NC STATE Engineering

SPRING / SUMMER **2019**

A FACILITY LIKE NO OTHER

On-campus nuclear reactor has always been an innovator

Monteith served as dean of engineering from 1978 to 1989 and then as chancellor from 1989 until his retirement in 1998. McKinney left his position as dean of the School of Design in 1988 to serve as a special assistant to the chancellor leading development of Centennial.

Cavin was head of the Department of Electrical and Computer Engineering and served as dean of engineering from 1994 to 1996. Whitten is a former dean of the College of Physical and Mathematical Sciences and now a professor emeritus in the Department of Chemistry.

A NEW KIND OF CAMPUS

1991 was an important year for Centennial Campus.

North Carolina Gov. James B. Hunt Jr. established Centennial on Dec. 19, 1984, by allocating 355 acres from the Dorothea Dix Hospital property. The new campus was named in honor of NC State's centennial in 1987.

By 1991, more land had been added to the campus and a master plan developed. That year, Research Building I, the first building on campus, was completed and the College of Textiles opened its new home there. ABB became Centennial's first corporate tenant that same year.

In this photo taken that year, from left, Dr. Jerry L. Whitten, Claude E. McKinney, Dr. Ralph K. Cavin III and Chancellor Dr. Larry K. Monteith look over a model of early buildings on the campus.

Today, the thousand-acre campus is home to 76 industry, government and nonprofit partners and 75 university centers, institutes and departments.

The College will continue its move to Centennial with the opening of Fitts-Woolard Hall, the newest engineering building on the campus, in summer 2020. Fitts-Woolard Hall will be the new home of the Department of Civil, Construction, and Environmental Engineering; the Edward P. Fitts Department of Industrial and Systems Engineering; and the dean's administration. With its opening, eight of the College's nine academic departments will call Centennial home.

Fitts-Woolard Hall represents a new paradigm for NC State, using a public-private partnership to fund the construction of an academic building.

Learn more about what's happening on Centennial Campus in our Q&A on **page 2** and about how you can support construction of Fitts-Woolard Hall on **page 32**.

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SPRING / SUMMER **2019**

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DEAN **Dr. Louis A. Martin-Vega**

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Q&A

QUESTIONS FOR **DENNIS KEKAS**

Dennis Kekas is NC State's associate vice chancellor of partnerships and economic development, where he oversees industry and government partnerships, including those on Centennial Campus. As the College continues its move to Centennial, we asked him about what makes it a great campus.

What makes Centennial unique among research campuses in the United States?

On Centennial Campus, leaders in industry and government work side by side with university researchers and students to solve some of society's biggest challenges. Centennial is a true live-work-play-learn community, offering a mix of corporate and university buildings, housing and dining, and outdoor amenities, such as a championship golf course, walking and biking trails, a hotel and conference center, and a public lake.

What are some recent successes for the campus that you'd like to highlight?

Last spring, NC State was named the first university IBM Quantum Computing Hub in North America, joining a global network of top Fortune 500 companies, national research labs and leading universities to advance quantum computing. NC State, in partnership with IBM, established a membership-based hub, enabling access to IBM's commercial quantum computing devices, including the most advanced and scalable universal systems available. Quantum computing has the potential to solve problems currently intractable with classical computing. Another example came last year when leading apparel company VF Corporation announced a long-term, strategic partnership with NC State and opened an innovation center on Centennial to collaborate with our researchers and students.

What impact will eventually having the entire College of Engineering located on Centennial Campus have?

While NC State is one of the top producers of engineers and computer scientists in the U.S., demand has never been higher, and that is only expected to continue. By unifying the College on Centennial, NC State will continue to produce a future-ready workforce and create jobs by developing new technologies, launching new companies and bringing cutting-edge products to market.

What types of companies have a presence on Centennial Campus?

Centennial is home to more than 70 companies, government agencies and nonprofits, ranging from early-stage startups to large enterprises listed on Forbes' Global 1000. For example, global technology company LexisNexis started with 150 employees on campus in 2014 and has more than 700 today. Much of their growth is a result of hiring our graduates. Also, Eastman Chemical Company has invested more than $16 million in its partnership with NC State, with a significant ROI. Their partnership is heavily focused on sponsored research — they've worked with NC State on 86 research projects in 11 departments across the University.

What are the next steps in the campus' growth?

Fitts-Woolard Hall, which broke ground last year, will provide critical infrastructure for the College, and help attract more businesses and industries to North Carolina. Starting construction this year, the Plant Sciences Initiative Building brings together the state's agriculture community and biotech industry to support our farmers in feeding a growing global population. By developing new methods to increase yields, enhance sustainability and extend growing seasons, it will have a significant impact on global food production. The next mixed-use development will be multi-phase, with lab, office, retail, residential and innovation space. ▪

FROM THE DEAN

LOUIS A. MARTIN-VEGA

Welcome to the spring 2019 issue of *NC State Engineering* magazine. While our engineering departments still provide the underlying framework of our College, increasingly, the practice of engineering and engineering education is driven as much or more by cross-cutting societal challenges and the solutions they need, as it is by traditional engineering disciplines. This reality has made interdisciplinary work a focus of engineering education and research at NC State.

In this issue we highlight examples of interdisciplinary endeavors which have contributed to our increased prominence among Colleges of Engineering nationwide. This includes faculty in our UNC/NC State Joint Biomedical Engineering Department who are working with colleagues and graduate students in biomolecular science and veterinary medicine to develop a new system that could save the lives of heart attack victims.

You'll also learn about research targeted on fighting antibiotic-resistant pathogens that are causing a significant threat to public health. This research team includes a faculty member with joint appointments in the Departments of Materials Science and Engineering and Chemical and Biomolecular Engineering working with faculty in biological sciences and chemistry.

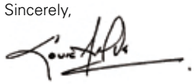
At the College level you can also see it in research centers we lead that are addressing large areas of societal need, such as the NSF ASSIST Engineering Research Center creating wearable personal health monitoring devices, and our two Department of Energy centers focused on nuclear nonproliferation and creating the next generation of light water nuclear reactors.

At the University level the Chancellor's Faculty Excellence Program has brought more than 75 new faculty members to NC State to work across academic disciplines in clusters that focus on important research areas. Engineering faculty members are leading clusters in carbon electronics; global water, sanitation and hygiene; and sustainable energy systems policy.

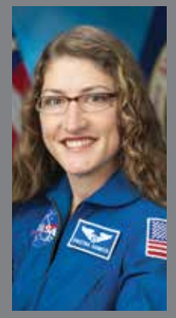
This interdisciplinary and collaborative spirit is what also makes Fitts-Woolard Hall so special. Our newest engineering building on Centennial Campus will bring together the Department of Civil, Construction, and Environmental Engineering and the Fitts Department of Industrial and Systems Engineering. This will allow their faculty and students to more easily collaborate with each other and other engineering departments, the College of Textiles and the 76 industry, government and nonprofit partners located on Centennial Campus. In this issue you will learn more about what a remarkable building this will be as well as our request that you continue to support our fundraising efforts to complete this transformative facility without placing a financial burden on your College of Engineering.

We trust that our efforts make you prouder every day to be an alumni or friend of NC State's College of Engineering. Thank you for your support and we encourage you to stay in contact with us.

Sincerely,



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



Alumna blasts off for the ISS

Engineering graduate Christina Hammock Koch launched from the Baikonur Cosmodrome in southern Kazakhstan on March 14, bound for the International Space Station.

Koch, who holds bachelor's degrees in physics and electrical engineering and a master's degree in electrical engineering, is expected to spend six months in orbit. It will be the culmination of nearly six years of training since she was selected as one of NASA's eight astronauts in the Class of 2013.

As a child, Koch dreamed of becoming an astronaut. At NC State, she received encouragement from faculty mentors in both physics and electrical engineering and did summer undergraduate research in an astrophysics lab.

"As I grew up in Jacksonville, North Carolina, there weren't necessarily a lot of engineers that I saw on a daily basis," she said in an interview before the launch. "Somehow, though, I got it into my head that I wanted to be an engineer. So I hope I can be an example to people who might not have someone to look at as a mentor that it doesn't matter where you come from or what examples there might be around you, you can achieve whatever you're passionate about." ▪

> "...it doesn't matter where you come from or what examples there might be around you, you can achieve whatever you're passionate about."
>
> **CHRISTINA HAMMOCK KOCH**

INAUGURAL DAY OF GIVING A SUCCESS FOR THE COLLEGE

ON MARCH 27, NC State University hosted its inaugural Day of Giving — a 24-hour fundraising campaign to maximize support for the University — and the College of Engineering's alumni, students and friends rose to the challenge and did the extraordinary.

The College raised $1,972,851 from 1,564 gifts, and it received more gifts than any other college or program and raised the second-most dollars overall.

These gifts support innovative research, scholarships, study abroad and other educational programs for student engineers and the College's state-of-the-art facilities.

"I want to thank each and every one of you who helped us with our first annual Day of Giving," Dean Louis Martin-Vega said. "This was a wonderful day for all of us."

Within the College, the nine academic departments competed to win a share of $15,000 from Martin-Vega based on the number of gifts received. The Department of Mechanical and Aerospace Engineering (MAE) took home the top prize with 428 gifts, followed by the Edward P. Fitts Department of Industrial and Systems Engineering (ISE) with 289 gifts and the Department of Civil, Construction, and Environmental Engineering (CCEE) with 172 gifts.

Additionally, the NC State Engineering Foundation Board of Directors awarded $11,000 in prize money after Day of Giving based on a percentage of participation by department alumni.

Throughout the day, the College competed in the Red Division Leaderboard against five other colleges and programs. NC State's engineering community kept the momentum going by using the #GivingPack hashtag on social media and helping the College win several giving challenges, including both of the Most Gifts Challenges, a competition to see which college received the most gifts at a designated hour. The College also won the First Gift Challenge when an ISE student was the first to make her gift at 12 a.m., as well as the Out-of-State Challenge, receiving the most gifts from outside North Carolina.

The College's faculty and staff took part in the spirit of the day, celebrating and encouraging gifts of all sizes. MAE, ISE and CCEE all hosted well-attended Day of Giving events that evening to continue the fun.

The highest single gift of the day was a $1 million gift, and the farthest gift came from Singapore. Of the 1,564 gifts, almost two-thirds — 994 gifts — were from College alumni.

In a video posted after the event, Chancellor Randy Woodson thanked those who made gifts, saying he was proud of what donors helped NC State accomplish. The University in total raised more than $13.5 million from more than 10,000 gifts on Day of Giving. ▪

FUNDING WILL HELP UNDERREPRESENTED STUDENTS PURSUE STEM DEGREES

NC STATE IS THE RECIPIENT of funding from the National Science Foundation (NSF) to support the Louis Stokes Alliance for Minority Participation (LSAMP) Bridge to the Doctorate (BD) Fellowship program.

Funding from this award helps support graduate students from domestic underrepresented minority backgrounds who are pursuing graduate studies in science, technology, engineering and mathematics (STEM) programs at the University.

NC State is one of seven University of North Carolina System schools that are part of the North Carolina LSAMP program, joining Fayetteville State University, North Carolina A&T State University, North Carolina Central University, UNC Chapel Hill, UNC Charlotte, UNC Pembroke and Winston-Salem State University.

"This bridging program allows students who are interested in STEM to not only work toward a doctoral degree, but also to receive the tools to be successful not only academically, but also in their profession and beyond," said Dr. Joel Ducoste, director of college graduate student recruitment and advancement and professor in the Department of Civil, Construction, and Environmental Engineering. "As the name implies, it bridges undergrads to Ph.D. and helps with the career development process and answering students' unknown questions on what they should be engaged with while on the road to being a scholar and expert in their chosen field."

> "This is a wonderful opportunity for NC State to do its part in broadening participation and making the College more inclusive to all people."
>
> **DR. JOEL DUCOSTE**

Starting in fall 2019, the LSAMP BD Fellowship will support 12 students with a stipend of $32,000 annually for the first two years; tuition, fees and student health insurance waiver for the first two years; continued funding at unit level for up to three additional years for qualified Ph.D. candidates; personalized mentoring; up to $4,000 in travel funding for professional conferences; links to research and professional opportunities; enriched academic services and support; a summer orientation program; and academic and research enhancement.

Ducoste, who has been leading recruiting efforts for the program since fall 2018, feels the recruitment process has gone well and is looking forward to working with the incoming students.

"This is a wonderful opportunity for NC State to do its part in broadening participation and making the College more inclusive to all people," he said. "Programs like this are the first step in creating an environment in which everyone feels welcome and helps contribute to the greater good. The power and ideas coming from this aids in shaping the future innovators of the world and transforming the impossible to more of what's possible." ▪

WASHINGTON DC INTERNSHIP PROGRAM INTRODUCES STUDENTS TO POLITICS

MANY ENGINEERING STUDENTS never consider a future career in politics or public policy, even though their expertise can often be critical. A new seven-week Washington D.C. internship program piloted by Dean Louis Martin-Vega and John English, engineering dean at the University of Arkansas, aims to change that.

During the internship, students gain valuable experience while helping with research on policy proposals related to engineering and working on typical congressional intern tasks, such as giving Capitol tours or organizing mail. Their engineering knowledge gives them a unique perspective on issues facing the country, while they also get to learn about how the policymaking process works.

Last year, NC State sent four students to D.C. for the first summer of the internship program. Students receive a $3,000 stipend, free room and board and transportation to D.C. and back at the end of the program.

In 2018, Tyler Conrad, a junior industrial engineering major, and Claire DeCroix, a sophomore chemical engineering major, interned in North Carolina Rep. David Rouzer's office. Abby Kinlaw, a sophomore environmental engineering major, and Jansen Quarandillo, a sophomore construction engineering major, interned with the House Transportation and Infrastructure Committee chaired by Pennsylvania Rep. Bill Shuster.

All four students shared that they were excited to live in D.C. for a summer and to get a chance to see how Congress operates.

Conrad said he felt well prepared to assist with policy and campaign research, thanks to the research he does in his NC State classes.

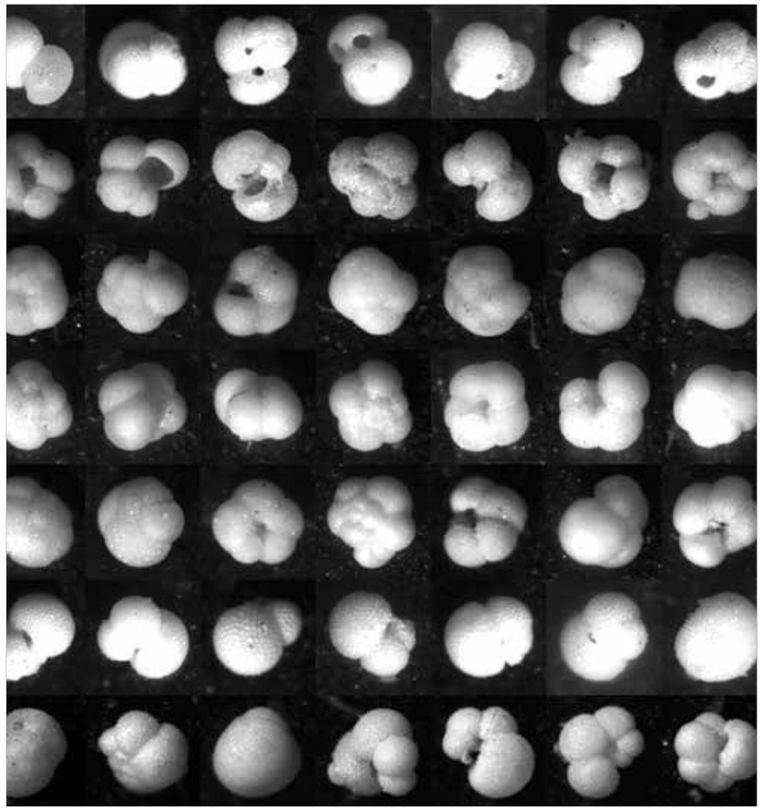
"It's important for engineers to be engaged in politics because new innovative technology brings with it new challenges," he said. "There will need to be certain laws surrounding that technology in order for it to be effectively introduced to the public."

Kinlaw also drew parallels between the research she did during her internship and the problem-solving mindset she uses in her engineering classes.

"I think it's very key for engineers to be more directly engaged in politics if we want to increase awareness and understanding of — and action on — the complex and increasingly difficult problems facing us in the future," Kinlaw said.

The internship program also helped the students build up their networks and improve their communication skills. Students were able to attend congressional hearings and meetings and, outside their working hours, they went to lectures and toured D.C. landmarks.

"It showed a different side of engineering," DeCroix said. "We get kind of wrapped up in our technical world and classes, and it was really nice to be in a different kind of atmosphere and to share our knowledge." ▪



ARTIFICIAL INTELLIGENCE CAN IDENTIFY MICROSCOPIC MARINE ORGANISMS

> "At this point, the AI correctly identifies the forams about 80 percent of the time, which is better than most trained humans."
>
> **DR. EDGAR LOBATON**

RESEARCHERS HAVE DEVELOPED an artificial intelligence (AI) program that can automatically provide species-level identification of microscopic marine organisms. The next step is to incorporate the AI into a robotic system that will help advance our understanding of the world's oceans, both now and in our prehistoric past.

Specifically, the AI program has proven capable of identifying six species of foraminifera, or forams — organisms that have been prevalent in Earth's oceans for more than 100 million years.

Forams are protists, neither plant nor animal. When they die, they leave behind their tiny shells, most less than a millimeter wide. These shells give scientists insights into the characteristics of the oceans as they were when the forams were alive. For example, different types of foram species thrive in different kinds of ocean environments, and chemical measurements can tell scientists about everything from the ocean's chemistry to its temperature when the shell was being formed.

However, evaluating those foram shells and fossils is both tedious and time consuming. That's why an interdisciplinary team of researchers, with expertise ranging from robotics to paleoceanography, is working to automate the process.

"At this point, the AI correctly identifies the forams about 80 percent of the time, which is better than most trained humans," said Dr. Edgar Lobaton, an associate professor of electrical and computer engineering and co-author of a paper on the work.

"But this is only the proof of concept. We expect the system to improve over time, because machine learning means the program will get more accurate and more consistent with every iteration. We also plan to expand the AI's purview, so that it can identify at least 35 species of forams, rather than the current six."

The current system works by placing a foram under a microscope capable of taking photographs. An LED ring shines light onto the foram from 16 directions — one at a time — while taking an image of the foram with each change in light. These 16 images are combined to provide as much geometric information as possible about the foram's shape. The AI then uses this information to identify the foram's species.

Dr. Ritayan Mitra, a former postdoctoral researcher at NC State, is lead author of the paper. Co-authors include Qian Ge and Boxuan Zhong, Ph.D. students at NC State, and Bhargav Kanakiya, a former master's student at NC State. ▪

STUDENTS LEARN ABOUT GRAND CHALLENGES IN E102

FIRST-YEAR ENGINEERING STUDENTS are getting a better idea of what kind of impact they can make with their degrees — and a more thorough understanding of the College of Engineering's degree programs — through a newly required course, E102: Engineering in the 21st Century.

E102 not only builds on what students learned in E101, Introduction to Engineering, but also introduces the 14 Grand Challenges for Engineering and goes into more depth on the College's 18 degree programs and 12 departments. In 2008, the National Academy of Engineering announced the Grand Challenges, which focus on the problems that need to be solved to perpetuate life into the next century. These Grand Challenges include advancing personalized learning, developing better medicines, improving urban infrastructure and providing access to clean water.

Dr. David Parish, assistant dean of academic affairs, created the course, which has been offered for four years. The curriculum was updated in summer 2017 to make the spring-only course mandatory starting in 2018, and as an interdisciplinary course, 25 percent of the spots are available to students not majoring in engineering.

"The course takes the big picture of engineering and brings it down to smaller perspectives. In E101, they all do the same design process. But in this class, they learn what each department and type of engineering does, and how it fits in with the Grand Challenges," Parish said.

The students start off the course by watching a series of videos overviewing the Grand Challenges. Then, each week, students watch videos of NC State faculty members explaining a Grand Challenge and how it relates to their department. In the next session, they meet to discuss and ask questions.

Haley Beard and Andrew Healy, both first-year students interested in civil engineering, took a spring 2019 E102 section taught by Parish. Both said they were interested in learning about the Grand Challenges and how they can personally have an impact on them. Beard also said she was glad to be getting a more detailed understanding of the different degree programs.

"I haven't (joined a department) yet, so it's always nice to hear about the other departments just in case I change my mind," she said.

In the first class of the semester, Parish explained to the students that the class will help them be certain of their selected degree path, as it's more difficult to change it when they start taking specific courses related to their degree.

Parish said that because of the class, some students end up changing their majors, while others are more enthusiastic about what they've chosen to pursue. ▪

BIOSENSOR ALLOWS REAL-TIME OXYGEN MONITORING FOR "ORGANS ON A CHIP"

A NEW BIOSENSOR allows researchers to track oxygen levels in real time in "organ-on-a-chip" systems, making it possible to ensure that such systems more closely mimic the functions of real organs. This is essential if organs on a chip are to achieve their potential in applications such as drug and toxicity testing.

The organ-on-a-chip concept has garnered significant attention from researchers for about a decade. The idea is to create small-scale, biological structures that mimic a specific organ function, such as transferring oxygen from the air into the bloodstream in the same way that a lung does. The goal is to use these organs on a chip to expedite high-throughput testing to assess toxicity or to evaluate the effectiveness of new drugs.

But while organ-on-a-chip research has made significant advances in recent years, one obstacle to the use of these structures is the lack of tools designed to actually retrieve data from the system.

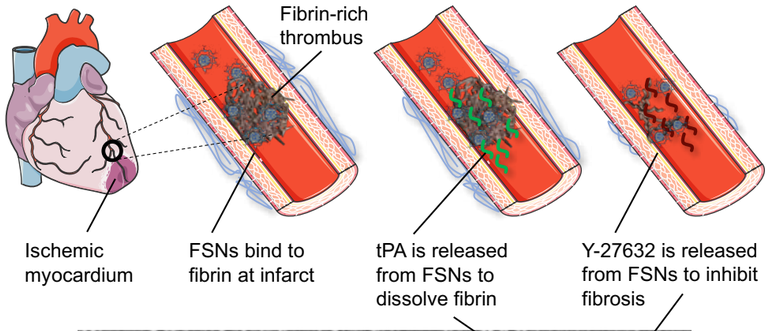
"For the most part, the only existing ways of collecting data on what's happening in an organ on a chip are to conduct a bioassay, histology, or use some other technique that involves destroying the tissue," said Dr. Michael Daniele, corresponding author of a paper on the new biosensor and an assistant professor in the Department of Electrical and Computer Engineering (ECE) and in the UNC / NC State Joint Department of Biomedical Engineering (BME).

"What we really need are tools that provide a means to collect data in real time without affecting the system's operation," Daniele said. "That would enable us to collect and analyze data continuously and offer richer insights into what's going on. Our new biosensor does exactly that, at least for oxygen levels."

Oxygen levels vary widely across the body. For example, in a healthy adult, lung tissue has an oxygen concentration of about 15 percent, while the inner lining of the intestine is around zero percent. Oxygen directly affects tissue function — so if you want to know how an organ is going to behave normally, you need to maintain "normal" oxygen levels in your organ on a chip when conducting experiments.

"What this means in practical terms is that we need a way to monitor oxygen levels not only in the organ on a chip's immediate environment, but in the organ on a chip's tissue itself," Daniele said.

First author on the paper is Kristina Rivera, a Ph.D. student in BME. The paper was co-authored by Ashlyn Young and Patrick Erb, Ph.D. students in BME; Vladimir Pozdin, a postdoctoral researcher in ECE; and Scott Magness, an associate professor in BME. ▪



NEW SYSTEM ALLOWS RAPID RESPONSE TO HEART ATTACKS

RESEARCHERS IN THE UNC / NC STATE Joint Department of Biomedical Engineering (BME) have developed a drug-delivery system that allows rapid response to heart attacks without surgical intervention. In laboratory and animal testing, the system proved to be effective at dissolving clots, limiting long-term scarring to heart tissue and preserving more of the heart's normal function.

"Our approach would allow health-care providers to begin treating heart attacks before a patient reaches a surgical suite, hopefully improving patient outcomes," said Dr. Ashley Brown, corresponding author of a paper on the work and an assistant professor in BME. "And because we are able to target the blockage, we are able to use powerful drugs that may pose threats to other parts of the body; the targeting reduces the risk of unintended harms."

"Our approach would allow health-care providers to begin treating heart attacks before a patient reaches a surgical suite, hopefully improving patient outcomes."

DR. ASHLEY BROWN

Heart attacks occur when a thrombus — or clot — blocks a blood vessel in the heart. In order to treat heart attacks, doctors often perform surgery to introduce a catheter to the blood vessel, allowing them to physically break up or remove the thrombus. But not all patients have quick access to surgical care.

More damage can occur even after the blockage has been removed. That's because the return of fresh blood to tissues that had been blocked off can cause damage of its own, called reperfusion injury.

To address these problems, researchers have developed a solution that relies on porous nanogel spheres, about 250 nanometers in diameter, which target a thrombus and deliver a cocktail of two drugs: tPA and Y-27632.

A thrombus can be made of various substances, such as platelets or arterial plaques, but they all contain a substance called fibrin. So, to target blockages, each nanogel is coated with proteins that bind specifically to fibrin. In other words, when the nanogels reach a thrombus, they stick.

The tPA and Y-27632 are layered inside the nanosphere, with the tPA forming a shell that surrounds the Y-27632. As a result, the tPA leaks out first at the thrombus site, allowing it to do its job — which is to break down fibrin and dissolve the clot.

As the tPA is released, the Y-27632 escapes the nanogel. While the tPA targets the clot itself, the Y-27632 aims to limit the damage caused by reperfusion injury.

Co-lead authors are Emily Mihalko, a Ph.D. student in BME, and Ke Huang, a Ph.D. student in the College of Veterinary Medicine. The paper was co-authored by Dr. Ke Cheng, a professor of biomolecular sciences at NC State and a professor in BME, and by Dr. Erin Sproul, a former postdoctoral researcher in BME. ▪

APPROACH PAVES WAY FOR NEW GENERATION OF ANTIMICROBIAL MATERIALS

RESEARCHERS IN THE COLLEGE have successfully incorporated "photosensitizers" into a range of polymers, giving those materials the ability to render bacteria and viruses inactive using only ambient oxygen and visible-wavelength light. The new approach opens the door to a range of new products aimed at reducing the transmission of drug-resistant pathogens.

"The transmission of antibiotic-resistant pathogens, including so-called 'superbugs,' poses a significant threat to public health, with millions of medical cases occurring each year in the United States alone," said Dr. Reza Ghiladi, associate professor of chemistry at NC State and co-corresponding author of a paper on the research. "Many of these infections are caused by surface-transmitted pathogens.

"Our goal with this work was to develop materials that are self-sterilizing, nontoxic and resilient enough for practical use. And we've been successful."

"A lot of work has been done to develop photosensitizer molecules that use the energy from visible light to convert oxygen in the air into biocidal 'singlet' oxygen, which effectively punches holes in viruses and bacteria," said Dr. Richard Spontak, Distinguished Professor in the Department of Chemical and Biomolecular Engineering (CBE) and co-corresponding author of the paper. "There is no resistance to this mode of action.

"However, the bulk of previous work in this area has been done using substrates — such as cellulose — that are not practical for daily use in places like hospitals. Our work here moves well beyond that."

The new approach involves incorporating photosensitizers into hydrophobic, semi-crystalline elastomers, which are waterproof and mechanically resilient — while also allowing oxygen to access the photosensitizers. What's more, the distribution of photosensitizers in the material means that it will retain its antimicrobial properties even if the surface of the material is scratched or worn away.

"This is the tip of the iceberg."

DR. RICHARD SPONTAK

"This paper focuses on one class of polymers, but it is a fundamental proof of concept that demonstrates the ability to put these photosensitizers into a range of robust 'soft' materials without sacrificing functionality," said Spontak, who is also a professor in the Department of Materials Science and Engineering. "This is the tip of the iceberg."

In lab testing, the researchers found that a photosensitizer-embedded polymer inactivated at least 99.89 percent of five bacterial strains — and 99.95 percent of two viruses — when exposed to light for 60 minutes.

First author of the paper is Bharadwaja Peddinti, a Ph.D. student in CBE. The paper was co-authored by Dr. Frank Scholle, associate professor of biological sciences at NC State. ▪

RESEARCH LOOKS TO BACTERIA TO HELP PREVENT COAL ASH SPILLS

SPILLS OF COAL ASH from containment ponds have caused environmental damage to several waterways across the Southeast.

Now, engineers from NC State have developed a technique that uses bacteria to produce "biocement" in the ponds, making the coal ash easier to store and limiting the risk of spills.

Coal ash is produced by coal-fired power plants and is often stored in ponds. If the walls of these ponds fail, they can spill coal ash into nearby surface waters — as happened in the wake of Hurricane Florence in 2018, in Virginia's Dan River in 2014 and in Tennessee in 2008. These spills can have significant consequences, because coal ash contains contaminants such as mercury and arsenic.

"Our goal with this work was to see whether we could use bacteria to create a biocement matrix in coal ash ponds, making the coal ash stiffer and easier to contain," said Dr. Brina Montoya, an assistant professor in the Department of Civil, Construction, and Environmental Engineering (CCEE), and co-author of two papers on the work.

Specifically, the researchers wanted to make use of bacterial species that feed on urea and, in the presence of calcium, produce a stiff substance that binds to surrounding solids. The resulting byproduct is called biocement.

"The idea is to introduce these bacteria — which are normally found in soil — into coal ash ponds, along with urea and calcium," Montoya said. "The resulting biocement wouldn't make the coal ash completely solid, but it would be a lot more viscous than the existing coal ash slurry."

In laboratory experiments, the researchers found that the process works with coal ash — the bacteria create biocement using coal ash, and the coal ash slurry becomes stiffer. In other words, the coal ash mixture is much less runny.

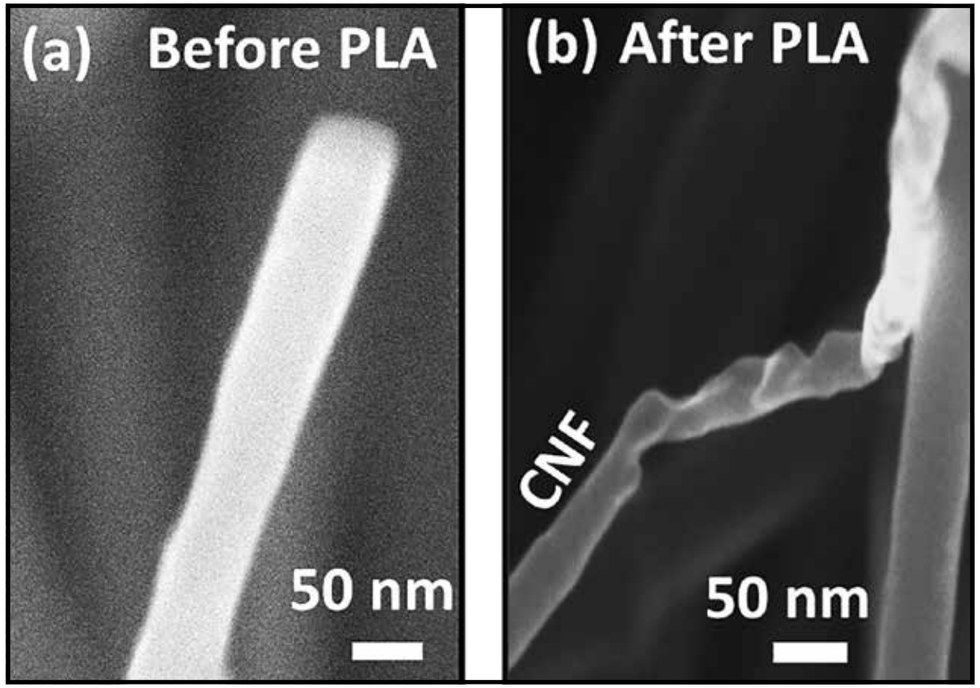
"This will certainly make it easier to contain, and less likely to contribute to pond failures that discharge coal ash into surface waters," Montoya said.

But the researchers are hoping that the bacterial biocement will also have a second benefit.

Because most coal ash ponds are simply unlined holes in the ground, contaminants in the coal ash can leach into groundwater, raising environmental and public health concerns. The researchers are hoping that the biocement can also trap potentially toxic metals in the coal ash, though that work is ongoing.

Both papers were co-authored by Dr. Shahin Safavizadeh, a former Ph.D. student in CCEE, and Dr. Mohammed A. Gabr, a Distinguished Professor in the department. ▪

NEW METHOD TURNS CARBON FIBERS AND NANOTUBES INTO DIAMOND FIBERS



NEW RESEARCH from the Department of Materials Science and Engineering (MSE) has demonstrated a technique that converts carbon fibers and nanotubes into diamond fibers at ambient temperature and pressure in air using a pulsed laser method.

The conversion method involves melting the carbon using nanosecond laser pulses and then quenching, or rapidly cooling, the material.

These diamond fibers could find uses in nanoscale devices with functions ranging from quantum computing, sensing and communication to diamond brushes and field-emission displays. The method can also be used to create diamond-seeded carbon fibers that can be used to grow larger diamond structures using hot-filament chemical vapor deposition and plasma-enhanced chemical vapor deposition techniques. These larger diamond structures could find uses as tool coatings for oil and gas exploration as well as deep-sea drilling, and for diamond jewelry.

Previous methods used to convert non-diamond carbon to diamond have involved using extreme heat and pressure at great expense with a limited yield. Melting the carbon with laser pulses and then undercooling it with a substrate made of sapphire, glass or a plastic polymer are the two keys to the discovery, said Dr. Jagdish Narayan, John C. Fan Distinguished Chair Professor in MSE and corresponding author of a paper describing the work.

"Without undercooling, you cannot convert carbon into diamond this way," said Narayan, a member of the National Academy of Engineering.

When heated, carbon normally goes from a solid state to a gas. Using a substrate restricts heat flow from the laser pulse enough that the carbon does not change phases.

The laser, similar to those used for Lasik eye surgery, is used for only 100 nanoseconds and heats the carbon to a temperature of 4,000 Kelvin, about 3,727 degrees Celsius.

NC State has filed for a patent licensing the technology.

The paper was coauthored by Anagh Bhaumik, a research assistant in the Narayan lab; Dr. Ritesh Sachan, a former researcher in the Narayan lab; Ariful Haque and Siddharth Gupta, graduate students in the lab; and Dr. Punam Pant, a research scientist in the Narayan lab. ▪

Four faculty members earn **NSF CAREER awards**

DR. ASHLEY BROWN

DR. MATTHEW BRYANT

DR. XIAOGANG HU

DR. MICHAEL DANIELE

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

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

The recipients, who will each receive $500,000 in funding over five years, are:

Dr. Ashley Brown, assistant professor in the UNC / NC State Joint Department of Biomedical Engineering (BME), for her project, "Dynamic microgels that mimic platelet behavior to promote healing."

Dr. Matthew Bryant, assistant professor in the Department of Mechanical and Aerospace Engineering, for his project, "Muscle-Inspired Load-Adaptive Actuation for Compliant Robotics."

Dr. Xiaogang Hu, assistant professor in BME, for his project, "Robust Decoding of Neural Command for Real Time Human Machine Interactions."

Dr. Michael Daniele, assistant professor in the Department of Electrical and Computer Engineering and in BME, for his project, "Reconfigurable Microfluidic-Microbalance Sensors to Monitor and Optimize the Performance of Microphysiological Models." ▪

Augustyn named **Sloan Research Fellow**

Dr. Veronica Augustyn, an assistant professor of materials science and engineering, has been awarded a 2019 Sloan Research Fellowship in Chemistry. Augustyn's research focuses on the electrochemistry of materials. This research has important implications regarding how energy is converted and stored in devices such as batteries, electrochemical capacitors and fuel cells.

Open to scholars in eight scientific and technical fields — chemistry, computer science, economics, mathematics, computational and evolutionary molecular biology, neuroscience, ocean sciences and physics — the two-year Sloan Research Fellowships are given to U.S. and Canadian researchers whose achievements mark them as among the very best scientific minds working today. Fellows receive $70,000 for research-related expenses from the foundation.

Augustyn is the fifth NC State faculty member to receive the prestigious award and the second from the College of Engineering. ▪

DR. VERONICA AUGUSTYN

Kim receives **RJ Reynolds Award**

Dr. Youngsoo "Richard" Kim, Jimmy D. Clark Distinguished University Professor in the Department of Civil, Construction, and Environmental Engineering (CCEE), was named the thirty-fourth recipient of the RJ Reynolds Tobacco Company Award for Excellence in Teaching, Research and Extension.

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

One of the world's leading scholars on asphalt materials, Kim's research has helped change industry standards for asphalt materials specifications, and he developed widely used predictive tests and models to show how asphalt pavements and materials will perform under varying traffic and climatic conditions. Kim's work has influenced asphalt materials research worldwide and has been instrumental in developing safer, longer-lasting asphalt materials and structures.

Kim is a Fellow of the American Society of Civil Engineers and a Fellow of the Korean Academy of Science and Technology, which is similar to The National Academies of Sciences, Engineering and Medicine in the United States. ▪

DR. YOUNGSOO "RICHARD" KIM

Hsiao receives **AAAS Marion Milligan Mason Award**

DR. LILIAN HSIAO

Dr. Lilian Hsiao, assistant professor in the Department of Chemical and Biomolecular Engineering, has received the 2019 Marion Milligan Mason Award for Women in the Chemical Sciences.

Hsiao is one of only five winners of the 2019 award, given by the American Association for the Advancement of Science (AAAS).

First awarded in 2015 and funded by the Marion Milligan Mason Fund, the award is designed to kick start the research efforts of early-career women researchers in the chemical sciences. The 2019 awardees have made extraordinary contributions through their research programs and demonstrate a commitment to move their fields forward.

Hsiao's research interests are in the areas of soft materials and complex fluids — specifically on the use of shaped colloids and functionalized polymer surfaces. She specializes in using microscopy and rheology to identify the frameworks used to engineer the mechanical properties of soft surfaces. ▪

Escuti named **Senior Member of National Academy of Inventors**

Dr. Michael Escuti, professor in the Department of Electrical and Computer Engineering, has been elected to the inaugural class of Senior Members of the National Academy of Inventors (NAI).

The inaugural class is comprised of 66 accomplished academic inventors representing 37 research universities and governmental and non-profit research institutes worldwide. They are named inventors on over 1,100 issued U.S. patents.

Escuti is a leading photonics and electro-optic materials expert pioneering the development of polarization-independent devices and transformational diffractive optics. He currently directs applied and fundamental research for applications including ultra-efficient / portable liquid crystal displays, opto-fluidics, ultra-efficient beam steering for high energy applications and laser communications, IR / MIR polarimetry imaging and novel diffractive lenses. ▪

DR. MICHAEL ESCUTI

IN OUR LABS

THESE ARE THE SPACES THAT ENABLE
GROUNDBREAKING RESEARCH

SUBSONIC AND SUPERSONIC WIND TUNNELS

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

IT'S A SOUND that may be familiar to students attending class in Engineering Building III (EB III) on NC State's Centennial Campus — a roar that's reminiscent of a commercial jet preparing for takeoff.

In reality, it is the sound of the Department of Mechanical and Aerospace Engineering's (MAE) supersonic wind tunnel, located in an annex building on the back side of EB III. The building is also home to a closed-loop subsonic wind tunnel operated by the department.

The two wind tunnels are used to simulate flight conditions so that research data can be gathered on everything from unmanned aerial vehicles (UAVs) to military jets. The slower subsonic tunnel can also be used to simulate storm conditions that test the durability of structures such as buildings or bridges.

While the subsonic tunnel only reaches wind speeds of 90 mph, the supersonic tunnel can hit anywhere from Mach 1.5 to Mach 4.5. The supersonic tunnel uses blasts of compressed air that only last about six seconds. The subsonic tunnel, which came to NC State by way of NASA in the 1950s, is powered by a propeller from a World War II-era aircraft.

THE SUBSONIC TUNNEL utilizes a four-foot by 3.5-foot testing area. Because of the high pressure used in the supersonic tunnel, the testing area is a mere six inches tall and 1.5 feet wide.

The subsonic tunnel is used to test UAVs, cars and some smaller aircraft, and the supersonic tunnel is ideal for fighter jets and the next generation of supersonic commercial aircraft to replace the Concorde.

Dr. Srinath Ekkad, professor and head of MAE, hopes to install a transonic tunnel for the department to fill in the gap between the two existing facilities. Transonic tunnels, which reach wind speeds of Mach 1 or a little more, would be useful for research on commercial aircraft.

Both facilities stay busy, said Dr. Shreyas Narsipur, a teaching assistant professor who manages both facilities for the department. Along with faculty members and graduate students, the tunnels are used by sophomore, junior and senior undergraduate aerospace engineering students as part of the three Experimental Aerodynamics labs all are required to take as part of their coursework.

TESTS LOOK AT HOW AIR FLOWS around an aircraft and how components hold up under high wind speeds. So, an experiment might use a scaled-down model of a jet fighter or just a section of wing from a real plane.

Will a wing made of a new material flutter under flight conditions? Will components produced by additive manufacturing hold up as well as those made using traditional techniques? Using load sensors, a faculty member can determine how and where force impacts a material.

Airflow can be measured with high-speed cameras using particle image velocimetry, in which particles released into the flow pass through a laser sheet. A similar technique uses smoke released into airflow. Sometimes airplane models and components are painted with a fluorescent dye, and data can be gleaned by the way in which the dye is blown away.

Though much relevant data can be arrived at computationally, Narsipur said, wind tunnel experiments are still needed because those methods are not able to model flow dynamics with complete accuracy.

"Computations need experimental data to validate against," he said. "That process is always going to be there."

BETTER by Design

Senior design benefits both students and sponsors

ON DECEMBER 7, 2018, seniors in the Edward P. Fitts Department of Industrial and Systems Engineering (ISE) and the Department of Electrical and Computer Engineering (ECE) held their end-of-semester senior design exhibitions at the McKimmon Conference and Training Center on NC State's campus.

In each department's exhibition room, rows of tables displayed intriguing project posters and prototypes of designs intended to solve real-world problems, such as a simulation model to help mitigate high wait times for patients at the Durham VA Prime Clinic and an in-flight system to alert helicopter pilots to damaged blades.

This was their day – the day ISE and ECE seniors got to demonstrate their engineering design chops.

All engineering departments at NC State have capstone design courses for their seniors with variations among course length — one semester or two — and program size. Most, but not all, are sponsored projects.

Bobby Compton is the director of ECE's Senior Design course. ECE's design program is one of the largest senior design programs in the College.

"We have 200 students in any one semester involved in senior design across four class sections," he said.

Compton and Dr. Rachana Gupta, teaching associate professor and associate director of ECE Senior Design, teach the two senior design capstone courses, ECE 484 and 485. Each course is one semester long, but students begin their design project in ECE 484 and complete it in ECE 485.

"The students go from the prototype in the first course to full-scale implementation in the second," said Stacy Nelson, an ECE lecturer who provides instructional support and is responsible for the logistics of ECE Design Day.

According to Nelson, ECE 484 ends with the product requirements fleshed out and a prototype made. Seniors in ECE 485 continue the project but focus on budgeting, project management, marketing and project presentation. Students in both courses make end-of-semester presentations on Senior Design Day.

Dr. Kanton T. Reynolds (IE '95), teaching associate professor and director of ISE's undergraduate programs, runs ISE's senior design program. The department's Engineering Design Day is the result of work completed in capstone courses ISE 498 and ISE 521. ISE 498 is one semester long. Reynolds and lecturer Jason Low typically co-teach ISE 498, depending on how many students are part of the course. This spring, associate professor Dr. Rohan Shirwaiker was added. Also in the spring, health systems capstone course ISE 521 is held, which is taught by Dr. Julie Ivy. Students spend a year on the ISE 521 projects.

BENEFITS TO STUDENTS

Reynolds knows that senior design provides significant benefits to students.

"It allows the students to take the knowledge they've accumulated over their academic career at NC State and punctuate it with a course that encapsulates all of the opportunities that they may have to display that knowledge," he said.

Reynolds adds that the students get to work in a team on a long-standing project and deliver it to a customer while demonstrating they are worthy of working for that company.

Early on, Reynolds makes sure that the students have the skills needed to meet the sponsors' needs.
Students are assigned to project

teams as soon as the second day of class.

Kurtis Konrad, who graduated in December with degrees in industrial engineering and economics, was teamed with Trevor Bryant, Adam Dorr and Stephanie Stugg. They worked for HSM Solutions, a furniture manufacturing company in Hickory, NC, developing an inventory tracking and performance management system.

Konrad said that senior design projects provide an excellent experience for students as they prepare to join the work force: "(Senior design) allows you to work on a team and gives you the guarantee of working on a specific project. You follow an entire project from start to some sort of finishing point, so you get to see all of the steps involved," he said.

BENEFITS TO SPONSORS

Both programs rely on various means of recruiting sponsors.

"We actively meet and engage with companies and research centers throughout the year to harvest projects," Compton said.

ECE Senior Design has a number of repeat sponsors including the Army Research Office, Duke Energy, NAVAIR, Pentair and Schneider Electric.

Trudi Brown, ECE director of external relations, said that sponsors like to work with the senior design teams. "What sets our students apart is our in-depth program, and when you talk to external people that have been involved with the program, they will tell you how pleased they are with the students' knowledge and approach to problem-solving."

ISE recruits many of its sponsors through cold calls and the Engineering Career Fair. When Reynolds recruits company sponsors, he'll tell them, "It's try before you buy ... You're getting a group of three to five students working for you exclusively for an entire semester and you get to take them for a test drive. You get to see them work with your staff, each other and with external partners."

He further points out that senior design teams provide dedicated resources to work on a problem, resources the company may not have. For example, Toshiba makes point-of-sale systems and was looking to understand the shopping and buying patterns of "twenty-somethings." Toshiba used an ISE senior project team to design an optimal self-checkout for a shopper in the team's age demographic.

Among its many repeat sponsors, ISE has a group of strong company and industry supporters of senior design including IBM, Tyndall, Caterpillar and Altec.

Juli Trexler (ISE '97) is global executive and director of IBM Support as a Service Business Line. She serves on ISE's advisory board, has served as an Engineering Design Day judge and has sponsored several senior design projects, including one last semester. Team members Rodrigo Cabrera, Shadia Garrison, Matt Hutmacher and Rachel Nagley collaborated on a global project with all regions to create recommendations to reduce IBM's parts delivery timeliness (PDT) reporting time and increase global consistency.

Trexler found the team to be very quick to "jump in, assess the project from a process standpoint and then make recommendations on a pretty complex operation." She was pleased with their final recommendations.

Altec Industries, Inc., is a trucking equipment company in Creedmoor, NC. According to Scott Cunningham, plant manager, the company recently purchased a second facility next door. Altec wanted to move all fiberglass operations to the new building.

Senior design team members Rollin Jenkins, Spain Niemer and Mikayla Slomski came up with two ways of transporting parts between the two facilities, detailing the pros and cons of each. Cunningham said that the company plans to move forward with one of the concepts and that the manufacturing team enjoyed the experience. "It helped us. I hope it helped them to see some real-world challenges out there and apply what they learned in school ... I felt that it was a win for us, it was a win for the students."

There's a consensus among faculty members, students and sponsors: Senior design projects make everyone a winner. ▪

FEATURES

"What sets our students apart is our in-depth program, and when you talk to external people that have been involved with the program, they will tell you how pleased they are with the students' knowledge and approach to problem-solving."

TRUDI BROWN

If you are interested in sponsoring an engineering senior design team, go to **go.ncsu.edu/engineering-senior-design**. You will find a list of key contacts in the departments.

HOMEGROWN

Engineering alumni are playing a major role in Fitts-Woolard Hall

LEFT TO RIGHT: Cameron Smith, *Senior Director,* Capital Project Management, NC State Facilities Division; **Mary Beth Russo**, *Project Manager,* Clark Nexsen; **Trey Warren**, *Estimator,* Warco Construction, Inc.; **Mark Collins**, *Project Executive,* Skanska USA Building.

ALONG WITH MORE THAN 300 ALUMNI DONORS helping to fund construction, Fitts-Woolard Hall is benefiting from the expertise of several NC State engineering alumni working on the project. The newest engineering building on Centennial Campus is scheduled to open in summer 2020 and will be the new home of 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.

ALUMNI PARTICIPATION

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SUBCONTRACTORS AND VENDOR MANAGERS

Cameron **Smith**

After finishing a bachelor's degree in civil engineering, construction option in 1996, Cameron Smith spent time in Cuba, Pennsylvania and Iraq's Al Anbar Province with the Navy Civil Engineers Corps.

In 2007, he made his way back to NC State's campus to join the Facilities Division.

The Wrightsville Beach, NC, native has helped guide more than a decade's worth of major projects that have changed the face of campus, including renovations for Reynolds Coliseum and Talley Student Union and the construction of the James B. Hunt, Jr. Library. Now he is guiding work on Fitts-Woolard Hall.

"To be able to come back to your alma mater and participate in its growth building facilities that are going to be here for 50 to 100 years is pretty exciting," Smith said. "And then to be able to be involved in the building that's going to be home to your degree program, I'm even more fortunate."

Mary Beth **Russo**

A 2009 CCEE graduate, Mary Beth Russo still sees familiar faces among the department's faculty members as she works on their new building.

As the project manager on Fitts-Woolard Hall for designer Clark Nexsen, Russo has invested a lot of time talking to faculty members about what they need to make the new building the perfect home for their work.

"I spent the bulk of my college years in Mann Hall and am excited to be involved in creating the new space for the next generation of civil engineers," the Raleigh native said.

Russo excelled in math in high school and alongside her father, an NC State alumnus, was steadily exposed to construction through her early years.

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DESIGN TEAM MEMBERS

So, NC State felt like a good fit, and once on campus she gravitated toward structural engineering.

Russo has worked with Clark Nexsen since 2008 when she started as an intern her senior year.

Trey **Warren**

Trey Warren's father and grandfather are both NC State engineers. He followed in their footsteps, graduating with a bachelor's degree in construction engineering and management in 2011. Today, the family company — Warco Construction Co. — is a subcontractor on the Fitts-Woolard Hall project tasked with applying fireproofing material to the steel structure.

"NC State construction engineering is pretty close to home," he said.

As a student, he was an Engineering Ambassador and involved in the Engineers Council. During the summer, Warren returned home to work in the field and help out in the office at Warco.

Those hours in Mann Hall taught him problem-solving skills that have translated well to his professional life.

Charlotte-based Warco was started by Warren's grandfather, father and uncle. The company offers a range of services, from thermal and moisture protection and preconstruction consulting to acoustical remediation and manufacturer representation.

07

NC STATE FACILITIES DIVISION MEMBERS

Mark **Collins**

Mark Collins, project executive for construction manager at risk Skanska, has built his career overseeing high profile and complex higher education projects at NC State, Duke University and UNC Chapel Hill.

A Raleigh native and NC State 1988 civil engineering construction option graduate, Collins is a lifelong Wolfpack fan. The NC State tradition is ingrained in his family, as his wife graduated with a degree in electrical engineering, and his son is a recent College of Natural Resources graduate.

Collins has been an integral part of the growth on Centennial Campus, leading the construction of Engineering Building III and the award-winning James B. Hunt, Jr. Library and currently overseeing the new Fitts-Woolard Hall project.

"I am proud to have had the opportunity to lead these amazing projects, and it is especially meaningful to build at my alma mater creating spaces for generations to come." ▪

CHARGING UP

Research within the College is advancing electric vehicle technology

LAST YEAR, the International Energy Agency (IEA) forecast the number of electric vehicles in operation around the world would grow to 125 million by the year 2030 — a monumental leap when you consider that the IEA also reported just over three million electric vehicles on the road in 2017.

To get there, however, will require some improvements in technology. Size, weight and efficiency are all major considerations in today's electric vehicle market. For example, a larger battery holds more charge but also takes up more space and weighs more. Meanwhile, the charging infrastructure has to be established to support the influx of electric vehicles. At the same time, systems and materials must remain affordable if electric vehicles are to be widely adopted.

That's where faculty members in the College of Engineering come in. From research involving the materials within lithium ion batteries, which are used to power electric vehicles, to the development of a smaller, faster charger, faculty members are working to ensure wider adoption of electric vehicles will be possible in the future.

"The electric vehicle has been in development for many, many years, but from the performance and cost point of view, we do have significant room to improve," said Dr. Wensong Yu, associate research professor. "The projects we do here can make a big impact for the industry."

Yu, along with Dr. Iqbal Husain, ABB Distinguished Professor, and Dr. Srdjan Lukic, associate professor, are all faculty members in the Department of Electrical and Computer Engineering. In addition, they are part of the Future Renewable Electric Energy Distribution and Management (FREEDM) Systems Center led by the College, which is building a more intelligent power grid that can incorporate renewable energy sources and has a focus on electric vehicles as well. There, Husain serves as director and Lukic as deputy director.

The FREEDM team conducts its own research and partners in research, with several projects expected to improve the materials and functionality of electric vehicles. Dr. Srdjan Srdic was also a member of the team until recently as an assistant research professor and was part of the research efforts.

Their research is complemented by the work of Dr. Hsiao-Ying Shadow Huang, associate professor in the Department of Mechanical and Aerospace Engineering and an associate director of the Analytical Instrumentation Facility, who is working on the efficiency and safety of the lithium ion battery.

SAFER, HIGHER-CAPACITY BATTERIES

Right now, "range anxiety" is a fear among electric vehicle operators. Most electric vehicles on the road today can travel fewer than 250 miles before they need to charge.

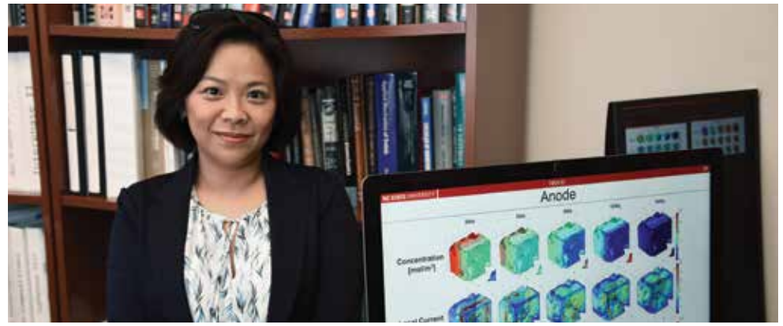
Electric vehicle batteries could be made smaller and hold more charge, but they may not be as safe. Huang's research examines how to maintain and improve the safety of a lithium battery, while at the same time increasing storage capacity in a smaller battery.

"Battery A may give us 100 miles, while battery B gives us only 30 miles, but battery A may cause a fire because it heats up too fast," Huang said. "We need to find the balance — a battery that will not cause a fire but also will not take up too much space in the vehicle."

She uses computational mechanics to couple different factors together, or to single out factors, with the goal of finding an optimal combination. Yet, Huang acknowledges there is still a gap between the computational mechanics and the materials that are available.

"My job here is to predict what would be the best combination," she said. "However, it probably couldn't be achieved at this time — there are limitations in the available materials."

By doing the research now, however, Huang said the data will be available as materials available today are refined and improved, meaning her ideas can be executed in the future.



A SMALLER, MORE EFFICIENT CHARGER

Working together, the researchers at the FREEDM Center have developed a medium voltage fast charger (MVFC) that, in comparison to existing electric vehicle chargers, is cheaper to install, cheaper to operate, modular and scalable, Srdic said. It is 10 times smaller than existing systems and wastes 60 percent less power during the charging process.

While this current version of the MVFC charges at the same speed as existing charging stations, the researchers are in the process of developing a next-generation MVFC that will be capable of charging more vehicles and charging them more quickly.

The long-term benefits to electric vehicle owners and charging station operators are numerous, Lukic said. Faster charging means more opportunity to take the electric vehicle on long road trips. Currently, a battery can take six to seven hours to charge, and drivers sometimes can't wait that long if they're on their way to a destination, Lukic said. There will be cost savings, and charging stations will also require a smaller footprint, meaning they can be offered in more places, he said.

"It's cheaper to install and run, because it's more efficient," Lukic said.

IMPROVING VEHICLE RANGE

Meanwhile, the work of Husain and Yu shows promise in improving electric vehicle efficiency and range.

In electric vehicles, a battery serves as the power source and operates at a certain voltage — usually around 400 volts. From the battery, a power electronics inverter is used to convey energy to the motor while the vehicle is in operation, Husain said.

Where silicon is traditionally the material used in these inverters, researchers at NC State explored the use of silicon carbide instead and found that it resulted in lower energy losses and better efficiency — 99 percent efficiency to be exact, Husain said. What's more, this result was also achieved in a much smaller footprint and with less weight. Measuring the efficiency and the power density of this and other components in an electric vehicle is similar to gas mileage in a traditional vehicle.

"Ultimately, this translates to how many more miles it can go on a given battery charge," Husain said. "One problem with the electric vehicle is that customers have range anxiety, so anything that can be done to improve that is our goal." ▪

A FACILITY LIKE *NO OTHER*

IN THE CENTER OF NC STATE'S CAMPUS, the university-operated 1-megawatt PULSTAR reactor facility — the only reactor of its type still in operation — powers one of the most exceptional nuclear facilities in the world, where researchers conduct experiments to explore questions about the constituents of matter and the creation of the universe.

Over the last 15 years, the Nuclear Reactor Program (NRP) has added state-of-the-art instruments to its reactor, including two facilities that are the only ones of their kind in the United States — an intense positron beam that makes it possible to observe the energy created when positrons (i.e., antimatter electrons) and electrons annihilate, and an ultra-cold neutron source that can generate rare species of neutrons and slow them down to answer questions about major physics models.

"It's a very unique facility in that it is used standalone on its own, and that is the sort of spirit we have here," said Dr. Ayman Hawari, distinguished professor of nuclear engineering and director of the NRP. "Researchers either can't do some of the things that we do here elsewhere, or can do it just as well here."

Since Hawari started at NC State in 2002, the PULSTAR reactor has shifted from a staging ground that ran only a few hours a week to a renowned facility that often runs for months at a time. Major universities are regularly using the reactor for research. NC State pioneered the internet reactor lab, which allows students at universities around the world to learn, using a remote cyber-secure connection to the PULSTAR, how to operate nuclear reactors.

Just as NC State is leading the way now — ahead of other leading engineering universities, and with even more advanced capabilities than those available at reactors affiliated with major research centers — it was also the first to have an on-campus nuclear reactor.

NC State's on-campus **nuclear reactor** has always had an innovative streak

FIRST OF ITS KIND

In 1949, Dr. Clifford K. Beck came to North Carolina State College, as it was called then, with an unprecedented idea — an on-campus nuclear reactor, open to students, professionals and the public.

At the time, nuclear engineering was a secretive field, especially in the wake of the atomic bombing during World War II. But university officials approved the reactor in 1950 and established the first nuclear engineering curriculum. In 1953, the Raleigh Research Reactor — designated and licensed as R-1 by the U.S. Atomic Energy Commission — opened as the first reactor to be used for peacetime training and research, and in 1954, NC State awarded the first two Ph.D.s in nuclear engineering.

UNC System President Gordon Gray (1950-55) called the nuclear reactor a "milestone in preparing to use atoms for education and free enterprise," after it became operational in September 1953. "Its story is a major item in the development of atoms for peace."

Since the completion of the first reactor, NC State has been home to four others. After R-1 was shut down in 1955 due to corrosion and leaks, nuclear engineers initialized criticality of R-2 in 1957. That core was removed in 1958 to the Bureau of Mines Building, where it became known as R-4 and was operational from 1959-61. R-3 operated from 1960-73, when it was shut down after the PULSTAR nuclear reactor was completed in 1972.

"Who would think that someone would have this imagination to envision an educational nuclear reactor on a university campus?" Hawari said. "The origin story makes me want to do more, and to rise up to those expectations."

SURPASSING EXPECTATIONS

Today, NC State's NRP is on a playing field of its own. The reactor's core currently powers four research facilities located in the reactor beamports: a neutron imaging facility, a neutron powder diffraction facility, an intense positron beam and an ultra-cold neutron source. Additional beamport facilities are under development, and may be used in parallel with the reactor's multiple in-pool irradiation facilities. Using this equipment, scientists conduct groundbreaking research in a world-class nuclear facility, which also happens to sometimes be run by undergraduate students.

Students may become licensed operators after completing two semesters of hands-on training at the PULSTAR and passing a two-day test administered by the Nuclear Regulatory Commission. Scott Lassell, nuclear services manager, said a great deal of effort goes into training the students, but their support is necessary.

"For the past two years, there were long stretches of months at a time where we were running for three shifts, so the students were instrumental," Lassell said. "Not only do they get the license qualification, they get valuable operations and research experience, too."

While students are operating the controls and ensuring everything is running smoothly, scientists and officials from across the country — and globe — are using the PULSTAR for medical, military and environmental research. The Environmental Protection Agency, National Cancer Institute, and U.S. and British navies, as well as university researchers, run different experiments simultaneously.

Dr. David Thomas, a research toxicologist at the National Health and Environmental Effects Research Laboratory in Research Triangle Park, first used NC State's reactor in 1972, the year he graduated from Duke University, for a project on mercury release caused by coal burning.

He returned to the reactor in the 2000s for research on the quantitation of toxins in biological and environmental samples. EPA researchers initially used neutron activation analysis (NAA) to measure arsenic in toenail samples from a U.S. population that used drinking water containing arsenic. This information helped them understand the relation between exposure to arsenic and its accumulation in the body. More recently, NAA has been used to study bioavailability of arsenic present in soil. Their data made it possible to develop and validate an assay that measures bioavailability, which helps guide cleanups of Superfund sites contaminated with arsenic.

"The growth and development at NC State have been remarkable," he said.

The NRP has plans to keep growing its nuclear capabilities in order to meet research needs. It is in the process of increasing the PULSTAR reactor's power from 1 megawatt to 2 megawatts. Additionally, researchers continue to look to the future, examining and developing advanced nuclear fuel concepts for the next generation of nuclear power reactors, measuring and generating fundamental nuclear data to support studies of neutron interactions in matter, and developing capabilities and methods of radioisotope production for medical and industrial applications.

The reactor's history and pioneering spirit — the inspiration to do something unprecedented, to take what was regarded as a secretive and destructive technology and develop an open, educational facility that enables research to better humankind — underlies the progress NC State's NRP continues to make.

"History probably helped in the culture of accepting a nuclear reactor on campus," Hawari said.

If he were to develop a nuclear reactor facility now, Hawari said he probably couldn't do it the way it was done in 1949, putting it in the middle of a college campus. But its location makes it unique and integral to the university and to North Carolina.

"We turned it into a facility that is relevant in the portfolio of science and engineering right now, and especially high-tech engineering because engineering is moving toward nanoscale and microscale engineering," Hawari said. "We're aiming to develop capabilities that are useful and unique." ▪

R-1 UNDER CONSTRUCTION IN 1952.

"Who would think that someone would have this imagination to envision an educational nuclear reactor on a university campus?"

DR. AYMAN HAWARI

AFTER THE STORM

Faculty members find research opportunities in hurricane's wake

When Hurricane Florence hit North Carolina in September 2018, it devastated parts of the state and caused record flooding. Since then, some College of Engineering faculty members have been working on research that will help improve how we prepare for storms and handle the aftermath.

MODELING FLORENCE'S STORM SURGE

Dr. Casey Dietrich, an assistant professor in the Department of Civil, Construction, and Environmental Engineering (CCEE), leads the Coastal and Computational Hydraulics Team and develops computational models that predict storm surge and coastal flooding. Using the model ADCIRC, the team makes predictions about how high sea waters will rise, which areas will be flooded and for how long. These predictions are made for the entire coastline, and then his team visualizes the flooding at the scales of individual buildings and coastal infrastructure. During Florence, Dietrich's team and collaborators acted as liaisons for state emergency managers to aid their decision making.

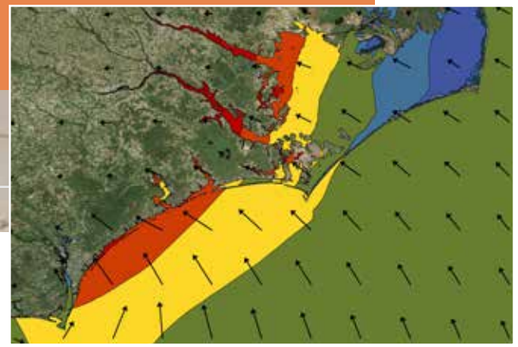
"The models are just one data point among many, but they're helpful in understanding hazards and used to make predictions in real time — partly to make decisions about evacuation, where to deploy resources after, safe places to put emergency vehicles and water supplies," he said.

The state emergency managers are able to use the flooding predictions to get immediate estimates on damages, which helps communities that are figuring out how much recovery will cost.

After Hurricane Matthew in 2016, Dietrich and his colleagues improved the models' ability to forecast encroaching water along shorelines. Post-Florence, Dietrich said the research focus is to speed up the model and allow for more permutations to see what might happen if a storm slows down or shifts direction.

A BETTER WAY TO MANAGE VOLUNTEERS

After a natural disaster like Hurricane Florence, people come in droves to help with ongoing post-disaster relief efforts. But these good intentions can sometimes cause problems, as local and national organizations try to manage large quantities of volunteers.



Dr. Maria Mayorga, a professor of personalized medicine in the Edward P. Fitts Department of Industrial and Systems Engineering (ISE), is conducting research on these "spontaneous volunteers" to figure out how to more effectively and efficiently organize an influx of people wanting to help after a catastrophe. In addition to other data collection efforts, Mayorga and her students developed a set of questions for volunteers and volunteer coordinators to gain a better sense of why people volunteer, how they are currently managed and how success is defined.

Mayorga's research is being funded by a National Science Foundation (NSF) Rapid Response Research (RAPID) grant. In the fall, Mayorga and her collaborators from New York and Alabama, along with a group of undergraduate students, visited Brunswick County to see an affected community and conduct interviews. Students have continued interviews over the phone, video chat and in person. Mayorga said it's been an important experience for students, who are seeing the ways they can make an immediate impact as an engineer.

"By going to volunteer, we met the people who are affected," she said. "All of the volunteer coordinators we talked to saw value in our research and realized it was important to look at."

Another ISE professor, Dr. Julie Ivy, received a RAPID grant to evaluate the challenges faced by the Food Bank of Central and Eastern North Carolina during Florence. Ivy and her team will look at how the food bank prepared for, responded to and recovered from Florence and the disruptions it caused to its networks.

EVALUATING THE DUNES

While the northeastern part of North Carolina's coast was not as heavily affected as other parts of the state, Florence's effects on dunes still provided valuable research on coastal erosion. Dr. Beth Sciaudone, CCEE research assistant professor, led a group of graduate students and research faculty members in collecting 39 field samples and 43 profile surveys in Dare County to help make predictions about coastal erosion and prepare for the next storm. NC State has conducted ongoing research in partnership with the state Department of Transportation (DOT) to study erosion along N.C. 12, which often experiences overwash.

Students looked at variations in sediment size and compared how the dunes fared during Florence with previously collected data. They studied how sediment size distributions are changing due to beach nourishment — when sand is dredged and added to an area to combat erosion. Areas recently nourished had coarser grain sizes than natural areas, and the constructed beaches and dunes also held up better compared to areas that had not been nourished recently. Members of the research team also operated drones to evaluate the topographic surface and conduct geospatial analysis.

The research report from the expedition will help improve storm surge forecasting by providing better data on coastal morphology changes.

ASSESSING INFRASTRUCTURE STABILITY

Dr. Brina Montoya, CCEE assistant professor, headed to affected inland areas in the Neuse and Cape Fear river basins to assess damage to dams, bridges and other structures.

Montoya, who was part of an NSF-funded Geotechnical Extreme Events Reconnaissance (GEER) team, brought four graduate students with her. Through Sept. 24-27, they surveyed how wind, rain and flooding caused changes to soil and engineered structures — and looked at how those changes could have negatively affected infrastructure and public safety.

In the GEER report, researchers found that because of the changes North Carolina DOT made after Hurricane Matthew in 2016, many bridge pilings performed better during Florence than they did in previous storms. ▪

CROWN **JEWEL**

Fitts-Woolard Hall will give Centennial Campus **another iconic structure**

SINCE IT OPENED IN 2013, the James B. Hunt, Jr. Library has stood out on NC State's Centennial Campus for its modern look, sustainability and integration of technology.

Soon, it will be joined by another iconic structure.

Fitts-Woolard Hall, the newest engineering building on Centennial, will open its doors in summer 2020. This landmark facility, which will stand next to Hunt Library just south of the three existing engineering buildings on Centennial, will put some of the College's most impactful research on display and become a flow-through point for campus foot traffic. With its own unique design and large footprint, Fitts-Woolard Hall will stand as an impressive complement to the library.

"It will catch your eye and keep it," said Doug Morton, NC State's associate vice chancellor for facilities. "You will be looking not only at the library next door, you'll be looking at Fitts-Woolard Hall. It will be a unique structure on this campus."

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 another important step toward unification of the College of Engineering on Centennial.

It also represents a first-of-its-kind infrastructure project for NC State, using a public-private partnership to fund the construction of an academic building.

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, with the College pledging to fund the remaining $60 million from private commitments.

Thanks to generous commitments from more than 300 alumni donors and a $25 million naming gift from industrial engineering graduates Edward P. Fitts and Edgar S. Woolard, the College stands at $48 million of its $60 million goal.

Reaching that fundraising goal is vital to help the College reach its full potential as the top public college of engineering in the country and one of the world's preeminent colleges of engineering.

ENGINEERING ON DISPLAY

Sitting at the southwest corner of a grassy oval ringed by Engineering Buildings I, II and III, Fitts-Woolard Hall will serve as a connection for students and faculty and staff members walking to and from the Oval, especially on rainy days.

So, designer Clark Nexsen built in broad passageways and monumental staircases to handle the crowds. While they are passing through, visitors will have a chance to take in the work going on in some of the most impactful labs in CCEE and ISE. This "engineering on display" concept will celebrate the accomplishments and aspirations of the College and the two departments.

CCEE's asphalt, structural testing, materials and hydraulics labs and ISE's advanced manufacturing and brain computer interface labs will be located on the first two floors in open, airy spaces with floor-to-ceiling glass walls that will allow passersby to take in the work going on inside.

Outside, stormwater runoff and building condensate will be filtered through a series of step pools that will eventually lead to nearby Lake Raleigh.

Clark Nexsen designed a structure with open frame systems that will allow lab and teaching spaces to be adjusted based on faculty members' needs over the coming decades. Mann and Daniels Halls, the current homes of CCEE and ISE, respectively, are both more than 50 years old and are using spaces for laboratories that were not originally designed for that purpose.

"We're building Fitts-Woolard Hall so that the faculty members in those two departments will have exactly the spaces they need for those labs to be successful," said Cameron Smith, senior director of the University's Capital Project Management Department.

LEAVING A LEGACY

Alumni who have benefitted from their education in the College of Engineering at NC State have a chance to pass that opportunity to future students and leave a mark on this important building through a number of naming opportunities.

The College, along with Clark Nexsen and construction manager Skanska, celebrated progress on Fitts-Woolard Hall in December with a topping-off ceremony that marked the placement of the highest steel beam in the building's framework. Meanwhile, the NC State Engineering Foundation is hosting a series of information sessions on campus and in cities around North Carolina. Hard-hat tours of the building site will begin this fall.

With $12 million in commitments needed to help finance construction, the College needs many more of its graduates in all disciplines to step up and support the effort. Reaching its fundraising goal will help the College avoid having to assume debt payments that would take away from scholarships and programs that benefit students and faculty members.

"Fitts-Woolard Hall embodies the strengths of the College of Engineering and is a crucial step in the achievement of our goals and full potential," said Dr. Louis Martin-Vega, dean of the College. "Alumni who support this effort will truly be making an investment that will benefit the University and the state of North Carolina for generations to come." ▪

GET INVOLVED

Learn how you can support Fitts-Woolard Hall by contacting Lora Bremer with the NC State Engineering Foundation at **lora_bremer@ncsu.edu** or **919.513.0983**.

With hopes of new innovation, alumni and friends of the College share why they support **Fitts-Woolard Hall**

BRAD, LEFT, AND ANNA SULLIVAN.

JACK MCDONALD, LEFT, AND SMEDES YORK.

IT'S BEEN ALMOST A YEAR since the University broke ground on the new Fitts-Woolard Hall on Centennial Campus. This new building — which will house the Department of Civil, Construction, and Environmental Engineering (CCEE); the Department of Industrial and Systems Engineering; and the dean's administrative offices — is integral to helping the College come together on one campus and in helping meet the demand for engineers and computer scientists. Meet three alumni and a friend of the College who have supported the project and are helping to facilitate innovation in research and education.

"My hope is that this new first-class building will help attract even more innovative faculty members that will educate the civil engineers of tomorrow."

JACK MCDONALD

SMEDES YORK AND JACK MCDONALD

With a family legacy to follow, Smedes York knew attending NC State was the best choice for him, especially because he wanted to work in the construction business.

"My grandfather attended and was part of the class of 1903 — leaving to create a construction company — and my dad graduated in 1933 with a degree in civil engineering," shared York, who played on the NC State basketball team under Everett Case and graduated with a bachelor's degree in civil engineering in 1963.

He went on to serve as a lieutenant in the United States Army Corps of Engineers — where he received an Army Commendation Medal in 1966 for his service in South Korea. After his time in service, he returned to academia and earned his MBA from UNC Chapel Hill in 1968, then joined his father's company.

York was highly involved in civic groups and public service in Raleigh. He served on the city council and was elected mayor of Raleigh and served from 1979-83.

Currently, he serves as chairman of both McDonald York Building Company and York Properties.

Thinking back on his time as an NC State student, York finds his NC State degree and the time he spent in the College invaluable.

"My degree helped me with learning very tight scheduling. During my time playing basketball and being active with the fraternity, while being a full-time student, it taught me how to use my time wisely and to be disciplined," he shared. "I learned confidence — confidence with numbers and math and applying it all in business."

Jack McDonald attended Merrimack College in North Andover, Mass., where he earned a bachelor's degree in civil engineering in 1965. Shortly after graduation, he went on to serve as a lieutenant in the US Army Corps of Engineers, where he was awarded the Army Commendation Medal in 1968. He became a registered Professional Engineer in 1977.

McDonald and York came together in 1993 to form McDonald York by merging Coleman and Wood, a general contractor company, with York Construction Company. In 2003, they bought the company outright. McDonald currently holds the title of co-owner and executive chairman of McDonald York Building Company.

With an interest in engineering and the community, McDonald was a founding member of the CCEE Advisory Board.

"We have a number of NC State grads working for us and it seemed natural to help NC State develop curriculum for future engineers," McDonald said.

The two business partners recently came together and made a gift to support Fitts-Woolard Hall.

McDonald said that during his time on the advisory board, he would meet the board in Mann Hall on main campus and note the impact that using an aging building was having on faculty members and students.

"To be a leader in civil engineering, this new building is needed," he shared. "My hope is that this new first-class building will help attract even more innovative faculty members that will educate the civil engineers of tomorrow."

"As a company and culture, we want to be part of moving forward — so naturally we're pleased to be part of the efforts to help create this new building," York said. "It wasn't a difficult decision — anything we can do for NC State is a labor of love."

BRAD AND ANNA SULLIVAN

Husband and wife Brad and Anna Sullivan each chose NC State for different reasons.

For Anna, who earned her bachelor's degree in civil engineering in 1983, her abilities in math led her to pick engineering. Watching David Thompson and the NC State men's basketball team as a young girl was also a factor.

With an interest in furniture manufacturing and NC State having a great furniture manufacturing and management program, Brad, who graduated in 1982 with a bachelor's degree in furniture manufacturing and engineering, felt drawn to the University and to the College. "I knew that I wanted a career in furniture manufacturing and the degree from State would help me tremendously in achieving this goal."

The Sullivans are the co-founders, former co-owners and presidents of Thomas-Bain Leather, Inc., a manufacturer of upholstered and leather furniture in Conover, NC.

Brad credits his degree from NC State in helping him learn the discipline he would need when he and Anna started their manufacturing business. But, he also credits NC State for so much more.

"One of my favorite memories at State was when classes would change and the plaza between Riddick Hall and Mann Hall would be crowded with students. In that crowd I noticed a very pretty girl, who later became my wife of 35 years and counting," he said.

For the Sullivans, giving to the Fitts-Woolard Hall effort felt right. "I'm a civil grad, and my husband was industrial, and that the two were combined in the building, it was a no-brainer," shared Anna.

The duo had attended an event in Newton, NC, where Dean Louis Martin-Vega was speaking about the College and the current needs. "Hearing what the dean had to say, how can you say no to him?" laughed Anna. "Dean Louis' excitement is contagious."

Brad and Anna have each named something in their respective departments in the new building. He named the Brad Sullivan Study Lounge in ISE, and Anna named the Anna Callanan Sullivan Lab, which will be home to the Structural Behavior Measurements Lab in CCEE.

"We didn't want to do Mr. and Mrs. — we felt it was important to have something in each of our home departments," shared Anna.

The impact to be felt by the new building, according to the Sullivans, will show that the College is growing and that with support it will bring the best and brightest to the University and to the state. ▪

FROM LEFT, DEAN LOUIS MARTIN-VEGA, PETER LEHRER, ALAN WEINBERG, SUZANNE GORDON AND GIL WEST.

Gordon, Lehrer, Weinberg and West receive **DEA awards**

The College of Engineering bestowed the Distinguished Engineering Alumnus award on **SUZANNE GORDON**, **PETER LEHRER**, **GIL WEST** and **ALAN WEINBERG** at a banquet on Oct. 31.

Gordon earned her bachelor's degree in computer science and mathematics in 1975 and master's degree in statistics from NC State in 1980. During her more than 30 years at SAS Institute, she held a variety of key leadership roles, rising to vice president of information technology, and eventually chief information officer, at the world's largest privately held software company.

She is the current president of the NC State Engineering Foundation Board of Directors and is the first woman to hold that position. She was a member of the NC State Board of Trustees from 1999 to 2009 and has served on the Alumni Association Board of Directors and on the College of Management Advisory Board. She is a Distinguished Alumna of the College of Physical and Mathematical Sciences.

Lehrer earned his bachelor's degree in civil engineering from NC State in 1963. In 1979, Lehrer co-founded Lehrer McGovern, Inc., a construction management firm that consistently ranked as one of the top construction companies in the country. After the firm merged into Bovis, Ltd. (London), in 1988, he became vice chairman of Bovis, Ltd., and chief executive officer of all U.S.-based subsidiaries. Previous projects include the 1996 Atlanta Olympic Games, Euro Disneyland, Canary Wharf, and restoration of the Statue of Liberty and Ellis Island.

Currently, he is the chief executive officer of Lehrer Cumming, a division within Cumming Corporation focused on client markets in Boston; New York City; Washington, D.C.; and Miami. In 1996, he founded Lehrer, LLC to provide construction consulting services to owners, developers and institutions engaged in major capital projects.

Weinberg earned his bachelor's degree in chemical engineering from NC State in 1963. After a 36-year career at Cryovac, he retired as global vice president of technology with 29 years in RD&E and seven years in marketing and business development. He authored 15 original patents and saw Cryovac global sales grow from about $100 million to almost $3 billion with operations in more than 20 countries and several RD&E facilities.

He is a previous member of the Society of Plastics Engineers, the Department of Chemical Engineering's Advisory Board at Clemson University, and the Department of Chemical and Biomolecular Engineering's Alumni Advisory Board at NC State. He has served on various community boards including the Warehouse Theater, the International Chamber Music Series and the Osher Lifelong Learning Institute (OLLI) at Furman University.

West earned his bachelor's degree in mechanical engineering from NC State in 1984. Additionally, he received a Master of Business Administration degree from National University in San Diego. As senior executive vice president and chief operating officer for Delta Air Lines, he leads the team responsible for safe, reliable operations across the globe, including more than 70,000 employees in areas that include Airport Customer Service, Cargo, Corporate Safety, Fleet Strategy & Technical Procurement and Flight Operations.

He serves as a key alumni volunteer in the Atlanta area and is an annual contributor both to the Dean's Circle and Fitts-Woolard Hall. West is also assisting the University in forming a "C-Suite Advisory Group" consisting of the College's top alumni. ▪

College homecoming draws engineering alumni to campus

At the College of Engineering's annual homecoming program Nov. 2, alumni got a unique — if unscheduled — view of the ongoing construction of Fitts-Woolard Hall, which is expected to be completed in 2020.

Alumni are invited each year during the University's homecoming weekend for a keynote presentation and updates on the College's current successes and projects. Due to weather, the BBQ luncheon was moved indoors to Duke Energy Hall in Hunt Library, which overlooks the construction site.

Todd Delk, a Benjamin Franklin Scholar who graduated in 1999 with degrees in civil engineering and multidisciplinary studies, said he attended the College's homecoming to become more involved with NC State. He was excited to see the new building and changes to Centennial Campus.

"While I love Mann Hall, it's good to see some new technologies and for everybody to join forces over here on Centennial," Delk said.

Following the luncheon, **JEFF GARWOOD**, founder and CEO of Liberation Capital, kicked off the presentations. Garwood graduated in 1984 with a degree in chemical engineering. In 2010, he founded the Charlotte-based global equity firm, which provides project finance for clean technology infrastructure. Garwood, who is the former president and CEO of GE Water & Process Technologies, has visited places all over the world working on sustainable solutions to improve clean water access, create alternative energy solutions and convert waste to useable products.

"Applied engineering, to me, is the most amazing thing that I've come across the last 15 years," he said. "If you say, 'I want to figure out how to fix this problem, and there are going to be 100 applications, and we want to minimize the cost, and after we finish it, we don't want to do new engineering,' that rocks my world."

Following Garwood's presentation, three student entrepreneurs — **CHANDRA MANIVANNAN**, **NICK SISCHO** and **RYAN KELLEY** — talked about their startups and shared how NC State supported them through grants and entrepreneurship classes.

Manivannan, a junior majoring in computer science and applied mathematics, developed Math Mundo, a multilingual math education program. Sischo, a senior environmental engineering student, is the CEO of Trashr and is part of a team that created a sensor that collects fill-level data in dumpsters. Kelley graduated in 2018 with a mechanical engineering degree. He talked about Atomo, his spatial intelligence startup.

Senior civil engineering students **HANNAH QUEEN** and **HARRISON DEAN**, president and conference chair of NC State's student chapter of the American Society of Civil Engineers, then gave an update on ASCE's success at the 2018 Carolinas Conference, where the team took home third place overall.

Dean Louis Martin-Vega closed the program, starting with a remembrance of Dr. Nino Masnari, dean emeritus of the College. Masnari was dean from 1996 to 2006, and passed away in May 2018. Martin-Vega credited Masnari for stabilizing the College and helping to move it forward to where it is today.

"The reality is, it doesn't matter what we may have accomplished in any area — we basically are standing on the shoulders of those who came before us," Martin-Vega said.

Martin-Vega also noted improvements in the College's rankings — in the last 10 years it has passed Duke University, Ohio State, Virginia Tech, Penn State and University of Florida and went from 34th in *U.S. News & World Report* rankings of graduate engineering programs to 24th. ▪

NC STATE Engineering

ANNUAL GIVING

ENGINEERING FOUNDATION

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

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

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JOIN THE DEAN'S CIRCLE

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

INCREASE YOUR IMPACT

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

If you have already made your 2018-19 gift to the College of Engineering, please accept our sincere thanks. If you have questions or would like to learn more about your giving options, contact Angela Martin at **919.513.1714** or **anstalli@ncsu.edu**.

IRWIN HOLMES, LEFT, WITH CHANCELLOR RANDY WOODSON.

University names building for Irwin Holmes, groundbreaking engineer

THERE WAS A TIME not too long ago when **IRWIN HOLMES, JR.** would not have been allowed to attend classes at NC State.

In fall 2018, the University named a building for him.

When Holmes graduated with a bachelor's degree in electrical engineering in 1960, he was the first African American to receive an undergraduate degree from the University. He also broke barriers as the first African American to compete as an athlete, win a varsity letter and co-captain a varsity team in the Atlantic Coast Conference as a member of NC State men's tennis team.

In September 2018, the NC State Board of Trustees approved changing the name of University College Commons to Holmes Hall.

Holmes and his family attended a dedication ceremony for the renaming held on Nov. 1, 2018, during Red and White Week. Joined by NC State Chancellor Randy Woodson, Director of Athletics Debbie Yow and Dean of Engineering Louis Martin-Vega, Holmes spoke of how his experiences at NC State helped set him up for a successful career.

"I may have contributed something to NC State, but NC State has contributed a whole lot to me and made my life very special," Holmes said.

Holmes, who also earned a master's degree in electrical engineering from Drexel University, worked for several companies before working for IBM for 19 years until his retirement. As a senior manager of computer development at IBM, he received two patents and was a key member of the task force that led to the development of the IBM PC product line.

He has also been an entrepreneur who developed a shopping center in Durham, NC, started a gourmet restaurant, and founded a staffing company with his wife, Meredythe.

At the building dedication, he referenced mentors at NC State, including varsity tennis coach John Kenfield, Jr. and electrical engineering professor William D. Stevenson, Jr.

Kenfield and Holmes' teammates welcomed him and stood united against the prevalent forces of segregation. Throughout his career, Holmes wasn't allowed to compete in South Carolina, which had an unwritten rule barring interracial athletic competition. Kenfield arranged for all matches against Clemson and the University of South Carolina to be played in North Carolina.

When the team stopped for a meal at a diner outside Chapel Hill after a match against UNC, the owner told Kenfield that he wouldn't serve Holmes. The coach and the entire team got up and walked out.

Holmes said much of what he achieved in his career came from a class he took his senior year that detailed how to build a computer. When he graduated, Stevenson recommended him for his first job, with RCA in Camden, New Jersey.

Over the years, Holmes worked with many accomplished engineers and supervised quite a few. He said his NC State education served him well.

"Let me tell you something, there's no better engineer than at NC State," he said. ▪

Ph.D. graduate balances **research**, **minority mentorship** — and **wins game show**

> "There was a sense of accomplishment but also a sense of 'We need to do more,'... so that when students arrive, they feel welcome."
>
> **MAKITA PHILLIPS**

DR. MAKITA PHILLIPS

Four years out of her Ph.D. program at NC State, **DR. MAKITA PHILLIPS** is forging her own, unique path toward making impactful, accessible change.

Phillips works for a startup that is setting the new standard for thermal materials in electronics packaging while continuing on the route to becoming a tenure-track professor. She's also taking her mechanical engineering knowledge outside of her career by actively mentoring minority engineers — and more recently, to win $15,661 toward her student loans on the game show Paid Off with Michael Torpey.

Phillips, who is from Clinton, Md., is currently an American Society for Engineering Education/National Science Foundation Small Business Innovation Research Postdoctoral Fellow at Carbice Corporation, an Atlanta-based startup that has introduced Carbice Carbon, an innovative aligned nanostructure multi-functional composite that is used today in the world's most important electronic products.

Phillips, whose Ph.D. in the Department of Mechanical and Aerospace Engineering focused on thermal management, has also researched how to improve the efficiency of solar cells, how heat can be converted to energy using magnetic materials and how to store thermal energy for later use.

In her time at NC State, Phillips learned how to focus her career and the different pathways available to her through her interactions with professors and with advisors and fellow students in the Minority Engineering Programs (MEP).

"I knew I wanted to go the tenure-track route, but I also had different opportunities to not only be a post-doc conducting research, but also look at 'How do you build a company? How do you take the things we engineer and make them commercially available?'" Phillips said. "At NC State, I learned a lot about being observant to your surroundings and then making your pathway fit for you and going after those different things you're interested in."

Phillips earned her bachelor's and master's degrees in mechanical engineering from Florida A&M University. She said part of the reason she decided to pursue a Ph.D. was because of the low number of women and members of underrepresented minority groups who have advanced graduate degrees in engineering. Phillips is the first African-American woman to graduate with a Ph.D. in mechanical engineering from NC State.

"There was a sense of accomplishment but also a sense of 'We need to do more,'" Phillips said. "We have to do a better job of recruiting and making sure the environments are inclusive for everyone who we do recruit, so that when students arrive, they feel welcome."

While at NC State, Phillips founded the Minority Engineering Graduate Student Association (MEGSA) to provide a way for minority graduate students to get to know each other and talk about issues that affect their community, as well as provide peer mentoring for first-generation graduate and undergraduate students.

"I felt very supported by (MEP Director Angelitha L. Daniel) and by my advisor, Dr. Justin Schwartz," she said. "It went great, and I'm glad it's still going."

On the game show, which is filmed in Atlanta and airs on TruTV, contestants answer questions to win money that will help pay off their student loans. Phillips made it to the final round and had one minute to answer as many questions about mechanical engineering as she could. She answered five correctly, winning money to pay for 30 percent of her loans, in addition to what she had already won on the show. ▪

DR. DOUGLAS REEVES

THOMAS GRIFFIN

DR. JOSEPH P. ARCHIE, JR.

Graduate fellowships help attract **top students**

When students are deciding on which school to attend for a master's degree or Ph.D., the type of funding they receive is often a key part of their decision. Graduate fellowships, which provide the flexibility to focus on research without being tied to other responsibilities, are among the best ways to attract top students

DR. DOUGLAS REEVES, the College's associate dean of graduate and international programs and a professor of computer science, said that financial support for graduate students is critical as they focus on their research and classes.

The benefit of a fellowship is that students have more time to figure out what kind of research they want to be doing or which professors they are interested in working with, rather than being financially supported through a teaching assistant or research assistant position, which requires them to devote time to that position and to that area of study.

"It's helpful for recruiting students — you can say to a student, 'You're not locked in to a specific research project before you get there, you have the luxury of sampling, surveying what research projects are of interest to you,'" Reeves said.

Several engineering alumni have given back to the College by endowing fellowships, helping NC State compete for top engineering students who conduct innovative research that benefits the University and state.

NC State alumnus **THOMAS GRIFFIN**, who graduated with a B.S. in civil engineering in 1966 and earned a master's degree in 1971 and is now the vice president of Forensic Engineering, Inc., endowed the Thomas Griffin Graduate Award in 2015.

Griffin said he was initially inspired to fund a higher education scholarship for NC State students when he thought back to a student he grew up with, who was the smartest boy in his high school class but unable to attend college because of a lack of financial resources. When he learned of the need to support graduate programs, he decided to give there.

"It's important to have those resources available to bring in super bright students to our graduate program at NC State," he said.

DR. JOSEPH P. ARCHIE JR. endowed the Patrick H. McDonald Jr. and Clement Kleinstreuer Fellowship, also for graduate students, in 2000. Archie earned a B.S. in 1960 and an M.S. in 1962, both in mechanical engineering, as well as a Ph.D. in engineering mechanics in 1968 and an M.D. from UNC-Chapel Hill that same year.

Archie named the scholarship after his two mentors. McDonald helped make it possible for him to attend medical school and work on a Ph.D. at NC State at the same time. Kleinstreuer was Archie's partner in starting a graduate education program in biofluids at NC State, which graduated several Ph.D. and M.S. students.

"The benefits of educating outstanding engineering graduate school candidates are compounding," he said. "Successful graduates reflect positively on their university programs, tend to support them in turn and enhance the overall engineering school quality and excellence." ▪

DEAN J. HAROLD LAMPE

Engineering Foundation marks **75th anniversary**

The North Carolina Engineering Foundation was founded in fall 1944 by a group of 49 business leaders interested in promoting engineering in North Carolina and, by extension, growing the state's economy.

The organization, renamed the NC State Engineering Foundation, Inc. (NCSEF) in 1999, has continued that tradition ever since. The Foundation marks its diamond anniversary in 2019.

North Carolina Gov. J. Melville Broughton served as the Foundation's first president. Early on, the group pledged that its funds would not go toward equipment or building construction, only to supplement state salary funds so that what was then the School of Engineering could attract the best faculty members available. And the first order of business was to attract a new dean.

DR. J. HAROLD LAMPE came to NC State in 1945 and would serve 17 years, the longest term of any NC State engineering dean. During his tenure, Lampe would expand the engineering curricula, create the Department of Nuclear Engineering and the Industrial Extension Service and oversee the construction of three new engineering buildings on campus.

By the late 1970s, Foundation endowment funds totaled just under $1 million. Areas that those monies supported had expanded to include undergraduate merit scholarships and graduate fellowships and support for the College's Minority and Women's programs.

A BROADER REACH

Today, the Engineering Foundation has built endowment funds available to the College of more than $143 million. That endowment helps support scholarships, fellowships, professorships, academic programs, faculty research and other initiatives that are not typically supported through state appropriations.

Over the last five years, the Foundation has brought in an average of $21.6 million per year in new funding.

The NCSEF staff has also led fundraising to support Fitts-Woolard Hall, the newest engineering building on Centennial Campus and the first building project at NC State using a public-private funding model.

Today, a staff of 12 is led by a 36-member board of directors. Foundation President Suzanne S. Gordon is the first woman to head the board. NCSEF hired Griffin Lamb as its new executive director this spring (see story on **page 43**).

In recent decades, the Foundation has expanded the number and diversity of its board members, implemented a more robust strategic planning process and significantly increased outreach to younger alumni.

The NCSEF board has also been increasingly directly involved in identifying, meeting with and cultivating alumni and asking them to give back to the College both with their time and personal resources.

Having an independent fundraising organization supporting the College helps provide vital private monies beyond what state appropriations make possible. Attracting the best students and faculty members with the help of NCSEF funds can make the difference between a good college of engineering and a preeminent one.

Tom McPherson, a Foundation board member and past president, likens it to a basketball game. Just a few plays, a break here or there, can make the difference. Especially in a closely matched contest.

"We can make the difference between having a win with a potential student or faculty member and not having a win," McPherson said.

Learn more about the Foundation at **www.engr.ncsu.edu/alumni-and-giving/ncsef**. ▪

AN ENDURING FOUNDATION

Foundation undergoes **leadership change**

GRIFFIN LAMB is the College's new assistant dean for development and college relations and executive director of the NC State Engineering Foundation. She succeeds Brian Campbell, who left the College in November for a similar position at Virginia Commonwealth University.

LORA BREMER, executive director of major gifts and campaign planning for the Foundation served as interim director of the Foundation during a national search for Campbell's permanent successor.

"Brian arrived at NC State in October 2011 and in these seven plus years has provided great vision and leadership for our development efforts," said Dr. Louis Martin-Vega, dean of the College. "His accomplishments include significant enhancement of alumni engagement both regionally and nationally, major increases in alumni participation at NC State Homecoming activities, and enhancement and growth of department alumni recognition events and many related efforts."

Lamb joins the College from East Carolina University, where she served as associate vice chancellor for development in the Division of University Advancement. Her higher education experience also includes positions at Harvard University and Davidson College.

Lamb holds a B.A. in English from Davidson College and a Ed.M. from the Graduate School of Education at Harvard University.

During Campbell's time at NC State, the College saw its endowment and the number of endowed professorships both double. He led the College's fundraising efforts for Fitts-Woolard Hall, the newest engineering building on NC State's Centennial Campus and the first public-private building project in the University's history. ▪

Two join Engineering Foundation staff

CHRIS PRICE joined the Foundation in January 2019 as director of development working with alumni in Washington D.C., Virginia, Maryland, South Carolina and the Research Triangle region of North Carolina. Price will also act as liaison for the Department of Electrical and Computer Engineering. He came to NC State in 2015 as a director of development for the University Advancement team. Previously, he worked as a development director and adjunct professor at West Virginia State University. Price received his bachelor's degree in public policy and his Master of Business Administration from the University of Charleston in Charleston, West Virginia.

SARA SELTZER joined the Foundation in January 2019 as director of development for the Department of Computer Science and the Department of Materials Science and Engineering. As director, Seltzer will build connections with alumni and lead fundraising and engagement efforts. Before coming to the Foundation, Seltzer was assistant director of development for NC State's Division of Academic and Student Affairs. Seltzer received a Bachelor of Business Administration degree from Stetson University in Florida and a Master of Arts Administration from the Savannah College of Art and Design. ▪

GRIFFIN LAMB

LORA BREMER

CHRIS PRICE

SARA SELTZER

Ways to give to the **NC State Engineering Foundation**

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

ENDOWMENT: An endowment is a fund held in perpetuity that benefits a specific purpose. Most endowments held by the Engineering Foundation are either for scholarships or endowed faculty positions.

PLANNED GIVING: Planned gifts can be as simple as a bequest (including us in your estate plans). Other options include trust vehicles and annuities, which have the potential to provide an income stream and significant tax benefits.

CAPITAL GIFTS: These gifts go toward "bricks and mortar" projects. Donors are given "naming opportunities." Opportunities include Fitts-Woolard Hall and other engineering buildings on Centennial Campus.

IN-KIND GIFTS: These are gifts of goods or services to the College at a discount or no cost.

SPECIAL GIFTS: These gifts are directed to unique projects, centers or initiatives as directed and approved by the dean of engineering. ▪

ENGINEERING ALUMNI, **YOUTUBE STARS** RETURN TO CAMPUS

WHEN RHETT MCLAUGHLIN AND LINK NEAL — better known as comedy duo Rhett & Link — were teenagers, they made a blood oath that they were going to create things together. But what they didn't know at the time is that they'd first be attending the College of Engineering at NC State together, earning degrees that helped them in unexpected ways in their entertainment careers.

Rhett and Link ended up at NC State, they said, because they were doing well in math and science during their senior year of high school, so people suggested that they study engineering — and Rhett's dad said he wouldn't pay for film school and thought his son should pursue a more practical degree.

The duo returned to NC State on Oct. 13 to speak to a full auditorium in the James B. Hunt, Jr. Library on Centennial Campus, talking about their non-traditional path into entertainment and their advice for students.

"Engineering is something worth investing in," Link said in an interview before the event, thinking back to what Rhett's dad said. "Turns out, in a weird way, he was right," Rhett responded.

Rhett graduated with a degree in civil engineering in 2000, and Link finished a semester later in 2001 with a degree in industrial engineering. Both worked in their respective fields for a few years before deciding to pursue entertainment full time. They started their YouTube channel in 2006, after realizing that people were downloading videos from their website, posting the videos on YouTube and getting more views than they did on their website.

Now, their channels have a combined 23 million subscribers, and their videos have more than 6 billion views. They film a daily talk show called *Good Mythical Morning*, created the entertainment company Mythical, host the podcast *Ear Biscuits* and published *Rhett and Link's Book of Mythicality: A Field Guide to Curiosity, Creativity, and Tomfoolery.*

"We approach what we do, even if it's creative, we approach the comedy and the creative things as problems — problems with solutions. It's different kinds of solutions, but it's a similar process," Rhett said when asked how their engineering degrees influence their work. "So I don't think we've changed very much in the way that we approach things. Still doing it in a very technical way, even though it's something very creative."

During their hour-long Q&A session with students, Rhett and Link answered questions submitted by students while Dr. Jerome Lavelle, associate dean for academic affairs in the College, moderated. The two were also inducted into the NC State chapter of the Order of the Engineer, an organization created "to foster a spirit of pride and responsibility in the engineering profession." Members of the order are given rings to wear on the pinky finger of their working hand. ▪

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JOIN THE CLUBS

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.

To learn more about how you can support Fitts-Woolard Hall and about membership in these groups, contact Lora Bremer with the NC State Engineering Foundation at **919.513.0983** or **lora_bremer@ncsu.edu**.