2,000 and would be capable of filtering water from 500-gallon drums.

Alfieri and Duke worked on the technical side of the project, talking to professors in the Department of Civil, Construction, and Environmental Engineering and in the College of Agricultural and Life Sciences. During the fall semester, Alfieri will conduct research on a small-scale prototype, making her own coffee wastewater based on chemical composition.

Meanwhile, Figard, Jordan and Payne focused on the business plan, assisted by professors in the Poole College of Management. After being selected as one of 30 schools to compete in D.C., the five students took an intensive entrepreneurship immersion course taught by two professors from the National Science Foundation.

Throughout the process, the students also reached out to local coffee shops to learn more about where they sourced their beans and contacted dozens of coffee bean producers in South and Central America to gauge interest for the filtration device.

Once they had their design and plan developed, the group practiced their presentation to anyone who would listen, including deans in the College, engineering professors and entrepreneurship professors.

In the spring, they plan to apply for entrepreneurship competitions like the Lulu eGames at NC State, as well as other funding sources. They're looking forward to seeing their idea take off, and they want this technology to one day be implemented at every coffee farm.

"We were invested in the idea more than the outcome," Jordan said. "We want the project to succeed, and that's where we're focused." ■

FOG ALERT

CCEE researchers lead the way on **fats, oils** and **grease problem**

ON THE SURFACE, it might seem harmless enough: hot fats, oils and grease from cooking are poured down the drain in liquid form and disappear just as water does, right?

Wrong, say three researchers in the department of Civil, Construction, and Environmental Engineering (CCEE).

Fats, oils and grease (often shortened to FOG) become hardened deposits in pipes and sewer systems. Even worse, they can trap non-biodegradable solids, such as wet wipes, creating a mass over time that can cause backups and spills.

These so-called “fatbergs” have made headlines in recent years. In 2013, a fatberg weighing roughly 17 tons was discovered in drains under a road in London. In 2017, one discovered under the streets of Baltimore caused a sewage spill totaling 1.2 million gallons.

“Because of the revitalization of cities, this problem is getting worse as urban environments grow,” said Dr. Joel Ducoste, professor in CCEE and assistant dean of graduate student

advancement and faculty enrichment in the College. “It’s a problem that will only grow unless people stay on top of it.”

It’s been more than a decade since CCEE’s Ducoste; Dr. Francis de los Reyes, III, professor and University Faculty Scholar; and Dr. Tarek Aziz, assistant professor and coordinator of undergraduate advising, began researching this topic of what they call an often under-recognized pollutant.

It began when an employee of the nearby town of Cary, NC, approached the researchers. The town was seeing problems with its sewer lines related to fat cells and grease, and couldn’t get academics to pay attention to the issue, Ducoste said.

“We started looking at it and found there was not much research out there,” he said.

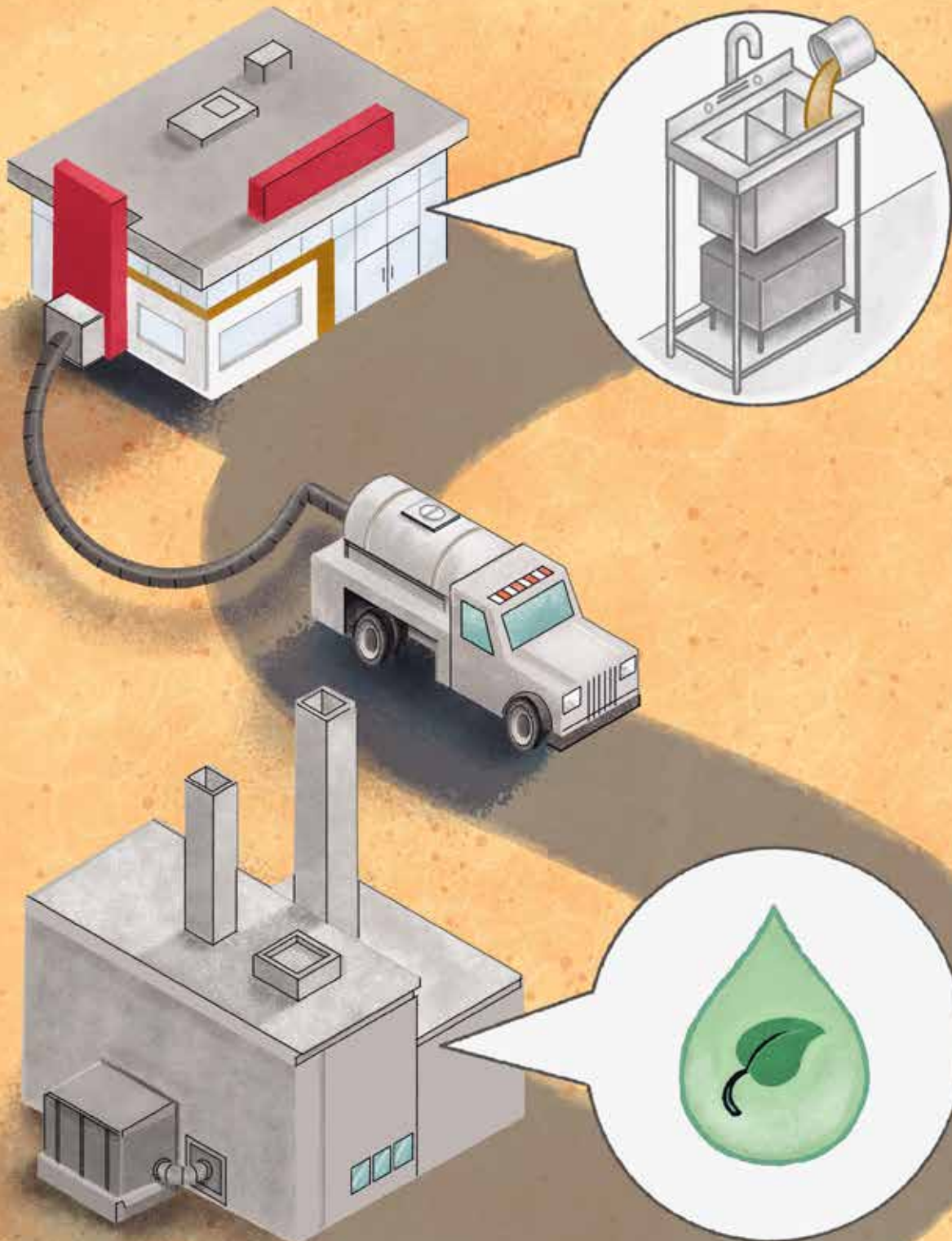
The group began investigating and in the years since, has performed comprehensive research on everything from potential ways to stop FOG from getting into the collection system, to

processes that can be used to treat and remove existing FOG blockages and damage, and whether there are benefits to be had from these pollutants — even proving they can instead be converted to energy.

THE SYSTEM

The food service industry produces the largest amounts of FOG, thus urban areas tend to see the brunt of the problems, however, suburban areas are not immune, the researchers say. From the time fats, oils and grease leave the stove, there are a number of mechanisms in place to keep FOG out of the sewers, but they don’t always work perfectly, de los Reyes said.

In the food service industry, there’s often a grease trap to catch FOG as it goes down the drain, or a larger tank underground called a grease interceptor, which serves as the last line of defense before the sewer line, he said. Usually, trucks extract the FOG from these



FEATURES

interceptors and haul it away, but FOG and fatty acids still get through into the sewer pipes.

There's also the issue of what to do with the substance when trucks do haul it away, Aziz said. For example, they found it is sometimes driven to a rural area and sprayed back out onto the land. That information led the three to begin exploring whether biology could be used to convert FOG into fuel.

FAR-REACHING RESEARCH AND RESULTS

Research reached across the sciences, from chemistry to physics to biology. Among their projects, the three examined the biology of FOG and whether there are microbial ways to break it down. They've looked at the concept of anaerobic co-digestion and whether methane, a gas that can be used for energy, could be created from the pollutants. It turns out it can, which presents the possibility of using this "pollutant" as a biofuel, Aziz said.

They've researched structural changes as well — whether there are ways to stop grease from flowing through the grease traps and grease interceptors — as well as ways to "clean" the FOG from the pipes to which it can adhere.

For years, the three have been leaders in this area of research. Fatbergs prompted some research in the United Kingdom and other locations, however, Ducoste said those research projects have traditionally been smaller and more specialized.

"NC State has been the primary bearer of what's going on," he said. "We've set the tone as far as challenges, potential solutions and energy use strategies."

Drawing from their research, the three faculty members are focused on three

pillars of change: improving education, educating food service workers about the problem; changes to technology, such as improvements to grease interceptors; and more vigilant attention paid to the maintenance of sewer pipes.

The three continue to offer education and training, often receiving requests to educate the engineers who are out there dealing with the issue. Today, they serve as advisors to town and city officials, receiving calls from all over the United States.



WORKING TOGETHER YIELDS GREATER RESULTS

Collaboration has been the key to success, the three say. While there has been empirical and anecdotal information over the years that explains what leads to FOG deposits, or states that additives will make the problem go away, the NC State researchers are focused on the science of the problem. They say they're asking the questions that will help understand how FOG



behaves so that the engineering can be improved in the future.

Rather than one research project, the three have approached the issue as one phenomenon around which there are many aspects, de los Reyes said.

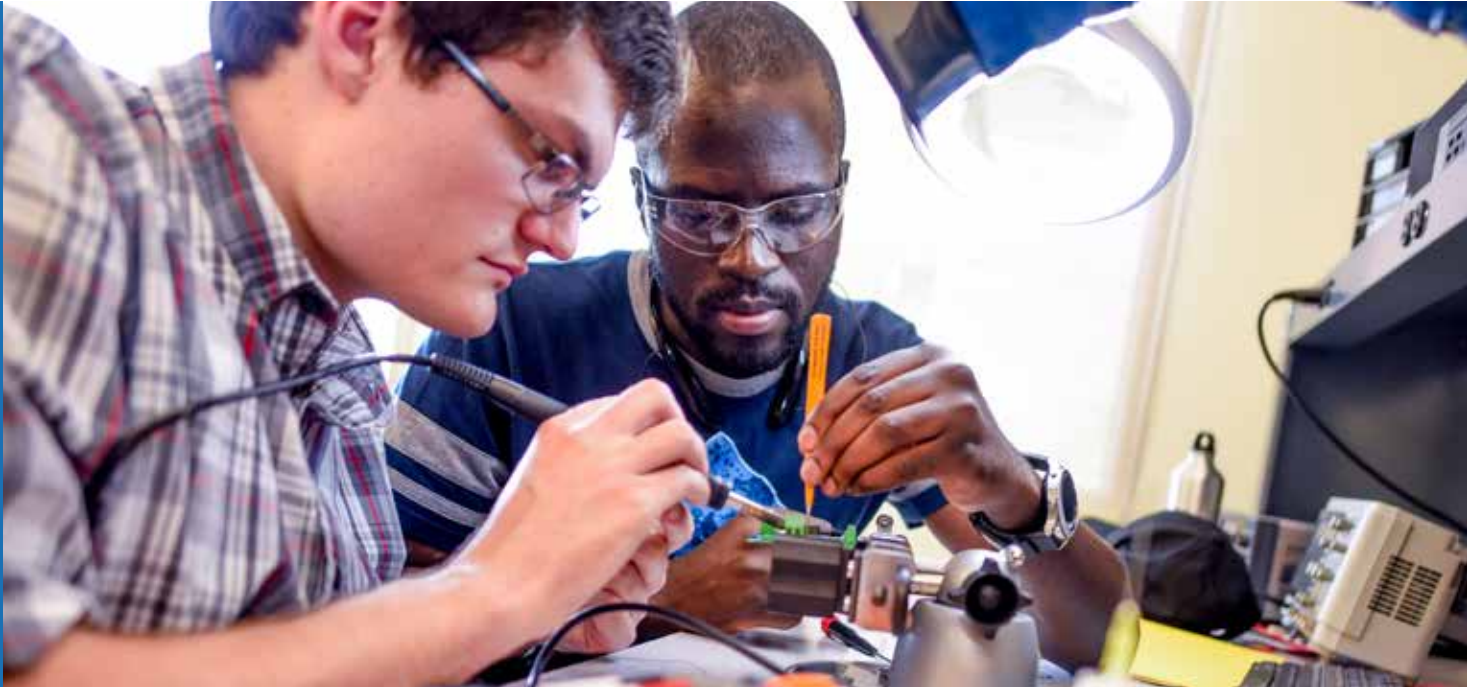
"This research speaks to the power of collaboration that NC State does well," Ducoste said. "It builds off the idea that a complex solution requires multi-disciplinary thinking." ■

"NC State has been the primary bearer of what's going on. We've set the tone as far as challenges, potential solutions and energy use strategies."

DR. JOEL DUCOSTE

RESEARCH **AS** RECRUITMENT

Summer research experiences strengthen student skills, help recruit graduate students



KATIE BERKOWITZ

EACH SUMMER, students throughout the United States pack up their field clothes and put on their lab equipment to conduct research with NC State faculty members.

For students, these summers are an important time to learn more about potential graduate programs and to improve their research skills, culminating in a poster presentation at the NC State Summer Undergraduate Research and Creativity Symposium. And for faculty members, it's a chance to further their research, recruit future students and spread the word about the innovative work happening at NC State.

Many students participate in Research Experiences for Undergraduates

(REUs) funded by the National Science Foundation. The College of Engineering hosted several REU sites in 2019, including: the FREEDM Systems Center and PowerAmerica REU, the Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST) REU, the Socially Relevant Computing and Analytics REU and the Joint Engineering Research Center REU.

Students from NC State and other universities can apply to these programs, and in addition to their research, participate in labs and other activities that improve their understanding of the research process. These REUs have been so successful that the College has created similar programs, such

“The knowledge gained and the support I’ve received from all of the people I’ve interacted with at NC State was unlike anything I’d experienced before.”

KATIE BERKOWITZ

as the Research Internship Summer Experience (RISE) with the Department of Civil, Construction, and Environmental Engineering (CCEE).

In the FREEDM Systems Center and PowerAmerica REU program this summer, junior Hampton Moore conducted research while also participating in technical labs and meeting local industry professionals — and he began to feel more settled at NC State. Moore, who is majoring in mechanical engineering, transferred from Johnston County Community College in August 2019.

His summer research focused on a magnetic core characterizing device, which tests the core of power transformers to see how much power is being lost by an electronic device’s magnetic core. The research’s ultimate goal is to determine the best waveform to minimize core loss in electronic devices.

While Moore won’t be continuing with his current research, he said the program has helped clarify how to pursue research at NC State.

“It definitely gives me an idea of the relevance of undergraduate research,” he said. “If I had an idea I wanted to develop further, I would know where to reach out to for funding or a mentor.”

For other students, these summers allow them an in-depth experience at NC State while they are deciding on graduate schools.

Yashira M. Valentín-Feliciano participated in CCEE’s eight-week RISE program, which is open to graduate students. She is in her final year of an engineering master’s program at the

University of Puerto Rico-Mayagüez and will be applying to Ph.D. programs for 2020.

“I like to do REUs because of the knowledge I’ll gain and because I’ll get exposed to a different environment, so I’ll have more diversity within my academic career,” she said.

This summer, she worked with CCEE professor Dr. Francis de los Reyes on using molecular methods to evaluate the microbial communities of pit latrines through fecal sludge analysis. Her research has ties to public health, as it could help improve researchers’ understanding of prevailing infections in specific communities. Similar analysis has been done for chemicals in sewer samples, but there isn’t much existing research specific to pathogens in pit latrines.

For de los Reyes and other faculty members, RISE and similar programs allow current graduate students to gain more mentoring experience, and principal investigators (PI) are sometimes able to assign research projects that might not fit with a current student’s thesis or dissertation.

“If a PI had a wild idea, it’s possible a RISE student might test it out,” he said. “There’s also additional manpower for research projects that are ongoing, so it pushes the research forward.”

These programs are also great recruiting tools for future graduate students and help with getting NC State more national recognition.

“It’s a good program, and I’m glad we have it in our department,” de los

Reyes said. “It’s important for NC State to have our name out there, and it’s also important for students to go back and say they had a really good experience.”

In some cases, a student’s involvement with summer research is what seals their decision to come to NC State for graduate school. Katie Berkowitz said she was thrilled when she learned that she was accepted to an REU in NC State’s Department of Mechanical and Aerospace Engineering (MAE) in 2017, and she started her Ph.D. in mechanical engineering at NC State this fall.

Berkowitz, who has a B.S. in mechanical engineering from the University of Maryland, Baltimore County, first came to NC State for the Composites for Extreme Environments REU because she was seeking a program that emphasized research on materials within a mechanical engineering department. At NC State, she worked under two PIs, Dr. Mark Pankow and Dr. Landon Grace, who are both assistant professors in MAE. She studied the effects of impact damage on the dielectric properties of bismaleimide, a composite used in the radome — a weatherproof enclosure that protects an antennae — of a B1 aircraft, and she returned during the summer of 2018 to continue her research.

“The knowledge gained and the support I’ve received from all of the people I’ve interacted with at NC State was unlike anything I’d experienced before,” she said. “I could not imagine going any place else to continue my education.” ■

The College **needs your help** to complete
Fitts-Woolard Hall

FILLING THE GAP

RELOCATING THE COLLEGE OF

ENGINEERING to NC State's Centennial Campus has been a University priority for years, and by 2010, six of the its nine academic departments had made the move. A fourth engineering building seemed just over the horizon.

But with a shift in the long-established state funding model for university facilities and the effects of a recession that began in 2008, plans for a fourth building were delayed.

So, the College took a bold step, making a commitment to help finance construction of the fourth building through private fundraising, a new model for North Carolina but one that NC State would need to adopt to further its academic mission.

"It was imperative that we carry on with this momentum," said Dr. Louis Martin-Vega, dean of the College. "To reach our full potential as a preeminent public college of engineering, we needed to continue the process of unifying

on Centennial so that we could take advantage of everything that the campus has to offer."

Today, construction of Fitts-Woolard Hall is going full steam ahead. The future home of 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 is on track to open in summer 2020. Thanks to generous commitments from more than 300 alumni donors, the College has fulfilled 80 percent of its commitment of \$60 million.

But there is still a fundraising gap of \$11.7 million to fill. Now, more than ever, those who have benefitted from the College's research, education and extension programs are being asked to help ensure that NC State Engineering

remains strong for decades to come.

"Our alumni and friends have risen to the occasion, accepting the challenge of securing private support to fill the gap between what public funding

alone could accomplish and realizing the dream of the next engineering building," said Griffin Lamb, assistant dean for development and college relations and director of the NC State Engineering Foundation. "The finish line is in sight, but we still need the help of the collective engineering community. Every gift counts and puts us one step closer to our goal."

ENGINEERING ON DISPLAY

The \$154 million project received \$75 million from the voters of North Carolina through a 2016 bond referendum. The NC Legislature provided \$2 million and the University is providing \$17 million. The fundraising effort received a substantial boost when industrial engineering alumni Edward P. Fitts and Edgar S. Woolard made a transformative \$25 million gift to support it. The University broke ground on Fitts-Woolard Hall and named it for the two donors in April 2018.

Fitts-Woolard Hall will allow ISE and CCEE to move out of buildings that are more than 50 years old and leave behind the constraints of limited space and outdated facilities. Students and faculty members will take advantage of a uniquely collaborative environment,

GET INVOLVED

Contact Erica Fuller with the NC State Engineering Foundation at ecacinder@ncsu.edu or **919.515.9958** to learn more about how you can contribute to the fundraising effort or help host an informational event.



LEAD WITH A GIFT

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

For gifts beginning at \$100,000

Your name will be permanently associated with the space of your choosing, and your gift will be recognized in a central location in Fitts-Woolard Hall along with a special recognition biography and photo.

DEAN'S OVAL CLUB

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.

DEAN'S YOUNG ALUMNI OVAL CLUB

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.

where leading companies share real estate with classrooms and lab spaces and the beneficial collisions that result can lead to groundbreaking ideas.

Fitts-Woolard Hall was designed by architecture and engineering firm Clark Nexsen with "engineering on display" as a theme. The building will showcase the two departments' labs to give visitors a glimpse of research being conducted in areas of great societal impact including additive manufacturing, smart infrastructure and environmental engineering. The building's location on the south side of Centennial's Engineering Oval next to the Hunt Library will make it a prominent through point and put engineering achievements front and center.

The building should be ready for occupancy in July 2020, with a goal of having both departments moved in when the fall 2020 semester begins.

MAKING AN INVESTMENT

Meeting its fundraising obligation will allow the College to continue to grow and improve in a fiscally sustainable way. Having to borrow to meet that obligation means debt service that would take

money from scholarships and programs that enhance the educational experience for students.

The College has created three exclusive giving societies (see sidebar) that offer donors insider access to the project. Tours of the facility are planned for Friday, November 8, 2019, during homecoming festivities. The Engineering Foundation is continuing its information sessions on the building across the state, with upcoming events planned in Greensboro and Charlotte.

NC State Engineering research is improving lives both at home and abroad and helping to drive the state's economy. Engineering students engage in hands-on educational experiences that prepare them for work in industry, entrepreneurship and leadership, giving them a solid foundation for future success.

The College has made tremendous strides in the last decade, growing its research, elevating its national prominence and improving its recruitment of the most-sought-after students and faculty members. Fitts-Woolard Hall is the next step in that progression and is part of a \$250-million investment by the College that

will continue that upward trajectory in an environment in which no peer colleges of engineering are standing still.

"Support for Fitts-Woolard Hall represents an investment in NC State and in our College of Engineering," Martin-Vega said. "With your help, the College will continue to grow, continue to achieve and continue to make our alumni and friends proud." ■

Alumni give to Fitts-Woolard Hall to invest in North Carolina's future



RICHARD ROHRBAUGH, CE '81

“To me, it’s just a no-brainer because the facilities have got to keep up with the type of instruction we’re trying to give.”

RICHARD ROHRBAUGH



STUART PHOENIX, ESM '76

IN THE MORE THAN A YEAR since the University broke ground on the new Fitts-Woolard Hall on Centennial Campus, construction is more than 70 percent complete, with an opening date expected for June 2020. This state-of-the-art structure will house the Department of Civil, Construction, and Environmental Engineering (CCEE); the Edward P. Fitts Department of Industrial and Systems Engineering; and the dean’s administrative offices. Upon completion, the College will be closer to its goal of being fully united on Centennial Campus. Get to know more about two alumni who have supported the project and why they see supporting the building as a priority.

STUART PHOENIX

Returning to his home state made sense to Stuart Phoenix when he was deciding on colleges as a high school senior in Florida.

His parents, who were both Raleigh natives, had moved around for his father's job, and when his family was relocating to New York just as he was going to college, he decided to come back to his family's home state.

"NC State was one of the schools I applied to because I was interested in math, science and technology," Phoenix said. "I was a math and science guy in school."

Phoenix graduated from NC State in 1976 with a B.S. in engineering science and mechanics. In 1987, he began working with FMI Corporation, a firm that was started in Raleigh by Doc Fails, an NC State professor, and provides investment banking and management consulting services for construction firms, engineers and others serving the built environment. He currently serves as chairman emeritus and is assisting with FMI's newest venture, FMI Investment Partners, and he is a former member of the NC State Engineering Foundation's board of directors.

As a student, Phoenix remembers enjoying his classes and the opportunity to take a wide range of courses outside of engineering, including constitutional law, ancient history and finance. He also remembers nights spent watching basketball. NC State won its first national championship in men's basketball during his freshman year.

"I remember going to the NCAA tournament game against Pittsburgh in Reynolds Coliseum when David Thompson tripped over Phil Spence's shoulders and really hurt his head. I also remember running to the (North Carolina State) Capitol building when we beat UCLA in the Final Four, and again when we beat Marquette for the national championship," he said.

In addition to witnessing some historic NC State basketball moments, Phoenix says that his time at NC State was when he learned valuable skills that have served as a base education for him throughout his career.

"I learned how to think and how to analyze things, how to do things right and be a lifelong learner," he said.

To Phoenix, that was part of what made NC State a great university. He says it's exciting to see the impact NC State is having on North Carolinians and the state's economy. For him, an important part of ensuring NC State continues to effect positive change in the state is by recruiting the best students and professors — and facilities like Fitts-Woolard Hall help with that.

"You just can't depend on the state and tuition dollars for that — you need the alumni to support those things that make a difference to make a great university. Fitts-Woolard Hall is a world-class facility. Being right next to Hunt Library and on Centennial Campus, it helps recruit professors and students, and it helps recruit industry to invest in the University and ally with the University," he said. "It sets the stage for the future."

RICHARD ROHRBAUGH

Growing up in North Carolina, Richard Rohrbaugh would often help his father, who was a professional engineer and land surveyor.

"Engineering seemed to be the thing I wanted to do," he said. "I was half-decent at physics and math, and it seemed like a really natural fit."

Rohrbaugh's interest led him to apply to NC State, and he graduated with a degree in civil engineering in 1981. He is a senior vice president and principal at the consulting firm Kimley-Horn and Associates. He also served on the CCEE Industry Advisory Board for several years.

At NC State, Rohrbaugh quickly realized how much he enjoyed learning how things

work. He credits his courses with helping him to become a problem solver, which influenced much of his career.

"I felt invigorated that I got to learn about how stuff worked," he said. "As I sat with professors, especially in my junior and senior years, that was when you really started to get into some of the technical aspects of civil engineering, it's almost like somebody had given me permission to learn more about how things work, and I just loved that."

Today, Rohrbaugh believes that the value of his diploma is greater than it was in 1981 — which is why he wants to give back to the University to ensure that legacy continues. He saw supporting Fitts-Woolard Hall as a way to do that with a tangible result.

"To me, it's just a no-brainer because the facilities have got to keep up with the type of instruction we're trying to give," he said.

While Rohrbaugh will miss Mann Hall, longtime home for civil engineering located on North Campus, he's excited about the new opportunities Fitts-Woolard Hall will provide for students. It was when he was serving on the CCEE advisory board and spending more time in Mann Hall that he realized how important it was for the College to construct new facilities.

Rohrbaugh said he thinks the CCEE faculty members have done a great job managing the constraints in the facility they have, and he's looking forward to students and faculty members having a better facility where they don't have to worry about those limitations. The new facilities at Fitts-Woolard Hall will improve students' learning environments, as well as help with recruitment.

"So many students who come here learn about North Carolina and come to love it, and when they graduate from NC State, a lot of them want to stay," he said. "I think we're going to benefit a lot from the people who take what they've learned and apply it." ■



GLOBAL GROWTH

Alumnus and donor Ralph Edwards has a passion for the impact of study abroad

RALPH EDWARDS WAS AN UNDERGRADUATE student in industrial engineering in 1959 when Dr. Clifton A. Anderson, the department head, called him into his office. It was a meeting Edwards would never forget.

Anderson, who did consulting work with Italian typewriter manufacturer Olivetti, had an opportunity to send an engineering student to the company's headquarters in the town of Ivrea as a summer intern. Edwards said yes, but it was a daunting assignment.

"I didn't know where Italy was and I certainly didn't have a passport," Edwards said.

He didn't have a camera, either. But Anderson loaned him his Leica camera and gave him simple instructions: write a story for the student newspaper when you return. And have fun.

With that invitation, Anderson gave

the young Salisbury, NC, native a love of travel (and of photography) that would serve him well during a career in international real estate and become a personal passion.

"That experience changed me," said Edwards, who settled in Atlanta, Ga., with his wife, Ree.

The Ralph and Ree Edwards Study Abroad Scholarship the couple established within the College and recently furthered with a significant gift helps engineering undergraduate students take the kind of impactful spring or summer study abroad trip that Ralph Edwards took.

All they ask of the scholarship recipients is that they try to attend an annual dinner in the fall with the couple in Raleigh to share their experiences and that they have fun.

And take pictures.

INTERNATIONAL EXPERIENCE

Olivetti was the world's leading manufacturer of typewriters at the time. Edwards spent his six weeks with the company's executives and engineers seeing every aspect of the operation. In between, he ate a lot of fine pasta and spent his off time in Paris, Rome and the Riviera.

Today, Edwards is chairman and CEO of EBS Property Investments, a private real estate company that invests in and provides asset management services for U.S. office, retail and industrial properties. Over the years, he has built a number of relationships with European investors. Edwards says that traveling internationally gave him the confidence to do that kind of work, and it all started with that first trip to Italy.

For Charles Blum, a junior in industrial



A NEW CONFIDENCE

and systems engineering, a study abroad trip to London offered a more dynamic educational experience that went beyond the normal coursework completed at a university. He studied business writing and economic analysis from a European perspective during nearly two months overseas in summer 2018. From facility analysis at the BMW Mini Plant and Coca-Cola European Partners facility, to participating in focus groups at IBM, to Blum, "this experience made the world my classroom."

That kind of experience, and the kind of confidence that it builds, is what the Edwardses want for the engineering students who take advantage of their scholarship. Six years of the program has produced 60 seasoned travelers, each with their own life-changing stories to share.

"If we could give an experience to someone reminiscent of mine and have it have a similar impact, what a great legacy that would be," Ralph Edwards said.

Savannah Abel had traveled overseas with her family growing up. But her study abroad trip to Segovia, Spain, the summer before her senior year was different.

The industrial engineering major knew none of the other 25 students on the trip. After a long flight and then a bus ride, hers was the first name called by the NC State faculty member leading the trip. An older Spanish gentleman who didn't speak English grabbed her bags and headed to the apartment he shared with his wife. It would be her home for the next four weeks.

The 2018 graduate, who now works for Ernst & Young in Charlotte, NC, figured things out after a few days and came out stronger because of the trip.

"After going through that, I feel comfortable that I can do almost anything," she said.

As a Benjamin Franklin Scholar, Rebeca Teran is pursuing a double major in computer science and French language and literature. She spent a spring semester on a study abroad trip in Lille, France. Speaking and hearing

French spoken on the streets and seeing the country's most historic sites was different than learning from a textbook.

"History came alive. That's the most important thing for me about study abroad," Teran said. "I was experiencing history instead of simply reading it."

The College's annual study abroad trip to Zhejiang University in Hangzhou,

China, was a kind of homecoming for Sandy Lin and Anna Davis. Students can take classes in engineering, international relations and Mandarin during their stay and have a chance to work on a design project for heavy equipment manufacturer Caterpillar at one of the company's Chinese facilities.

Lin's family is from China, and she had not been to the country in 10 years. She described the Hangzhou trip as "a good cultural identity trip for me." She was able to brush up on her Mandarin, learn about how China uses its resources in a course titled "Geographies of Energy" and spend time exploring.

Davis is an aerospace engineering major who was adopted from China at eight months old. Her experience was similar to those described by other beneficiaries of the Edwards Scholarship. The students returned with a finer appreciation of travel, plenty of photos of their adventures and a new confidence.

"I learned that I'm a lot more adaptable than I thought I was previously," she said. ■

PLANNED GIVING

ENGINEERING FOUNDATION

Have you included the NC State Engineering Foundation in your will, trust or other estate plans? It's a great way to make sure the opportunity that meant so much to you is there for future generations.

If you have already included the NC State Engineering Foundation in your estate plans please let us know.

Call Mike Walsh at **919.515.7237** to discuss any of these charitable options or visit www.engr.ncsu.edu/alumni-and-giving/ways-to-give for more information.

GIFT IN A WILL OR TRUST

Create your personal legacy by including the NC State Engineering Foundation, Inc. in your will or trust.

CHARITABLE GIFT ANNUITY

Provide fixed income for yourself or a loved one.

CHARITABLE REMAINDER TRUST

Create life income for you and your spouse.

RETIREMENT PLAN BENEFICIARY

Name the Foundation to receive part or all of your IRA, 401(K) or 403(B).

ENGINEERING ONLINE

Engineer Your **Future** with 16 Online Graduate Degrees Available from **NC State's College of Engineering**

Visit engineeringonline.ncsu.edu to learn more



Engineering Foundation hosts 21st annual Endowment Dinner

FROM LEFT, SHOSHANNA CONWAY, OLIVIA GARTZ, HANNAH FLETCHER, SHREYAS ASHOK, EVAN YOUNGBERG AND BRIAN WU AT THE COLLEGE'S 2019 ENDOWMENT DINNER.

EACH SPRING, Shoshanna Conway travels to the NC State campus to spend time with the engineering student who is benefitting from the scholarship named for her late husband. The annual Endowment Dinner hosted by the NC State Engineering Foundation makes it possible.

This event allows donors of endowed scholarships, fellowships and professorships to meet the recipient(s) of their award for the current year or semester. Both donors and students alike enjoyed sharing stories of their lives and their love of the Wolfpack and the College of Engineering. The 21st annual Endowment Dinner was held on April 4, 2019 at the Talley Student Union Ballroom.

The John Estes Conway Memorial Scholarship established by his family has benefitted more than 50 students in the Department of Mechanical and Aerospace Engineering (MAE). John Conway, who passed away in 1977 at the age of 27, earned a bachelor's degree in aeronautical engineering and a master's degree in mechanical engineering, both from NC State. Conway was a member of music and engineering honor societies and the University concert and marching

bands while on campus and was named the Outstanding Aerospace Student at NC State.

"Although his life was cut short, he contributed much during his time at NC State, to his work environment, his family and friends, his church, Scholar Cantorum, and in particular to me," Shoshanna Conway said. "In John's untimely death, there was a determination that something good would come out of it. I get to see that every spring at the Engineering Scholarship dinner."

Evan Youngberg, a senior in MAE, has received the Conway scholarship and was able to spend time with Shoshanna Conway at this year's Endowment Dinner.

"It means a lot to me to become a part of this scholarship's continuing story," Youngberg said. "I am more thankful than words can say for the financial support this scholarship has given me to continue working on my aerospace engineering degree."

At this year's event, Dean Louis Martin-Vega spoke of the importance of endowments to the College, its students and its faculty. He acknowledged and gave heart-felt thanks to all of the

generous donors who support the College in this way and introduced many of them in attendance.

Suzanne Gordon, whose family has endowed the Gordon Family Scholarship, is one of these donors. Gordon, who serves as president of the Engineering Foundation, spoke at the event sharing her thoughts on why people choose to give. There are so many reasons — to pay it forward, to pay it backward (give as you were given to), to support the school you love, to support the growth and opportunity of others or to honor someone you care about.

Carmen Davis, a student recipient, also spoke at the event. She described how meaningful receiving a scholarship was to her and her family, not only financially, but also as a motivator for her success. Davis, who received the Garwood Family Scholarship Endowment, plans to one day offer a scholarship to an NC State undergraduate student herself.

There are many types of endowments — scholarships, fellowships, professorships and general funds that support research and special programs for students and faculty members. The College has 313 endowed scholarships and 56 endowed professorships. ■



STUART NISBET, CS '87

Meet the DEAN'S CIRCLE

STUART NISBET

When Stuart Nisbet was looking at colleges, he felt drawn to NC State, but not just for the academic offerings.

"I had an affinity to NC State because of the athletics — thanks to people like (NC State men's basketball stars) Kenny Carr, Dereck Whittenburg," shared Nisbet. "But, I was also drawn to fields of computer science and applied sciences. There was so much NC State was doing in those fields that I wanted to be a part of it."

After graduating from NC State in 1987 with a B.S. in computer science, Nisbet began his career at SAS as a software developer. Over the last 32 years, he has held multiple positions at SAS, including R&D manager; R&D director; senior R&D director; vice president of

business intelligence R&D; and senior vice president, head of R&D.

Nisbet credits the education he received at NC State for his success in life and business.

"There's a lot to be said for learning the theory of how things work — but the application of technology and how to apply it is greater. At NC State I not only went through the process of studying the how, but was also taught to think more broadly."

For Nisbet, supporting the College is not an obligation, it is a small way to give back to the university that gave so much to him.

"When I was a student, NC State gave so much to me — in opportunities, in learning, and experiences. So as an alum, you have the opportunity to give back and help current and future students to

succeed," Nisbet said. "Giving back is not an obligation, but a way to contribute to the amazing work being done by the university for the community, the state of North Carolina and the country."

EVAN ARNOLD

Growing up with parents who are both alumni of NC State meant there was no shortage of Wolfpack pride for Evan Arnold.

"I grew up going to football games and watching NC State sports on TV," shared Arnold, who earned his B.S. in aerospace, aeronautical and astronautical engineering in 2015 from NC State. "It meant so much to me to attend NC State."

As a student, Arnold interned at the Institute for Transportation Research and Education (ITRE), located on NC State's



EVAN ARNOLD, AAA '15



DR. CHRISTINE GRANT

STUDENT SUPPORT AND PROVIDING SCHOLARSHIPS and fellowships to the next generation of engineers and computer scientists is vital to the College's mission. Through the generosity of alumni, friends and faculty members, the Dean's Circle helps provide support to the College's outstanding students. The Dean's Circle is a comprehensive society for all unrestricted gifts of \$1,000 or more to the College and its departments. Meet three Dean's Circle donors and learn why they give.

Centennial Campus. After graduation, he continued his work with ITRE as an unmanned systems engineer and research associate.

His work with ITRE focuses on aviation and furthering drone technology — including maintaining small UAV fleets for flight readiness, performing airworthiness inspections and reports to the FAA for flight readiness, and managing flight operations.

Arnold said that his time at NC State not only helped him with his career, but in cultivating lasting friendships.

"The sole reason I am where I am in my career is due to NC State and the work I did as a student," Arnold said. "As a student, I also met some of the greatest people in my life and cultivated relationships that I am forever thankful for."

As a young alumnus, Arnold felt it was time to support the College in more than just attending football games.

"I wanted a way to interact with my alma mater that had a lasting impact and to support those in the same degree program," said Arnold. "My hope is to help create a legacy for future students — to give them opportunities to succeed."

DR. CHRISTINE GRANT

Working in academia was a long-term goal for Dr. Christine Grant when she graduated with her Ph.D. in 1989 from the Georgia Institute of Technology.

"My plan after getting my Ph.D. was to work in industry, then make the transition to academia. But, former NC State Department of Chemical and

Biomolecular Engineering (CBE) faculty member Dr. Ron Rousseau mentored me in his role as department chair while we were both at Georgia Tech. He even had career discussions with my mother in his office," said Grant, now a professor in CBE and associate dean for faculty advancement. "As a result, NC State was the only university I applied to, and I got the call they wanted me to join right after I completed my degree. I have been here ever since."

Grant felt at home at NC State and was impressed with the scope of the College.

"There was also a great deal of promised growth. When I started, there was only one main building on Centennial Campus — look at us now."

As a Dean's Circle member, Grant believes that giving back to the College makes donors feel that they are part of something larger than themselves.

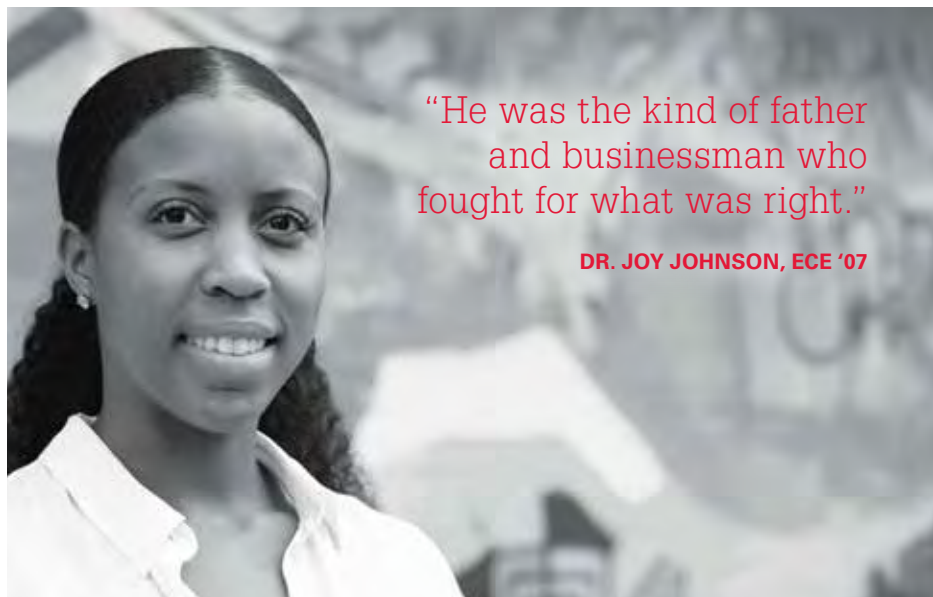
"Initially, I thought it a bit strange for an employee to donate, then I saw colleagues contributing to 'the cause.' It helped me to see that if I really believed in what we were doing that I could contribute to the College of Engineering initiatives," shared Grant.

In her position as an associate dean and as a faculty member, she feels that passion is a major factor in giving back.

"I am passionate about the success of our faculty — there are some really great colleagues (and students) that I wanted to indirectly support."

Grant said that different life seasons result in different donor capabilities, so no matter the amount, large or small, support for the College is welcome.

"The main thing is to contribute." ■



“He was the kind of father
and businessman who
fought for what was right.”

DR. JOY JOHNSON, ECE '07

Young alumna endows scholarship in honor of father



DR. JOY JOHNSON didn't grow up dreaming about becoming an engineer. But she did grow up with a father who taught her to give back what she can to other people.

Johnson's father, Kenneth T. Johnson, left school after sixth grade. He later went to trade school and went on to build a successful waterproofing company in Greensboro, NC, through word of mouth. In a way, Joy Johnson said, his work involved engineering — he had to draw schematics of client's

basements and design and review final construction plans.

Her father was one of her greatest supporters, and he encouraged Johnson to consider an engineering degree.

“He was the kind of father and businessman who fought for what was right,” said Johnson, who earned her dual B.S. in computer and electrical engineering in 2007. “I don't think I would have ever been at NC State if it wasn't for him.”

In her father's honor, Johnson endowed the Kenneth T. Johnson Minority Engineering Award to fund two students per year in the College's Minority Engineering Programs — one in the Summer Transition Program (STP) and one in the Minority Summer Research Program (MSRP). STP helps incoming students build a network of other minority engineering students and introduces them to alumni and industry partners while they live and take classes on campus through Summer Start. MSRP is a six-week program

for undergraduate minority students to conduct research and increase their awareness of research opportunities.

When Johnson was preparing for her first year at NC State, she hadn't yet taken some of the physical science courses required of an engineering major. So, when a spot opened up in the summer programs, she jumped on it.

That summer, Johnson took physics, chemistry and calculus III, helping her get a head start on coursework while making connections with other engineering students.

“Having the opportunity to take the coursework that you weren't offered or did not have in high school before is golden,” she said. “Starting off right is so helpful, and so is having a network of people who are pursuing engineering and who look like you.”

Johnson built on her early accomplishments and continued to be successful at NC State and beyond. She interned at Intel, participated in a summer research program at Cornell University and was a Park Scholar. After graduating from NC State, she earned her master's and Ph.D. degrees in electrical engineering from the Massachusetts Institute of Technology. She now works at Apple in the special projects group for hardware engineering.

STP, she said, made her realize that she would be able to survive and thrive at NC State, and she wants other students to have the same opportunity to get an early start on course work or build up a support group before the semester begins.

“To me, it's a no-brainer. I was privileged enough to get this opportunity, and there's a responsibility there,” she said. “My dad was the kind of person who was always giving. I think if you have it, you should give it.” ■

Young alumni spotlight

FOUNDATIONS



Hometown Raleigh, NC
Graduation Year 2015, Valedictorian

ALEX STONE

Degree B.S., Mechanical Engineering
Current Job Title Mechanical Engineer
Hipp Engineering & Consulting, Inc.
Young Alumni Advisory Board College Relations Committee

ALEX STONE grew up with NC State in his blood. “My grandfather, a College alumnus, uncle, and mom all attended State. My wife is an NC State alumna, my father-in-law a College alumnus, and my brother-in-law a current student. I was born in Raleigh and rooted for the Wolfpack my whole life.” When it came time to decide on a university, Stone applied early to NC State and decided to only apply to NC State. “I was ‘one and done’ when it comes to college applications. I loved the campus and its proximity to the heart of Raleigh, and let’s be honest, the State Fair.”

Post graduation, Stone is a mechanical engineer with Hipp Engineering & Consulting, Inc. — an engineering consulting firm in Raleigh specializing in the design of manufacturing facilities in the life sciences sector. According to Stone, there are no typical days for him in the consulting engineering business. “There are days spent at different pharmaceutical manufacturing facilities doing field work, days spent doing calculations and selecting equipment for various projects and days spent drafting in AutoCAD (2D) or Revit (3D). It’s a great mix of being in an office and getting out in the field. There is no such thing as a boring day at work.”

One of the things Stone finds interesting about his job is seeing the different facilities that manufacture various medicines and learning the different processes used for each. For example, the process used to manufacture acetaminophen is vastly different than the process for manufacturing insulin — meaning each requires its own highly specialized facility. “Being an engineering consultant, I have the opportunity to interface with many different clients and learn many different manufacturing processes. I have the opportunity to see a lot of cool things at a bunch of different facilities — some even being a few million square feet in size. Every day is a learning opportunity.”

Thinking back on his time as an engineering student, he shares that the most important thing he learned was time management. In college, he says, there are many things that always need to be done for classes and clubs, with it still being important to maintain an appropriate school-life balance. “It takes effective time management to organize, prioritize and complete all tasks at hand,” said Stone. “The same can be said in the consulting business — there are always multiple projects that must progress simultaneously. Being proficient with

time management is key to finishing projects on time, on budget and with your work-life balance still in check.”

He is grateful for all that he learned at NC State and for the engineering degree that was instrumental in providing him with the tools needed to propel him into a career that is both challenging and fulfilling. “During school, I learned how to think critically, solve problems and work collaboratively to accomplish bigger goals than are possible for any single individual. These skills have proved to be crucial in the short time I’ve been out of school, both from a personal and professional standpoint.”■

Please join the Young Alumni Advisory Board (YAAB) at its Homecoming event, Thursday, November 7, 2019 6-8 p.m. at Raleigh Times.

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**.

www.engr.ncsu.edu/alumni-and-giving/ya

FOUNDATIONS

NC STATE ENGINEERING FOUNDATION, INC.

BOARD OF DIRECTORS

Bruce Baldwin, MAE '92
Ashley Barnes, IE '95
Suzanne Beckstoffer, CE '82
Ashok Bhatnagar, NE '79
Robert (Bob) Brooks, EO '69
Linda Butler, NE '86
Calvin Carter, Jr., MSE '77, '80, '83
W. H. Clark, Jr., IE '56
Mike Creed, CE '73 '84
Heather Denny, CE '95
Casey Dean, EE '67
David Dove, AE '69
Ralph Edwards, IE '61
John Freeman, MSE '57
Suzanne Gordon, CSC '75, MA '75, ST '80*
Len Habas, EE '66
Rashida Hodge, ISE '02, '03
Jake Hooks, MSE '78
Seneca Jacobs, CE '99
Rob Loftis, EE '02
Helene Lollis, CHE '87
Samuel (Sam) McCachern, CE '85
Tom McPherson, Jr., EE '76
Mark Norcross, FMM '65
Chi Nguyen, AE '92
V. Nelson Peeler, Jr., EE '88
Scott Stabler, MAE '82
Carl Stutts, Jr., CHE '68
Alvin Sumter, ISE '87
Pam Townsend, CE '84, '87
Hannibel (Hans) Warren, Jr., CE '84
Greg Washington, ME '89, '91, '94
David Whitley, EE '92
Robert (Bob) Womack, MAE '59
Mark Wyatt, CSC '80
Deborah B. Young, CE '77
*President

FOUNDATION STAFF

Griffin Lamb

Assistant Dean for Development and College Relations
Executive Director of the NC State Engineering Foundation Inc.

Michael Walsh

Interim Executive Director of Major Gifts and Campaign Planning

Nora Brodsky

Business Services Coordinator

Carissa Burroughs

Lead Event and Alumni Relations Coordinator

Erica Fuller

Assistant Director of Development and Alumni Engagement

Shawnda Hill

Business Officer

Angela S. Martin

Associate Director of Annual Giving and Prospect Development

Chris Price

Director of Development
Department of Electrical and Computer Engineering

Sara Seltzer

Director of Development
Department of Materials Science and Engineering
Department of Computer Science

Lindsay Smith

Director of Development
Department of Civil, Construction, and Environmental Engineering

DEPARTMENT REPRESENTATIVE

Trudi Brown

Department of Electrical and Computer Engineering

Russ O'Dell

Department of Chemical and Biomolecular Engineering

Kenneth M. Tate

Department of Computer Science

Foundation Year in Review

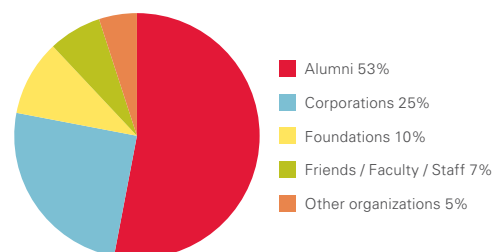
Fueled by strong support for Fitts-Woolard Hall and the Think and Do the Extraordinary campaign, the **NC STATE ENGINEERING FOUNDATION** had another excellent fundraising year with giving totals to the College at \$19,090,566.

Endowments to the College generally fall into one of three categories: scholarships, named professorships and fellowships. There are now 313 permanently endowed scholarships in the College and 56 permanently endowed named professorships. Total endowment support for the College is \$139.7 million as of Dec. 31, 2018, including directly owned assets as well as endowments held outside of the Engineering Foundation.

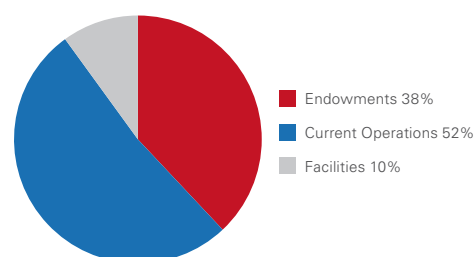
The annual giving program for the COE raised a total of \$1,504,343 for the College of Engineering Leadership Fund and all nine department enhancement funds. The Dean's Circle, the leadership annual giving society, grew by 17 members, bringing our total membership to 504 alumni and friend donors, representing a 3-percent increase from the previous year. These gifts often represent our "pipeline" for major gifts and an important part of the College's overall advancement plan.

The Think and Do the Extraordinary Campaign began in 2013 and concludes

GIFTS AND NEW COMMITMENTS BY GIFT SOURCE, FISCAL YEAR 2018-19



GIFTS AND NEW COMMITMENTS BY GIFT USE, FISCAL YEAR 2018-19



in 2021. The College of Engineering's goal is \$230 million and thus far has raised \$182,108,859.

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. ■

GRIFFIN LAMB

Assistant Dean for Development and College Relations and
Executive Director of the NC State Engineering Foundation Inc.
grlamb@ncsu.edu | 919.515.9956

MICHAEL WALSH

Interim Executive Director of Major Gifts and Campaign Planning
mpwalsh2@ncsu.edu | 919.515.7237

ERICA FULLER

Assistant Director of Development and Alumni Engagement
Contact for Young Alumni and Annual Giving
eacinder@ncsu.edu | 919.515.9958

ANGELA S. MARTIN

Associate Director of Annual Giving and Prospect Development
anstalli@ncsu.edu | 919.513.1714

CHRIS PRICE

Director of Development
Department of Electrical and Computer Engineering
ccprice3@ncsu.edu | 919.513.1338

SARA SELTZER

Director of Development
Department of Materials Science and Engineering and
Department of Computer Science
skseltzer@ncsu.edu | 919.515.3730

LINDSAY SMITH

Director of Development
Department of Civil, Construction, and Environmental
Engineering
lksmith4@ncsu.edu | 919.515.7738

TRUDI BROWN

Department of Electrical and Computer Engineering
tabrown@ncsu.edu | 919.513.2251

RUSS O'DELL

Department of Chemical and Biomolecular Engineering
russ_odell@ncsu.edu | 919.513.2071

KENNETH M. TATE

Department of Computer Science
tate@csc.ncsu.edu | 919.513.4292

HIGH-POWERED ROCKETRY CLUB WINS ALTITUDE AWARD AT NASA COMPETITION

AS THEIR ROCKET CLIMBED TOWARD THE SKY

outside NASA's Marshall Space Flight Center in Huntsville, Ala., the NC State High-Powered Rocketry Club members watched it go up — and up, and up.

"It went straight up, and we thought it went really high," said Ashby Scruggs, president of the club and a senior majoring in aerospace engineering. "We thought, 'Wow, that must be so much over our expected altitude.'"

It wasn't. The rocket went just 12 feet above the team's projected altitude of 4,090 feet. As the team whose rocket was closest to the predicted altitude, NC State won first place in the altitude award section of the NASA Student Launch Competition. The second- and third-place teams were 35 and 48 feet off their respective predicted altitudes.

"We were all so shocked because in our last couple of test launches, we were off by several hundred feet," said Joseph Taylor, media officer for the club and a senior majoring in plant biology and environmental science. As part of the payload operations team, he was one of the first to hear the results from the altimeters, the instrument that measures altitude.



During the club's test launches, when winds hit the rocket, it would lean slightly in that direction rather than adjusting back to center, making it apparent that their rocket was slightly over-stable, explained Frances McBride, safety officer for the club and a sophomore majoring in aerospace engineering. Because of the over-stability, the rocket fell short of the predicted altitude during test launches. But it all worked out on the day it mattered, and with that first-place finish, NC State finished eighth overall.

"We're really proud of our accomplishment," Scruggs said. "That's the best we've done in a couple of years."

The club attends the NASA competition every April after eight months of preparation. NASA issues a request for proposal in August, and the assignment is based on one of NASA's current projects. This year, because NASA is developing unmanned aerial vehicles (UAVs) to collect soil samples from Mars, the students also developed a UAV that deployed when the rocket landed.

The club, which has between 45 and 60 members each year, works together on the reports for NASA and on the design and construction of the rocket and its payload. The club is comprised mostly of NC State engineering students but is open to students in other colleges and majors.

About 20 members travel for the competition, where they have a chance to tour Marshall Space Flight

Center and other facilities, learning about the latest space exploration developments.

"I went from zero to a fair understanding of rocketry in a whole year," McBride said. "I would not be where I am without this club." ■



NC STATE Engineering

NC State University
College of Engineering
Campus Box 7901
Raleigh, NC 27695-7901



@ncstateengr



NC State Engineering



@ncstateengr



NC State Engineering Alumni

www.engr.ncsu.edu

NON-PROFIT
ORGANIZATION
U.S. POSTAGE PAID
RALEIGH, NC
PERMIT NO. 2353

COLLEGE OF ENGINEERING HOMECOMING CELEBRATION

RED AND WHITE WEEK

NOVEMBER 7-8, 2019

Visit go.ncsu.edu/homecoming to learn more.

- BBQ lunch with fellow alumni
- Tours of Fitts-Woolard Hall
- Connect with other young alumni at a happy hour social