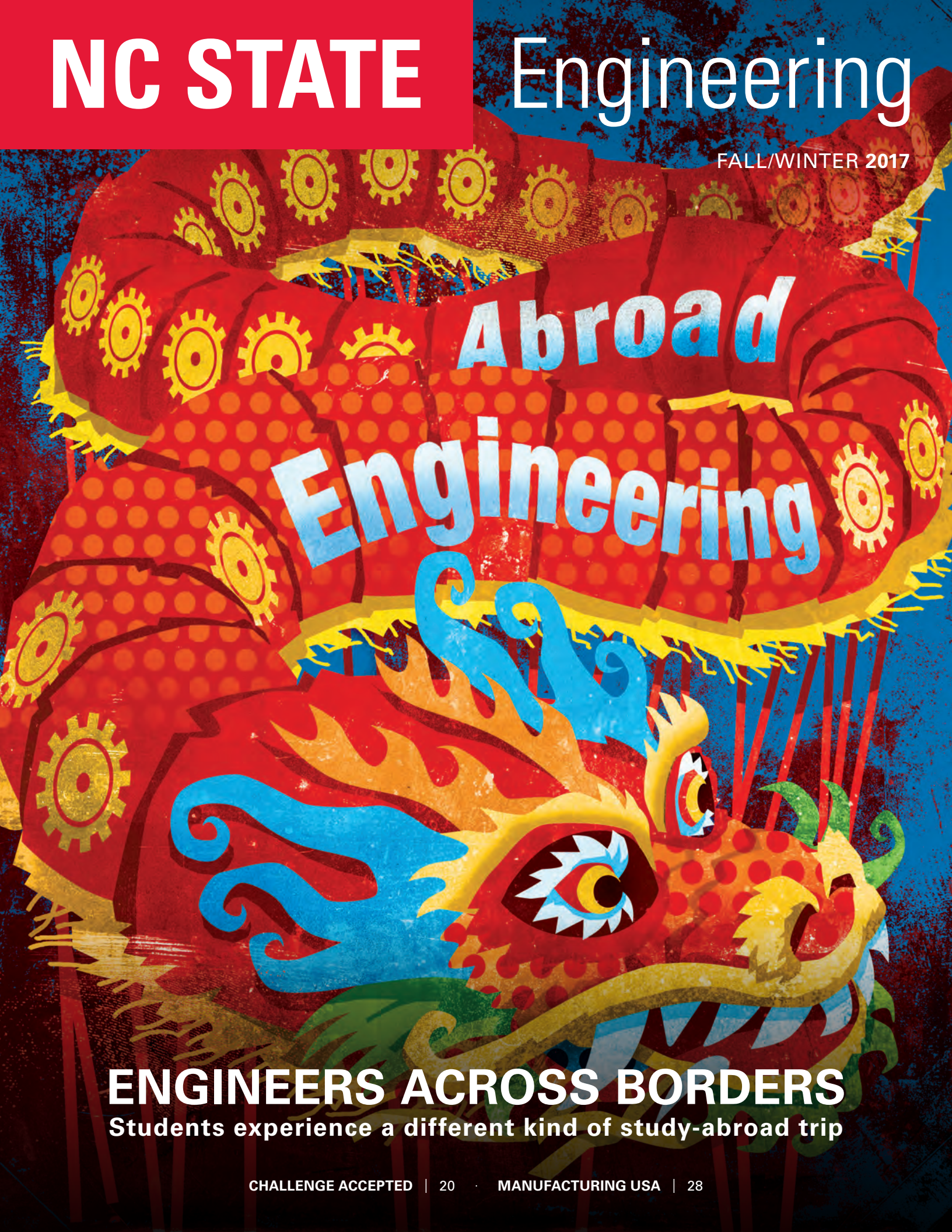
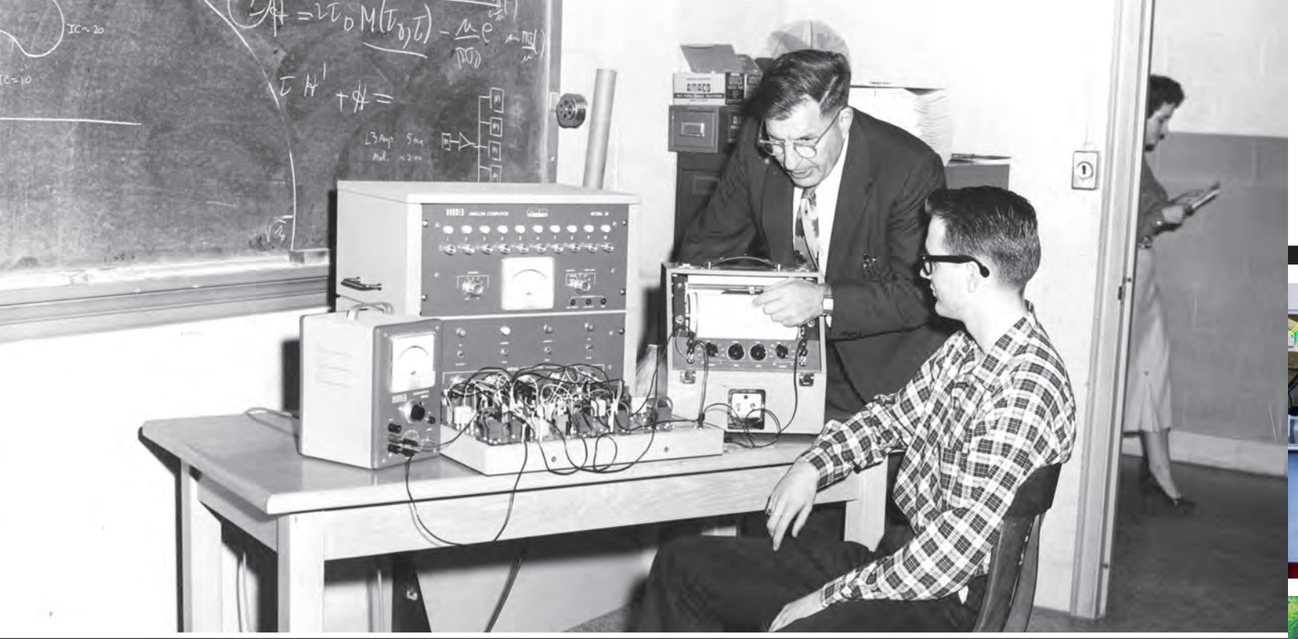
NC STATE Engineering

FALL/WINTER **2017**



ENGINEERS ACROSS BORDERS

Students experience a different kind of study-abroad trip



A CAMPUS WITHOUT COMPUTERS

Computers – be it laptops, desktops or smartphones – are everywhere at NC State. But 60 years ago, there were only a few on the entire campus.

In this photo, taken in December 1956, Dr. John Cell shows student James Wallace how to operate a Donner Model 30 analog "computor."

Manufactured by Donner Scientific Company, based in Berkeley, Calif., the Model 30 was a vacuum tube computer that featured a removable problem board and reset and hold circuits for five integrators. Two or more of the machines could be interconnected to work together.

Cell came to Raleigh in 1935 after earning a Ph.D. from the University of Illinois. He introduced new graduate courses in applied mathematics and transform theory and helped the Department of Mathematics obtain its first degree programs, Master of Engineering Mathematics in 1947 and Bachelor of Engineering Mathematics in 1956. He became head of the Department of Mathematics in 1957 and served in that capacity until stepping down in 1967, according to a history of the department.

He held close ties to the engineering departments and introduced several mathematics courses with numerous applications to engineering problems. He became an active member of the American Society for Engineering Education and was even the first recipient of a faculty award from the NC State chapter of the Tau Beta Pi engineering honor society.

Cell also played an instrumental role in the establishment of the Department of Computer Science at NC State. The department's origins can be traced back to 1957, when the Department of Experimental Statistics placed computers in the basement of Patterson Hall.

He was part of an ad-hoc committee on computer science established in 1965 that included faculty members from mathematics, engineering, statistics and economics. Cell and Dr. Paul E. Lewis, director of the computer center in the Department of Mathematics, wrote a report for the committee that recommended reconstituting the computer center into the Department of Computer Science within the School of Physical Sciences and Applied Mathematics (later renamed Physical and Mathematical Sciences or PAMS).

The Department of Computer Science began instruction in fall 1967 with 21 declared majors and 460 students. Lewis was the first department head. The Department moved to the College of Engineering in 1989.

The department is marking its 50th anniversary this fall with several activities celebrating the occasion.

contents

FALL/WINTER **2017**

FEATURES

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

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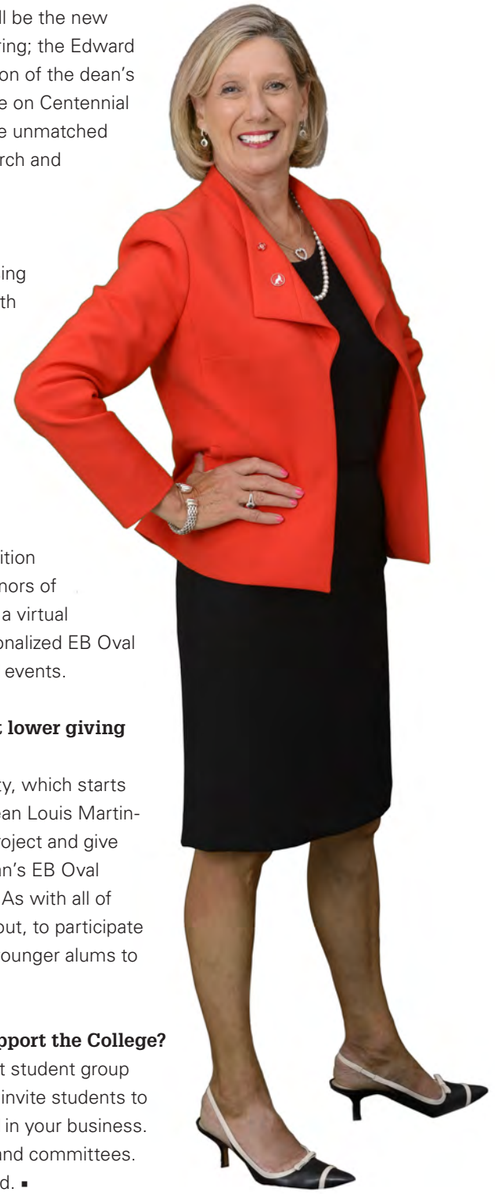
Q&A

QUESTIONS FOR **LORA BREMER**

Lora Bremer is the executive director of major gifts and campaign planning for the NC State Engineering Foundation. Among her many duties is leading the College's fundraising efforts for the Engineering Building Oval (EB Oval) project.

What is the EB Oval project and why do we keep talking about it?

EB Oval is the realization of engineering education for the 21st century. It will be the new home to the Department of Civil, Construction, and Environmental Engineering; the Edward P. Fitts Department of Industrial and Systems Engineering; and a large portion of the dean's administrative programs. EB Oval will move us closer to unifying the College on Centennial Campus and will provide students and faculty members with an atmosphere unmatched anywhere in the nation, one that will foster and facilitate innovation in research and education through partnership opportunities.



How much money has been raised? How much more do we need?

This is the first time in the University's history that we are charged with raising private funds for a building and, so far, we have had a positive response. With a $154 million total project cost, the State of North Carolina provided $77 million through budget allocation for design and the Connect NC Bond provided funds for construction. The University is contributing $17 million, and to date we have raised more than $25 million in gifts, pledges and verbal commitments.

Are there any perks to making a donation?

We are developing a schedule of naming opportunities to recognize alumni, corporations and friends who make lead philanthropic commitments. In addition to actual named spaces available for our Cornerstone Society donors, all donors of $50,000 or more will be recognized on a permanent display wall, as well as a virtual donor recognition display showing the donor's story. They will receive personalized EB Oval hard hats and will be invited on exclusive hard hat tours and to other special events.

Not everyone can write a check for millions of dollars. Are donations at lower giving levels going to make a difference?

We understand that not everyone can make a gift in the Cornerstone Society, which starts at $100,000 and goes up through the naming of the building. In January, Dean Louis Martin-Vega and his wife, Maggie, decided that they, too, wanted to support the project and give others an opportunity to show their support. This fueled the idea of the Dean's EB Oval Club and opened the opportunity for gifts between $50,000 and $100,000. As with all of our fundraising efforts, we like to encourage our young alums, 10-15 years out, to participate so we rolled out the Dean's Young Alumni EB Oval Club, which allows our younger alums to support EB Oval with gifts of $25,000.

Besides making a monetary contribution, how else can alumni help support the College?

Recruit our students and offer internships and co-ops. Sponsor and speak at student group meetings and support senior design projects. Guest lecture for classes and invite students to visit corporate offices and demonstrations of equipment and software used in your business. Volunteer to be a mentor to students or volunteer for departmental boards and committees. There are so many ways to help. Call us. We are happy to get you connected. ▪

FROM THE DEAN

LOUIS A. MARTIN-VEGA

Welcome to the fall 2017 issue of *NC State Engineering* magazine. Each fall, as students return and new students take their first steps onto campus, we are reminded of the important job we have here at NC State. It is up to each of us to ensure that our students have the experiences and opportunities that will bring them success in the classroom, laboratory and, ultimately, in life.

We take our commitment to educating tomorrow's engineers and computer scientists seriously. While classroom education is the necessary beginning of that education, it is just a beginning. Teaching our students to apply that learning in real world situations thereby assuring that they both "think and do" is also a critical part of what we must achieve to prepare them to compete in today's global economy and solve the engineering and computer science challenges of the future.

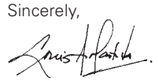
In this issue we feature one of the many ways we provide that global learning opportunity — our study abroad programs. Through immersive study abroad experiences, our students travel around the world acquiring unique perspectives provided by classes and projects in multicultural and oftentimes unfamiliar environments. This is an important part of the education process because when they graduate, they will be competing not just with students from U.S. universities but also universities from around the world. And many of our graduates will go to work for global companies where they may be stationed in another country.

This fall, we are excited to welcome Dr. Julie Swann as the new head of the Edward P. Fitts Department of Industrial and Systems Engineering (ISE) and Dr. Srinath Ekkad as the new head of the Department of Mechanical and Aerospace Engineering (MAE). Dr. Donald Brenner has stepped into his new role as interim head of our Department of Materials Science and Engineering following the departure of Dr. Justin Schwartz. We are grateful to Dr. Paul Cohen (ISE) and Dr. Rich Gould (MAE) for their dedicated service as department heads and congratulate Justin on his appointment as the dean of engineering at Penn State University.

We are also excited about our upcoming Homecoming Celebration and the many alumni it attracts to the campus for a weekend of remembering times past and learning about the future of your college. Information about homecoming is available at go.ncsu.edu/homecoming.

As always, I invite you to visit, stay engaged with, and celebrate your college. I hope you enjoy this issue of *NC State Engineering*.

Sincerely,



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

Departments change leadership

Two academic departments within the College have named new leaders and another has said goodbye to its department head.

Dr. Srinath Ekkad has been named the new head of the Department of Mechanical and Aerospace Engineering (MAE), while Dr. Julie Swann is now leading the Edward P. Fitts Department of Industrial and Systems Engineering (ISE). Meanwhile, Dr. Justin Schwartz has left his position as head of the Department of Materials Science and Engineering to become the new dean of engineering at Penn State.

Ekkad replaces Dr. Richard Gould, RJ Reynolds Professor, who has served as the department head in MAE for 13 years.

Ekkad was most recently the Rolls-Royce Commonwealth Professor for Aerospace Propulsion Systems in the Department of Mechanical Engineering at Virginia Tech, the associate vice president for research programs and the director of the Rolls-Royce University Technology Center for Advanced Diagnostics.

Swann succeeds Dr. Paul Cohen, Edgar S. Woolard Distinguished Professor, who served as head of ISE for 10 years.

She was most recently the Harold R. and Mary Anne Nash Professor in the Stewart School of Industrial & Systems Engineering at Georgia Tech and is co-founder and co-director of the Center for Health and Humanitarian Systems. ▪

BENEFITS OF ADVANCED WOOD-BURNING STOVES GREATER THAN PREVIOUSLY THOUGHT

A RECENT STUDY out of the Department of Civil, Construction, and Environmental Engineering (CCEE) finds that advanced wood-burning stoves designed for use in the developing world can reduce air pollution more than anticipated because gaseous emissions from traditional wood stoves form more particulate matter in the atmosphere than researchers previously thought.

"Previous studies have looked solely at direct emissions from cookstoves," says Dr. Andrew Grieshop, an assistant professor in CCEE and corresponding author of a paper describing the work. "We've now done a series of experiments to determine what happens to those emissions while they are in the atmosphere."

At issue is particulate matter (PM): minute, airborne particles that can contribute to human health problems, such as asthma.

For this study, researchers tested three types of wood-burning stoves: traditional stoves; natural-draft stoves; and forced-draft stoves, which use battery-powered fans to improve combustion. The researchers collected emissions from each of the stoves and used an environmental chamber and a custom-built oxidation flow reactor to mimic the chemical reactions that would normally take place with the emissions over the course of up to two weeks in the atmosphere.

The researchers found that, while traditional stoves emitted an average of 6 grams of PM per kilogram of fuel burned (g/kg), that number jumps to an average of 14g/kg when you include the PM that the emissions form over time due to chemical reactions that take place in the atmosphere.

Natural-draft stoves, by comparison, produced an average of about 4 g/kg of PM — even after aging in the atmosphere. And forced-draft stoves produced less than 3 g/kg.

"All of this is based on lab measurements, which is important to note because previous studies have found that advanced stoves don't necessarily work as well in the field as they do in the lab," Grieshop says. "However, the study does tell us that looking solely at stove emissions at the point of use doesn't give us a full picture of what's going on. The effects of atmospheric chemistry are extremely important to understanding the potential air quality benefits."▪

PAPER PUMPS POWER PORTABLE MICROFLUIDICS, BIOMEDICAL DEVICES

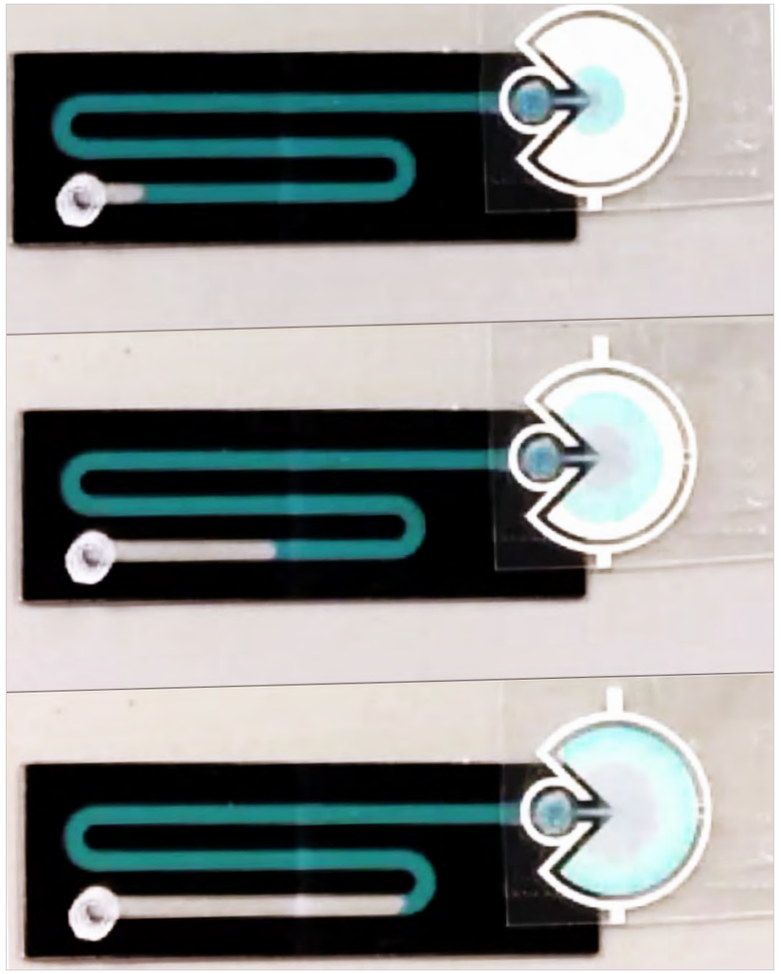
RESEARCHERS IN THE UNC/NC STATE Joint Department of Biomedical Engineering (BME) have developed inexpensive paper pumps that use capillary action to power portable microfluidic devices, opening the door to a range of biomedical tools.

Microfluidic devices are devices that manipulate fluids that have a volume of one microliter or less — volumes substantially smaller than a single teardrop. These devices hold promise for use in applications ranging from biomedical diagnostic tools to drug testing technologies.

"One longstanding challenge to the development of portable, real-world microfluidic device technologies has been the need to find a cost-effective way to pump fluids through the device when outside of the lab," says Dr. Glenn Walker, co-corresponding author of a journal article on the work and an associate professor in BME.

"Portability is important because it makes new applications possible, such as diagnostic tools that can be used in the field. Electric pumps, and tubing to connect them, are fine for a laboratory environment, but those aren't easy to take with you."

Now Walker and his collaborators have developed a new way to not only pump fluids through microfluidic devices but to exert substantial control over that flow. They can stop and re-start the flow, control the rate of the flow, and control how long the flow lasts.



"And, because our approach is a new twist on an age-old technology, our pumps are extremely cost effective," Walker says.

The age-old technology he's referring to is paper.

The researchers call their pumping system a hydraulic battery, but it doesn't involve electricity in any way. Instead, the "battery" draws its pumping power from capillary action.

If you've ever seen a paper towel soak up a spill, you've seen capillary action at work. Broadly speaking, capillary action is the tendency of liquids to be drawn into small spaces by surface tension. In the context of the hydraulic battery, it is the tendency of water — and aqueous liquids, such as blood — to be drawn into the pores found in a piece of paper.

"Our system uses pieces of paper that are 125 microns thick, little more than the width of a single hair," Walker says. "Capillary action pulls a liquid into the paper. And by changing the shape of the paper, we are able to control how much liquid is pulled through an attached device — and how quickly that happens."▪

ALUMNA BECOMES FINALIST ON "MYTHBUSTERS: THE SEARCH"

GROWING UP, Tamara Robertson had aspirations of becoming an attorney in the military, but a visit to NC State's campus where she had the chance to sit in on an engineering class changed her mind and her life.

"I just fell in love almost immediately," she said. "It's a school that you feel at home at."

As a transfer student to NC State, Robertson kept busy with extracurricular clubs that she was passionate about, including Engineers Without Borders and the American Institute of Chemical Engineers, and spent as much time as possible at the climbing wall in Carmichael Gymnasium. "There is nothing like the rock wall at NC State. I have been to other campuses that have climbing gyms, and I always tell people that if I could just go back to my alma mater and climb every night I would be happy."

After earning her degree in chemical and biomolecular engineering in 2009 from NC State, her job path led her to an array of opportunities, including running a biodiesel plant at NC State, designing and building vaccine facilities, and wardrobe design for television and movies in Los Angeles.

Her most recognized job title, though, is as a finalist on "Mythbusters: The Search," a reality television show that aired on the Science Channel in the spring of 2017 and globally throughout the spring and fall on Discovery. The show's 10 contestants, Robertson included, were competing to determine who would be the replacements for previous Mythbusters Jamie Hyneman and Adam Savage.

> "It's a school that you feel at home at."
>
> **TAMARA ROBERTSON**

As a contestant, she worked on myth-busting challenges such as figuring out if an ejection seat could be built that would shoot vertically out of a moving car and devising a system to use explosives to paint a room.

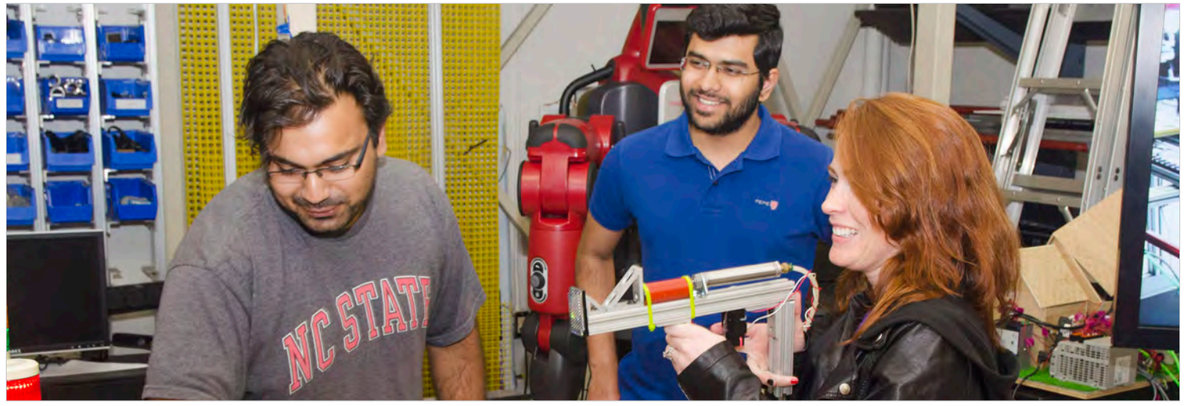
Robertson was not selected as a winner of the show but found many takeaways from her time as a contestant, including inspiring words from Savage: failure is always an option.

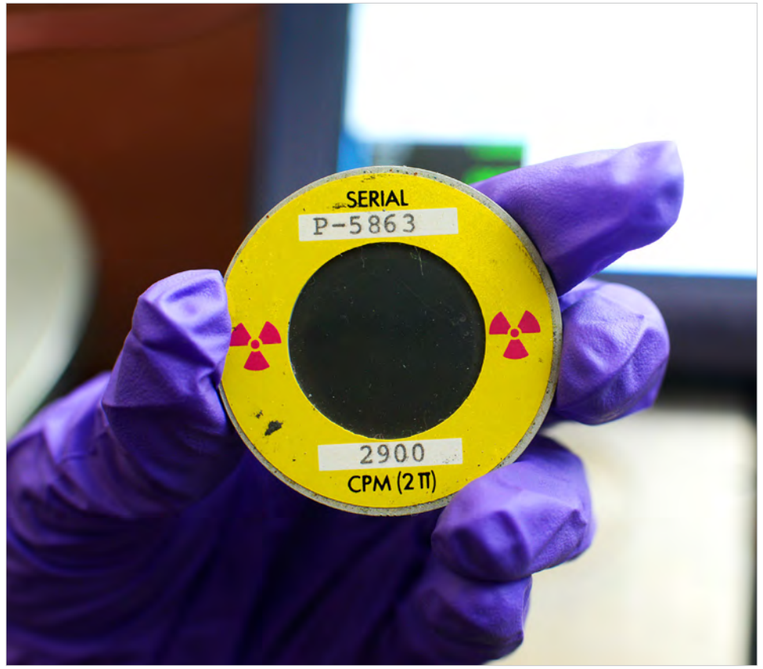
"When you go into a reality setting like the show where it's a competition — for the first time as an engineer you start to fear failure. You start to think that if the experiment fails you are being sent home. But failure is an option, and sometimes we proved that the myth is correct, and other times we proved that it's wrong or that it's impossible to test and get a definitive answer. Both are options."

For Robertson, the experience reiterated that as a scientist and engineer you have to be able to fail, because if you're not willing to fail, you're not going to innovate.

The biggest motivator for Robertson for auditioning and participating in the show was so she could be a role model for STEM girls and show that where your journey starts doesn't define where it ends.

"My engineering degree is very different than the average person. I didn't go the four-year route, I had to work full time, but at the end of the day, I got the degree, and I was able to do it," she said. "Enabling children to be brave enough to try and to potentially fail, to teach them how to pick up the pieces afterwards, to see that working in the STEM field is an option — that's what I find important."▪





NEW TECHNIQUE 'SEES' RADIOACTIVE MATERIAL EVEN AFTER IT'S GONE

A NEW TECHNIQUE allows researchers to characterize nuclear material that was in a location even after the nuclear material has been removed — a finding that has significant implications for nuclear nonproliferation and security applications.

"Basically, we can see nuclear material that is no longer there," says Dr. Robert Hayes, lead author of a paper describing the work and an associate professor of nuclear engineering at NC State. "For example, we could identify and characterize a dirty bomb based on samples taken from a room the bomb was in a year ago.

"This is a valuable tool for emergency responders, nuclear nonproliferation authorities and forensics because it allows us to get a rough snapshot of the size of a radiation source, where it was located, how radioactive it is, and what type of radioactive material it is," Hayes says.

The technique takes advantage of the fact that radioactive material changes the arrangement of valence electrons — or outer electrons — in insulator materials, such as brick, porcelain, glass — even hard candy. Basically, radiation displaces electrons at defect sites in the crystalline structure of these materials.

By taking samples of multiple materials in a room, applying conventional radiation dosimetry techniques, and evaluating how the electrons at those defect sites are organized, researchers can determine the presence and strength of any nuclear materials that were in that room.

"If the samples were taken at regular intervals in a grid pattern, the relative radiation dose profile can be used to triangulate where in the room the source was located, in three dimensions," Hayes says. "It can also provide a very rough idea of the physical size of the source, but that depends on various factors, such as how close the source was to the materials being sampled."

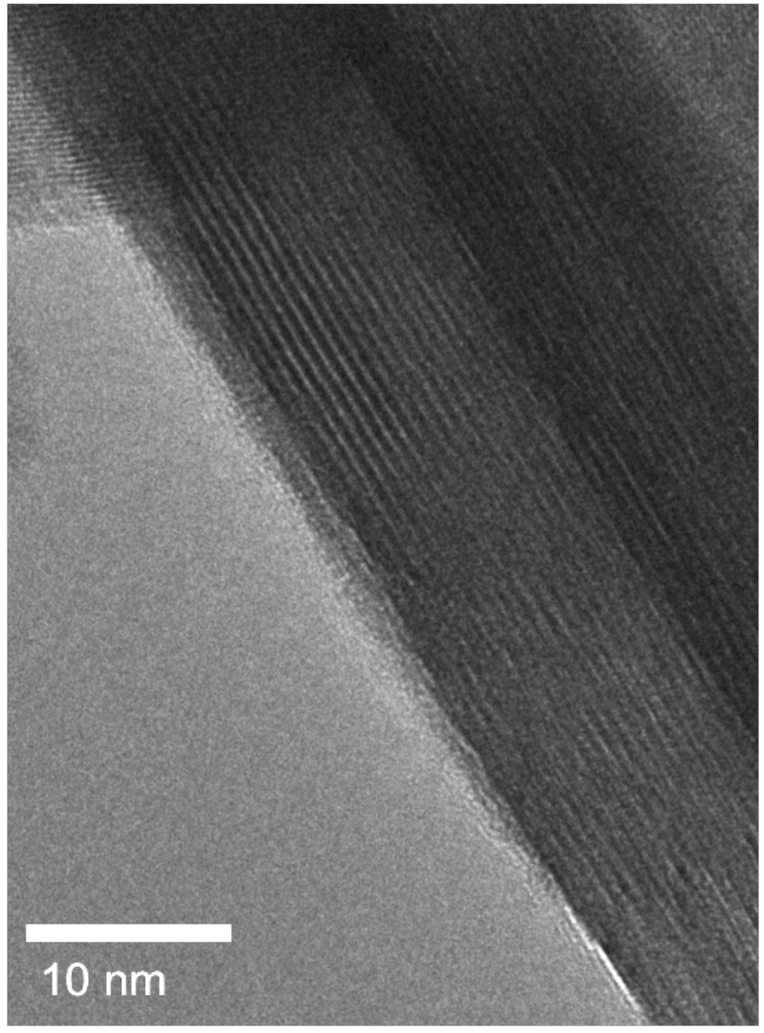
By taking a core sample of the insulating material and measuring the radiation dose at various depths in the material, researchers can also ascertain what type of radiation source was present. This is possible because different radioactive materials have characteristic distributions of gamma rays, X-rays, etc., and each type of energy penetrates materials with different strength.

"This is not extremely precise, but it does allow us to answer important questions. For example, distinguishing between different kinds of nuclear material such as naturally occurring, medical, industrial, and 'special' nuclear materials — the latter being used for nuclear weapons," Hayes says.

"This is a proof of concept," Hayes says. "We're now focused on exploring its detection limitations along with spatial and energy resolution, and how to make use of this approach moving forward.

"But this is a big deal for nuclear nonproliferation efforts because it means you can't handle nuclear material in secret anymore," Hayes adds. "It means the world is now densely blanketed by low-resolution integrating gamma-ray spectrometers, so we can always go back and measure what was present. There's no hiding."▪

THIN LAYERS OF WATER HOLD PROMISE FOR THE ENERGY STORAGE OF THE FUTURE



RESEARCH IN THE DEPARTMENT of Materials Science and Engineering (MSE) has found that a material that incorporates atomically thin layers of water is able to store and deliver energy much more quickly than the same material that doesn't include the water layers. The finding raises some interesting questions about the behavior of liquids when confined at this scale and holds promise for shaping future energy-storage technologies.

"This is a proof of concept, but the idea of using water or other solvents to 'tune' the transport of ions in a layered material is very exciting," says Dr. Veronica Augustyn, an assistant professor in MSE and corresponding author of a paper describing the work. "The fundamental idea is that this could allow an increased amount of energy to be stored per unit of volume, faster diffusion of ions through the material, and faster charge transfer.

"Again, this is only a first step, but this line of investigation could ultimately lead to things like thinner batteries, faster storage for renewable-based power grids, or faster acceleration in electric vehicles," Augustyn says.

"The goal for many energy-storage researchers is to create technologies that have the high energy density of batteries and the high power of capacitors," says James Mitchell, a Ph.D. student at NC State and lead author of the paper. "Pseudocapacitors, like the one we discuss in the paper, may allow us to develop technologies that bridge that gap."

For this work, the researchers compared two materials: a crystalline tungsten oxide and a layered, crystalline tungsten oxide hydrate — which consists of crystalline tungsten oxide layers separated by atomically thin layers of water.

When charging the two materials for 10 minutes, the researchers found that the regular tungsten oxide stored more energy than the hydrate. But when the charging period was only 12 seconds, the hydrate stored more energy than the regular material. One thing that's intriguing, the researchers say, is that the hydrate stored energy more efficiently — wasting less energy as heat.

"Incorporating these solvent layers could be a new strategy for high-powered energy-storage devices that make use of layered materials," Augustyn says. "We think the water layer acts as a pathway that facilitates the transfer of ions through the material." ▪

COLLEGE OF ENGINEERING STUDENT TEAMS PLACE AT ANNUAL LULU eGAMES STARTUP COMPETITION

SEVEN VENTURES SUBMITTED by NC State College of Engineering students came away with top place finishes from the 2017 LuLu eGames startup competition held in April.

Winning teams that included students from the College are:

VIEMETRICS | **James Dieffenderfer**, UNC/NC State Joint Department of Biomedical Engineering (BME), **Eric Beppler**, Department of Electrical and Computer Engineering (ECE), and **Charles Hood** (ECE)

The development of a low-cost, portable spirometer that can potentially predict asthma attacks. First place ($10,000) New Venture category, first place ($5,000) Social Impact category and first place ($5,000) Design and Prototype category.

SAKAROTEC | **Scott Frazee**, Department of Chemical and Biomolecular Engineering (CBE) and **Karthik Narasimhan**, Department of Mechanical and Aerospace Engineering (MAE)

An innovative new way to preserve red blood cells that will revolutionize the blood supply industry. Second place ($7,000) New Venture category.

BYT NO PRESSURE | **Bhavana Kaki** (CBE), **Elyse Pizzella** (CBE), **Ashle Page** (CBE) and **Minh Nguyen** (ECE)

An enhanced dental guard that combines a slim fit structure with a maximum pressure-absorbing design to relieve pain from involuntary clenching and grinding. Third place ($5,000) New Venture category.

RIPENOW, LLC | **John Malatras** (ECE) and **Alexander Tulenko** (MAE)

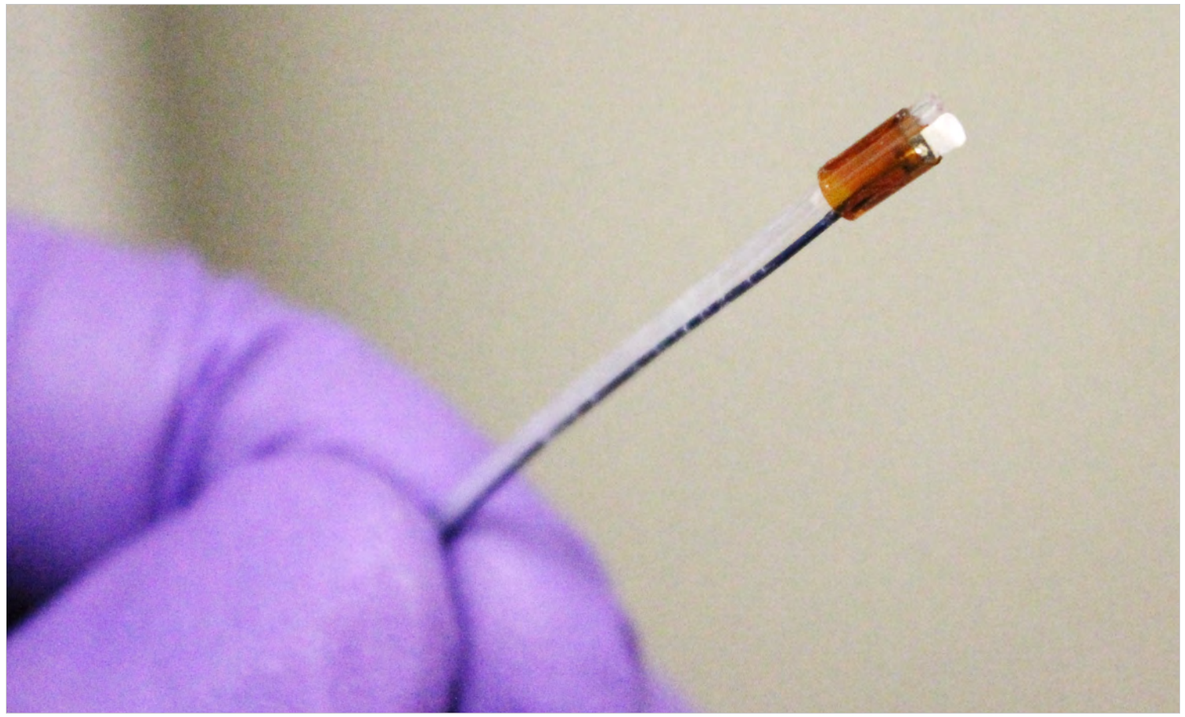
A platform that connects restaurants with crowdsourced produce from local farms. First place ($5,000) Built on Cloud category.

MEDTRAQ | **Alexander Leonov** (ECE)

A handwashing compliance system that aims to reduce the $9.8 billion in preventable healthcare costs associated with hospital-acquired infections. Second place ($3,000) Built on Cloud category.

RYTHCOR | **Travis Murray** (ECE), **Alexander Bless** (MAE), **Brian Graham** (MAE), and **Jack Dodd** (ECE)

PulseAware by Rhythcor aims to combat the biggest killer among firefighters — heart attacks. Second place ($3,000) in Social Impact category and third place ($2,000) Design and Prototype category. ▪



NEW ULTRASOUND ‘DRILL’ TARGETS DEEP VEIN BLOOD CLOTS

RESEARCHERS AT NC STATE and the University of North Carolina at Chapel Hill have developed a new surgical tool that uses low-frequency intravascular ultrasound to break down blood clots that cause deep vein thrombosis. The tool is the first ultrasound “drill” that can be aimed straight ahead, allowing doctors to better target clots — which holds promise for significantly reducing treatment time. To date, the technology has been tested only in synthetic blood vessels.

Existing intravascular ultrasound tools for clearing clots emit ultrasound waves laterally. This makes it harder to target clots exclusively, meaning that the ultrasound can also damage surrounding blood vessels. However, ultrasound breaks the clots into very small pieces, so doctors don’t need to use large doses of blood thinner to dissolve the clot remnants.

Another technique uses a diamond-tipped drill to effectively chew through clots. This is more targeted, posing less risk to blood vessels. However, this technique breaks the clot into relatively large pieces, requiring higher doses of blood-thinning drugs — which can pose risks of their own.

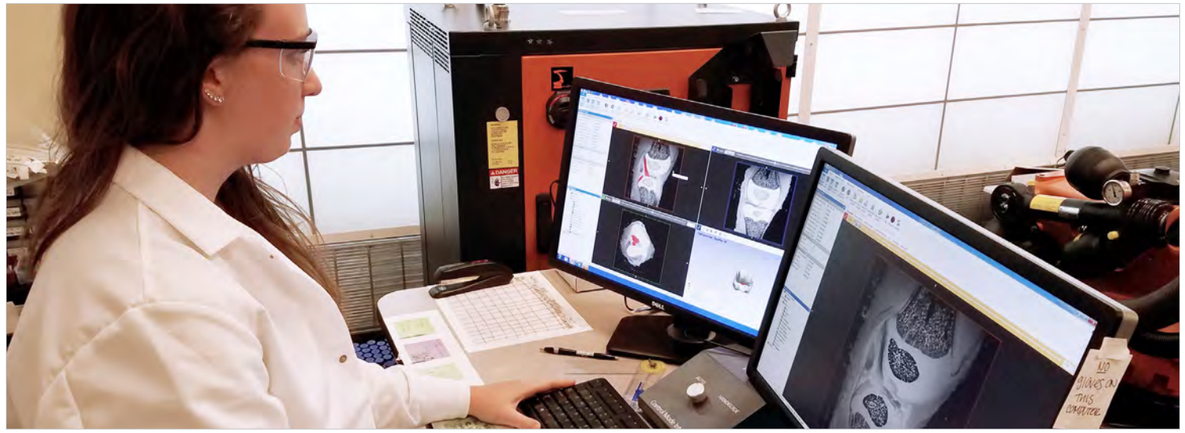
“Our new ultrasound tool is forward-facing, like a drill, but still breaks down clots into very fine particles,” says Dr. Xiaoning Jiang, a professor of mechanical and aerospace engineering at NC State and corresponding author of a paper describing the work. “Our approach improves accuracy without relying on high doses of blood thinners, which we hope will reduce risks across the board.”

The tool also incorporates an injection tube that allows users to inject microbubbles at the site of the clot, making the ultrasound waves more effective at breaking down the clot.

The researchers tested a prototype of the device in a synthetic blood vessel using cow’s blood.

“We found that we could dissolve 90 percent of a clot in 3.5 to 4 hours without using any blood thinners at all,” says Jinwook Kim, lead author of the paper and a Ph.D. student in Jiang’s lab. “That’s compared to 10 hours for the combination of conventional ultrasound tools and blood thinners.”▪

PIG MODEL TO HELP RESEARCH ON HUMAN KNEE GROWTH, INJURY TREATMENT



TO LEARN MORE about the human knee, biomedical researchers from NC State and UNC-Chapel Hill looked to pigs’ knees. Their work on how the knees of pigs compare to human knees at various stages of maturity will advance research by this group and others on injury treatment in young people.

“There’s a lot we still don’t know about how human knees work at different stages of maturity,” says Dr. Matthew Fisher, corresponding author of a paper on the research.

“What we’ve developed is a model that will allow us — or any research team — to study changes in the knee joint using pig knees,” says Fisher, who is an assistant professor in the UNC/NC State Joint Department of Biomedical Engineering (BME).

“Our ultimate goal is to improve clinical treatment of joint injuries in children and teens, given the increased participation in sports and rise of injuries, such as to the anterior cruciate ligament or ACL,” Fisher says. “We’re specifically focused on changes that take place during the growth process — such as changes in the placement and orientation of ligaments during growth.”

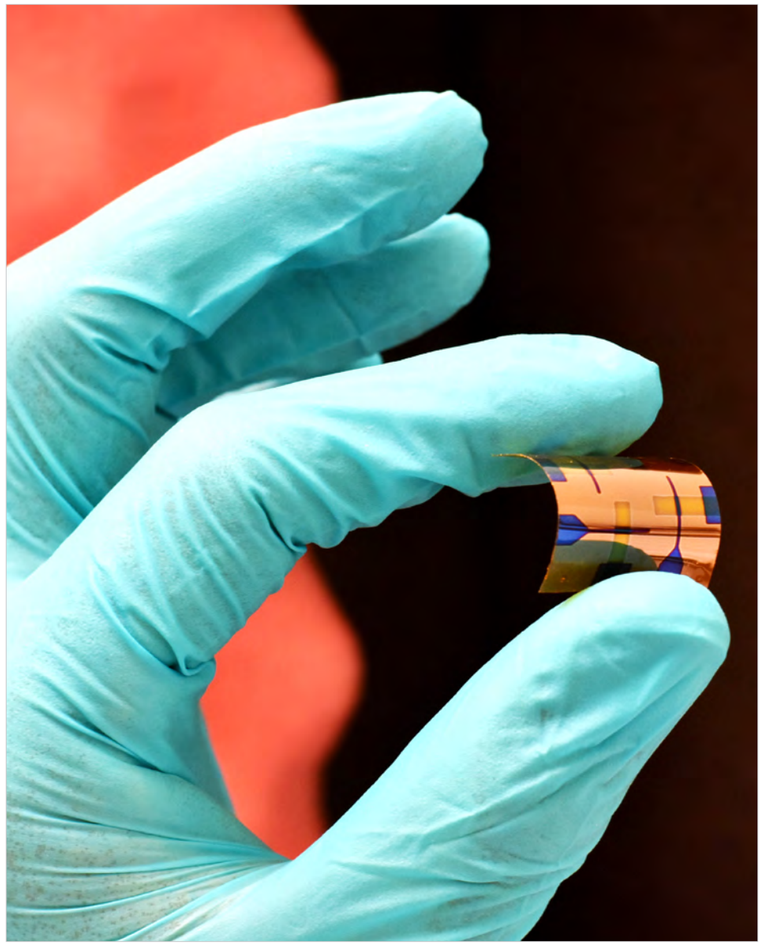
Previous research had established that adult pig knees serve as a good model for research into adult human knees. However, less was known about how comparable pig and human knees were at various stages of growth.

For this study, researchers examined pig knees at six stages of growth, between birth and 18 months — which is comparable to early adulthood in humans. The researchers then compared the growth stages found in pigs to the available data on human knee growth.

“We focused on how the orientation of knee ligaments changes over time,” says Stephanie Cone, lead author of the paper and a Ph.D. student in BME. “We found that the transitions in ligament orientation we saw in pig knees at various stages of maturity mapped very closely to the existing research on humans at comparable stages of maturity.”

“We’re excited about the potential for this model, but tracking ligament orientation using MRIs is really only a starting point,” Fisher says. “Our next steps include testing the pig knees mechanically in order to help us better understand how they move at various stages of growth: which joint components bear load, how these elements interact, and so on. A number of things change as we mature, but we are still trying to clarify the details — and those details can eventually inform future clinical practice. In fact, surgeons can use the pig model to test new surgical approaches for children and adolescents.”▪

> “We found that the transitions in ligament orientation we saw in pig knees at various stages of maturity mapped very closely to the existing research on humans...”
>
> **STEPHANIE CONE**



RESEARCHERS MAKE THE FIRST FLEXIBLE MEMORY DEVICE USING OXIDE FERROELECTRIC MATERIAL

FOR THE FIRST TIME, researchers have been able to deposit an ultra-thin oxide ferroelectric film onto a flexible polymer substrate. The research team used the flexible ferroelectric thin films to make non-volatile memory devices that are wearable and resilient.

"Ferroelectric materials are capable of storing charge, which makes them ideal for non-volatile memory devices," says Dr. Jacob Jones, a professor of materials science and engineering and co-author of a paper on the work. "But ferroelectric materials tend to be brittle, and normally have to be made at high temperatures — which would destroy most polymers. We've now found a way to make an extremely thin film of ferroelectric material that can be made at low temperatures."

"What is most exciting about this work is the ability to make ferroelectric thin films at low temperatures and integrate them with carbon-based organic semiconductors to make highly flexible memory devices," says Dr. Franky So, the corresponding author of the paper and Walter and Ida Freeman Distinguished Professor of Materials Science and Engineering.

"The key to success of this work is the special technique we developed to make these ferroelectric thin films at low temperature and maintain the flexibility," says Dr. Hyeonggeun Yu, a postdoctoral researcher at NC State and lead author of the paper. "We have created a new device platform which can integrate these memory devices with other flexible electronic circuits."

"This advance allowed us to create a pliable ferroelectric that can be used to create stable memory storage units for use in energy-efficient electronic applications for use in everything from space exploration to defense applications," says Ching-Chang Chung, a postdoctoral researcher at NC State and co-author of the paper.

The researchers worked with hafnium oxide, or hafnia, a material that has ferroelectric properties when applied as a thin film. And, for the first time, the researchers were able to show that the flexible hafnia thin films exhibited ferroelectric properties with thicknesses ranging from 20 nanometers (nm) to 50 nm. ▪

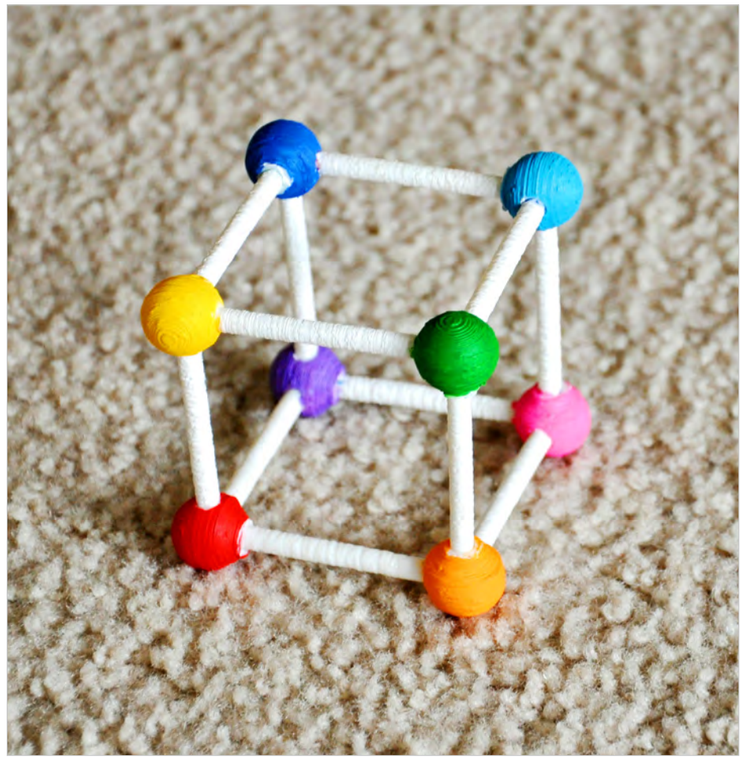
DEVICE ALLOWS USERS TO MANIPULATE 3-D VIRTUAL OBJECTS MORE QUICKLY

COMPUTER SCIENCE researchers have developed a user-friendly, inexpensive controller for manipulating virtual objects in a computer program in three dimensions. The device allows users to manipulate objects more quickly — with less lag time — than existing technologies.

The device, called CAPTIVE, offers six degrees of freedom (6DoF) for users — with applications ranging from video gaming to medical diagnostics to design tools. And CAPTIVE makes use of only three components: a simple cube, the webcam already found on most smartphones and laptops, and custom software.

"There are a number of tools on the market that can be used to manipulate 3-D virtual objects, but CAPTIVE allows users to perform these tasks much more quickly."

ZEYUAN CHEN



The cube is plastic, with differently colored balls at each corner. It resembles a Tinkertoy but is made using a 3-D printer. When users manipulate the cube, the image is captured by the webcam. Video recognition software tracks the movement of the cube in three dimensions by tracking how each of the colored balls moves in relation to the others. Video demonstrating CAPTIVE can be seen at **https://youtu.be/gRN5bYtYe3M**.

"The primary advantage of CAPTIVE is that it is efficient," says Zeyuan Chen, lead author of a paper on the work and a Ph.D. student in computer science. "There are a number of tools on the market that can be used to manipulate 3-D virtual objects, but CAPTIVE allows users to perform these tasks much more quickly."

To test CAPTIVE's efficiency, researchers performed a suite of standard experiments designed to determine how quickly users can complete a series of tasks.

The researchers found, for example, that CAPTIVE allowed users to rotate objects in three dimensions almost twice as fast as what is possible with competing technologies.

"Basically, there's no latency; no detectable lag time between what the user is doing and what they see on screen," Chen says.

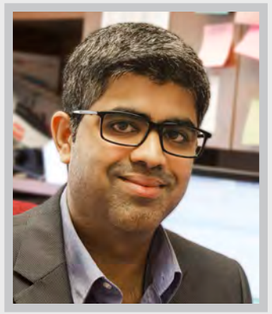
CAPTIVE is also inexpensive compared to other 6DoF input devices.

"There are no electronic components in the system that aren't already on your smartphone, tablet or laptop, and 3-D printing the cube is not costly," Chen says. "That really leaves only the cost of our software."▪

Three faculty members earn **NSF CAREER awards**

DR. RAMON COLLAZO

DR. MIN CHI



DR. ROHAN SHIRWAIKER

Three 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 are:

Dr. Ramon Collazo, assistant professor in the Department of Materials Science and Engineering (MSE), for his research proposal, "Engineering point defect formation in UWBG-based optoelectronic devices."

Dr. Min Chi, assistant professor in the Department of Computer Science, for her research proposal, "Improving Adaptive Decision Making in Interactive Learning Environments."

Dr. Rohan Shirwaiker, assistant professor in the Edward P. Fitts Department of Industrial and Systems Engineering, for his research proposal, "Ultrasound-Assisted Biofabrication Of Biomimetic Soft Tissue Constructs With Aligned Fiber Organization."

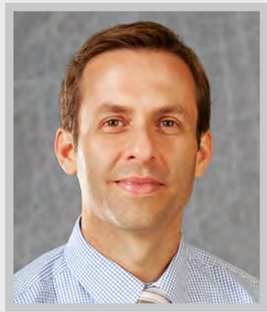
Collazo, Chi and Shirwaiker join Dr. Veronica Augustyn, assistant professor in MSE, and Dr. Stefano Menegatti, assistant professor in the Department of Chemical and Biomolecular Engineering, giving the College five CAREER winners in 2017. ▪

Gu, Dickey receive **Alcoa Foundation Engineering Research Awards**

The 2017 Alcoa Foundation Engineering Research Awards were presented to **Dr. Zhen Gu**, associate professor in the UNC/NC State Joint Department of Biomedical Engineering, and **Dr. Michael Dickey**, professor in the Department of Chemical and Biomolecular Engineering.

Gu was awarded the Alcoa Foundation Engineering Research Achievement Award, which recognizes young faculty members who have accomplished outstanding research achievements during the preceding three years. Dickey received the Alcoa Foundation Distinguished Engineering Research Award, made to a senior faculty member for research achievements over a period of at least five years at NC State.

Gu's accomplishments in developing novel material and biological chemistry tools to address important questions in controlled drug delivery are impressive and internationally known. His groundbreaking contributions at the interface between drug delivery and materials science have resulted in inventions including a smart insulin patch, liquid metal nanomedicine and immune blockade platelets.



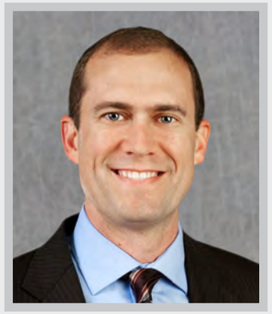
DR. MICHAEL DICKEY

DR. ZHEN GU

Dickey is recognized internationally as a leader in the field of actuating polymers and soft materials. His work in the advancing of the novel use and fundamental understanding of liquid metals based on gallium is noted as an important and impactful intellectual contribution. ▪

Eischen and Jones receive **Blessis Outstanding Undergraduate Advisor Award**

DR. JEFFREY W. EISCHEN



DR. JACOB JONES

Dr. Jeffrey W. Eischen and **Dr. Jacob Jones** are the winners of this year's George H. Blessis Outstanding Undergraduate Advisor Award.

Eischen is an associate professor in the Department of Mechanical and Aerospace Engineering and director of undergraduate student affairs. Jones is a professor of materials science and engineering, director and principal investigator of the Research Triangle Nanotechnology Network, and director of the Analytical Instrumentation Facility.

Eischen, who also received the Blessis award in 2012, has served on the NC State faculty for 30 years. He is a recipient of the Thank a Teacher award (2016) and an awardee of the ASME District F Student Section Advisor Award (2011). He received his B.S. in civil engineering from the University of California at Los Angeles and M.S. and Ph.D. in mechanical engineering from Stanford University.

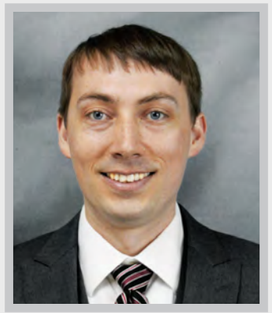
Jones has been a part of the NC State faculty for three years. He received the Best Paper Award in Materials Applications Category in the journal *Microscopy and Microanalysis* (2016), was named a University Faculty Scholar (2015-20) and in 2015 was elected a Fellow of the American Ceramic Society. He received his B.S., M.S., and Ph.D. in mechanical engineering from Purdue University. ▪

Castorena, Pankow and Saul receive **Outstanding Teacher Award**

Three faculty members in the College received Outstanding Teacher Awards for 2016-17.

Dr. Cassie Castorena is an assistant professor in the Department of Civil, Construction, and Environmental Engineering. **Dr. Mark Pankow** is an assistant professor in the Department of Mechanical and Aerospace Engineering. **Dr. Katherine Saul** is an associate professor in the Department of Mechanical and Aerospace Engineering.

DR. CASSIE CASTORENA



DR. MARK PANKOW

DR. KATHERINE SAUL

According to Castorena's colleagues, she is regarded as a positive and motivating force to her students and has developed and implemented several pedagogical innovations in her lectures that enable a deeper fundamental understanding of the course material, all while preparing students for the next step outside of the lecture and inside the laboratories.

Pankow is regarded as a world-class mentor and advisor by his peers. As was noted in his nomination, his ability to lead a classroom, bring clarity to complicated topics and the opportunities he affords students to succeed are noticed by all who take his courses.

Saul was praised in her nomination for the award for her dedication to cultivating diverse and unique learning styles that have proven successful in aiding accessible learning for students of all backgrounds while making her classes engaging and thought provoking. ▪

IN OUR LABS

THESE ARE THE SPACES THAT ENABLE
GROUNDBREAKING RESEARCH

ADVANCED METAL FORMING AND TRIBOLOGY LABORATORY

DEPARTMENT OF MECHANICAL AND AEROSPACE ENGINEERING

ONE WAY TO DESCRIBE Dr. Gracious Ngaile's lab in Engineering Building III on NC State's Centennial Campus is "heavy metal."

Ngaile, a professor in the Department of Mechanical and Aerospace Engineering, conducts research on design and manufacturing, tribology (the science of interacting surfaces in motion) in manufacturing, hybrid manufacturing processes, modeling and optimization of manufacturing processes, material characterization and finite element analysis.

He is also interested in the influence of ultrasonic vibration on microforming processes and in developing new formulations of metal-forming lubricants that are easier on the environment.

Ngaile teaches courses that give students a hands-on introduction to modern manufacturing processes and to a wide range of metal forming processes including state-of-the-art techniques. He also teaches applied finite element analysis and materials processing by deformation.

A native of Tanzania, Ngaile earned a B.S. degree in mechanical engineering from the University of Dar Es Salaam. He had to learn to speak and read Japanese in order to complete master's and Ph.D. degrees at Japan's Kumamoto University.

IN TUBE HYDROFORMING, water or hydraulic oil is forced into a metal tube at pressure of as much as 20,000 pounds per square inch, blowing even thick stainless steel up like a balloon. That tube is in a die (or more commonly a mold, as it is referred to in plastics manufacturing) and the end result is a sturdy metal tube formed into an unusual shape. The shaping process can be done in as little as 10 seconds, making tube hydroforming a quick, efficient way to form tubes of unusual shapes that are used in everything from automobiles and satellite antennas to bicycle frames and saxophones.

At this macro level, much of Ngaile's lab research is looking at ways to hydroform tubes made of lighter metals, like aluminum, as automobile manufacturers work to improve their vehicles' fuel economy. These lighter metals are usually less ductile (less formable) making it difficult to form complex shapes, so the lab is looking at solutions like wrinkling parts of the tube before hydroforming to strengthen areas that might otherwise burst during the process.

AT THE MICRO LEVEL, Ngaile and graduate student James Lowrie have developed a new technique to hydroform tubes as small as .3 millimeters in diameter for applications in electronics and medical devices.

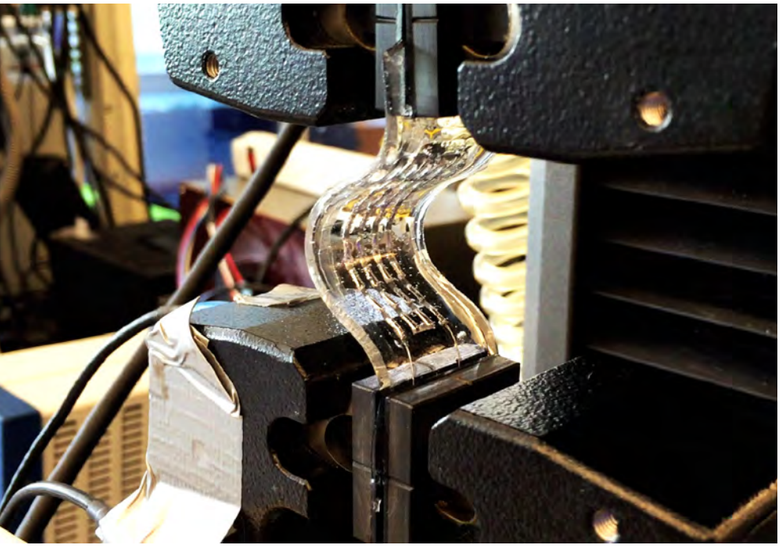
Other researchers and manufacturers have tried to scale down the conventional macro-level process to hydroform at the micro level but have been unsuccessful because they could not achieve a sufficient seal at the ends of such a tiny tube.

Ngaile and Lowrie for the first time have created a novel solution that has made it possible to hydroform tubes at such a small size.

Instead of attempting a perfect seal of the ends of the tube, the researchers flooded an entire chamber including the tube and die with fluid and placed a plastic sheet around the die and applied pressure to the entire chamber.

Because of the plastic sheet, pressure was applied everywhere but the die cavity itself, meaning that as the tube is deforming the material will flow (form) into the die cavity, creating the desired shape.

"We went on an entirely different route," Ngaile said. ▪



PUT TO THE TEST

ASSIST technologies are ready for clinical trials

IN ITS FIRST FIVE YEARS, the Nanosystems Engineering Research Center for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST) focused on building the platforms for wearable health monitoring systems and the sensors that would drive them.

As those platforms have matured and the center moves into its sixth year of National Science Foundation (NSF) funding, ASSIST's focus is transitioning to placing its technologies into clinical trials.

"At the end of the day we want medical relevance and validation of our sensors," said Dr. Veena Misra, ASSIST director and Distinguished Professor of Electrical and Computer Engineering.

Established by NSF in 2012 and led by NC State, ASSIST is part of a crowded field of research on wearable health monitoring devices that includes interest from many companies and academic institutions. The center's niche is developing devices that require limited power and on harvesting the energy needed to drive them from the human body.

"We're specifically not focused on hundreds of different kinds of sensors, we're specifically not focused on different kinds of circuit designs," Misra said. "We have picked our goal, which is ultra-low power, and in that space ASSIST stands out uniquely."

In leading ASSIST and the Future Renewable Electric Energy Delivery and Management (FREEDM) Systems Center, NC State is one of only two schools currently leading two NSF engineering research centers and one of only two schools to ever be awarded the lead role in three.

ASSIST has developed three platforms, or testbeds. One monitors an asthmatic's breathing and the quality of the air that surrounds her and another extracts sweat from the wearer's body in a noninvasive way and uses it to test glucose levels. A third testbed provides readings of the cardiovascular system and is entirely powered by energy harvested from the human body.

The goal is to turn these testbeds into devices that combine comfort and long-term wearability to provide a vital new tool for chronic disease management.

The data collected will benefit not only the individual patient working with a physician but, when combined with data from other wearers, other patients through broader insights into the treatment of diabetes, asthma and other ailments.

ASSIST has already placed its devices into clinical trials with center partners at UNC Hospitals and hopes to participate in future trials with the medical schools at the University of Virginia and Florida International University.

In the trials, readings from ASSIST devices will be compared to the current best standard for health monitoring of that particular patient, be it an electrocardiogram or a lung challenge test.

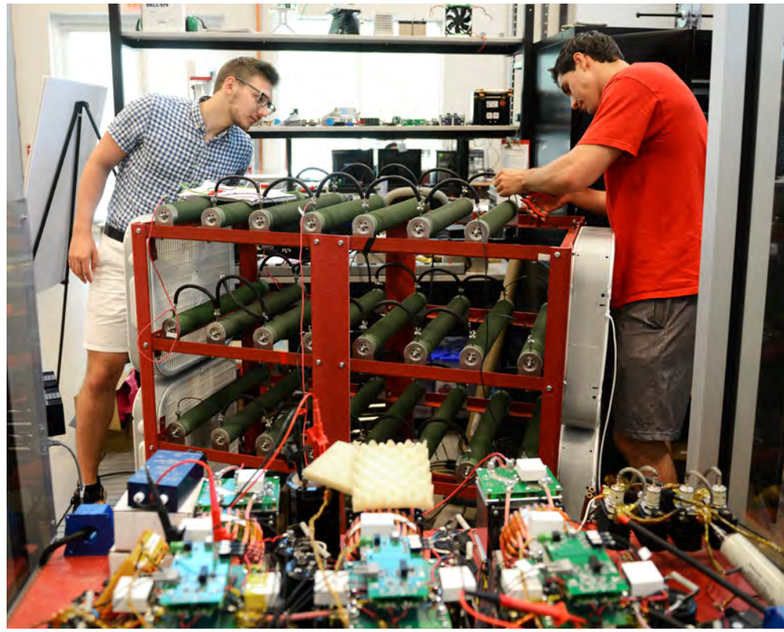
The center's ultimate goal is to hand these testbeds off to a partner company that will perfect and manufacture these wearable devices. Along the way, the ASSIST technology that underpins the testbeds, from a recently developed flexible thermoelectric energy harvester to improvements in how a wearable device transmits data to a smart phone at low power, will have applications in wearables and other sectors. The center has produced 40 invention disclosures, with some patents and interest in licensing, and a new startup company called Viemetrics that is developing and prototyping biomedical devices.

"Center success comes from many different directions, not just the complete platforms but the individual technologies, the licenses that are coming out, the startup companies and implementation of clinical studies," Misra said. ▪

LEAVING THE LAB

FREEDM works to demonstrate its technology

NSF ENGINEERING RESEARCH CENTERS



CALL IT THE FREEDM HOUSE.

The Future Renewable Electric Energy Delivery and Management Systems Center, a National Science Foundation (NSF) Engineering Research Center led by NC State, is developing the technologies that will change how we use, produce and transmit electricity.

Now in its ninth year, FREEDM hopes to demonstrate both the system it has worked to create — an improved electric grid that can handle bidirectional energy flow and integrate larger percentages of renewable energy sources — and the pieces that make it work. That system will include houses outfitted with solar panels that can be not just consumers, but also producers, of electricity.

To that end, the center plans to purchase and install a small house near its headquarters on Centennial Campus. It will become both a demonstration model and a lab as FREEDM researchers continue to refine the components that will change both the grid and how we interact with it: a solid-state transformer that allows bi-directional flow and takes away the need to convert DC current to AC for home use, a more efficient fault-isolation device and the controllers and algorithms that allow them to work together.

Established by NSF in 2008 to set the groundwork for a better national electricity network, FREEDM hopes to demonstrate a working model of its system at the end of its 10-year NSF funding cycle. Along with the house, the center is in talks to set up a small version of a FREEDM concept demonstration at an outside facility with help from Duke Energy and the utility's Center for Advanced Power Engineering Research.

"We want to get out of the lab and into a field demonstration," said Dr. Iqbal Husain, FREEDM director and ABB Distinguished Professor in the Department of Electrical and Computer Engineering. "This year we focused on developing these things in the lab, and we want to take it one step further."

FREEDM also plans to collaborate with Duke Energy and the Electric Power Research Institute (EPRI) on a project that would grow the electric vehicle charging infrastructure in the Raleigh metropolitan area. The 150 to 350 kilowatt charging stations being considered would be bi-directional and could supply DC current to electric vehicles and other distribution loads with connection to the medium-voltage grid.

"That's essentially the FREEDM system concept," Husain said.

As NSF funding winds down, FREEDM is transitioning to a future that will be funded by research grants, fees from industry members and an endowment started with a $1.5 million gift from Duke Energy.

The center also has close ties with PowerAmerica, a National Manufacturing Innovation Institute led by NC State that is furthering development and manufacturing of wide bandgap semiconductor-based power electronics. The two centers have already merged their education programs under the direction of FREEDM Education Director Dr. Pam Carpenter, and Husain says that collaborating will boost FREEDM's research and deployment efforts.

In the meantime, FREEDM is working to complete the goal it started nearly a decade ago: to demonstrate a workable system that will one day be the model for a new and improved national power grid.

"What NSF expects to see is the FREEDM vision demonstrated in a mature testbed," said Husain. "In year nine, we were dedicated to that goal. In year 10 we hope to complete it."▪

CHALLENGE ACCEPTED

THE NATIONAL ACADEMY OF ENGINEERING in 2008 announced 14 Grand Challenges of Engineering in the 21st century, calling on the nation's engineers to tackle these problems and improve the lives of every person on the planet. On these pages, you will learn about the 14 challenges and just some of the ways in which the College of Engineering is answering the call.

NC State's **Science of Security Lablet**, led by faculty members in the Department of Computer Science, is funded by the National Security Agency and tasked with stimulating the creation of a more scientific basis for the design and analysis of **trusted cyber systems**. These efforts have provided a deeper understanding of users' susceptibility to deception, developers' adoption of security tools and how trust between people relates to their commitments. The lablet has supported 32 faculty members and students and engaged more than 30 colleagues from industry partners.

Dr. Karen Chen in the Edward P. Fitts Department of Industrial and Systems Engineering is using virtual reality technology to help patients with musculoskeletal pain. Using a **VR headset**, patients can perform exercises comparable to what they would do at home or in the office with a physical therapist, by themselves. It would give patients with transportation issues or time constraints another option for treatment.

Researchers in the Nanosystems Engineering Research Center for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST), funded by NSF and led by NC State, are developing the technologies underpinning the next generation of **wearable health monitoring devices**. Those devices will gather health information that will be useful to track the health of the individual user but also vital when combined with readings from other wearers to provide new insights into health conditions. Learn more about ASSIST on *page 18*.

SECURE CYBERSPACE ▪ ENGINEER THE TOOLS OF SCIENTIFIC DISCOVERY ▪ ENHANCE VIRTUAL REALITY ▪ ADVANCE HEALTH INFORMATICS

Faculty members in the Department of Computer Science lead the Center for Educational Informatics, a center that conducts research on **advanced learning technologies**, such as educational games or intelligent tutoring systems, and works to develop and disseminate them. It means using artificial intelligence to develop virtual tutors or building a game-based learning environment to train cadets at the United States Military Academy.

Dr. Mohamed Bourham and graduate student Jonathan Coburn in the Department of Nuclear Engineering are conducting research to support the International Thermonuclear Test Reactor, a **fusion test reactor** under construction in France. In collaboration with Oak Ridge National Laboratory and the General Atomics DIII-D National Fusion Facility, they hope to learn which materials for use within the reactor will do the best job containing plasma. Materials including silicon carbides are being tested at Oak Ridge at DIII-D, and an NC State-created plasma computer code called ETFLOW is being used to simulate the interactions.

Despite decades of research, much is still unknown about the transport and fate of **nitrogen in the environment**. Dr. François Birgand, associate professor in the Department of Biological and Agricultural Engineering, is using new high-frequency sensors to better measure the fate of nitrogen in man-made and natural treatment systems such as soils, wetlands and streams. His team captures never-before-seen spatial and temporal dynamics of nitrogen compounds. This helps them better quantify nitrogen fate and propose better designs to lower the leaking of excess nitrogen into the environment.

ADVANCE PERSONALIZED LEARNING ▪ PROVIDE ENERGY FROM FUSION ▪ REVERSE-ENGINEER THE BRAIN ▪ MANAGE THE NITROGEN CYCLE

MAKE SOLAR ENERGY ECONOMICAL ▪ ENGINEER BETTER MEDICINES ▪ RESTORE AND IMPROVE URBAN INFRASTRUCTURE

As the implementation of **solar energy** grows, the existing energy infrastructure must change to accommodate. The National Science Foundation (NSF) Future Renewable Electric Energy Delivery and Management (FREEDM) Systems Center led by NC State is creating the next-generation smart grid that can handle bidirectional power flow and a higher concentration of renewable resources like solar. Learn more about FREEDM on *page 19*.

In Dr. Zhen Gu's Biopolymeric Healthcare Engineering Laboratory, researchers are developing microneedle smart patches that can **deliver immune checkpoint inhibitors** for melanoma treatment, insulin for diabetics or blood thinners as needed to prevent blood clots. Gu, an assistant professor in the UNC/NC State Joint Department of Biomedical Engineering, has also created a suite of "programmed" approaches for targeting the delivery of anti-cancer drugs, the release of which can be promoted inside the tumor microenvironment or cancer cells.

Faculty researchers in the Department of Civil, Construction, and Environmental Engineering are addressing a wide range of **urban infrastructure** issues. Dr. Detlef Knappe's research helped identify the presence of toxic industrial pollutants in the drinking water in three counties in eastern North Carolina. Dr. Rudi Seracino is interested in the application of advanced fiber reinforced polymers to develop systems for the repair or strengthening of existing bridges and other critical infrastructure. Dr. Douglas Call is developing ways to recover resources, such as energy and nutrients, from wastewater and generating electricity from North Carolina's coastal salinity gradients.

PROVIDE ACCESS TO CLEAN WATER ▪ PREVENT NUCLEAR TERROR ▪ DEVELOP CARBON SEQUESTRATION METHODS

Dr. Francis de los Reyes, professor in the Department of Civil, Construction, and Environmental Engineering, leads the Global Water, Sanitation and Hygiene faculty cluster. This multidisciplinary team conducts research not just on emerging technologies that improve access to **clean drinking water** and adequate sanitation but on the global policy issues and socioeconomic and cultural barriers that might impede their implementation.

NC State leads the Consortium for Nonproliferation Enabling Capabilities, a partnership of universities and national laboratories funded by the National Nuclear Security Administration. Faculty members in the Department of Nuclear Engineering are developing the next generation of tools to detect the proliferation of **nuclear weapons** and training the experts to drive that new technology forward.

Dr. Michael Burchell, associate professor in the Department of Biological and Agricultural Engineering, is working with the U.S. Geological Survey Wetland and Aquatic Research Center to learn more about the role that salt marsh restoration may have in **carbon sequestration**. Several key drivers inherent to salt marshes have the potential to influence whether a salt marsh serves as a source, sink, or transformer of carbon. The research aims to understand the role of salinity in determining greenhouse gas losses in restored salt marshes and how the balance of greenhouse gas losses changes with age following salt marsh restoration. Another goal was to estimate the amount of carbon that could be stored in the system due to biomass accumulation after the losses of greenhouse gases were subtracted. ▪

Engineers**across**borders

The College helps revive a study abroad program that takes students to China

CIARA JONES DECIDED during her sophomore year at Richlands High School in eastern North Carolina that she wanted to study aerospace engineering. But until the summer between her freshman and sophomore years at NC State, she had never actually flown in an airplane.

"I love them, but I'm not in them," she said.

That changed on May 16, when Jones and a group of fellow students began a 19-hour trip from Raleigh, NC to Beijing, China.

As an early-morning American Airlines flight rumbled down the runway at Raleigh-Durham International Airport, Jones covered her mouth with her hands as if in prayer. Friends Kaylee Saaranen and Chandra Manivannan, seated across the aisle, had spent time as the airplane taxied away from the terminal trying to help with her apprehension.

As the jet broke free from gravity's constraints and began its climb over the Triangle suburbs, Jones breathed a sigh of relief.

Everyone laughed when Jones said "Oh my god. I feel closer to Jesus already."

Started 10 years ago, NC State's annual study abroad trip to Zhejiang University in Hangzhou was revived in 2016 after a three-year hiatus. Though the trip is open to students from all colleges on the NC State campus, it has long had a strong engineering presence. Most of the group was made up of engineering majors, but they were joined by students from the Poole College of Management and the College of Humanities and Social Sciences.

The program offers students a journey outside of their comfort zone. While two of the 25 students on the 2017 trip had not flown before, several others had never traveled outside of the United States.

Students spend five weeks living and attending classes in the International College at Zhejiang University. Along with seeing the sites in this green, vibrant city known for its beautiful scenery and burgeoning technology sector, students also experience Beijing, Huangshan (Yellow) Mountain and Shanghai during their 42 days away.

For engineering students, the program offers a unique chance to work side by side with Chinese engineering students on a design project for an international company with a manufacturing facility in China.

Apart from taking summer-session classes that count toward graduation, they are immersed in a culture completely apart from their own. The students quickly bonded as they worked as a group to figure out how to shop for groceries, where to eat and how to do laundry. They searched for good wi-fi and coffee, tried to overcome the language barrier and figured out how to access their university Gmail-based student e-mail accounts in a country that blocks access to Google.

"I think a trip like this can be an eye-opener for a lot of students," said Dr. Jeffrey Eischen, associate professor and director of undergraduate student affairs in the Department of Mechanical and Aerospace Engineering (MAE) and one of the faculty members involved in the program. "It gives them a larger view of the world."

The program is partially supported by revenue generated from the College's Engineering Enhancement Fee. The fee, introduced in 2015, helps fund enhancements to the learning experience for undergraduate and graduate students in engineering and computer science as the College deals with reductions in state funding.

College leaders believe that this is one initiative that can help move the College from a good engineering school to a great one and help make its graduates not just great technical thinkers, but engaged global citizens who can thrive in an economy that knows few borders.

BEIJING AND BEYOND

Sporting travel neck pillows and bleary eyes, a somewhat dazed group arrived at Beijing Capital International Airport on Wednesday, May 17, with multiple suitcases in tow. Boarding a tour bus, they got their first look at the enormity of Beijing.

Jiang Chao Yi, the group's tour guide, asked to be called Joey because it's a close translation of his first name. He explained that, just as in the United States, this city of 30 million people has developed rings as growth necessitates a new circular highway, then another as the growth moves further out. Beijing has six such rings.

Dr. Clifford Griffin, associate professor of political science and director of the program, reminded students that the university's code of student conduct is in effect on the trip and asked that the students be mindful that they are in a different country with a different culture and that they be respectful of that culture.

The next day, the group visited Tiananmen Square and the Forbidden City, the Chinese Imperial Palace from the 15th century through the early 20th century. Then it was on to a section of the Great Wall outside of Beijing, where the students spent more than two hours scaling the steps of a particularly steep section of the wall that climbed up and over a mountain.

Along the way, students were exposed to authentic Chinese cuisine and learned to use chopsticks.

"You've got to go for the big chunks of rice," Liam Truong, a rising sophomore from Charlotte studying nuclear engineering told the students at his table during one lunch. "The bigger the chunk, the easier it is to pick up."

As the group traveled out of Beijing to tour the Great Wall, Jalen McGee, a sophomore from Durham, NC studying electrical and computer engineering, talked to Joey about the differences between higher education in China and the United States. Saaranen, another rising sophomore from Raleigh who had not decided which engineering department to join, watched the scenery pass by outside the bus window and reflected on how far she had traveled.

"I never imagined myself going to China my first year in college. But here I am."

JUST LIKE HOME

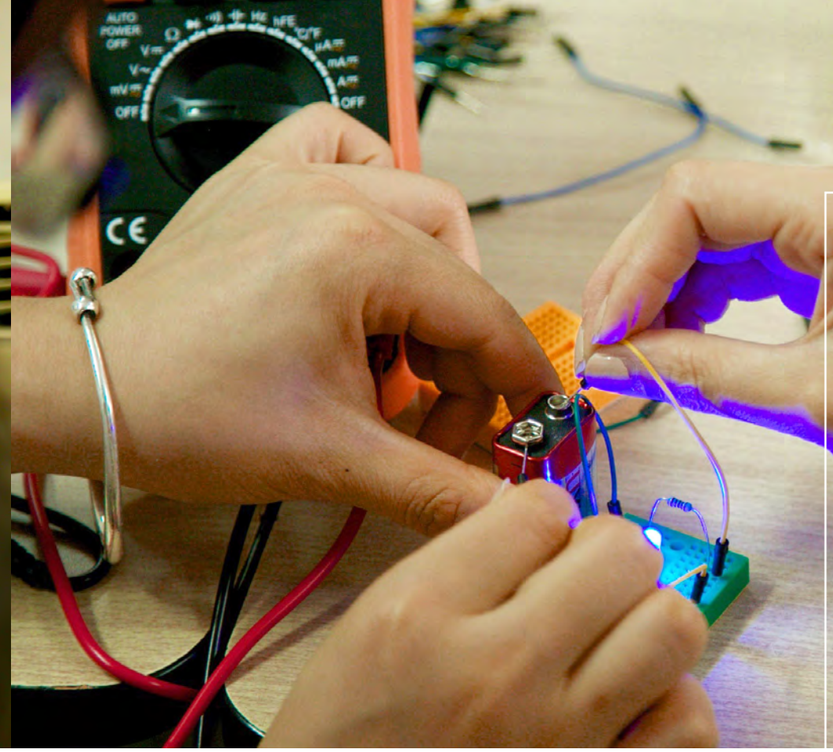
The group left Beijing on a high-speed train to Hangzhou, a trip that took just six hours to travel 800 miles at speeds of up to 186 mph. They settled into the international dorm at Zhejiang University amongst Chinese, French and American students.

Some of them were already friends or at least recognized each other from classes they had taken back in Raleigh. Others they had met only twice, during two orientation sessions that had taken place in early spring where Griffin walked the students and a smattering of parents through the process of applying for a passport and Chinese visa and what to pack. Griffin, who has been a part of the program since 2008 and director since 2012, talked about how the group would stay safe, what they shouldn't eat or drink and how to negotiate prices for gifts to take back home to loved ones.

"I have learned to do the walk away," he said, mimicking his tough negotiating style.

With the beginning of classes the following Monday, the students settled into a daily routine not unlike what they were used to in Raleigh. They attended classes in the morning and spent the rest of the day reading, studying, exercising or exploring the city.

A cluster of businesses right across the street from the dorm, including a bakery, coffee shop, fruit stand and convenience store, provided most of what they needed on a daily basis. More coffee shops and restaurants (including one that served cheeseburgers, pizza and Mexican food) and even a Wal-Mart were available within a 10-minute walk. Mindful of the faculty members' requests that they go out in groups both for safety and to ensure that quieter students were not left out, the students used a text messaging app called GroupMe to coordinate meals, study sessions or grocery runs. Many rented bicycles, fitting into the local culture and gaining an economical way to explore their surroundings.



Students could take a class in basic Mandarin taught by a Zhejiang faculty member and choose two of three classes taught by NC State faculty members who traveled with the group. Griffin's Introduction to International Relations class examined how and why countries work together. Lisa Marshall, a lecturer and advisor in the Department of Nuclear Engineering who also serves as the department's director of outreach, retention and engagement, taught Geographies of Energy — "How a nation assesses resources and why a nation does what it does with energy sources," she told the class on the first day. Both classes touched heavily on China but other countries as well.

Dr. Laura Bottomley — a professor of electrical engineering and director of the College's Women in Engineering program and The Engineering Place, the College's K-20 engineering education program — referred to her Electrical Engineering 331 class as "circuits for nonbelievers." Using hands-on demonstrations of how electric circuits are built and work, it was designed to appeal and be useful to students in civil, mechanical and other engineering programs.

Bottomley, who traveled to Hangzhou for the first time in 2017, led the students' interaction with Chinese engineering students and Apex, NC-based Caterpillar Machine Design Center.

PROJECT-BASED APPROACH

Dr. Carl Zorowski wasn't planning on going to China in 2007.

Zorowski, Reynolds Professor Emeritus in the Department of Mechanical and Aerospace Engineering, was having lunch with an engineering faculty associate who had wanted to travel on the first study-abroad trip to Hangzhou following NC State's signing of a cooperative agreement with Zhejiang University. But he didn't have a passport, and it was too late to get one.

Zorowski had a passport and had been to China before. He and his wife, Louise, were soon making plans for a trip, along with faculty members from political science and management and 17 students.

"The first year we were there we were basically trying to figure out where the bathroom was and how to live in China," he said.

But the program grew stronger year by year. After giving an invited lecture at Zhejiang, Zorowski met Professor Gu Daqiang, a member of the faculty in the Department of Mechanical Engineering. Both had an interest in teaching classes that were project-based. What if Zorowski offered the Mechanical Design Engineering course he taught in Raleigh to both NC State and Zhejiang students?

"We had a lot in common in our educational goals," Zorowski remembers. "Conversation was initially difficult. Prof. Gu spoke only a little English and I no Chinese. With the help of an NC State graduate student, Sonny Wong, serving as translator we did agree to collaborate on offering a combined NC State – Zhejiang engineering design class the following year."

In 2009, NC State engineering students worked with their Chinese colleagues to redesign a component on a front-end loader manufactured by Caterpillar, Inc. at the company's facility in the city of Suzhou.

"The thing that most pleased me was that Caterpillar actually adopted one of the students' designs, and if you look at a Caterpillar front-end loader today you will see that student's design," Zorowski said.

The collaborations with Caterpillar have been part of the trip ever since, with Eischen taking over teaching of the course from Zorowski and Bottomley joining after being recruited by Marshall. Students now visit a newer Caterpillar facility in the city of Wujiang, a couple of hours from Hangzhou by bus.

In 2017, the engineering course offered to students was in electrical engineering rather than mechanical, but the work with Caterpillar continued; Bottomley and her students were asked to develop a lightning detector for Caterpillar equipment so that operators on a construction site would know when an approaching storm was close enough for them to stop work.

Each year, the students present their completed projects to Caterpillar engineers, who both attend physically in China and virtually from Clayton, NC.

It's a tremendous experience for today's engineering students. Even if they aren't traveling overseas in their jobs, Zorowski said, they will likely be working digitally with colleagues overseas, overcoming language barriers, dealing with time-zone differences and learning how to collaborate on complex tasks using email and video conference calls when they can't be in the same room. It's also a more enriching undertaking than many university study abroad programs in which students might be physically located in another country but are only interacting with each other and the professors who traveled with them.

"You're there with your group, but you may not get a lot of that experience of actually working on a project with the local people," Eischen said.

HERE FOR THE EXPERIENCE

Most of the engineering students on the Hangzhou trip recognized the need for international experience to prepare them for a career as a 21st-century engineer.

Many preferred a study abroad trip during the summer rather than one that would take up an entire semester during the academic year. Add to that the fact that the classes offered were ones that many of the students needed to graduate.

McGee, the sophomore in electrical engineering from Durham, found a mentor in Bottomley while attending engineering summer camps in high school. It helped lead him to NC State and on the trip.

Others were convinced after talking to Griffin about the benefits of the trip. Or they had friends who were interested in the program and encouraged them to sign up.

Six of the students are part of the Goodnight Scholars program started by NC State alumnus and SAS founder Dr. Jim Goodnight. Their scholarship includes funding to study abroad.

The group included six NC State students who were born in China. Several took the opportunity to visit home either before or after the trip. Their language skills and familiarity with Chinese culture were an invaluable asset for the rest of the group.

Several said they were interested in seeing what university life in China would have been like had they stayed in their native country.

Ben Jiang first came to the United States as a junior in high school to live with a family in Indiana as an exchange student. He is now a junior at NC State studying electrical engineering. He left Raleigh right after spring semester finals to visit family in Nanjing, China and then met his fellow students after they had arrived.

"For me, it's not like study abroad," Jiang said. "It's study and come home."

Doug Moore, a junior from Rocky Mount, NC studying civil engineering, said he thought traveling to China would provide a broader cultural experience than a trip to western Europe.

That seemed to interest Evan Grant, a sophomore in mechanical engineering from Cullowhee, NC as well.

"I have never been abroad before so I wanted to do the extreme and go to a country where I didn't speak the language and it's on the other side of the world," he said. ▪

MANUFACTURING USA

NC State and the College are giving U.S. manufacturing an advantage

MANUFACTURING USA, launched in 2015, is a nationwide network of 14 public-private institutes, each of which focuses on a specific field of manufacturing technology. NC State is directly involved in seven of the 14 institutes — the most of any university in the country.

And while the technologies vary, all the institutes share a common goal: securing the future of manufacturing in the U.S. through innovation, collaboration and education.

"NC State's role in Manufacturing USA is a result of the University's reputation for fostering research and innovation with real-world impact," said Chancellor Randy Woodson. "We have invested resources strategically and deliberately to align with industry needs. Our partnership in these institutes reflects that we've done this effectively, and it's a credit to our breadth of experience and expertise."

In 1978, manufacturing employed nearly 20 percent of the country's overall workforce; today, it accounts for 9 percent. Manufacturing USA brings together partners from academia and the public and private sectors to revitalize industry and help the U.S. gain back lost ground.

"This is a big deal — not just for our work at NC State but for North Carolina and the country," said Nick Justice, executive director of the PowerAmerica institute at NC State and chair of the national director's council for Manufacturing USA. "Manufacturing is a core underpinning of our nation's economy, and as it's declined over the past several decades, we're looking to build the new future of the industry and remain competitive."

Across the University, experts are working to uncover new innovations and apply them directly to the industry. NC State is either the lead member or a participating member in the following institutes:

- PowerAmerica (Lead)
- Clean Energy Smart Manufacturing Innovation Institute (Southeast Lead)
- Advanced Functional Fabrics of America
- America Makes
- National Institute for Innovation in Manufacturing Biopharmaceuticals
- Digital Manufacturing and Design Innovation Institute
- Rapid Advancement in Process Intensification Deployment

"As the industry has changed, the country is looking to institutions like NC State for new technologies and processes to help manufacturers be more efficient, safer and more profitable," said Dr. Phil Westmoreland, a professor in the Department of Chemical and Biomolecular Engineering (CBE) who leads NC State's work with the Clean Energy Smart Manufacturing Innovation Institute (CESMII).

DR. PHIL WESTMORELAND

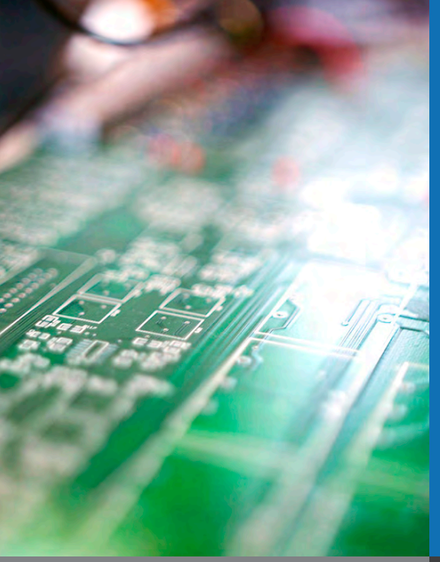
"Smart manufacturing gives us an opportunity to become leaders in collecting data and useful information so people can run processes better, make better business decisions, coordinate supply chains and maintain safe, clean operations."

DR. PHIL WESTMORELAND

DR. RUBEN CARBONELL

"NC State's role in Manufacturing USA is a result of the University's reputation for fostering research and innovation with real-world impact."

CHANCELLOR RANDY WOODSON



CLEAN ENERGY SMART MANUFACTURING INNOVATION INSTITUTE

Real-time feedback can help companies make better decisions that save money and increase efficiency. With leaders from NC State, CESMII aims to improve output and measurement for 12 industry sectors, including food and beverage, aerospace, paper and pulp, and plastics.

POWERAMERICA

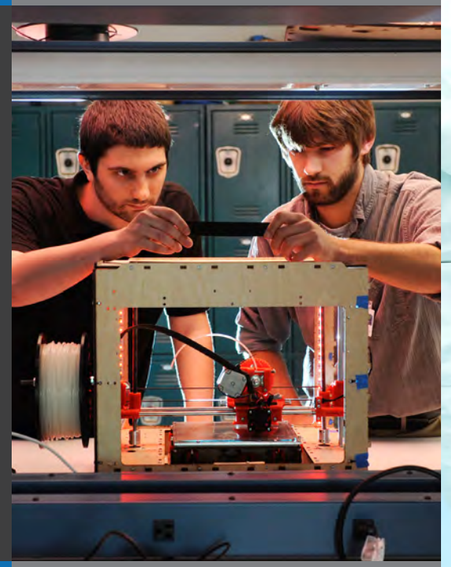
Better charging stations for electric vehicles, more efficient cars and power distribution centers, and more compact power adapters for consumer electronics. Through PowerAmerica, NC State and other partners seek to make these breakthroughs possible by accelerating the adoption of wide bandgap semiconductor technologies.

RAPID ADVANCEMENT IN PROCESS INTENSIFICATION DEPLOYMENT INSTITUTE

How do we make the manufacturing process cleaner and more efficient? NC State, through the Rapid Advancement in Process Intensification Deployment Institute, seeks to answer that question and make the manufacturing industry stronger for the future.

DIGITAL MANUFACTURING AND DESIGN INNOVATION INSTITUTE

More efficient, less expensive and faster manufacturing in the U.S. — that's the goal for the Digital Manufacturing and Design Innovation Institute. Alongside NC State, DMDII partners are creating improved design tools and processes, and they're using data to help manufacturers make the best decisions.



AMERICA MAKES

Additive manufacturing and 3-D printing technology are rapidly evolving. America Makes, in partnership with NC State, is on a mission to innovate and accelerate additive manufacturing and 3-D printing technologies to increase the U.S.'s global manufacturing competitiveness.

ADVANCED FUNCTIONAL FABRICS OF AMERICA

Wearable tech that can see, hear, sense and communicate? Through Advanced Functional Fabrics of America, NC State is helping to make these types of textiles and fibers widely available and smartly produced.

NATIONAL INSTITUTE FOR INNOVATION IN MANUFACTURING BIOPHARMACEUTICALS

The United States has been the global leader in biopharma for decades, but other countries are catching up. Through NIIMBL, NC State is working to accelerate U.S. innovation in the field, improve efficiency, and educate and train a world-leading workforce.

"When people think of manufacturing, they usually think of things like cars and large equipment," Westmoreland added. "But in North Carolina especially, manufacturing also means using processes to make pharmaceuticals, biofuels and food products.

"Smart manufacturing gives us an opportunity to become leaders in collecting data and useful information so people can run processes better, make better business decisions, coordinate supply chains and maintain safe, clean operations."

AMBITION AND VISION

Data from the National Science Foundation ranks NC State No. 7 in the country among public universities without a medical school for total research expenditures — and third for industry-sponsored research. A driving force behind that success is the University's Centennial Campus, home to more than 70 industry, government and nonprofit partners, including many of the researchers involved in Manufacturing USA.

"Centennial Campus has been focused on successfully growing public-private research and business partnerships for years," Justice said. "We're able to scale up quickly, and we have a proven track record of success for this type of work. When the opportunities came up for these institutes, it just made sense for NC State to demonstrate our expertise in the field."

"NC State has the ambition and vision," Westmoreland agreed. "That grows out of the strength of our state and region, as well as our mission as a land-grant university. We want North Carolina to be at the leading edge of learning around smart manufacturing."

ADDRESSING TODAY'S CHALLENGES

NC State's proven success in partnership was instrumental to the arrival of the newest Manufacturing USA institute on campus: the National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL). The University's track record in establishing and leading the Golden LEAF Biomanufacturing Training and Education Center (BTEC) — which helps educate and train students and industry professionals in biomanufacturing — makes NC State a strong partner for NIIMBL.

"BTEC will enhance what we're able to do with NIIMBL — improving workforce development and helping us uncover new processes to ensure success for the industry," said Dr. Ruben Carbonell, chief technology officer for NIIMBL and director of BTEC.

Carbonell, Frank Hawkins Kenan Distinguished Professor in CBE, added that the launch of an institute like NIIMBL couldn't be more timely.

"The U.S. was a leader in the first wave of the biopharmaceutical manufacturing industry; we've essentially dominated the field for two decades. But other countries are catching up and investing in smarter technologies. We now have to produce products that are cheaper and more widely available, without compromising safety. That's our challenge, and if we're successful, that means more jobs and expanded industry here at home."

Although some of the institutes are still in the initial phases of setup and research, leaders look forward to the contributions NC State will make to the industry as a whole.

"We can all learn from each other," said Carbonell. "That's the beauty of the collaborative environment we've built at NC State." ▪

DOWN THE **STRETCH**

The College looks to its alumni and friends to help **complete EB Oval dream**

STAND ON THE GRASSY OVAL on the north side of NC State's Centennial Campus and you'll take in some impressive sights.

A spot that 20 years ago was an undeveloped section of Centennial Campus is now ringed on the north side by three engineering teaching and research buildings. On the south side are Wolf Ridge Apartments, dormitories that engineering students from previous decades would have loved to live in. Across from Wolf Ridge is the James B. Hunt Jr. Library, one of the most impressive facilities of its kind in the world.

Just north of that library is an open field, a long grassy patch backed by a steep embankment.

"The library looks a little lonely sitting by itself at the end of the oval," said Doug Morton, the University's associate vice chancellor for facilities and an alumnus of the Department of Civil, Construction, and Environmental Engineering (CCEE). "We want to give it some company."

The College plans to break ground in April 2018 on Engineering Building Oval, its newest research and teaching facility on Centennial and the future home of CCEE and the Edward P. Fitts Department of Industrial and Systems Engineering.

But it's not a done deal yet.

The College received $75 million toward the $154-million project when North Carolina voters approved the Connect NC bond in March 2016. The College hopes to raise $60 million in private funds to help complete the project. So far, $25 million in commitments has been obtained.

Passing the state bond was a huge step, indicating support from both the legislative leaders who put the building into the bond package and the state residents who voted "yes."

That gave Dean Louis Martin-Vega and the fundraisers of the NC State Engineering Foundation a commitment to show potential donors. This summer, they received new designs from architecture and engineering firm Clark Nexsen that show a gleaming glass structure that will serve as a showcase for the College and bring it another step closer to unifying on Centennial.

"We've raised the first $25 million on a dream," said Lora Bremer, executive director of major gifts and campaign planning for the Foundation. "We've had such wonderful, loyal alumni who have started us off, even when we had nothing to show them."

The College will be asking alumni and friends to help close the fundraising gap between now and April 2018, when the University hopes to break ground.

"We're really now in a major push to close the gap between where we are and where we need to be to finish this project," Martin-Vega said.

The College may have to finance part of the cost to complete the project. That is not a comforting prospect, though, as debt service would cut into what the College can do to provide student services, recruit and retain the best faculty members and offer scholarships to deserving engineering students. It's a prospect that anyone who loves the College would like to avoid.

"This is where we are. This is what we have to do to make this a reality," Martin-Vega said. "If we've ever needed the support of our alumni and friends, now is the time."▪

A BUILDING **FOR ENGINEERS**

EB Oval puts research on display, looks to future

DESIGNERS WORKING on plans for EB Oval kept a couple of ideas in mind.

One could be called engineering on display. The new home of the Department of Civil, Construction, and Environmental Engineering (CCEE) and the Edward P. Fitts Department of Industrial and Systems Engineering (ISE) will incorporate as much glass as possible to take advantage of natural light. All that glass will also allow people passing through the building to get out of the rain or take a shortcut a chance to catch a glimpse of the work going on inside the civil engineering labs on the first floor or the advanced manufacturing labs on the second floor.

"If you go into Mann Hall today and you walk around, there's a lot of block and brick and wood," Doug Morton, the University's associate vice chancellor for facilities, said of CCEE's current home. "There's not a window into the asphalt lab. There's not a window into the soils lab or hydraulics lab. That's different here."

Another guiding principle for the building's design could be called engineering for the future. Mann and Daniels Hall, the current home of ISE, were each built more than 50 years ago. Many of their lab spaces simply no longer fit with what today's researchers need.

With an eye toward avoiding that problem for as long as possible in EB Oval, architects included a lot of flex space and talked to young faculty members in both departments about what they think researchers in their field will need in a lab space in the coming decades.

"Everyone knows how research is done today," said Cameron Smith, senior director of capital project management at NC State. "But how is research going to be done 10, 20, 30 years from now?"

EB Oval, which will also house much of the dean's administrative offices now located in Page Hall, will offer students, faculty members and staff facilities that are the equal of any college of engineering in the country. Light-filled and vibrant, the space will allow cross-disciplinary collaboration in some of the most vital areas of engineering research today, from biomanufacturing and rapid prototyping to health systems engineering and construction engineering and management.

A storm water system in the building will capture rain water from a section of the roof and condenser water from the mechanical system inside, treat it and use it to feed a small constructed wetland outside the first-floor entrance. The system, which will eventually route the treated water to a retention pond, will provide a learning lab for civil engineering students. EB Oval will also use reuse water for toilets, just as the Hunt Library does.

Plans for the building passed a design review committee made up of partners from across campus this summer and will go before the University's Board of Trustees this fall. ▪

ROUND TRIP

Oval building effort led by two civil department grads

DOUG MORTON, LEFT, AND CAMERON SMITH

Doug Morton earned a bachelor's degree in civil engineering, construction option, from NC State in 1983 and joined the Navy.

Thirteen years later, **Cameron Smith** did the same thing.

The two, who never met as members of the Navy's Civil Engineer Corps, are working together to oversee construction of EB Oval. Morton is the University's associate vice chancellor for facilities, while Smith is the senior director of capital project management.

"It's really an interesting coincidence," Morton, who finished his Navy career as its director of energy and environmental readiness, said. "Our paths are similar. To show up at the same spot here — both of us NC State grads, both of us Navy veterans."

The associate vice chancellor position came open the day Morton retired, he said. He applied immediately.

"I went into the Navy directly out of NC State, and I stayed 33 years," Morton, who has been in the vice chancellor position since November, said. "Then I came right back."

The pair's work overseeing construction and facilities management on Navy bases is remarkably similar to their work at NC State. Just like a base, a college campus has dormitories, dining halls, power stations and health clinics.

"We'd build a hanger instead of an athletic building," Smith, who spent more than a decade on Navy active duty and active reserve before coming to work for the University a decade ago, said.

While there are several campus construction projects in the works for Morton and Smith to oversee, they are paying close attention to and are particularly excited about EB Oval, the new home of the Department of Civil, Construction, and Environmental Engineering.

"This is our home," Morton said. "We know what it was like to live and study in Mann Hall. There's a care factor there that you can't just go out and buy."▪

DR. MARTY DULBERG

Alumni support
Engineering Building Oval to help future students

AS PART OF THE crucial next step in the College of Engineering's move to Centennial Campus, the NC State Engineering Foundation has been raising private donations to help fund construction of Engineering Building Oval.

The new building will be home to the Edward P. Fitts Department of Industrial and Systems Engineering; the Department of Civil, Construction, and Environmental Engineering; and the dean's administration.

The College received $75 million toward the $154-million project in March 2016 through the Connect NC bond. The College hopes to raise $60 million in private funds to help close the gap. As of now, $25 million in pledges and commitments has been raised.

Meet three NC State alumni who share why they donated toward the new building and why you should consider doing so as well.

DR. MARTY DULBERG

Looking for a change in his career, Dr. Marty Dulberg looked to NC State to further his education and expand his understanding of computer science.

"I felt NC State had the best combination of interest in me, resources, and I just felt the most comfortable here," said Dulberg, who earned his master's and Ph.D. degrees in computer science from NC State. "One of the things I really liked about coming to NC State was that whenever I wanted to try something as a graduate student, people would tell me that it wasn't a matter of, 'well you can't do that because we don't have whatever,' it was always more a matter of 'okay, how are you going to do this?' I felt like the faculty were invested in my success."

While working on his degrees, Dulberg ran the computer programming certificate program for the College's Engineering Online distance-learning program, teaching as a graduate student and then moving up to director of the certificate program.

Since graduating, he has remained at NC State and is currently the senior coordinator of learning technologies with Distance Education and Learning Technology Applications (DELTA), and the chair of the Learning Management System (LMS) Steering Committee in DELTA. With his work in DELTA, he is responsible for the coordination of the LMS governance structure, policy decisions and working with staff to coordinate tactical changes and implementation details.

Thinking back on his time as a student and where his degrees have taken him, Dulberg feels his NC State degrees prepared him for his career.

"It would have been impossible without it. There was an expectation when I was teaching and running a distance education program that I have a Ph.D. I had to finish my Ph.D. in order to keep my job," said Dulberg. "With this position at DELTA, having that kind of standing with faculty is very helpful and has trained me to operate at a much higher level intellectually."

Donating to the new EB Oval Building for Dulberg is a chance for him to help students.

"I believe in the mission of the University and what they're doing, so this is a way for me to help future generations."

In giving toward the new building, he has high hopes for how EB Oval will serve NC State.

"I am confident that it will continue to provide the type of facilities that future engineers need and to provide the resources to make it work."

PAMELA TOWNSEND AND BILL JENKINS

If you ask Pamela Townsend what initially brought her to Raleigh from West Virginia, the weather was a big draw. "It's always cloudy in Morgantown, so I was looking for a place to relocate with a nicer climate," laughed Townsend, who earned her bachelor's degree in civil engineering in 1984, summa cum laude, and her master's degree in civil engineering in 1987 from NC State.

Due to a recommendation by the department chair in the Civil Engineering Department of West Virginia University, where Townsend was working after high school, she found herself at home at NC State.

After graduating, she went on to hold several positions over 24 years with AECOM, a publically traded A/E firm, including senior vice president, southern states district general manager. That was followed by taking on the role of senior vice president for southeast region strategic planning with Dewberry, a family-owned firm. Today, she is a senior vice president for WSP (formerly Parsons Brinckerhoff), one of the world's leading engineering and professional services firms, including responsibility for the southeast region operations.

Thinking back on how her degrees from NC State have helped in her life and career, Townsend feels they were a major asset.

"The training throughout my undergraduate and graduate programs taught me how to objectively analyze, problem solve and never give up. This training has served me well through my professional career and tackling life's challenges."

Townsend's connection to her alma mater runs deep. She is currently on the NC State Board of Visitors, has served on the advisory board for CCEE and the NC State Engineering Foundation board of directors, and previously chaired the Paul Zia Lecture committee. So, when the opportunity arose for Townsend and her husband, Bill Jenkins, an NC State College of Sciences 1979 grad, to donate toward EB Oval, they felt it was time.

"Although I have fond memories of Mann Hall, state-of-the-practice training and testing facilities are needed to develop our engineers of the future," said Townsend. "It is important to Bill and me that we give back to our profession."

With hopes of attracting the top students and professors to the College and University, Townsend and Jenkins are optimistic for the future and the training of new engineers to help solve the grand challenges facing humanity.

"Many of the world's challenges today can be solved by engineers. Donating will help to further ensure that NC State remains one of the best colleges of engineering — a major driver of economic development and innovation in the state and country."▪

BILL JENKINS, LEFT, AND PAMELA TOWNSEND

Alumnus prepares to endow **fourth professorship**

DR. ROSS LAMPE JR.

As a young boy in the late 1950s, **DR. ROSS LAMPE JR.** would tag along with his grandfather, the dean of engineering, on weekend trips to his office in Riddick Hall on the NC State campus. Dr. J. Harold Lampe was the longest-serving dean of the College of Engineering.

Ross Lampe, who earned a bachelor's degree in industrial engineering from NC State and a doctorate in electrical engineering from the University of Illinois, has stayed close to the College, serving on the board of directors for the NC State Engineering Foundation and endowing multiple professorships. There is a Lampe Distinguished Professorship in the Department of Electrical and Computer Engineering held by Dr. Michael Steer and two in the UNC/NC State Joint Department of Biomedical Engineering, one held by Dr. Frances Ligler. Lampe is in the process of endowing a fourth professorship in the College's Department of Materials Science and Engineering.

Lampe, who received the College's Distinguished Engineering Alumnus award in 2010, sees endowed professorships as a gift that brings growth, providing multiple benefits to the College. He also supports, along with other family members, the J. Harold Lampe Engineering Excellence Fund, an unrestricted fund made available to the dean of engineering.

"Because I have an academic background, I understand the value that an endowed professorship gives to the College of Engineering," Lampe said. "When you endow a professorship, it helps attract the top professors and they often bring in research contracts and money that helps fund student assistantships and the overhead in the department and in the College."

And though his last name is closely associated with NC State, Lampe's desire to support the College of Engineering goes beyond family ties. When choosing academic departments and faculty members to support, Lampe looks for strong research programs in areas that promote the College, are important to students, and lead to economic growth and job creation for the state of North Carolina.

"I see it as an act of good citizenship," he said. "My business, SiteLink Software, has grown to the point where I can give something back. I feel good about these endowments because, after all, our community will be no better than what we make it." ▪

Foundation staff welcomes **new member**

KYLE KREMER joined the Engineering Foundation staff in March as the director of development and major gift contact for the Department of Materials Science and Engineering. He replaces Ketura Parker, who left the position in November 2016.

Kremer graduated from Bowling Green State University in 2009. He spent nearly four years employed as a program manager with Ruffalo Noel Levitz, a higher-education enrollment management and fundraising consulting firm, before moving to Durham, North Carolina, where he held the positions of associate and assistant director of annual giving at the Duke Fuqua School of Business for an additional four years.

A Durham resident, Kremer loves volunteering in his free time. He had his first Wolfpack experience helping the Cary Jaycees run the concession stands for a football game, though he has been more involved with the Durham Jaycees. The Jaycees organization is for young professionals ages 21-40 who want to help their community, socialize with like-minded individuals and develop their leadership skills. He also enjoys staying active and gets involved with local softball, kickball and bowling leagues.

KYLE KREMER

Kremer is currently planning a trip to Oregon, fueled by his love of travel, and particularly enjoys long road trips. He dreams of one day driving across the continent on Route 66 before turning his attention to the greater world beyond.

Kremer is excited to join the Wolfpack family and is already impressed by the amiability of everyone he has met at NC State. ▪

Meet the DEAN'S CIRCLE

Through the generosity of alumni and friends, the College is able to focus on providing support for its number one priority, its students. It's these gifts to the College that help provide competitive recruiting through undergraduate and graduate scholarships and fellowship awards. By giving $1,000 or more to the College and its departments annually, these alumni and friends receive recognition from the NC State Engineering Foundation as the Dean's Circle. Meet three Dean's Circle donors, and learn why they give.

STEVE THOMAS

As a sixth-grader, Steve Thomas watched the 1974 NC State men's basketball team win an NCAA national championship and became a Wolfpack fan for life. "I loved the fight in that team," said Thomas, who earned both his bachelor's (1984) and master's (1986) degrees in civil engineering from NC State.

After graduating from NC State, Thomas took a job offer from a private engineering company in New Haven, Conn. conducting toll road financing studies throughout the United States. His 30-plus-year career in the civil engineering field has led to him being an owner and chief operating officer of SEPI Engineering and Construction, an engineering and design firm.

"The leadership skills I acquired at NC State helped me to become a leader in my profession in North Carolina," said Thomas.

Giving back to the College and his home Department of Civil, Construction, and Environmental Engineering (CCEE) is important to Thomas.

"My father-in-law graduated from NC State with a B.S. in chemical engineering, my oldest son graduated with a B.S. in chemical engineering and my youngest son will be graduating with a B.S. in human biology, so NC State has meant so much to my family not only in terms of satisfying a career but also in memorable experiences and the joys of being an alumnus from one of the best colleges in the United States."

As a previous chair of the CCEE development committee and contributor to the department, Thomas feels the most important aspect of giving back to the College is the knowledge that his gifts are helping current and future students have the same opportunities he was afforded.

"These contributions are invaluable."

DOUGLAS E. UTLEY

With strong ties to the community and Raleigh, deciding to study at NC State was an easy decision for Doug Utley. "NC State was by far the best choice academically and financially," said Utley, who earned his B.S. in mechanical engineering in 1973.

With interest in the Air Force and a commitment to serve his country, Utley was commissioned and began pilot training in May 1973 and went on to fighter lead-in training, A-7D training, and survival school. Utley retired with a 25-year career as a fighter/attack pilot and fighter weapons instructor.

"My Air Force career involved much flying, instructing, and contingency planning. I was lucky to fly some of the most sophisticated aircraft in the world and employ some of the most accurate and powerful weapons," said Utley.

After his service, he became a general management consultant working with a variety of companies, including Warner Bros., Weyerhaeuser, Exelon, Southern Company, the Department of State, and the University of California, among others. He is currently a retired partner with ScottMadden, Inc., doing part-time contracting.

Thinking back on how his degree has aided his career, Utley feels that his degree helped him immensely. "As important as anything, I learned the ability to define problems, break down and analyze aspects and develop and evaluate solutions," he said. "Importantly, my education taught me the discipline of learning, and my learning has never stopped."

Utley has been a supporter of the Department of Mechanical and Aerospace Engineering (MAE) by serving on the department's alumni advisory board and as an alumni mentor and making gifts to the College's Leadership Fund and MAE Enrichment Fund. For him, the reasons for giving back are plentiful.

"I chose to contribute for loyalty to NC State, the desire to give back and a desire to participate. I'd like to think that I am helping in a small way the U.S. to compete better globally," said Utley. "More importantly, our country needs well-trained engineers, and NC State is among the best institutions to contribute to that mission."

LISA COOK

Lisa Cook made countless visits to NC State's campus growing up, attending Kay Yow basketball camp, enjoying "Cinderella" in Stewart Theatre, and even giving a high school graduation speech in Reynolds Coliseum. When the time came to pick a college, she knew where to go for a top-notch engineering degree.

"As a North Carolina resident, if you want to study engineering — you go to NC State," said Cook, who earned her bachelor's degree in industrial and systems engineering in 2013.

She took advantage of the College's civil, textile and aerospace summer camps as a local Raleigh native in high school where she found her passion for the business and people side of technology. When torn between a business and engineering degree, she will forever be grateful to her parents for reminding her that you can do anything you want with an engineering degree.

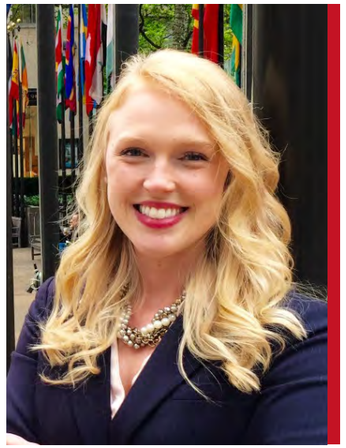
With an industrial and systems engineering degree in hand, Cook went to work in consulting with Ernst & Young (EY) in Charlotte. She is now aligned to the Data and Analytics practice, assisting banking and capital market clients with their strategic data agenda.

Cook attributes her success to core values of collaboration, innovation and philanthropy shared by both EY and NC State. "Being surrounded by brilliant people who care about the community and developing people inspired me in college and now in my professional career."

"My experiences at NC State co-oping, serving as an engineering ambassador, orientation counselor, and (Women in Science and Engineering) mentor taught me about fellowship, taking risks and leadership," said Cook. She remains an active alumna as an Engineering Charlotte Committee member and NC State Alumni Association member and enjoys returning to campus to recruit today's students.

Cook made her first gift in 2015 to the College's Leadership Fund in conjunction with EY's matching program and continues to do so. "It is important to give back to the University, College, and student organizations that are so much of who I am today," said Cook. "I see the progress and achievements people before me have made, am proud of my peers and want to support the future students who will continue to make outstanding contributions."▪

FOUNDATIONS



LISA COOK

STEVE THOMAS

DOUGLAS E. UTLEY

FROM LEFT, WILLIAM H. DEAN AND MARION CASEY DEAN

Success and generosity are in the Dean family's DNA

WILLIAM H. DEAN, president and CEO of M.C. Dean, Inc. and a 1988 alumnus in electrical engineering, and his father, Marion Casey Dean, retired president and CEO and current chairman of the company's Board of Directors and a 1967 alumnus in electrical engineering, have established two professorship funds: the endowed M.C. Dean, Inc. Distinguished Professorship in Electrical and Computer Engineering and the M.C. Dean, Inc. Term Professorship in Electrical and Computer Engineering.

Headquartered in Tysons, Va., the company is a global leader in power engineering, applied electronics, information technology, controls systems, software, and systems integration for local and federal governments, corporate and institutional clients. It specializes in mission-critical projects.

Casey Dean's father, Marion Caleb Dean, started the company in 1949 as an electrical specialty contracting business, growing it with projects for the Washington National Airport, Bolling Air Force Base and the Naval Research Laboratory, among others.

Having worked for his father in high school, Casey Dean knew that he wanted to be an electrical engineer and entered NC State in 1963.

"The first time I walked on campus I knew this was where I wanted to spend my four years. The electrical engineering professors I had were very important to me. I respected the heck out of those guys," he said.

Casey Dean joined his father's company when he graduated and took it over when his father retired in the late 1970s. During his tenure, projects evolved from the electrician work they had done for so many years to more technical electrical engineering work with highly skilled employees doing special projects for the government, including the White House.

Bill Dean, a 2011 Distinguished Engineering Alumnus, entered NC State in 1984. He recalled a transformative moment in one of his electrical engineering courses when a professor confronted his students' open frustration with the difficulty of the work.

"The professor stood up in front of his desk and said, 'I could spend the rest of the semester teaching you what IBM and Northern Telecom need you to know and then you will get a job right after you graduate that will last about six months. Or, I can teach you the technique to solve problems in electrical engineering no matter what they are.' It was a great course," Bill Dean said.

Perhaps this transformative moment explains part of the success of M.C. Dean, Inc. today. Bill Dean joined the company in 1990 to start the technology division and became president and CEO in 1997. Under his leadership, the company's growth exploded. It grew from 150 employees in 1997 to more than 3,000 employees today with 25 offices in North America, Europe and the Middle East and a small office in Asia. Projects grew in size and complexity.

"The most exciting things we do," Bill Dean said, "are when we create what I would more clearly define as edge-out solutions — really unique solutions to complex power and technology problems that are innate in big infrastructure and also in global enterprises. It has taken a decade to get the kind of organization where people trust us with those problems."

Three generations of company accomplishments and growth demonstrate that success runs in the Dean family. Generosity is also part of this family's DNA.

> "The first time I walked on campus I knew this was where I wanted to spend my four years."
>
> **CASEY DEAN**

As early as 1952, M.C. Dean started an electrical apprenticeship program. In the 1970s, Casey Dean continued his father's effort with two electrical apprenticeship programs whose graduates included women and minorities.

He worked with two other concerned individuals to build an apprenticeship program in Virginia because the industry needed better educated workers. He later established an apprenticeship program in inner-city Washington, D.C., to make it possible for minorities to break into the field. Both schools were highly successful.

These programs continue today, along with several other programs that Bill Dean has instituted such as the M.C. Dean, Inc. Scholarship Program and the M.C. Dean Foundation.

Both men have been equally generous supporters of the College of Engineering with their time and donations. Casey Dean joined the NC State Engineering Foundation Board of Directors in 2016 and serves on the Investment Committee. Bill Dean served on the board as recently as 2015.

Serving on the board allowed them to see how hard the College is working to build a premier engineering program, which is partly why they chose to establish two professorship funds in the Department of Electrical and Computer Engineering (ECE).

Their respect for Dr. Louis A. Martin-Vega, dean of the College, and Dr. Daniel Stancil, Alcoa Distinguished Professor and head of the department, also influenced their decision.

"Dean Martin-Vega is so spectacular," Bill Dean said. "The impact he has made on that university has been really special, and it's a privilege to support what he is trying to accomplish.

"In talking to Dr. Stancil," he continued, "we went through all the (research) areas. Cyber Physical systems and the Internet of Things are square down the center of the future of our organization. And frankly, there are not very many endowed professorships. I couldn't believe how few there were."

Stancil explained the significance of these gifts, "These M.C. Dean professorships are extremely important for the ECE Department. Having them allows us to take advantage of opportunities to bring world-class senior faculty to NC State. These resources enable new possibilities for our hiring this year, and it is possible that we will be able to award the term professorship as early as fall 2018."

Casey Dean noted, "We contribute to things in which we can understand how our contributions actually make a difference to humanity and our country. We feel that the NC State electrical and computer engineering department is run as well or better than any comparable school in this country and can produce world-class engineers at a lower cost."

He added, "Dan and the dean are way on top of my list of human beings. I just feel like any money you give those guys will really be put to good use, and you don't lose a minute's sleep worrying about where your money goes."▪

FOUNDATIONS

NC STATE ENGINEERING FOUNDATION, INC.

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Foundation **Year in Review**

THE NC STATE ENGINEERING FOUNDATION enjoyed another strong fundraising year in fiscal year 2017, which ended on June 30, 2017.

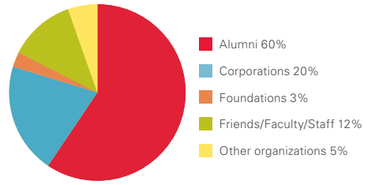
A large number of gifts were closed in the first quarter of the fiscal year, setting things up nicely for the kickoff of the $1.5 billion Think and Do the Extraordinary Campaign for NC State. This year, endowments were up by close to $3 million, and eight new professorships were established, bringing our total raised for the year to just under $23 million. Endowments to the College generally fall into one of these categories: scholarships/fellowships and professorships.

This was the second full year of the Campaign for Engineering Oval, and we launched the Dean's EB Oval Club (DBOC) and the Dean's Young Alumni EB Oval Club, giving more alumni and friends the opportunity to participate in the Oval Campaign. We have raised slightly more than $25 million for EB Oval, with 35 DBOC members and 25 members of the Cornerstone Society for donors of more than $100,000.

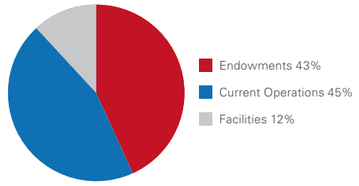
The annual giving program for the College of Engineering raised a total of $1,492,968 for the College of Engineering Leadership Fund and all nine department enhancement funds. This represents a 0.7-percent increase from the previous year. The Dean's Circle, the College's leadership annual giving society, grew by 33 members, bringing our total membership to 454 alumni and friend donors, representing an 8-percent increase from the previous year. These gifts often represent our "pipeline" for major gifts and an important part of the College's overall advancement plan.

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

GIFTS AND NEW COMMITMENTS BY GIFT SOURCE, FISCAL YEAR 2016-17



GIFTS AND NEW COMMITMENTS BY GIFT USE, FISCAL YEAR 2016-17



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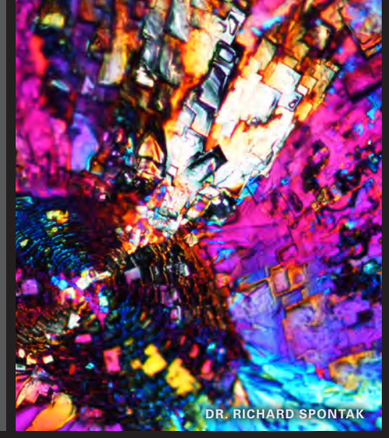
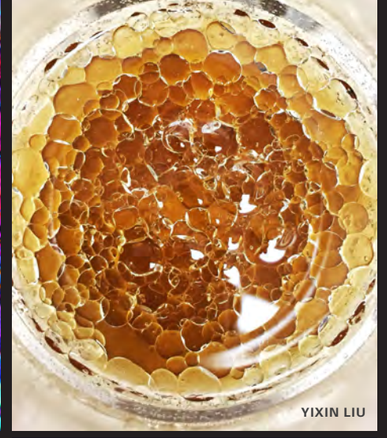
RESEARCH MEETS **ART**


DR. RICHARD SPONTAK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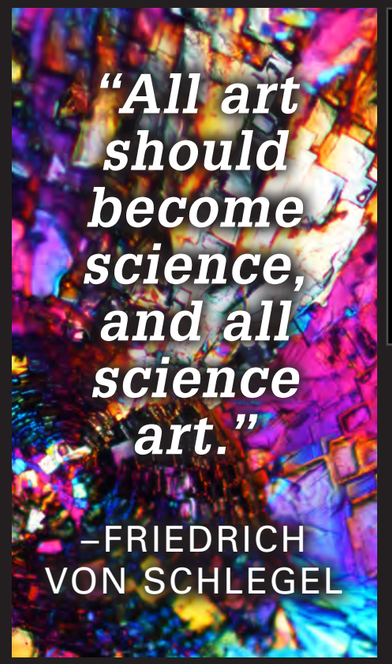
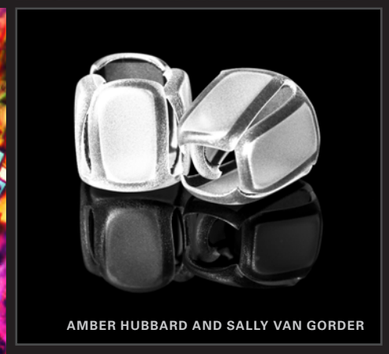
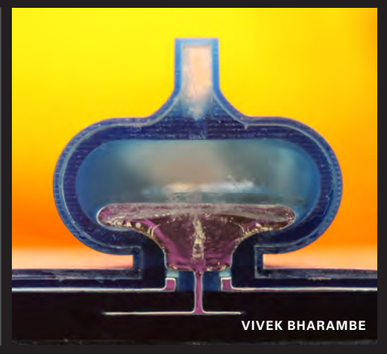



AMBER HUBBARD AND SALLY VAN GORDER


VIVEK BHARAMBE

FROM THE WORK NC State faculty members and students conduct in laboratories and in the field, beautiful images sometimes emerge.

The University has begun recognizing this beauty with an annual NC State Research Image Contest. The 2017 contest winners were announced in August, and the College of Engineering was well represented.

The contest was open to faculty and staff members, graduate students and postdoctoral researchers. The program is funded by NC State's Graduate School and Office of Research, Innovation, and Economic Development, with support from University Communications and the College of Sciences. Entries were received in four categories: Graphics and Illustration, Microscopy, Photography and Video.

Dr. Richard Spontak, Distinguished Professor of Chemical and Biomolecular Engineering, received second place in the Graphics and Illustration Faculty and Staff category and first place in the Microscopy Faculty and Staff category.

Dheepak Nandkishore Khatri, a master's student in the Department of Mechanical and Aerospace Engineering, received second place in the Graphics and Illustration Graduate Students and Postdocs category.

Amber Hubbard, a Ph.D. student in the Department of Chemical and Biomolecular Engineering, won second place in the Photography Graduate Students and Postdocs category for an image she produced with Sally Van Gorder, a former graduate student in the College of Design.

Yixin Liu, a Ph.D. student in the Department of Textile Engineering, received an honorable mention in the Photography Graduate Students and Postdocs category.

Vivek Bharambe, a Ph.D. student in the Department of Electrical and Computer Engineering, received an honorable mention in the Photography Graduate Students and Postdocs category.

Dr. Shreyas Narsipur, a postdoctoral researcher in the Department of Mechanical and Aerospace Engineering, won second place in the Video Graduate Students and Postdocs category.

Learn more about the contest and the winning images at **news.ncsu.edu/tag/image-contest-2017**. ▪

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