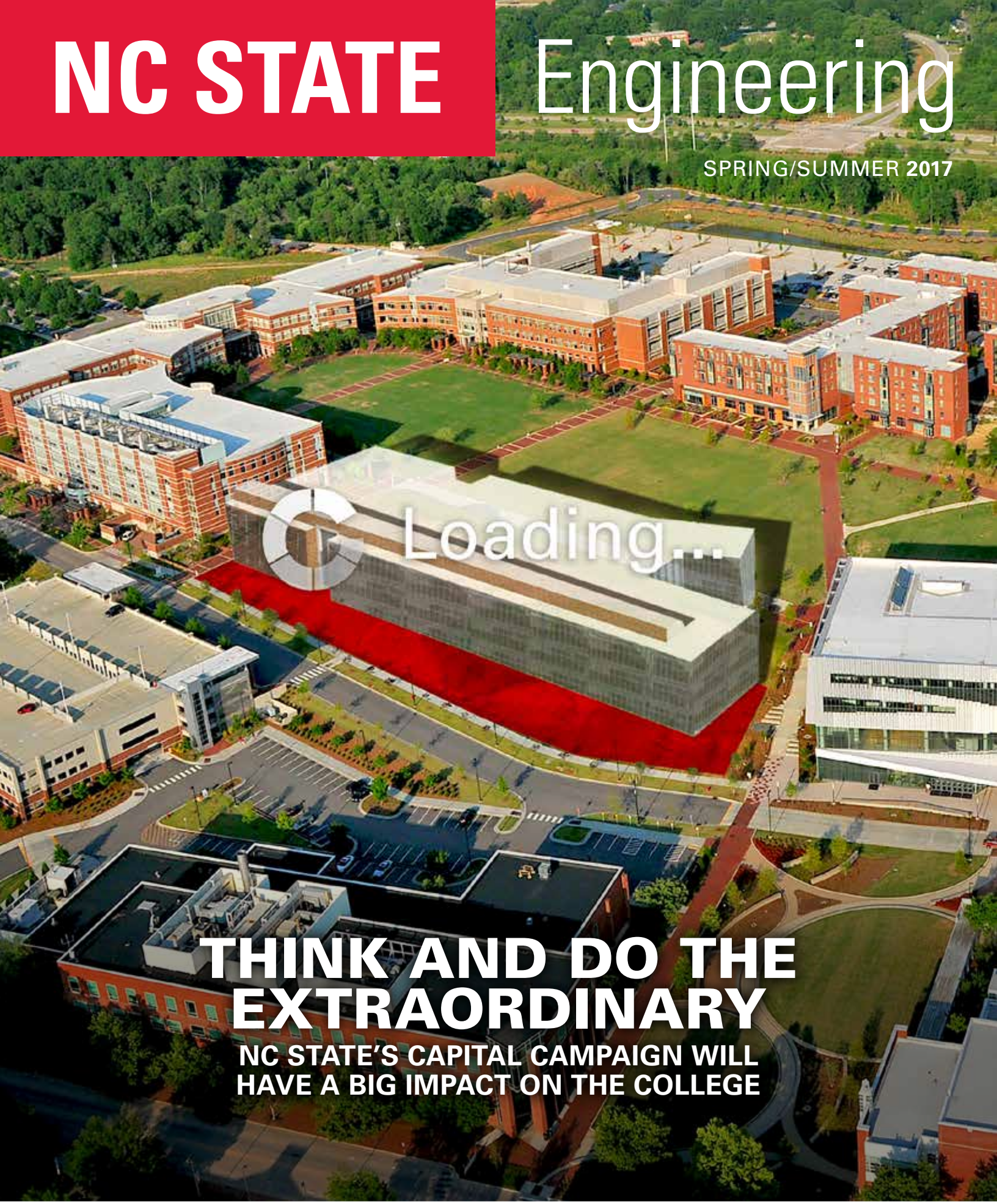
NC STATE Engineering

SPRING/SUMMER **2017**



THINK AND DO THE EXTRAORDINARY

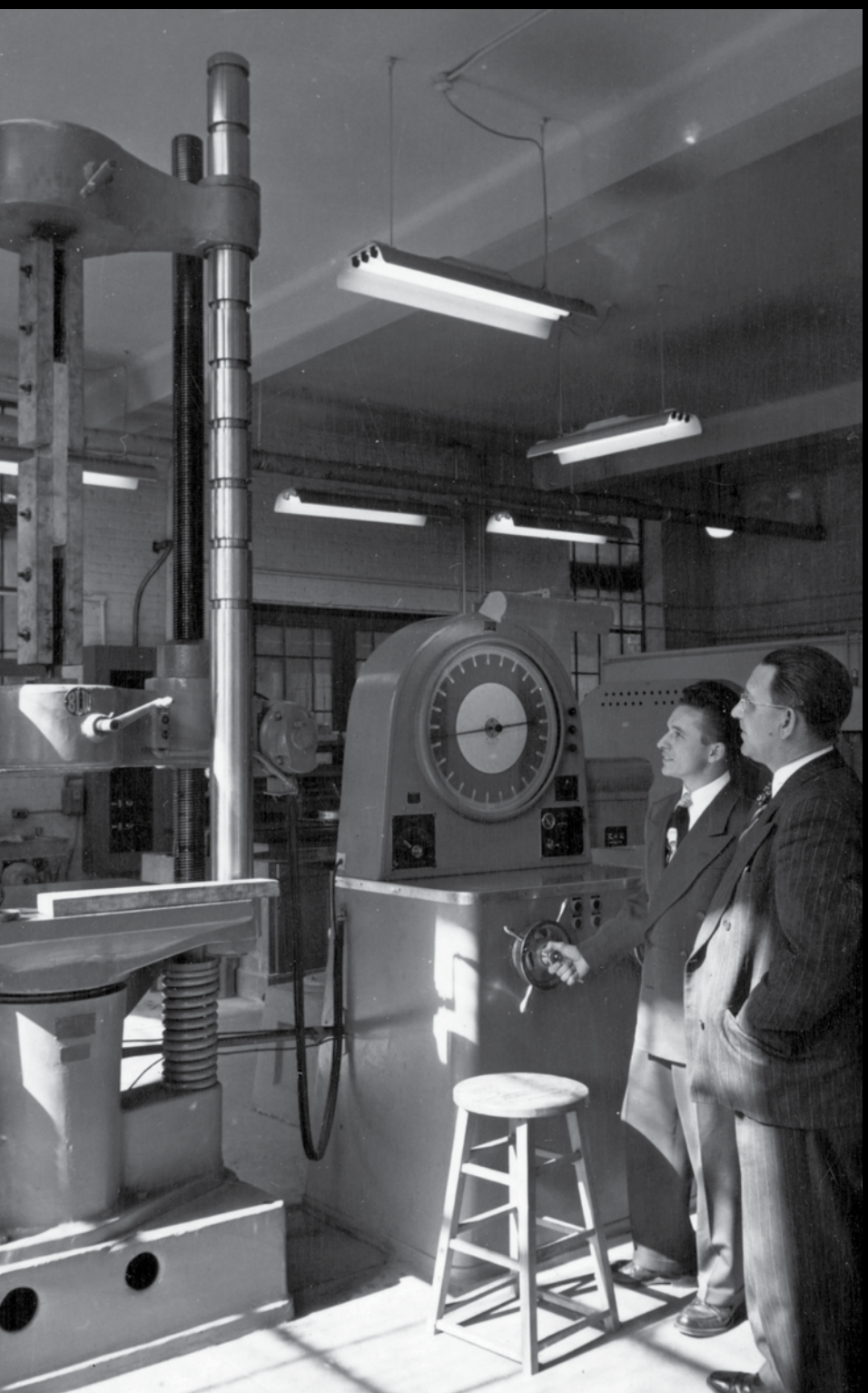
NC STATE'S CAPITAL CAMPAIGN WILL HAVE A BIG IMPACT ON THE COLLEGE

GRADUATE STUDENT GROWTH | 26 ▪ 3D-PRINTED HUMAN TISSUE | 30

A LAB FOR LOADS

Testing the effect of loading on large structures has long been a part of the teaching curriculum and research program in the Department of Civil, Construction, and Environmental Engineering (CCEE).

In this photo, taken around 1949, Dr. Charles R. Bramer, right, works on an investigation of wood truss member tension splices joined with split-ring connectors using the department's universal testing machine. The photo was taken in the department's former structures and materials lab located in "old" Mann Hall, now the east wing of Daniels Hall on North Campus.



The machine, manufactured by Baldwin-Southwark Corporation in 1947, could be used for either tension or compression testing.

While the control system that works with it has been replaced several times, the vertical frame shown in the photo is still used in undergraduate teaching labs in room 100 of "new" Mann Hall, built in 1962 and CCEE's current home. When the department makes the move in the next few years to the planned Engineering Building Oval on NC State's Centennial Campus, the versatile testing frame is expected to go with it.

Bramer taught in the Department of Civil Engineering from 1930 to 1975. He was acting head of the department in 1948-49 before Dr. Ralph Fadum's hiring as department head in 1949, and again in 1962-65 after Fadum became dean of engineering in 1962.

Today, CCEE faculty members and students can test large structures in the Constructed Facilities Laboratory (CFL) on Centennial Campus. The idea for the CFL, one of the premier facilities of its kind in the United States, started in the late 1970s with a discussion between Dr. Paul Zia, then the department head in civil engineering, and Dr. Larry Monteith, the dean of engineering. Zia identified a need for large-scale structural testing in a new lab that would provide space that the basement of Mann Hall could not. Gov. James B. Hunt Jr.'s decision in 1983 to designate state land for the university to create Centennial Campus provided the space needed for the College to expand its research facilities.

Opened in 1996, the CFL now hosts projects in collaboration with researchers from around the globe.

Learn more about the CFL on page 16. It's the focus of this issue's In Our Labs feature.

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

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Q&A

QUESTIONS FOR **CHASE BEISEL**

CRISPR-Cas is a genome editing tool that is making headlines for its potential impacts in medicine, agriculture and other areas. Dr. Chase Beisel, assistant professor in the Department of Chemical and Biomolecular Engineering (CBE), is working with colleagues across NC State's campus to determine how the system works and its potential benefits. Beisel joined the CBE faculty in 2011 after a postdoctoral fellowship at the National Institutes of Health.

What is a CRISPR-Cas system?

It is an adaptive immune system in bacteria that fends off bacterial viruses and other genetic invaders. While our adaptive immune systems use protein antibodies to recognize invaders, CRISPR-Cas systems use RNA as the recognition element. It is remarkably easy to design and use these RNAs along with the system's Cas proteins, which has spurred the development of tools that are revolutionizing biotechnology and medicine.

As researchers learn more about it, what are the possible uses?

The major use currently being explored is genome editing, whether to reverse genetic diseases in humans, improve crop plants, engineer microbial chemical factories, or combat disease vectors and agricultural pests. There are many other applications too, such as using CRISPR as an antimicrobial agent, an antiviral agent, or as a diagnostic tool.

What kinds of human diseases are we talking about?

The most immediate focus is on immunotherapy, or genetically augmenting our immune cells to recognize certain diseases such as cancer. There is also a concerted effort to address diseases that have a single causative mutation, such as muscular dystrophy.

How are you using it in your research?

We are exploring the natural functions of CRISPR-Cas systems and how these systems can be used as antimicrobial agents. As an antimicrobial, CRISPR can be programmed to selectively kill some bacteria such as pathogens while sparing others such as beneficial bacteria. It also acts separately from common mechanisms of multi-drug resistance and could provide a way to combat antibiotic-resistant infections.

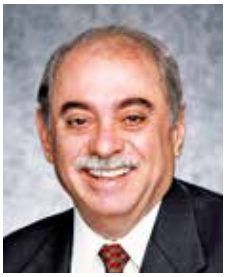
When you think about where research on CRISPR-Cas systems is going, what is the most impactful use you can imagine?

I am most intrigued by the use of CRISPR for genetic pest management. CRISPR can help spread genes through a wild pest population that either eliminates the pest or makes it less pest-like, such as genes that make it harder for mosquitos to carry the causative agent of malaria. The potential of these technologies is incredible, although they raise questions about controlling gene spread and obtaining public consent.

Can you give us a sense of how important the development of this tool is to the future of your field of study?

It is hard to understate the growing importance of CRISPR in my broad field of synthetic biology let alone biotechnology. CRISPR greatly accelerates genome editing and allows researchers to do what was otherwise thought extremely difficult or even impossible. CRISPR is becoming an essential tool used in almost every lab, and any labs that fail to adopt it are at a tremendous disadvantage.

FROM THE DEAN



LOUIS A. MARTIN-VEGA

Welcome to the spring/summer issue of the *NC State Engineering* magazine. This issue celebrates the launch of **Think and Do the Extraordinary**, The Campaign for NC State. Launched during the 2016 Homecoming Weekend, this capital campaign is critical for the future success of our College and University. Without the support of our alumni and friends, NC State and the College of Engineering cannot continue to provide the highest quality education and research environment for our students and faculty.

Our primary campaign focus continues to be our next marquee building — Engineering Building Oval. Thanks to the Connect NC bond, the University and diligent efforts of our the NC State Engineering Foundation, we have already raised $117 toward the goal of $154 million. We still need to raise $37 million to be able to break ground on EB Oval in 2018. You can learn more about EB Oval and opportunities to help us make it a reality on page 20.

Our campaign priorities also focus on supporting the mission and vision of our strategic plan — support for world-class infrastructure, professorships, fellowships and scholarships. These are the foundation for building a solid future in which our students learn from the best faculty, our undergraduates and graduate students work alongside top researchers in state-of-the-art facilities, and where students with high academic achievements and financial need receive the support needed to attain a highly valued degree from our College. More information about Think and Do the Extraordinary, The Campaign for NC State, can be found at campaign.ncsu.edu. I encourage you to learn more about how you can join us in strengthening our College.

Finally, we are delighted to share with you the latest *US News* Graduate Rankings for Colleges of Engineering, which now have NC State Engineering ranked 25th overall among more than 250 US colleges of engineering and 13th among public US engineering colleges. This is our highest ranking ever and is testimony to the tremendous commitment and effort made every day by our dedicated faculty, students and staff to make you, our alumni, ever prouder of being an NC State Engineering graduate.

I hope you enjoy this issue of *NC State Engineering*. And as always, I encourage you to stay connected to your College. Thank you for your support of the College of Engineering.

Sincerely,

Louis A. Martin-Vega, Ph.D.

THINK AND DO THE EXTRAORDINARY

The Campaign for NC State

University launches Think and Do the Extraordinary campaign

NC State has embarked on a five-year, $1.6-billion fundraising campaign, calling on alumni and friends to help the University accomplish the extraordinary.

Think and Do the Extraordinary: The Campaign for NC State is the largest such effort in the University's history.

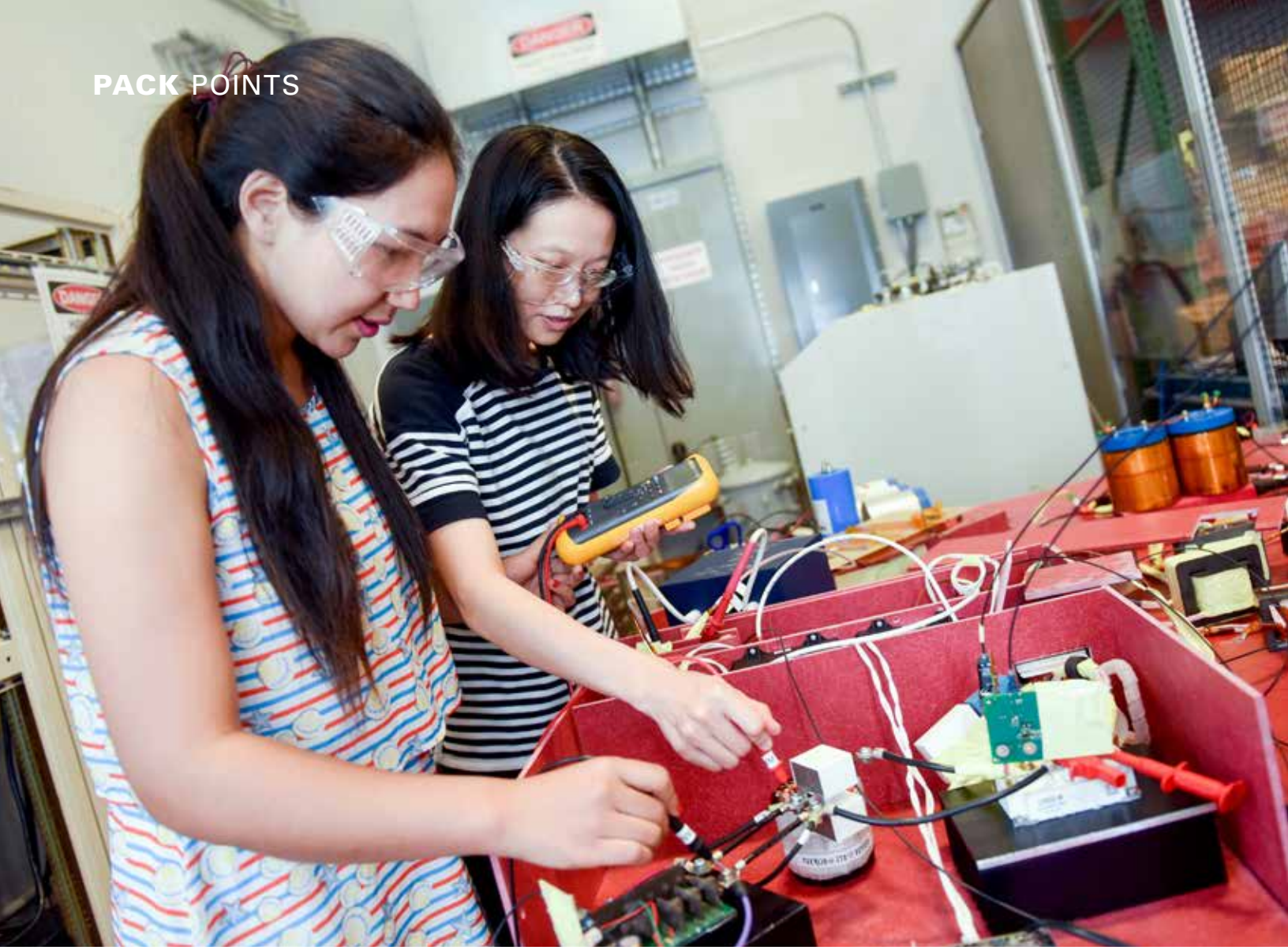
This campaign is the vital next step for the College, as it continues an upward trajectory toward a stated goal of becoming the leading public college of engineering in the country and one of the premier colleges of engineering in the world.

The money raised will help the College fund scholarships for deserving students, attract more recognized faculty members through named professorships and enhance the programs that give our students a well-rounded experience.

A key component for the College is raising private money to help support construction of Engineering Building Oval, the future home of the Department of Civil, Construction, and Environmental Engineering; the Edward P. Fitts Department of Industrial and Systems Engineering; and the dean's administration.

North Carolina voters approved $75 million in bond proceeds to help fund construction, and the College has pledged to raise $60 million in private donations.

Contact Lora Bremer, executive director of major gifts and campaign planning for the NC State Engineering Foundation, at lora_bremer@ncsu.edu or 919.513.0983, to learn how you can support the College. ▪



New cost-effective silicon carbide high voltage switch created

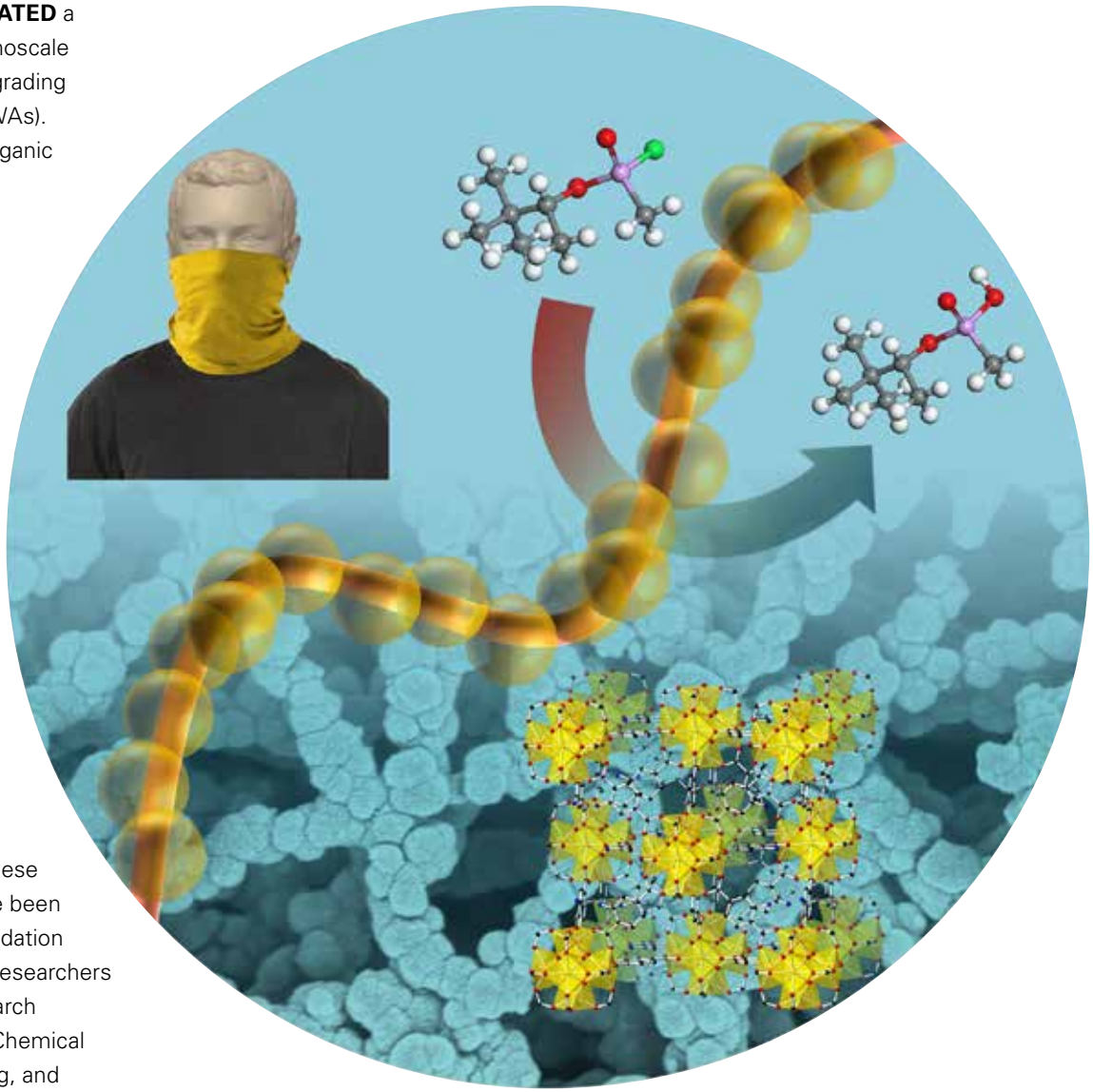
NC STATE RESEARCHERS have created a high voltage and high frequency silicon carbide (SiC) power switch that could cost much less than similarly rated SiC power switches. The findings may lead to early applications in the power industry, especially in power converters like medium voltage drives, solid state transformers and high voltage transmissions and circuit breakers.

Wide bandgap semiconductors, such as SiC, show tremendous potential for use in medium- and high-voltage power devices because of their ability to work more efficiently at higher voltages. Currently though, their high cost impedes their widespread adoption over the prevailing workhorse and industry standard — insulated-gate bipolar transistors (IGBT) made from silicon — which generally work well but incur large energy losses when they are turned on and off.

The new SiC power switch, however, could cost approximately one-half the estimated cost of conventional high voltage SiC solutions, says Dr. Alex Huang and Ph.D. candidate Xiaoqing Song, researchers in the FREEDM Systems Center, a National Science Foundation-funded engineering research center led by the College. Besides the lower cost, the high-power switch maintains the SiC device's high efficiency and high switching speed characteristics. In other words, it doesn't lose as much energy when it is turned on or off.

The power switch, called the FREEDM Super-Cascode, combines 12 smaller SiC power devices in series to reach a power rating of 15 kilovolts (kV) and 40 amps (A). It requires only one gate signal to turn it on and off, making it simple to implement and less complicated than the IGBT series connection-based solutions. The power switch is also able to operate over a wide range of temperatures and frequencies due to its proficiency in heat dissipation, a critical factor in power devices. ▪

‘Nano-kebab’ fabric breaks down chemical warfare agents



RESEARCHERS HAVE CREATED a fabric material containing nanoscale fibers that are capable of degrading chemical warfare agents (CWAs). Uniform coatings of metal-organic frameworks (MOFs) were synthesized on top of the nanofibers, forming unique kebab-like structures. These MOFs are what break down the CWAs, rendering them harmless.

“Current technologies for addressing CWAs rely on carbon-based materials — but these carbon materials can only adsorb hazardous compounds, they can’t degrade them,” says Dr. Junjie Zhao, a former Ph.D. student in chemical engineering and lead author of a paper on the work. “Our goal was to develop new materials that can detoxify these CWA compounds, and we’ve been successful.” The CWA degradation research was conducted by researchers in Dr. Gregory Parsons’ research group in the Department of Chemical and Biomolecular Engineering, and collaborators at RTI International and the Edgewood Chemical Biological Center.

“Previous research had found that MOFs can be effective at degrading CWAs,” Zhao says. “However, MOFs normally come in the form of a powder. We wanted to see if we could grow MOFs as functional coatings onto fibers, so that they could be used in masks, filters and protective garments.”

“We think that this demonstration of well-controlled MOF thin films that retain their chemical functionality is an important step for personal security and has implications for many other civilian and commercial uses,” adds Parsons.

The researchers begin by depositing a thin film of titanium oxide onto a fabric made of nanoscale fibers using a vapor-phase technology called atomic layer deposition. The titanium oxide serves as a nucleation layer, which enables the researchers to apply various zirconium-based MOFs onto the nanofibers in an evenly distributed way.

“We found that the MOFs formed on the nanofibers in a kebab-like structure, with the MOFs uniformly covering the entire nanofibers, like meatballs on a skewer,” Zhao says.

The researchers then tested the MOF-functionalized fabric against both a CWA simulant and the nerve agent soman. They found that, when exposed to the nano-kebab fabric, the half-life of the CWA simulant was as brief as 7.3 minutes. The half-life of the soman was as short as 2.3 minutes.

Next steps include integration of the MOF-nanofiber kebab structures into currently fielded garment and suit materials and evaluating the durability of the materials in various conditions. ▪

Computer science department ranks first nationally in female faculty members

ACCORDING TO 2014-2015 DATA from the American Society for Engineering Education (ASEE), NC State ranks first in the nation in the number of female tenure-track/tenured faculty in departments of computer science within colleges of engineering. The department currently has 20 female faculty members — including Dr. Laurie Williams, its interim department head — and several other female adjuncts.

Noting that the department has seven female faculty members who are NSF CAREER Award winners and a number considered to be among the leading experts in their field, Dr. Mladen Vouk, former department head, says, "We are very fortunate to have attracted so many incredibly gifted and talented female faculty. It speaks highly of the culture and environment within our department."

NC State computer science is particularly well positioned with some of the nation's leading authorities in the field, including Williams, one of the foremost researchers in agile software development and the security of healthcare IT applications; Dr. Carla D. Savage, a world renowned mathematician who now serves as the secretary of the American Mathematical Society (AMS); Dr. Nagiza Samatova, a data analytics expert who has conducted impactful climate change research; and Dr. Helen Gu, whose research recently led to the launch of InsightFinder.com, a cloud monitoring and system analytics startup.

Computer science senior, student ambassador and Women in Computer Science student chapter president Melissa Novitsky says the quantity and quality of female faculty members has a significant impact on the perception of the department with prospective female students.

"It caught my attention when I was considering schools," says Novitsky. "NC State computer science appealed to me as a place I could flourish as a female because of the incredible female mentors that we have on our faculty. It has a surprising impact on female students to see representation of their gender in the academic faculty." ▪

Technology would use drones and insect biobots to map disaster areas

INSECT CYBORGS, or biobots, may one day team with unmanned aerial vehicles (UAVS) to map disaster areas using technology being developed at NC State.

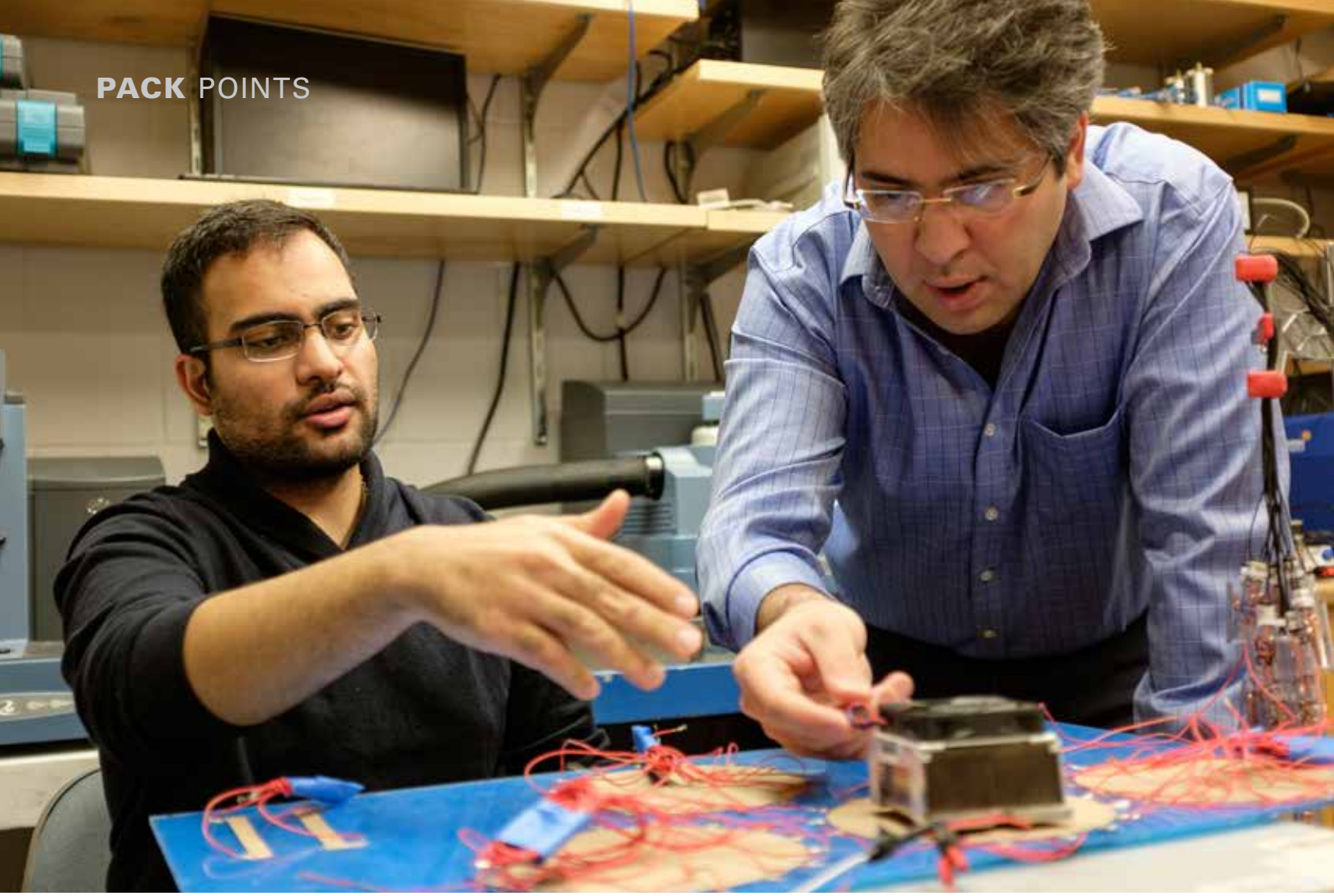
"The idea would be to release a swarm of sensor-equipped biobots — such as remotely controlled cockroaches — into a collapsed building or other dangerous, unmapped area," says Dr. Edgar Lobaton, an assistant professor of electrical and computer engineering and co-author of two papers describing the work.

"Using remote-control technology, we would restrict the movement of the biobots to a defined area," Lobaton says. "That area would be defined by proximity to a beacon on a UAV. For example, the biobots may be prevented from going more than 20 meters from the UAV."

The biobots would be allowed to move freely within a defined area and would signal researchers via radio waves whenever they got close to each other. Custom software would then use an algorithm to translate the biobot sensor data into a rough map of the unknown environment.

Once the program receives enough data to map the defined area, the UAV moves forward to hover over an adjacent, unexplored section. The biobots move with it, and the mapping process is repeated. The software program then stitches the new map to the previous one. This can be repeated until the entire region or structure has been defined, providing a map that could then be used by first responders or other authorities.

"This has utility for areas where GPS can't be used," Lobaton says. "A strong radio signal from the UAV could penetrate to a certain extent into a collapsed building, keeping the biobot swarm contained. And as long as we can get a signal from any part of the swarm, we are able to retrieve data on what the rest of the swarm is doing." ▪



New technology uses electricity to track water, ID potential problems in concrete

SLOW DRIPS can lead to large headaches. That's why researchers from NC State and the University of Eastern Finland have developed a new technique for tracking water in concrete structures — allowing engineers to identify potential issues before they become big problems.

"When we think about construction — from bridges and skyscrapers to nuclear plants and dams — they all rely on concrete," says Mohammad Pour-Ghaz, an assistant professor of civil, construction, and environmental engineering and lead investigator on the project. Tracking concrete degradation is essential to public safety, and the culprit behind concrete degradation is water. Water contributes to the degradation by itself, or it can carry other chemicals — like the road salt used on bridges — that can expedite corrosion of both concrete and its underlying steel reinforcement structure.

"We have developed a technology that allows us to identify and track water movement in concrete using a small current of electricity that is faster, safer and less expensive than existing technologies — and is also more accurate when monitoring large samples, such as structures," Pour-Ghaz says. "The technology can not only determine where and whether water is infiltrating concrete, but how fast it is moving, how much water there is, and how existing cracks or damage are influencing the movement of the water."

Previous technologies for assessing water in concrete relied on X-rays or neutron radiation, but both have significant limitations. X-rays offer only limited penetration into concrete, making it impossible to use with large samples or on structures. Neutron radiation is more accurate, but it also has limited penetration, is expensive and poses health and safety risks.

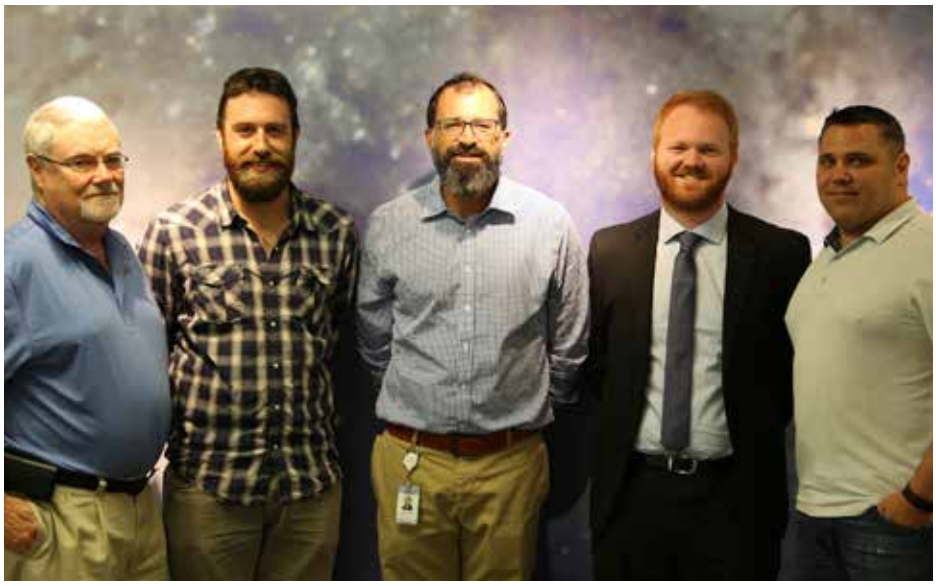
"Our electrical imaging approach is something that you could use in the field to examine buildings or bridges, which would be difficult or impossible to do with previous technologies," Pour-Ghaz says. ▪

NC State startup works to enhance the medical field as well as the community

DR. ANDREW DIMEO, an associate professor of the practice in the UNC/NC State Joint Department of Biomedical Engineering (BME), and Dr. Jason Long, a cardio-thoracic surgeon at UNC, started with a spin off idea.

After receiving a $10,000 grant from the Lineberger Cancer Center, they launched the Medical Innovators Collaborative (MEDIC) in summer 2015. Today, MEDIC has a physical location at the Frontier, in the Research Triangle Park, for two years thanks to an $85,000 Catalysts for Innovation grant awarded last fall.

"It's given us a place to call home," said Tim Martin, NC State BME grad and co-founder and acting president of MEDIC.



DR. ANDREW DIMEO, THIRD FROM LEFT, AND ANDY TAYLOR, FOURTH FROM LEFT, DURING A CATALYSTS FOR INNOVATION GRANT ANNOUNCEMENT.

The grant has helped legitimize MEDIC, according to DiMeo.

"We have a long history of innovative ideas that come out of the classroom and the huge majority of them are really cool ideas sitting on shelves. I'm certain this would be one of those cool ideas sitting on a shelf if it wasn't for the Catalysts grant."

MEDIC works to provide asset assessment and development, innovation training, industry relevant professional seminars and student internships. The goal is to create a medical device hub known for providing better, more mature technologies based on student and industry projects that lead to improving the quality of medical devices, which will hopefully lead to more startups and more jobs.

"It's really important for us to be an enhancement to the community; we want for (MEDIC) to be a reason to come to NC State and to the surrounding area," DiMeo said.

Currently, the collaborative is working on four projects with three more slated to begin this spring.

One of the current projects started with a mother looking for help. The mother of MaKayla Grace called College of Engineering Dean Louis Martin-Vega's office looking for someone to help her 2-year old daughter, who suffers from Arthrogryposis multiplex congenita (AMC), a congenital contracture disease that locks a patient's joints into place. She can only move her left arm at the shoulder.

The call was routed to DiMeo, and the team at MEDIC responded by assembling a group of NC State undergraduate and graduate student interns. Through the collaborative model MEDIC is setting up, they are working to provide assistance that other organizations don't have the bandwidth for.

"We're working with them to develop something that will help her get some motion back in her arm — just enough so she can play around — as kids should," said Andy Taylor, BME grad, co-founder and program director at MEDIC.

Other projects include creating an attachment for an existing wheel chair to help an Alzheimer's patient with limited mobility to move his feet, working with neonatologists at UNC Hospital to develop a simulator for inserting chest tubes, and continuing the work from Taylor's senior design class on a phototherapy device for infants with neonatal jaundice.

With the slew of projects the collaborative works on, MEDIC makes a point of hiring students not only from NC State, but also UNC Chapel Hill, Duke, and any other local college with students interested in acquiring biomedical device product development experience. "We are making product development education a big part of the focus," said Taylor.

"MEDIC's projects are the key to our model — addressing the gap in product development in the healthcare space with student teams from universities to give them an experience that they may not be able to get in the traditional education path," said Martin. ▪

BTEC will play prominent role in new manufacturing center

THE BIOMANUFACTURING Training and Education Center (BTEC) is part of a new initiative aimed at advancing U.S. leadership in the biopharmaceutical sector.

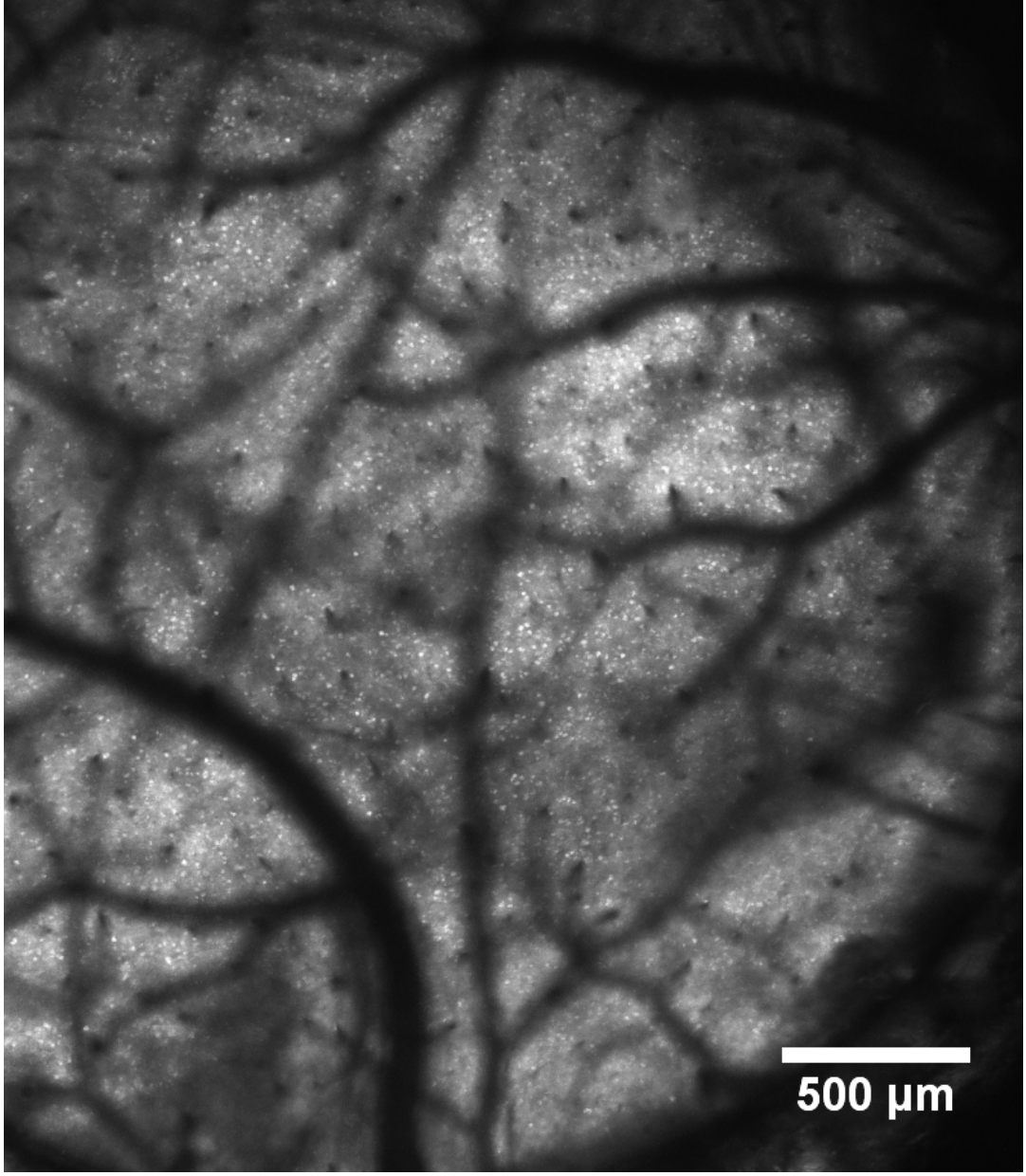
The National Institute for Innovation in Manufacturing Biopharmaceuticals (NIIMBL) is supported with a five-year, $70 million grant from the U.S. Department of Commerce and at least $129 million from a consortium of 150 companies, educational institutions, research centers, coordinating bodies, non-profits and Manufacturing Extension Partnerships across the country.

NIIMBL is the 11th institute in the overall Manufacturing USA initiative, and NC State is involved with four of them.

In addition to advancing U.S. leadership in the biopharmaceutical field, NIIMBL is also tasked with fostering economic development, improving medical treatments and ensuring a qualified workforce by collaborating with educational institutions to develop new training programs matched to specific biopharma skill needs.

"This is a fantastic opportunity for BTEC, NC State and the state of North Carolina," says Dr. Ruben Carbonell, who will serve as the chief technology officer for NIIMBL and is the director of BTEC. "BTEC will play a key role in workforce development, including academic and industry training programs, as well as process and analytical services and research," adds Carbonell, who is also the Frank Hawkins Kenan Distinguished Professor of Chemical Engineering.

NIIMBL will be coordinated by the University of Delaware, in conjunction with Commerce's National Institute of Standards and Technology (NIST). The consortium is also establishing a new nonprofit organization called USA Bio LLC to administer the cooperative agreement with NIST. ▪



Neuroscientists and an engineer take a closer look at the brain

IN A PARTNERSHIP melding neuroscience and electrical engineering, researchers from UNC-Chapel Hill and NC State have developed a new technology that will allow neuroscientists to capture images of the brain almost 10 times larger than previously possible — helping them to better understand the behavior of neurons in the brain.

Nervous systems are complex. After all, everything that any animal thinks or does is controlled by its nervous system. To better understand how complex nervous systems work, researchers have used an expanding array of ever more sophisticated tools that allow them to actually see what's going on. In some cases, neuroscience researchers have had to create entirely new tools to advance their work.

This is how an electrical engineering researcher ended up co-authoring a *Nature Biotechnology* paper with a group of neuroscientists.

A UNC-Chapel Hill research team wanted to be able to look at "ensemble" neuronal activity related to how mice process visual input. In other words, they wanted to look at activity in neurons across multiple areas at the same time.

To do that, the researchers used a two-photon microscope, which images fluorescence. In this case, it could be used to see which neurons "light up" when active.

The problem was that conventional two-photon microscopy systems could only look at approximately one square millimeter of brain tissue at a time. That made it hard to simultaneously capture neuron activity in different areas.

This is where Dr. Michael Kudenov comes in. An assistant professor of electrical and computer engineering at NC State, Kudenov's area of expertise is remote imaging. His work focuses on developing new instruments and sensors to improve the performance of technologies used in everything from biomedical imaging to agricultural research.

After being contacted by the UNC researchers, Kudenov designed a series of new lenses for the microscope that were incorporated into an overall two-photon imaging system that allowed the researchers to scan much larger areas of the brain. Instead of capturing images covering one square millimeter of the brain, they could capture images covering more than 9.5 square millimeters. ▪

Microscope uses heat and loading to offer new insights into creep fatigue

SINCE JOINING the NC State faculty in 2000, Dr. Afsaneh Rabiei has spent years assembling two labs' worth of equipment that enables her research in the manufacturing and characterization of advanced materials, metal foams, coatings, thin films and composites.

Rabiei, a professor in the Department of Mechanical and Aerospace Engineering (MAE), operates one lab for manufacturing (think casting molten metals, fine cutting, grinding and polishing) and another for analytical evaluation of the materials she is studying. The manufacturing lab is stocked with heavy industrial equipment such as a high temperature furnace, rolling mill, sand blaster and more. The analytical lab includes optical microscopes with digital image grabbers, a bond strength testing machine, an autoclave and a physical vapor deposition unit housed in the nano-fabrication facilities.

Her newest machine, though, might be the most exciting yet.

Upon joining MAE, Rabiei found that much of the manufacturing equipment that she needed to conduct her research was not available to her in one place. She had to be creative when it came to accessing the machinery she thought she needed.

So she started by collaborating with other researchers across various colleges and departments at NC State. She reached out to the national laboratories, NASA, the U.S. Army and other universities including Texas, California, Ohio State, South Carolina and more. At the same time, Rabiei wrote many proposals to use grant funds to acquire machinery of her own.

The work has paid off. A composite metal foam Rabiei has created is lighter than bulk steel, but more effective at stopping bullets, blast and fragments and has garnered national attention. The material's ability to shield X-rays, gamma rays and neutron radiation and its heat resistance could also make it useful in space exploration or in the shipping and storage of nuclear materials.

In 2014, the Department of Energy's (DOE) Nuclear Engineering University Programs (NEUP) issued a call for research proposals evaluating creep — the long-term deformation of a material under mechanical stress and heat — of a new class of stainless steel. DOE wanted more information on the creep fatigue behavior of this material, alloy 709, for use in nuclear power plants.

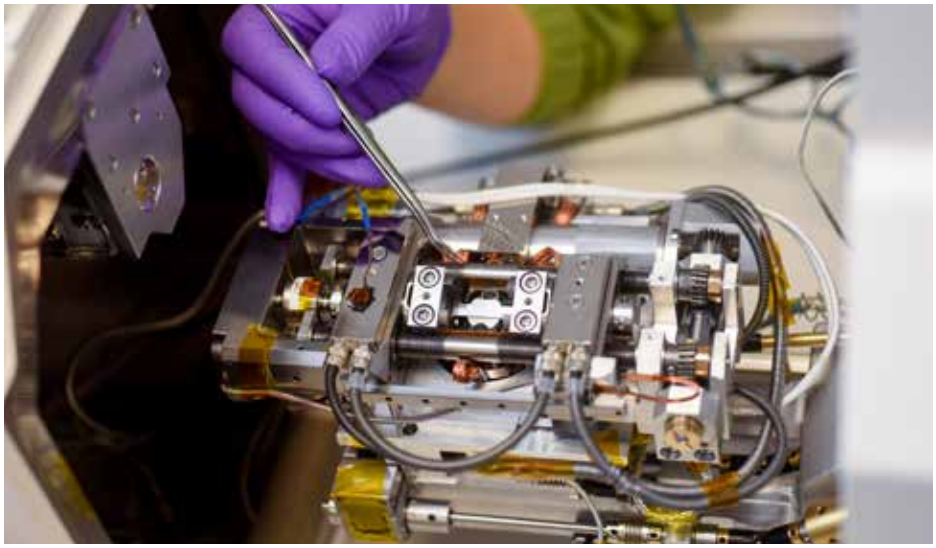
Rabiei proposed building a novel tool — a scanning electron microscope (SEM) that would examine a material's microstructure as it is being subjected to extreme heat and loading. Rabiei won the grant funding and now has the microscope she had hoped for.

The device can heat a material up to 1,000 degrees Celsius and apply tensile force for hours, simulating the conditions in a nuclear reactor so that Rabiei and her team can assess the behavior of the new alloy in such extreme conditions. While other similar SEMs exist, few if any combine both heating and loading and are able to do so at such a high temperature for an

extended amount of time. It's all thanks to the collaborative work of three companies: Japan's Hitachi, England's Oxford Instruments and Germany's Kammrath & Weiss GmbH.

Beyond this NEUP project, the new SEM can offer unique insights into the impact of loading and heating on the microstructure of other materials that researchers might be interested in testing, including Rabiei's own composite metal foam.

"I'm very proud of this," she said. "I think we are going to collect very good results using this new tool that can shed much light into the development of this novel class of stainless steel." ▪



College lands new National Science Foundation centers

THE COLLEGE'S FACULTY continues to be very successful in landing prominent roles in National Science Foundation (NSF) centers.

Several new awards have been announced in the last few months.

The Department of Computer Science was selected as a new site for the existing NSF Center for Hybrid Multicore Productivity Research (CHMPR) Industry/University Cooperative Research Centers (I/UCRC). The new NC State site, which opened on September 1, is hosted in the Laboratory for Science of Technologies for End-to-End Enablement of Data (STEED) in the department. The new site's main goal will be to conduct trans-disciplinary translational science and research of enabling better decision making in presence of big data.

Dr. Rada Chirkova, associate professor of computer science, is the principal investigator for the site.

NC STATE, THE UNIVERSITY OF Illinois at Urbana-Champaign and Georgia Tech are forming a center that aims to speed up design and verification of microelectronic circuits and systems, reducing development costs and time-to-market for manufacturers of microelectronic products, especially integrated circuits.

The center is funded for five years through the I/UCRC program and by the industrial members of the center.

Integrated circuits, or chips, power everything from smart watches to supercomputers. The semiconductor industry — perennially one of America's top exporters — has been searching for new ways to increase performance while reducing chip size and development cost.

The new Center for Advanced Electronics through Machine Learning (CAEML) will seek to accelerate advances by leveraging machine-learning techniques to develop new models for electronic design automation (EDA) tools, which semiconductor companies use to create and verify chip designs for mass production.

Dr. Paul Franzon, Distinguished Professor of Electrical and Computer Engineering, is the NC State CAEML site lead.

NC STATE AND NORTH Carolina Central University launched an NSF-funded program to recruit and train researchers in new ways of applying advanced statistical tools to physical science data. The five-year program, called Data-Enabled Science and Engineering of Atomic Structure (SEAS), is supported by a grant from NSF.

"Technology has advanced to a point where we now can get an enormous amount of experimental information on a material's structure and behavior," says Dr. Beth Dickey, a professor of materials science and engineering and the director of SEAS. "Computational techniques have also advanced, giving us unprecedented amounts of data from modeling and simulation. That means we need to develop new, hybrid areas of expertise that allow us to capitalize on these humongous data sets in an efficient and meaningful way." ▪

DR. JAY NARAYAN

DR. PAUL TURINSKY

Narayan and Turinsky named to National Academy of Engineering

Two faculty members in the College are among 84 new members of the National Academy of Engineering (NAE).

Dr. Jagdish (Jay) Narayan is the John C.C. Fan Family Distinguished Chair Professor in the Department of Materials Science and Engineering. **Dr. Paul Turinsky** is a professor in the Department of Nuclear Engineering.

Narayan and Turinsky will be formally inducted during a ceremony at the NAE's annual meeting in Washington, D.C. on Oct. 8, 2017. Their election will bring the number of NAE members in the College to 17.

Narayan was recognized by the NAE for contributions in heteroepitaxial film growth by laser ablation in large misfit systems and new materials.

He is a renowned expert in the areas of advanced materials processing, characterization and modeling, high-temperature superconductors, diamond thin films and advanced semiconductor thin film heterostructures and devices.

Turinsky was recognized by the NAE for the development of simulation technology for the economic operation, safety, and life extension of nuclear power stations.

Turinsky's areas of expertise are computational reactor physics in support of mathematical optimization of fuel management and nuclear fuel-cycle multiobjective decisions, uncertainty quantification and data assimilation in support of optimum experimental design applied to nuclear power plant safety and fuel-cycle assessments, and adaptive model refinement applied to nuclear power plant transient simulation. ▪

DR. SRIKANTH PATALA

Patala receives AFOSR Young Investigator Program award

Dr. Srikanth Patala, assistant professor in the Department of Materials Science and Engineering, has received a Young Investigator Program (YIP) award from the U.S. Air Force Office of Scientific Research.

Patala received the $360,403, three-year award for his research project, "A Machine-Learning Approach Towards Quantitative Structure-Property Relationships for Metallic Interfaces."

Grain boundaries (GBs) influence a wide array of physical properties in polycrystalline materials and play an important role in governing microstructural evolution under extreme environments. While the importance of interfaces is well documented, their properties are among the least understood of all the defect types present in engineering material systems. This is due to the vast configurational space of interfaces, resulting in a diverse range of structures and properties.

Patala plans to develop machine-learning tools and will construct reliable reduced-order models for GB energies and temperature-dependent mobilities as a function of their crystallography. ▪

Ligler to be inducted into National Inventors Hall of Fame

DR. FRANCES LIGLER

Dr. Frances Ligler, Lampe Distinguished Professor in the UNC/NC State Joint Department of Biomedical Engineering, is one of 15 inductees into the National Inventors Hall of Fame 2017 class.

Ligler is being recognized for her innovative application of emerging technologies in a variety of fields to make optical biosensors smaller, more versatile and more sophisticated. Her work conducted at the U.S. Naval Research Laboratory (NRL) moved biosensors out of the lab and into use for food safety, disease diagnosis, pollution control and homeland security.

Dr. B. Jayant Baliga, Distinguished University Professor in the Department of Electrical and Computer Engineering, and Dr. Donald Bitzer, Distinguished University Research Professor in the Department of Computer Science, are the College's other two Hall of Fame inductees.

With three inductees currently affiliated with universities, NC State is tied with Stanford and trails only MIT in the number of living members of the Hall of Fame who are affiliated with universities in the United States.

The 2017 class will be inducted and honored along with previous inductees during a Greatest Celebration of American Innovation two-day event on May 3 and 4 in Washington, DC. ▪

Augustyn, Menegatti receive NSF CAREER Awards

DR. VERONICA AUGUSTYN

DR. STEFANO MENEGATTI

Dr. Veronica Augustyn, assistant professor of materials science and engineering, and **Dr. Stefano Menegatti**, assistant professor of chemical and biomolecular engineering, have received Faculty Early Career Development awards from the National Science Foundation (NSF). The award, known as the NSF CAREER Award, is one of the highest honors given by NSF to young faculty members in science and engineering.

NSF will provide $517,000 in funding over five years to support Augustyn's project, "Understanding Ion Transport in Solvated Layered Oxides for Electrochemical Energy Storage." This research is supported by NSF's Solid State & Materials Chemistry program in the Division of Materials Research.

NSF will provide $509,930 in funding over five years to support Menegatti's project, "Light- and temperature-controlled peptide ligands for purifying blood factors and orphan enzyme drugs." This research is supported by NSF's Chemical and Biological Separations program in the Division of Chemical, Bioengineering, Environmental, and Transport Systems. ▪

IN OUR LABS

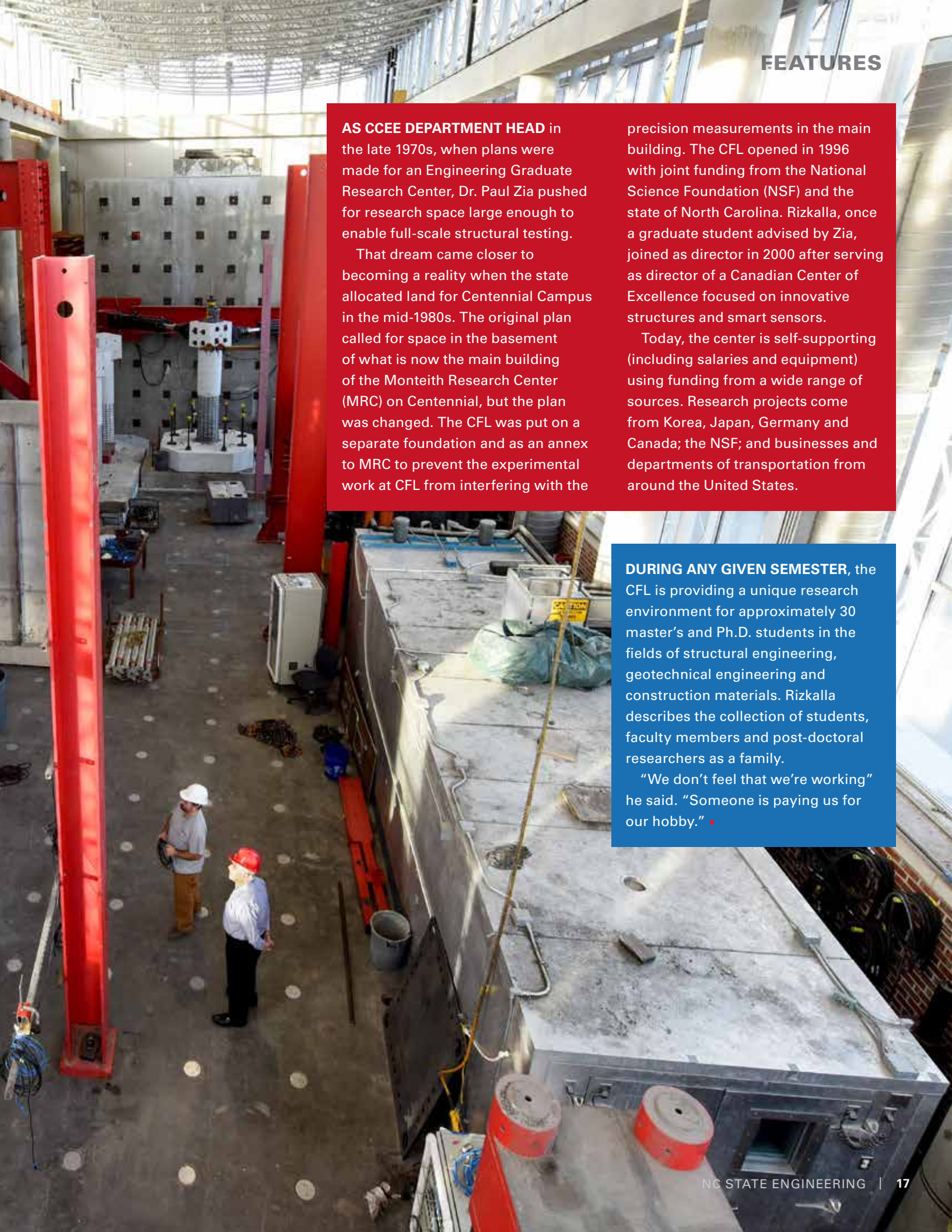
THESE ARE THE SPACES THAT ENABLE
GROUNDBREAKING RESEARCH

CONSTRUCTED FACILITIES LABORATORY (CFL)

DEPARTMENT OF CIVIL, CONSTRUCTION, AND ENVIRONMENTAL ENGINEEERING (CCEE)

IT'S THE JOB of researchers in the CFL to break things. And they enjoy it. The facility on NC State's Centennial Campus enables research, development and testing of construction materials and structural systems at full scale. Whether it's a bridge beam, a parking deck column or a concrete wall, the facility's 4,500-square-foot structural testing floor can probably handle it. If not, Dr. Sami Rizkalla, CFL director and Distinguished Professor of Civil Engineering, has set aside space behind the facility to test outdoors.

THE CFL IS EQUIPPED to simulate real loading conditions as seen in the field, but takes those conditions to an extreme to produce a failure. Then the structures are repaired and tested again. The materials tested range from concrete and steel to wood and masonry. The information gleaned leads to a better design that will head off such failures in the structure once it's built. To do it, CFL staff use 14 actuators that can exert up to 500,000 pounds of force each. Two 20-ton overhead cranes are used to move these large structures around. In order to provide real-world conditions, a 160-square-foot environmental chamber adds temperatures as high as 180 degrees Fahrenheit and as low as minus 60, and a steady saltwater spray to the loading. A shake table simulates the impact of an earthquake on a structure. The structural testing floor is built on top of a two-foot concrete slab and a nine-foot-deep basement beneath. That basement itself sits atop a two-foot concrete slab. In the basement, you will find long-term tests that provide years of pressure on a structure to study creep, time-dependent deformation of a material.



AS CCEE DEPARTMENT HEAD in the late 1970s, when plans were made for an Engineering Graduate Research Center, Dr. Paul Zia pushed for research space large enough to enable full-scale structural testing.

That dream came closer to becoming a reality when the state allocated land for Centennial Campus in the mid-1980s. The original plan called for space in the basement of what is now the main building of the Monteith Research Center (MRC) on Centennial, but the plan was changed. The CFL was put on a separate foundation and as an annex to MRC to prevent the experimental work at CFL from interfering with the precision measurements in the main building. The CFL opened in 1996 with joint funding from the National Science Foundation (NSF) and the state of North Carolina. Rizkalla, once a graduate student advised by Zia, joined as director in 2000 after serving as director of a Canadian Center of Excellence focused on innovative structures and smart sensors.

Today, the center is self-supporting (including salaries and equipment) using funding from a wide range of sources. Research projects come from Korea, Japan, Germany and Canada; the NSF; and businesses and departments of transportation from around the United States.

DURING ANY GIVEN SEMESTER, the CFL is providing a unique research environment for approximately 30 master's and Ph.D. students in the fields of structural engineering, geotechnical engineering and construction materials. Rizkalla describes the collection of students, faculty members and post-doctoral researchers as a family.

"We don't feel that we're working" he said. "Someone is paying us for our hobby." ▪

LENDING A HELPING HAND

Industry Expansion Solutions makes an impact across manufacturing, healthcare and the public sector

WHEN KYLE MARTIN needed help with a redesign of the office space in the manufacturing plant he oversees, he knew where to turn.

Martin, who is vice president and general manager of Electroswitch Electronic Products' Raleigh manufacturing facility, turned to Industry Expansion Solutions (IES), the College's extension unit serving manufacturers, healthcare providers, government agencies and service sector companies across North Carolina. The son of an NC State engineer, Martin had long been familiar with IES and has used its services previously in past positions.

Martin's company manufactures switch products for electronic applications, including switches that arm bombs, control the windshield wipers on a 737 and set the position on a dog training collar. The company was working to improve its processes on the manufacturing floor but also wanted to make the arrangement of the building's office space more efficient with an eye toward an eventual upgrade of those offices.

It's something Martin had some experience in doing but not enough time to take on.

Founded in 1955 as Industrial Extension Service, IES focused on helping North Carolina industries grow and prosper. It was also the first organization of its kind in the United States. Today, IES has broadened its reach to other

industries while still maintaining a strong base in working with manufacturers.

"We have developed a myriad of things that we do to help organizations get better and make strategic decisions on how they're going to move forward," said Phil Mintz, IES' interim executive director and state center director of the North Carolina Manufacturing Extension Partnership (NCMEP).

That could mean helping a manufacturer become more energy efficient or helping a nonprofit identify grant opportunities. It's teaching workplace safety courses or streamlining a government agency's processes to save taxpayer dollars and better serve clients.

Based on NC State's Centennial Campus, IES has multiple regional offices around the state, allowing regional client development managers quick access to clients from Murphy to Manteo. "They are constantly visiting with clients, asking them about their pressing needs and offering solutions," Mintz said.

A BETTER WAY

IES spent a few weeks visiting Electroswitch, observing and asking questions of employees in sales, finance, engineering, human resources, purchasing and other offices.

Martin knew there was wasted space in the building. But the study IES produced did more than just fill it. By gathering data on the way those employees communicate with each other, it identified a better way for them to be positioned in the building.

"We have people that are at opposite ends of the hallway that talk multiple times a day," Martin said. "They would be better if they were co-located. It was an eye-opener. It wouldn't have been how we would have laid the office out if we had done it freehand."

When the North Carolina Department of Health and Human Services (DHHS) obtained grant funding to help state and local agencies introduce process improvement plans to design, test and implement more effective, streamlined and integrated approaches to helping low income families, IES provided training to the state employees who would then go out and assist those agencies with implementing new processes. The Division of Social Services Operational Support Team looks for roadblocks to efficient service delivery, like redundant job responsibilities or outdated client forms and excessive wait times.

Thanks to that IES training, the team has worked on 27 projects across the state.

"Obtaining certification for the state level staff so that they can facilitate process improvement projects across the state has been very beneficial to the organization," said Regina Watkins Bell, an Operational Support Team manager with DHHS.

NEW AREAS

IES has long focused on the state's smaller manufacturers; some client businesses have fewer than 10 people.

"There are consultants who do some of the things that we do, but they're typically calling on the larger companies and they're not going to spend any time trying to help with the small ones," Mintz said.

As IES has expanded into other areas, it has taken many of the same solutions developed for manufacturing to other sectors. So lean manufacturing and lean healthcare or lean government share many of the same ideas and methods.

That includes a big focus on hospitals and public health agencies, which are often dependent on the level of government reimbursement for their bottom line. As those reimbursements fluctuate, IES has done things like examine emergency room workflow to help rural hospitals, so vital to their communities, survive.

IES grant evaluation services is a new growth area. The need for evaluation of grant projects has increased over the years, as funders and nonprofits have become more sophisticated and focused on results. IES has a team of evaluators who are trained to monitor the success of projects while providing information for improving projects and overall programs.

Another new area of focus is helping companies address cybersecurity. While many small-business owners might think they are too small to be victims of cyberattacks, IES is working with companies on the importance of cybersecurity and helping traditional manufacturers transition into solutions that involve use of automation.

"No matter the client and no matter the solution," Mintz said, "IES is a partner working hand in hand to make improvements and find fixes." ▪

YOUR **NAME** HERE

Would you like to leave a long-lasting mark on the College? Would you like to leave a legacy students and faculty members can look to and be reminded of the generosity that aids in their many academic and research opportunities? Naming rights are available in Engineering Building I, II, and III and the new Engineering Building Oval for classrooms, atriums, laboratory spaces or the building itself. This map highlights some of those opportunities and some spaces that other alumni have committed to naming.

To learn more about naming opportunities, contact Lora Bremer, executive director of major gifts and campaign planning for the NC State Engineering Foundation, at **lora_bremer@ncsu.edu** or **919.513.0983**. Want to learn more about Engineering Building Oval? **www.engr.ncsu.edu/oval**.

A NEW GENERATION

ISHITA TRIVEDI ENJOYS research and the process of learning.

"Sometimes I don't know what the end result of the day will be," Trivedi, a Ph.D. student in the Department of Nuclear Engineering (NE), said. "Sometimes it's frustrating. But I like that."

That means hours in front of a computer in a graduate student office in Burlington Engineering Laboratories doing modeling work on lead-cooled fast reactors. These next-generation reactors use fast neutrons to sustain the fission chain reaction that drives power generation. Unlike commercial nuclear plants now in place in the United States, these reactors use liquid metals for cooling, rather than water.

FOR NUCLEAR

The department has developed a broad research base

"It's more efficient," said Trivedi, whose research is conducted with Dr. Kostadin Ivanov, head of the department. "Since there is no need for a neutron moderator, the size of the reactor can be greatly reduced."

Home to the first university-based nuclear reactor and the first university nuclear engineering educational curriculum, the department has a long and storied history. NE has played a key role in helping maintain and expand the lifespan of the light water reactors (LWRs) currently in use across the United States. At the same time, the department is helping to drive research on the next generation of reactors like the one Trivedi is studying and moving into other areas such as nuclear nonproliferation.

> "I love the fact that what I'm doing has an effect."
>
> **ISHITA TRIVEDI**

"The department is growing, so we're trying to position ourselves in different areas," Ivanov said.

One way to measure NE's national importance is in the department's success in securing research funding from the Department of Energy's Nuclear Engineering University Program (NEUP), the largest source for federal research dollars for university nuclear engineering programs.

"NC State received more NEUP funding in 2016 than any other school in the country and is in the top three nationally in the nearly decade-long history of the program," said Dr. John Gilligan, Distinguished University Professor in the department and the College's executive associate dean.

If you count two Department of Energy (DOE) consortia based in the department, the College ranks first when it comes to federal funding for a university nuclear engineering program in the United States.

A NEED FOR NUCLEAR

Something remarkable happened last year near Spring City, Tenn. A new nuclear power plant was brought online in the United States for the first time in 20 years with the completion of the Tennessee Valley Authority's Watts Bar Unit 2.

Four more new plants are being built by utilities in South Carolina and Georgia. Roughly 60 new facilities are under construction worldwide.

At the same time, some existing commercial nuclear plants in the United States have been taken offline. Factors include a reduction in power demand, state policy decisions and the availability of cheap natural gas. However, the 99 reactors still in use produce 20 percent of the U.S. electrical power used.

"Things are moving ahead in nuclear energy and security in this country," Gilligan said. "Certainly, around the world."

According to Gilligan, the federal government is very supportive of research into nuclear engineering.

The department is playing an important role in both extending the operating life and improving the safety of the current fleet of LWRs, and in developing a new generation of reactors.

The Consortium for Advanced Simulation of Light-Water Reactors, funded by the DOE and led by the department, is using advanced modeling and simulation to help extend the lifespan of current LWRs from 40 to 60 years and maybe even longer.

At the same time, the department is collaborating with Westinghouse and researchers at the Oak Ridge, Argonne and Idaho National Laboratories on fast lead-cooled reactors and reactors that are cooled by molten salt.

Dr. Michael Fusco, a recent Ph.D. graduate from the department, conducted research on improving storage containers for spent nuclear fuel. With the decision to stop work on the Yucca Mountain nuclear waste repository in Nevada, the nation's nuclear plants are faced with the possibility of having to store spent reactor fuel at their facilities for decades.

With NEUP funding, Fusco conducted research with Dr. Mohamed Bourham, Alumni Distinguished Graduate Professor, on protective coatings for the stainless steel dry casks now used to hold the fuel. Those coatings, made from zirconium, titanium and aluminum oxides, are designed to reduce corrosion so that the casks can be made into a safer long-term storage option.

"A lot of work is being done to look into other options, but for the time being it's the casks," Fusco said. "Depending on how the political landscape shakes out, we could be stuck with those for longer."

After graduation in fall 2016, Fusco was applying for post-doctoral positions in national research laboratories with an interest in plasmas research.

"I don't see myself working as a traditional nuclear engineer," Fusco said. "But the things I do, I'd like to do them to further the nuclear industry and support research going on there."

The economics, politics and research funding may change as the years go by, but the department sees a carbon-free future ahead and the need for strong nuclear power generation to serve as a consistent clean baseload filling in gaps that intermittent renewable sources can't.

"Gas and coal, they cannot solve all of the issues, in our opinion," Ivanov said.

NEW DIRECTIONS AND OPPORTUNITIES

Joseph Cope is in his fifth year in the department and has signed on for more.

Cope completed a bachelor's degree in May 2016 and is now in an accelerated master's program with plans to continue on to complete a Ph.D.

"My undergraduate experience was challenging and enriching," he said.

"We have one of the top departments in the country for diverse research interests."

Working with Dr. Robert Hayes, associate professor of nuclear engineering, Cope is trying to characterize the radon that is always present in the atmosphere as a basis for prediction models used in emergency response following a nuclear event, whether their release is planned or accidental.

"In order to quantify radioisotopes present following a nuclear event, you need to know what the typical naturally occurring radioactive material contribution and uncertainty is such that abnormalities above background are readily measured and identified," he said.

That means lots of sampling work, often on Centennial Campus outside his office in Research Building II. Cope has long had an interest in the Navy and learned more about nuclear engineering during a summer camp experience on campus in 2011. As an undergraduate, he had internship experiences at two national laboratories and will continue these experiences this summer at Knolls Atomic Power Laboratory.

Cope has a four-year fellowship through the Consortium for Nonproliferation Enabling Capabilities (CNEC). Led by NC State, CNEC is developing the next generation of methods and tools to detect, locate, identify and characterize special nuclear material and ensure that it doesn't end up in the wrong hands. The $25 million award from the National Nuclear Security Administration to fund the consortium is the largest research award in the Department of Nuclear Engineering's history.

The move into nonproliferation marked a major turn for the department into a research area that it had not been involved in previously. It's a part of NE's expansion into new thrusts while also keeping a strong base in commercial nuclear power generation education and research.

Other areas the department is moving into include research and courses on plasma and nanofabrication. The big data insights coming out of the department — for instance, in the gathering and manipulation of all that information about where unsecured nuclear material is located — have broader implications for other fields of study.

"It expands what traditionally, in the public's eye, is considered nuclear engineering," said Lisa Marshall, the department's director of outreach, retention and engagement.

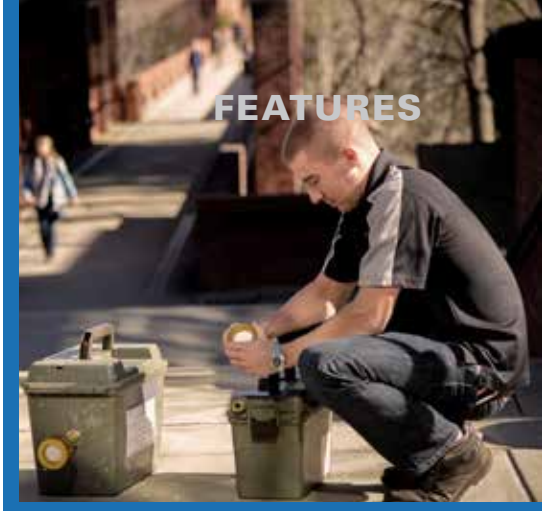
According to Marshall, the interdisciplinary nature of the department's programs is opening doors to a wider range of career fields for its students.

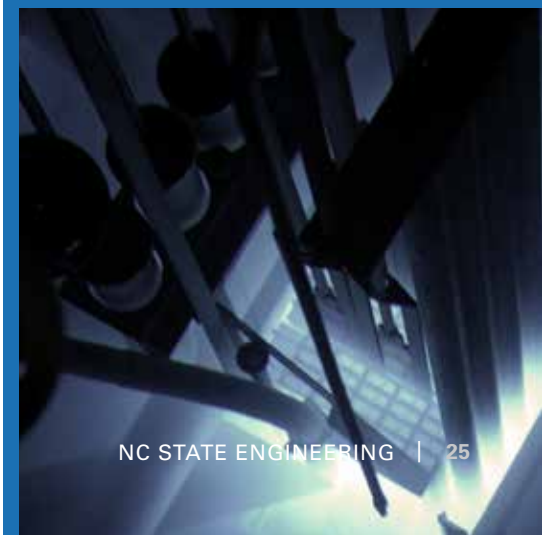
More nuclear engineering undergraduates are going on to medical school or to study medical physics than in previous years. With the increased use of radiopharmaceuticals, pharmacy schools are seeking students with a nuclear engineering background.

Marshall said that students in the department want to make an impact in nuclear engineering or in a growing number of associated fields after graduation.

For Trivedi, the work being done in the department is work that matters, especially with predictions of a dark future for humankind if power generation from carbon-based sources isn't curtailed in favor of nuclear and renewable sources like wind and solar.

"I love the fact that what I'm doing has an effect," she said. ▪





More master's and Ph.D. students make for a stronger, more prestigious College

Graduate growth

ARMED WITH an undergraduate degree in materials science and engineering, Alexandria Cruz could have joined the workforce after her University of Florida commencement ceremonies in June 2015.

Job prospects for engineering graduates are strong. Eight of the top 10 highest-paying majors for new undergraduates in a 2016 Forbes survey were in engineering or computer science.

Instead, Cruz took a month off after graduation before beginning a Ph.D. program in the Department of Materials Science and Engineering at NC State.

With help from a three-year National Science Foundation (NSF) graduate research fellowship, she is working in Dr. Justin Schwartz's research group on multiferroic magnetic composites with applications in sensors, signal filters, high-frequency devices and more.

Cruz says she has heard of fellow engineering undergraduates who went straight to work, only to find themselves stagnating in their positions in a couple of years. With an eye toward a career in industry, Cruz says that staying challenged in her work is a priority.

"The thing I like about school is that I get to learn something new every day," she said. "I really hope that I can continue my learning even after I go into the workforce, not just do the same things every day."

There are more Ph.D. students like Cruz enrolled in the College than in years past.

When Dr. Louis Martin-Vega, dean of the College, arrived on campus in 2006, there were about 7,500 students in the College and about three undergraduate students for every graduate student. Today, with a population in excess of 10,000 students in engineering and computer science, there are two undergraduate students for every graduate student. More than 35 percent of all graduate students at NC State are in engineering.

This decade-long push to grow graduate enrollment is designed to increase the College's national prominence.

As the College's research capacity expands, the nation and world benefit. NC State engineering researchers are driving innovation in energy, infrastructure, healthcare and other fields.

More graduate students mean more capacity for research, which leads to increased funding, research centers and higher-quality faculty members. Getting those things helps attract a higher number of top-notch graduate students in what becomes a productive cycle.

"The reputation of a college of engineering nationally and internationally is driven primarily by what it does at the graduate level and what it does with its scholarly

contributions," Martin-Vega said. "Where do the scholarly contributions come from? They come from the Ph.D. students."

"To me, this is a golden age of engineering."

DR. DOUGLAS REEVES

BIGGER AND BETTER

Across the country, colleges of engineering are making large commitments with an eye toward expansion. Engineering graduates earn excellent starting salaries and the research and extension efforts coming out of engineering schools have a positive impact on their communities.

For many of these schools, NC State included, growth means expanding at the graduate level.

As part of its 2011-2020 strategic plan, the University made a commitment to slow its undergraduate student growth with an eye toward graduate education and research. The College has followed the same path.

In one of the fastest-growing states in the country, and with high demand for undergraduate engineering education, the College has found a way to provide a quality experience for undergraduates while also growing the master's and Ph.D. programs.

Stronger graduate programs mean more opportunities for NC State engineering undergraduates to pursue a master's or Ph.D. And the College offers a strong undergraduate research program as a result of its growth in research capacity. The ability to do research as an undergraduate is a tremendous advantage for students, whether they end up continuing their education after graduation or going directly into the workforce.

Other benefits to the College in expanding graduate education can be seen in the growth in research awards and expenditures as well as the College's success in landing leading roles in federal research centers. The College is one of only two colleges of engineering in the country to lead two NSF Engineering Research Centers, and research expenditures in the College have grown from $127 million to more than $179 million since the 2009-10 academic year.

Two-thirds of the College's revenue is based on grants and contracts, Martin-Vega said. Those grants and contracts support Ph.D. students but if you don't

have great Ph.D. students, you won't get the grants and contracts. The two rely on one another to grow.

A GOLDEN AGE OF ENGINEERING

Dr. Douglas Reeves thinks that there has never been a better time to earn an engineering degree.

"I have never seen it this good in terms of opportunities, in terms of the recognition of the importance of engineers, in terms of the impact that engineers have on our daily lives," said Reeves, a professor of computer science and the College's associate dean for graduate programs. "To me, this is a golden age of engineering."

Along with outstanding job prospects, engineering graduates have an opportunity to make this a better world.

So how do schools of engineering convince new graduates with outstanding job prospects to sign up for more grueling schoolwork?

For Gilbert Castillo, part of the motivation for pursuing a Ph.D. came with the realization that he enjoys doing research.

The recipient of a GEM Fellowship, Castillo is in his fifth year of a Ph.D. program in the Department of Chemical and Biomolecular Engineering. Working with Eastman Chemical Company, he is modifying polyester surfaces for display applications on electronic devices with improved moisture barrier properties and better resistance to scratches and even smudges. The ultimate goal is to use the surfaces in flexible displays.

At the end of 2016, Castillo had just published a paper and was finishing a second manuscript. He submitted two patent applications in August and was writing his thesis with an eye toward defending in May. He also found time to enter and win the 2016 NC State Graduate School Three-Minute Thesis Competition, in which Ph.D. candidates learn to break their complex thesis topic into a short, compelling presentation that a lay audience can understand.

At the master's level, degree programs in the College have increasingly become professionally focused rather than research focused. And in many cases, students can earn a dual bachelor's and master's in five years, greatly increasing their job prospects.

A Ph.D., though, is a four- or five-year commitment.

Tyler Goode was a mechanical engineering undergraduate student at the University of Alabama doing an internship at NASA's Marshall Space Flight Center in Huntsville, Ala. when he was invited to sit in on a meeting with local business executives in the aerospace industry. What he heard stuck with him.

"They were really hammering grad school as something that's necessary to advance your career," he said.

Goode began a master's program in mechanical engineering at NC State in fall 2015. He plans to finish that degree this spring and continue on to earn a Ph.D. His master's work is being funded by the Department of Defense (DOD) for his work with Dr. Mark Pankow's Ballistic Loading and Structural Testing (BLAST) Lab in the Department of Mechanical and Aerospace Engineering. Goode received a NSF fellowship that will support his Ph.D. studies.

His current DOD research involves developing ways to test ballistic impacts on body armor with new techniques that let researchers see what's happening to the inside of the armor — something that is difficult for researchers because their view is obscured by the wearer's body.

ATTRACTING THE BEST

The College's departments use several methods to recruit the best graduate students.

Faculty members attend conferences with a large concentration of potential graduate students. Along with encouraging current engineering students to apply, the departments use services that provide information on students who have expressed an interest in graduate education in certain engineering disciplines or have posted strong scores in certain standardized tests. Broad-based marketing and communication about the outstanding work being done in the College plays a role, too.

The payoff for the College comes in increased research impact and more national prominence. That research, in turn, leads to societal change and drives economic development, especially in North Carolina. It's also a key part of achieving the goal the College has set under Martin-Vega's leadership — to become and be perceived as the leading public college of engineering in the country and one of the premier colleges of engineering in the world. ▪

ISE researchers are using 3D printing to engineer human tissue

PRINTABLE YOU

DR. BINIL STARLY envisions a day when human cells enter one end of a completely automated, totally sterile production line and leave the other end as packaged tissue or organs that a surgeon will take directly to an operating room for implantation.

Helping make that vision a reality is a focus for Starly and other industrial engineers in the Edward P. Fitts Department of Industrial and Systems Engineering (ISE). Starly, an associate professor of regenerative medicine in the department, thinks a research version of such a lab could be located on the NC State campus in the next few years.

3D printing, in which layers of a material are deposited to manufacture a single object, has been around since the mid-1980s. Research on the use of 3D printers to create human tissue, starting with human stem cells and a scaffolding to help those cells grow in the correct configuration, began in the early 1990s.

Today, researchers around the world are working to manufacture skin, bone and vascular tissue, with the potential creation of functional complex organs like a heart or liver still years or even decades away.

Medical researchers can culture tissue from a patient and grow that tissue outside the body in order to test certain combinations of, for instance, a drug to fight breast cancer.

"It's personalized to your tissue to see which drug combination would work and at which dosage," Starly said.

It's painstaking work. That's where

industrial engineers are needed, to scale up production.

"The shift that is happening now is moving from a very labor-intensive, expensive process to get the machines to do a lot of the harder work that humans are just not capable of doing," he said.

A BETTER USE FOR BELLY FAT

Using polymers and "bioinks" containing stem cells derived from the human fat that is the end product of liposuction treatments, Dr. Rohan Shirwaiker is working to rebuild tissues of the knee joint.

Shirwaiker, an assistant professor in ISE, is working on the manufacturing of multiple cartilaginous tissues of the knee joint, including the meniscus, which provides a cushion between the femur and the tibia. Joining him on the multidisciplinary meniscus engineering team are Dr. Matthew Fisher, assistant professor in the UNC/NC State Joint Department of Biomedical Engineering (BME) at NC State and UNC-Chapel Hill, and Dr. Jeffrey Spang, an orthopedic surgeon at UNC-Chapel Hill. Their team is also collaborating with Dr. Elizabeth Loboa, dean and professor of bioengineering at the University of Missouri, and other NC State and UNC faculty members on engineering the other knee tissues.

An important characteristic of these tissues is their highly specific network of collagen fibers. "This fibrous network created by cells is critical to the tissue's function. While engineering these tissues in the lab, it is imperative that we replicate its organization using appropriate design and manufacturing strategies," Shirwaiker said.

Their team has tested two approaches — using a 3D printed biodegradable polymer scaffold onto which cells attach and 3D bioprinting a hydrogel bioink containing the cells in the same geometry, but without the scaffold. So far, smaller prototypes tested in petri dishes or implanted in rats have provided a strong evidence of new tissue formation within four weeks. Most importantly, early results have shown that the collagen network characteristics in the engineered tissue can indeed be controlled by manipulating the scaffold design or bioink composition in conjunction with the bioprinting process parameters.

ISE researchers use machines that don't vary much from traditional extrusion-based 3D printing machines. One key difference is the need to control temperature and the operating environment to a greater extent than with traditional 3D printing. The optimal temperature for working with cells is, unsurprisingly, 98.6 degrees Fahrenheit. A 3D printing machine the researchers use that is located on NC State's Centennial Campus is set up inside a biosafety cabinet, much like a cleanroom, the kind of environment Starly envisions in the biomanufacturing assembly line of the future.

FROM CONCEPT TO MARKET

Taking a product to market and getting mankind closer to 3D printing major organs will be a long and complex process.

After more lab testing and animal trials, Shirwaiker's work could potentially move on to Food and Drug Administration (FDA) human clinical trials. But, it's a long and rigorous process that could take several years.

One of the challenges ahead as the field matures is finding a better way to test the quality and safety of tissue or an organ before it is implanted into a patient; current methods actually destroy the tissue or organ in order to test it. Should multiple versions of a product be produced at once so that one can be tested and another implanted? Whatever methods are developed, Starly said, time is of the essence.

"In a production-based environment, you can't take four or five days to find out if this sample is good. It has to be fast."

Like Starly, Shirwaiker envisions a future that seems like science fiction. He says we may see a day when bioprinted organs will include sensors that can alert a patient and their physician when something is wrong or even help the organ autocorrect.

To get there, we will need the kind of advances in multidisciplinary tissue engineering technologies, including bioprinting, that are being produced at NC State. Once the core technologies are perfected, Shirwaiker said, the types of cells used and the end-product organ desired can vary.

"Somebody making a bladder or a liver can still use the same fundamental principles and manufacturing methods but apply it for their cell types and their tissues," he said. "At the end of the day, it will take synergistic efforts from universities, federal agencies, and the industry to help realize the promise of printed tissues and organs." ▪

STEPHEN ANGEL

RASHIDA HODGE

Donating for the future

Alumni share why they have decided to support the new Engineering Oval project

THE NC STATE ENGINEERING FOUNDATION is well under way in its effort to raise $60 million in private funds to help fund construction of the Engineering Building Oval project — the next step in unifying the College on Centennial Campus. The new building will be home to the Edward P. Fitts Department of Industrial and Systems Engineering (ISE); the Department of Civil, Construction, and Environmental Engineering (CCEE); and the dean's administration.

With $75 million in funds being donated through the Connect NC bond that was passed in March 2016, these private donations being raised are essential.

Meet three alumni who share why they donated toward the new building and how essential EB Oval will be.

STEPHEN ANGEL

For Steve Angel, attending NC State was an easy decision to make.

"I was drawn to the first-class engineering education in a great social environment," said Angel, a 1977 graduate with a bachelor's degree in civil engineering. "The nationally recognized sports were a bonus."

After graduating from NC State, Angel went on to earn his MBA from Loyola College in Baltimore and spent 22 years in various management positions with General Electric. In 2001, he joined Praxair Inc. as an executive vice president and since 2007, has been chairman, president and CEO of the Fortune 300 producer and distributor of atmospheric, process and specialty gases and high-performance surface coatings.

As a longtime donor, Angel feels a connection to the College and the University.

"I believe in the school and in the school's product, which is a well-rounded, capable engineering graduate with the necessary foundation to succeed in a complex and dynamic global business environment."

As a distinguished engineering alumnus, he has generously supported the College, endowing with his wife, Lori, the Robert F. and Romaine S. Angel Scholarship, which generates income for students equivalent to full tuition and fees. In conjunction with Praxair, he has also supported the College through donations for the Angel Family Distinguished Professorship in Mechanical Engineering and a named space in Engineering Building I — "The Praxair Lecture Hall." Now on the list are donations that will support EB Oval.

Why has he chosen to support construction of the new building?

"I liked Dean Louis Martin-Vega's vision for the engineering school, and I hope the 'Oval' will be widely recognized and synonymous with a leading-edge education in engineering," Angel said.

JENNIFER AND JAKE HOOKS

RASHIDA HODGE

Rashida Hodge felt drawn to STEM fields given her love for math and science and her passion for solving problems. But growing up in the U.S. Virgin Islands, she wasn't sure how her career would take shape.

"After speaking with my physics teacher and attending a summer program at University of Illinois — Urbana Champaign, I was introduced to industrial engineering. When I found out what industrial engineering was, I fell in love with the fact it allowed me to use my math and science skills, but also take the human factor into consideration," said Hodge, who graduated with B.S. and M.S. degrees in industrial engineering (IE).

In paving her own way, she decided on NC State for its rankings, respected reputation and welcoming and nurturing approach. Hodge recalls calling the Department of Industrial Engineering to discuss her options and feeling a sense of community from the advisors who took the time to engage with a student thousands of miles away.

While working on her master's degree, she completed an internship at IBM, which provided her the opportunity to infuse her classroom learning with real life projects. She started working full time at IBM in 2002 after graduating and started as a development and research program manager. Since then, she has worked her way up the ranks holding a diverse set of roles and currently holds the title of director for worldwide client delivery for IBM Watson Group.

"I would not have been introduced or exposed to the many opportunities I have today, if it was not for my education at NC State. It opened doors for me," Hodge said.

When the opportunity came for Hodge to give back to the College, she felt giving to the new Oval building was a great chance to help future students succeed and help provide students with resources needed to ensure that happens.

"I was afforded my education because people invested in me. I want to do more early on to ensure that others, especially African Americans, have the resources and opportunities to see that they can apply, be accepted and compete successfully at NC State," said Hodge.

She has also endowed a scholarship, Real Hope for NextGen Engineers, and is one of the youngest alumni to start a scholarship to build toward endowment — her contribution to the Oval is an extension of her commitment to NC State and minorities.

JAKE HOOKS

There was never any doubt for Jake Hooks where he would attend college.

Hooks' father, J.T. Hooks Sr., was the captain of the NC State's freshman men's basketball team in 1924. So growing up wearing red and with a love for NC State, Hooks graduated in 1978 with a degree in materials engineering. After graduation, he worked as a product engineer before moving into management. He retired as president of Eaton Automotive North America in 2013 after a 35-year career.

For Hooks, the small size of the Department of Materials Engineering (ME) was a great draw, as was finding the studying of materials interesting. According to Hooks, the skills he learned helped carry him through his career and gave him an engineer's problem-solving skill set.

Hooks has been a great supporter of his home department and the College. In 2011, he spoke to incoming first-year engineering students at the annual College of Engineering Welcome Event and currently serves on the NC State Engineering Foundation Board of Directors and chairs the development committee. He and his wife, Jennifer Smith Hooks, endowed the Jacob T. Hooks Scholarship in Materials Science and Engineering in honor of his father.

"My NC State education and experience opened many doors for me in my career," said Hooks. "When I was able to give back to the University, Jennifer and I wanted to ensure that it was impactful."

The next impact the Hooks family is making is on EB Oval. With his wife, they have gifted a named space in the Department of Materials Science and Engineering (MSE) in Engineering Building I, but the gift money will go toward the building fund for the new building.

"As an MSE alum, I was able to see first-hand the teaching and research conducted at State, so I am excited to see innovation continue as engineering comes together on Centennial Campus." ▪

College of Engineering holds **first alumni event in South Korea**

DR. YOUNG MOO LEE

THE COLLEGE'S ALUMNI are doing important work all over the country and world, including a sizable contingent in South Korea.

Many of those alumni and other professionals with ties to the College joined Dean Louis Martin-Vega and other College representatives during an event in Seoul, South Korea in November. It was the College's first alumni event held in South Korea.

Martin-Vega was joined by his wife, Maggie; Dr. Linda Krute, director of the College's Engineering Online distance learning program; and Dr. Y. Richard Kim, Jimmy D. Clark Distinguished University Professor in the Department of Civil, Construction, and Environmental Engineering.

The gathering coincided with the 2016 World Engineering Education Forum and the Global Engineering Deans Council, held in Seoul. Martin-Vega was there representing the American Society for Engineering Education; he is currently the organization's president.

Martin-Vega participated in a panel discussion titled "Preparing Global Engineers for the Next Century" that Kim chaired. Martin-Vega was joined by Dr. Man-Sung Yim, professor and former department head in the Department of Nuclear and Quantum Engineering and director of the Nonproliferation Education and Research Center at the Korea Advanced Institute of Science and Technology (KAIST) and Dr. Wooil Lee of Seoul National University. Yim is a former associate professor and director of graduate programs in the Department of Nuclear Engineering at NC State.

An alumni reception was held at a hotel near the World Engineering Education Forum, and the visit included tours of KAIST and Hanyang University, two of the top schools in Korea.

FAMILIAR FACES

The visit also included a tour of a Samsung Electronics facility. Dr. Injong Rhee is the company's vice president

DR. INJONG RHEE

in charge of software R&D and mobile communications business and a former professor in the Department of Computer Science at NC State.

During the university visits, Martin-Vega said the group was continually introduced to professors, deans and department heads with degrees from or ties to NC State.

Dr. Young Moo Lee, an NC State College of Textiles graduate and president of Hanyang University, attended the alumni reception.

"I think the event was great as Dean Martin-Vega hosted the event for NC State engineering alumni in Korea," he said. "About 40 engineering alumni attended the meeting and heard about the past progress and future vision of NC State engineering."

According to President Lee, there is a chapter of the NC State Alumni Association in South Korea, and departmental alumni meet from time to time to "exchange information and remember our graduate student days at NC State."

President Lee said there are several engineering faculty members with NC State ties at Hanyang. He estimated that about 500 NC State engineering alumni are working in the country.

More than a dozen of those alumni are Ph.D. graduates who worked under Dr. Richard Kim, a worldwide authority in the area of asphalt pavement materials. Many of those students keep in touch with each other and with Kim, he said, and jokingly refer to themselves as the "NC State mafia."

"The students that I produced here at NC State went back to South Korea and really contributed to the improvement of Korean highway pavements," said Kim, who earned a bachelor's degree in civil engineering from Seoul National University and master's and Ph.D. degrees in the same discipline from Texas A&M University.

Kim said that engineering graduates from NC State are playing prominent roles in South Korea, comparable to graduates from Ivy League schools.

> "... people would arguably say that few, if any, universities in the United States have had as much of an impact on the development of South Korea as NC State."
>
> **DEAN LOUIS MARTIN-VEGA**

"There were testimonials made at that alumni meeting where people would arguably say that few, if any, universities in the United States have had as much of an impact on the development of South Korea as NC State," Martin-Vega said. ▪

ON THE ROAD

Dean Dr. Louis Martin-Vega and staff from the NC State Engineering Foundation have planned several events this year designed to inform alumni and friends about the important work going on in the College and the Engineering Building Oval project.

Look for more event details in invitations that will be sent to alumni and friends of the College:

4/11	**Charlotte, NC** | Mint Museum Uptown at Levine Center for the Arts
4/28	**Newton, NC** | Catawba Country Club
5/5	**Raleigh, NC** | Corporate Event Duke Energy The Peak-Capital Room
5/25	**Washington, DC** | Army & Navy Club
Fall 2017	**Texas**
Fall 2017	**Atlanta**

Homecoming kicks off university **fundraising campaign**

THE COLLEGE WELCOMED alumni back to campus for another homecoming celebration in late October. **ROB MANNING**'s message to the assembled Wolfpack engineers and their families was simple.

"We'll take your money, but what we need is your mind and your engagement," Manning, then president of the NC State Engineering Foundation and a 1978 electrical engineering graduate, said at the event.

While fundraising is certainly important, especially as the University kicked off the "Think and Do the Extraordinary" campaign during the homecoming weekend, Manning told an audience in the James B. Hunt Jr. Library on NC State's Centennial Campus that there are many ways to give back. As alumni connect back to the University, he encouraged them to remember where their degree came from and to learn more about how they can help.

"It's important to be plugged into athletics and the alumni association," he said. "If you want to make a difference, plug back into the College of Engineering."

Think and Do the Extraordinary: The Campaign for NC State hopes to raise $1.6 billion over five years for scholarships, research, programs and facilities, making it the largest effort of its kind in the University's history. The campaign kicked off with a gala at the renovated Reynolds Coliseum.

Earlier that day, engineering alumni enjoyed a barbecue lunch followed by a homecoming program that included insights into the impactful research being done in their College.

DR. FRANCIS DE LOS REYES, professor in the Department of Civil, Construction, and Environmental Engineering, described his work addressing a problem that affects 2.5 billion people globally — lack of access to adequate sanitation. Of those 2.5 billion people, about 1 billion defecate in the open, a problem with tremendous

human health and environmental impacts. Millions more use pit latrines, which must be cleaned using methods that put workers at risk for disease.

Next, **DR. VEENA MISRA**, Distinguished Professor of Electrical and Computer Engineering and director of the National Science Foundation Nanosystems Engineering Research Center for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST), described the center's work building wearable devices that are powered by the human body and provide important health data on the user's health and surrounding environment.

Misra detailed several research components ASSIST is involved in as it works toward building an integrated health monitoring system: making the battery in a wearable last longer, creating lower-power sensors so that the system can communicate data to a smartphone or computer and pulling more power from the human body.

Finally, **ANNA WINSLOW** and **DAVID LEE** demonstrated a powered upper-limb prosthesis developed in the UNC/NC State Joint Department of Biomedical Engineering (BME).

Winslow, a Ph.D. candidate in BME, and Lee, a laboratory manager in the department, explained that their work will benefit upper- and lower-limb amputees and patients with multiple sclerosis before putting the device into action as the assembled audience looked on.

Though Misra was speaking of the work in ASSIST, she summed up all of the research work presented when she said, "At the end of the day, we are working on something that will really have a global impact." ▪

Foundation staff **welcomes new member**

BRUCE GRADY

DR. BRUCE GRADY joined the Foundation in October 2016 as director of development and major gift contact for the Department of Electrical and Computer Engineering.

Prior to joining the Foundation, he worked as the chairperson of the board for AventWest Community Development Corporation in Raleigh, NC and was a member of the board for the Infinity Ballet Conservatory and Theatre in Apex, NC. Grady also worked for Shaw University as an associate professor of religion and philosophy, was a lecturer for Afrikana studies in the Department of Interdisciplinary Studies at NC State and was a lecturer in the Executive Certificate in Religious Fundraising program at the Lake Institute on Faith & Giving, part of the Lilly Family School of Philanthropy at Indiana University-Purdue University Indianapolis.

Grady continues to work as a member of the committee of the Yahve Jire Children's Foundation to support an orphanage-school in Port-au-Prince, Haiti. He is also a member of the Kappa Chapter of Kappa Delta Pi International Honor Society in Education and a member of the Chancellor's African American Community Advisory Council at NC State.

Grady received a Bachelor of Science in mechanical engineering from NC State (1991), a Master of Divinity in social justice and community development from The Divinity School at Duke University (1994), a Master of Theology in church and society from Princeton Theological Seminary (1996) and a Doctor of Education in religion and education from Teachers College, Columbia University (2002).

Grady is happily married to his best friend, Michele. They have two children, Isaiah and Alex. ▪

NC STATE Engineering

ANNUAL GIVING

ENGINEERING FOUNDATION

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

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

WAYS TO GIVE

- Make your gift online at **go.ncsu.edu/engineering-giving**
- Use the return envelope included in this magazine to pay by check or credit card
- Make a gift over the phone by calling 919.515.7458

JOIN THE DEAN'S CIRCLE

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

INCREASE YOUR IMPACT

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

If you have already made your 2016-17 gift to the College of Engineering, please accept our sincere thanks. If you have questions or would like to learn more about your giving options, contact Angela Stallings at 919.513.1714 or angela_stallings@ncsu.edu.

College names 2016 **Distinguished Engineering Alumni**

FROM LEFT, LEODIS JENNINGS, PAMELA TOWNSEND AND JASON RHODE

THE COLLEGE AWARDED its Distinguished Engineering Alumnus award to three deserving graduates at a ceremony on Oct. 26, 2016.

The College honored **BRIGADIER GENERAL LEODIS T. JENNINGS**, who has retired from the Army National Guard; **DR. JASON RHODE**, president and CEO of Cirrus Logic; and **PAMELA B. TOWNSEND**, senior vice president for WSP/Parsons Brinckerhoff.

The award honors alumni whose accomplishments further their field, foster professional development of young engineers and bring distinction to the University through engineering achievement.

Jennings earned his bachelor's degree in materials science and engineering from NC State in 1983. He also received a Master of Arts in international business from Webster University (1984), a Master of Military Art and Science from Fort Leavenworth, Kansas (1996), and a Master of Science in strategic studies from the Army War College at Carlisle Barracks, Pennsylvania (2002).

He was commissioned as an armor officer in the Army National Guard, where he became an experienced leader and force manager whose guidance was sought at all levels of leadership throughout the Army and from the Chairman of the Joint Chiefs of Staff, the Department of Defense and Congress until his retirement from the service. He currently serves on the Board of Visitors for the University and has been appointed to the Department of Materials Science and Engineering's external advisory board.

Rhode earned his master's degree in electrical engineering in 1993 and his doctorate in electrical engineering in 1995 from NC State. Upon completing his doctoral degree, Rhode joined Cirrus Logic as an analog design engineer. In his time at the company, he has taken on the role of design manager, director of marketing for analog and mixed signal products and vice president and general manager of Cirrus Logic's Mixed Signal Audio Division. In May 2007, Rhode was named president and chief executive officer of Cirrus Logic, Inc. Rhode is a member of IEEE and has been issued 19 U.S. patents in the area of mixed signal technologies.

Rhode and Cirrus Logic maintain a close relationship with the university and have provided vital financial support for NC State, the Department of Electrical and Computer Engineering (ECE) and the College. Cirrus Logic attends the College's Engineering Career Fair twice per fiscal year, has created two professorships in ECE and maintains a strong recruiting relationship with NC State.

Townsend 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. Her role as vice president for WSP/Parsons Brinckerhoff, one of the world's leading engineering and professional services firms, includes responsibility for the Southeast Region operations. Townsend was the senior vice president for Southeast Region Strategic Planning with Dewberry, a family-owned firm. She also held several positions over 24 years with AECOM, a publicly traded global infrastructure firm.

Townsend has served the state of North Carolina in many ways. She received an appointment from the NC House of Representatives to the Joint Legislative Blue Ribbon Commission to Study the Building and Infrastructure Needs of the State, has served on the leadership team for development of the STEM WAKE/NC State High School, and helped to bring the NC Future City middle-school outreach competition to North Carolina. She has served on the advisory board for NC State's Department of Civil, Construction, and Environmental Engineering and the NC State Engineering Foundation board of directors and previously chaired the Paul Zia Lecture committee. ▪

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

WOULD YOU LIKE TO HELP the College continue to provide world-class engineering education and relevant, cutting-edge research? Here are some giving options:

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

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

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

Capital Gifts: These gifts go toward "bricks and mortar" projects. Donors are given "naming opportunities." Opportunities include the planned Engineering Oval building and other engineering buildings on Centennial Campus.

In-Kind Gifts: These are gifts of goods or services to the College at a discount or no cost.

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

For more information, please contact Brian Campbell or Lora Bremer at 919.515.7458. The Federal Tax Identification Number for the Foundation is 56-6046987. ▪

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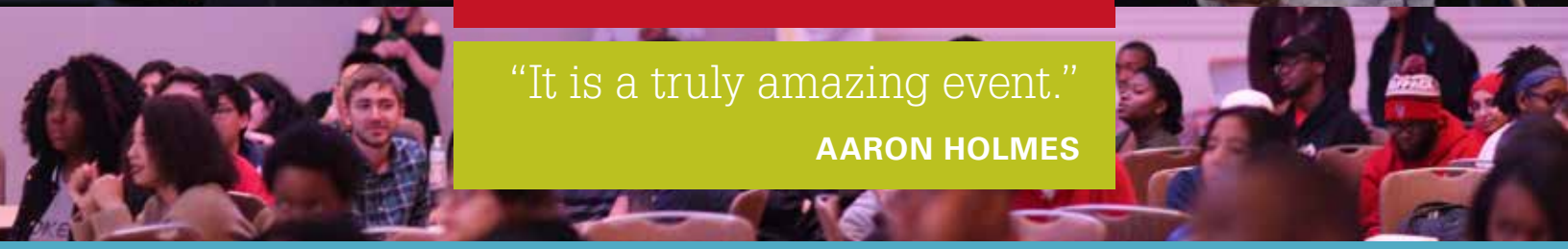
ANNUAL **POETRY SLAM** COMBINES **CREATIVITY** AND **STEM** FOR ENGINEERING STUDENTS



"It is a truly amazing event."

AARON HOLMES

AS A HUSHED TONE FELL over the Talley Student Union Ballroom, Aaron Holmes, an NC State engineering student and for one night, a spoken word poet, took the stage.

"I hate chemistry," Holmes, a senior studying chemical engineering and vice president of the National Society of Black Engineers (NSBE) NC State chapter, exclaimed in his dialogue. "I hate the entity that explains the very air we breathe. I hate to see the leaves turn green. Wait, let me rephrase that. I hate the interaction between the sky and a tree. The capture of CO_2 that we can't breathe. And the reactions that release the O_2 we receive."

The annual Technimetric Poetry Slam is an initiative designed to promote science, technology, engineering and math (STEM) by coupling it with poetry and spoken word.

"It is a truly amazing event," said Holmes after watching the other student performances. "To see the different thoughts and connections in how people approach STEM poetry is beautiful."

The 3rd annual performance, held on January 17, was hosted by STEMedia, a digital media company targeting the Science, Technology, Engineering, Arts and Mathematics community.

"It's technical intelligence meets creative genius," said Dr. Nehemiah Mabry, STEMedia president, NC State Engineering alumnus and creator of the event.

According to Mabry, Technimetric is a unique opportunity for engineering students and other STEM majors to express their creativity while also sharing their love of the sciences. "Every year it's growing, and it's amazing to see the building interest from students — which can be seen from the first event being held in Caldwell to now one of the ballrooms in Talley," said Mabry.

Kane Smego, international spoken word poet and hip-hop artist, served as one of the judges and also performed as a guest poet.

"Events like this help break down the stereotype that you have to choose between science and math and the humanities," Smego said. "It is a true innovation that comes through the imagination and blending of various subjects."

Looking to the future, Mabry is hoping for continued growth, future sponsorships and the possibility of taking the idea to other universities. "I can see the value that this event brings to companies, companies that are looking to hire creative and technical talent."

On January 17, 10 students from various departments in the College participated, sharing poetry on topics ranging from classes and grades to women's rights.

"The election was rough on me," said Kayla Mumford, a sophomore in the UNC/NC State Joint Department of Biomedical Engineering, who said the 2016 presidential contest acted as the inspiration for her entry. "I used it as a way to encourage others to use their voices and speak up."

Along with STEMedia, the STEM poetry slam was sponsored by NSBE, Arts NC State and the College's Minority Engineering Programs (MEP). Angelitha Daniel, director of MEP, was in attendance at the event representing the program and acting on the panel of judges.

"Every year, we are seeing an increase in student numbers and the event is growing as more students take a stab at creative poetry. I am happy to see this growth not only in numbers, but also in the different ethnic backgrounds of the student poets themselves." ▪

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Join Dean Louis A. Martin-Vega and his wife, Mrs. Maggie Martin, in the new Dean's EB Oval Club. Your gift of $50,000 to $100,000 toward the construction of Engineering Building Oval gives you the honor of membership in this exclusive group of visionaries who believe engineering education and research are vital to the future success of our state and nation. Engineering Building Oval will be the College's newest building on Centennial Campus.

DEAN'S EB OVAL CLUB **MEMBERSHIP BENEFITS**

Members of the Dean's EB Oval Club will be:

- Permanently recognized in a prominent location in Engineering Building Oval.
- Invited to exclusive events, including the groundbreaking ceremony, hard hat tours of the space and the dedication of the new building.
- Given regular insider updates about the progress of the construction and information about the education and research that will be conducted in the classrooms and labs.

For information on becoming a member of the Dean's EB Oval Club, please contact Lora Bremer at 919.513.0983 or lora_bremer@ncsu.edu.