

# NC STATE

# Engineering

SPRING/SUMMER 2016



## ENGINEERING ON THE MOVE

Bond package would make Engineering Oval building a reality

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## CIVIL, CONSTRUCTION, AND ENVIRONMENTAL ENGINEERING LOOKS FORWARD TO ANOTHER MOVE

Before moving to its current location in Mann Hall, what is now referred to as the Department of Civil, Construction, and Environmental Engineering (CCEE) called a number of spaces home, according to Dr. David Johnston, Edward I. Weisiger Distinguished Professor Emeritus in CCEE and author of a history of the department.

Civil engineering at NC State is as old as the university itself: Fundamentals of civil engineering was part of the mechanics curricula, one of two available to students when the North Carolina College of Agriculture and Mechanic Arts first enrolled students in the fall of 1889. A civil engineering department was established in 1895 and was first housed in the Mechanics Building, which was eventually torn down in 1927 to make room for Peele Hall. Then came stops in Primrose Hall starting in 1906 and Winston Hall beginning in 1910.

A new facility named the Civil Engineering Building opened in 1928 and was expanded in the early 1950s as GI Bill students flooded campus after World War II. That building, renamed Mann Hall in 1956 in honor of civil engineering alumnus, professor and department

head Carroll Lamb Mann, is now called Daniels Hall and is home to the Edward P. Fitts Department of Industrial and Systems Engineering (ISE).

Construction of what is now called Mann Hall began in April 1962 and the first classes were offered in the building in the spring of 1964. In its 50 years in the “new” Mann Hall, CCEE has more than doubled in size and also occupies space in other buildings on Main and Centennial Campuses.

These photos show crews constructing the current Mann Hall in 1964 and the finished building in 1965. The department hopes to be moving to a new home in a few years: the Engineering Oval building planned for Centennial Campus. CCEE will share space in the new facility – the fourth engineering academic building on Centennial Campus – with ISE and the dean’s administration.

On page 18, learn more about Engineering Oval and the March 15 Connect NC statewide bond referendum that would help fund its construction if voters give their approval.

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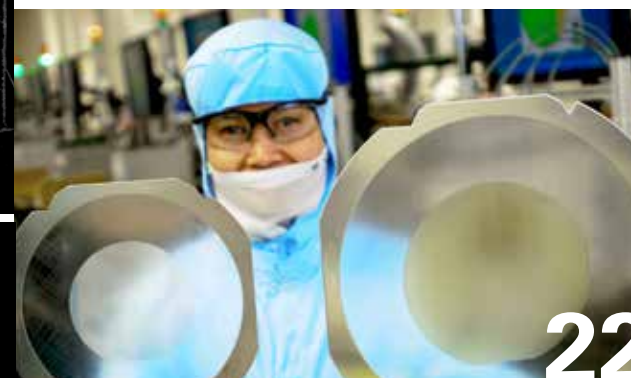
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**DEAN** Dr. Louis A. Martin-Vega

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# Q&A

## QUESTIONS FOR DOUGLAS REEVES

Dr. Douglas Reeves, professor of computer science and electrical and computer engineering, has served as an assistant dean working with graduate programs since fall 2013 and was named associate dean for graduate programs in 2015. Under his leadership, the College's academic departments have recruited a record number of high-quality students.

### How many graduate students are currently enrolled in the College? Is that number growing and does the College plan for it to continue to grow?

There were roughly 3,300 engineering graduate students (2,100 master's and 1,200 Ph.D.) enrolled in fall 2015, which is a third of the total graduate student enrollment at NC State. Ten years ago, the total number of engineering graduate students was about 1,800; we've grown substantially since then! The current plan is to hold steady the number of master's students, and grow the Ph.D. enrollment to approximately 1,500.

### Why is growing the Ph.D. program important?

As a research-intensive university (one of only two in the UNC system, along with UNC-Chapel Hill), it is critical to our mission to recruit the best minds and train them to be outstanding researchers. That training allows them to do things they could never otherwise do and gives us the opportunity to have an impact far greater than would otherwise be the case.

### What makes NC State a great place for graduate studies in engineering?

Most importantly, we have a world-class faculty. The chance to work with such faculty members, and with fellow students who are amazingly creative, is the best reason to come to NC State. Another reason for coming here is that employers and universities greatly value the quality of our students and our programs, which translates into excellent opportunities after graduation. We also have excellent facilities, particularly on Centennial Campus, and we're fortunate to be in one of the top places to live in the United States.

### Which schools are we routinely competing with for top engineering graduate students?

We frequently find our applicants are also being recruited by the top public engineering programs, such as the Universities of Michigan and Illinois, and Georgia Tech. It's not unusual to be competing with elite private universities as well, such as Carnegie-Mellon and MIT.

### You had recruiting success as director of graduate programs in the Department of Computer Science. What was the key?

The reputation of the program and the faculty ultimately are what attracts applicants. For top applicants, we made admissions decisions early and offered substantial financial aid. For domestic students, a visit to campus to meet faculty and students, and a positive experience, was key to getting them to accept. Most master's students are self-supporting, but the return on investment of our degrees was so good (because of the demand for our graduates) that we had a tremendous number of applications from well-qualified students.

### Is distance learning available at the graduate level?

Yes. The Engineering Online program is one of the oldest and best-established distance education engineering programs in the world. We offer 16 master's degrees through streaming-video technology, taught by the same professors, and in the same way, as our on-campus degrees.



# FROM THE DEAN



LOUIS A. MARTIN-VEGA

Spring semesters are typically filled with anticipation and excitement in the College of Engineering. This semester, though, is more exciting than usual. On March 15, North Carolinians will vote on the Connect NC bond referendum. This bond includes funds that will help the College come one step closer to relocating to Centennial Campus. If the bond passes, NC State will receive \$75 million in bond funds toward the \$154 million needed to construct the new Engineering Oval building with the agreement that the College and University will provide the remaining funding.

Planning for the new 227,000-square-foot home to our Department of Civil, Construction, and Environmental Engineering; Edward P. Fitts Department of Industrial and Systems Engineering; and dean's administration is already under way thanks to \$2 million in planning money appropriated by the North Carolina Legislature last fall.

The College and University are working diligently to educate North Carolinians on the benefits of the bond, which include funds for community colleges, parks, the zoo and critical infrastructure projects across the state as well as upgrades for important National Guard facilities. In addition, the bond will help fund a new Plant Sciences building on Centennial Campus that will support the state's vital agricultural economy. In all, the bond will directly affect 76 of North Carolina's 100 counties, and the projects it funds will provide jobs across the state. I invite you to learn more about the bond at [connectnc.ncsu.edu](http://connectnc.ncsu.edu).

Our NC State Engineering Foundation officers have already raised \$20 million in commitments for Engineering Oval and are working diligently to raise the remaining \$40 million in private funds needed for the project. I encourage you to contact the Foundation to find out more about this effort. You can also learn more about Engineering Oval at [www.engr.ncsu.edu/oval](http://www.engr.ncsu.edu/oval).

As always, I hope that you will enjoy this special issue of the *NC State Engineering* magazine. You will learn about an exciting new development in carbon materials and the College's latest leadership role in the new Research Triangle Nanotechnology Network. Also, please go ahead and mark your calendars for October 28th to attend Homecoming. We'll be sharing news about a very significant development in the history of the College.

Thank you for your support of the College of Engineering.

Sincerely,

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

## Ivanov succeeds Azmy as head of Department of Nuclear Engineering



Dr. Kostadin Ivanov, the new head of the Department of Nuclear Engineering, will build on predecessor Dr. Yousry Azmy's work to grow the department and move research into new areas.

Ivanov served as Distinguished Professor of Nuclear Engineering and graduate coordinator in the nuclear engineering program at Pennsylvania State University. His research interests are in reactor physics, fuel management and modeling, coupled space-kinetics/thermal-hydraulics modeling, core analysis and design methods, computer code qualification and uncertainty quantification.

Azmy's seven-year tenure saw the number of bachelor's degrees in nuclear engineering increase by 47 percent and the number of master's degrees increase by 56 percent. The department's faculty grew from eight in 2007 to 17 today.

The department is a founding partner of the Consortium for Advanced Simulation of Light Water Reactors, an effort to make sure that future nuclear reactors can work safely and more efficiently, and is leading the Consortium for Nonproliferation Enabling Capabilities, which is working on the next generation of nuclear material detection systems.

At Penn State, Ivanov established the Reactor Dynamics and Fuel Management Group, which addresses the demands for more accurate and efficient analyses concerning safety and economic performance of current and next-generation nuclear systems. He helped establish Penn State as an international center for qualification of coupled 3D kinetics/thermal-hydraulics codes. ■



TAYLOR FORBIS

## Engineering Ambassadors celebrate 10 years of leadership

The room was filled with excitement as students from middle and high schools watched a hovercraft glide across the floor, a concrete canoe attempt to float on water and an animatronic hand wiggle its fingers one at a time at the annual Freshman Engineering Design Day (FEDD) at the McKimmon Center on NC State's campus.

First-year engineering students work on projects during their first semester on campus to learn the basics of the engineering process and work in teams to present their results at FEDD. Older engineering students in red polo shirts assisting these young students and answering questions about projects are Engineering Ambassadors.

The Engineering Ambassadors (EA) team, which formed in 2006, is an initiative that puts the College's top students at the forefront of its recruiting, mentoring and marketing efforts. Of the 54 students on the 2015-16 EA team, 34 are University Scholars, 12 are Park Scholars and nine hold University Honors. All 54 are on the dean's list.

"When you take a step back, our team of 54 phenomenal students are some of the College's strongest leaders, almost one percent of the undergrads, and they are so committed to everything we do — namely student success — our number one priority," said Brian Koehler, the College's director of student engagement.

Ambassadors must have an outstanding academic record with a grade point average of at least 3.0 and have joined one of the College's 18 degree programs. Applicants must display a high level of personal and professional character, demonstrate a willingness to develop leadership ability, be committed to serving on a team, show dedication to delivering more than what is asked and be enthusiastic about the impact of engineering, the College and NC State.

EA Taylor Forbis, a sophomore studying civil engineering, learned about the program in her E101 Introduction to Engineering and Problem Solving class. Forbis says she has loved what being part of the team has taught her.

"Helping young students, grading papers, showing others what NC State is about, info sessions, working with parents — we are creating a support system not only with each other, but for (first-year students)," Forbis said.

Alberto Quiroga, a sophomore aerospace engineering major and current EA, saw a great opportunity in joining the team.

"It has been an incredible experience. I have definitely grown a lot since I was accepted. It has taught me to really value my education more and truly come to love such a great team. I learned so much to become a better team member and leader in the community — definitely an experience of a lifetime."

Ambassadors participate in a long list of activities that range from K-12 STEM nights at local elementary schools and an egg drop contest with the Boys Club of Raleigh to the NC State Engineering Career Fair and FEDD. Ambassadors also act as teaching assistants for the E101 course, which all first-year engineering students are required to complete. ■

## Monitoring of breathing could help doctors better assess patients' needs

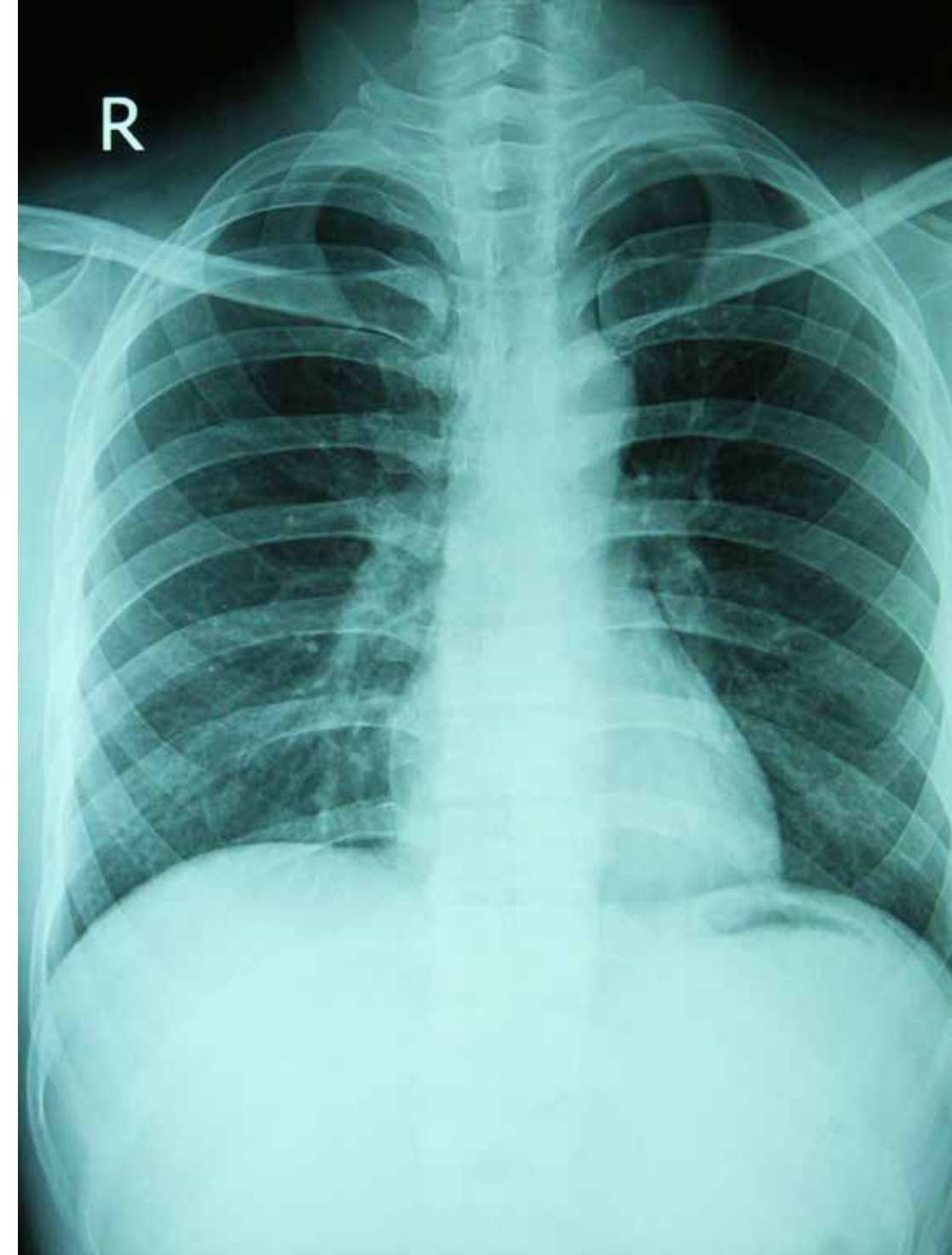
Dr. Hamid Krim, a professor of electrical and computer engineering, and Saba Emrani, a Ph.D. candidate, have developed an algorithm that can interpret the wheezing of patients with breathing difficulties and give medical providers more insight into what is happening in the lungs.

The work is part of research being done in the National Science Foundation Nanosystems Engineering Research Center for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST) led by NC State.

This algorithm is designed to work in tandem with wearable technology that allows physicians to monitor patients' breathing based on daily conditions.

"Researchers at ASSIST have developed wearable sensors that are powered by a patient's body heat and can monitor the sound of a patient's breathing," said Krim. "Now, we've developed an algorithm that can assess the onset time, pitch and magnitude (or volume) of wheezing sounds to give healthcare professionals information about the condition of the lungs. This information, in turn, can be used to help doctors make more-informed decisions about diagnosis and treatment."

Through their research, they plan on taking the sensors used to monitor breathing and transmit that information to a smart device, such as a smartphone. That data would then be calculated through the algorithm, and if it finds that there is a breathing problem, the smart device could then notify the patient and the medical provider.



The long-term goal is for the algorithm to be implemented on the sensor device itself and have it transmit an alert to the smart device only if it detects a problem.

"We have the sensors and we have the algorithm — and we know that they work — but we haven't yet integrated them into a smart device. That's next," said Krim. ■





DR. VERONICA AUGUSTYN, LEFT, WITH JOHN PAUL ENEKU, SCIBRIDGE AFRICA ORGANIZER.

## NC State students develop research collaborations with students in Africa

As a graduate student at UCLA, Dr. Veronica Augustyn spent two weeks in Ethiopia as part of a National Science Foundation workshop on materials for sustainable energy.

The workshop offered a unique opportunity for U.S. and African students to meet and learn about the latest advances in materials for clean energy. Over the course of the workshop, it became clear that many of the African students in attendance did not have access to the same materials and instruments as their U.S. counterparts. Augustyn, now an assistant professor in the Department of Materials Science and Engineering (MSE), set out to change that.

Augustyn started SciBridge, an outreach project created by the desire to grow the scientific discussion between U.S. and east African scientists around the critical need for sustainable, global, energy development. SciBridge sends

kits from the United States to African students, allowing them to conduct their own research experiments on materials for sustainable energy. After students perform the experiment, a U.S. researcher is invited to give a live Web seminar, which is followed by a Q&A and discussion session.

The program is based at NC State and Makerere University in Uganda. Augustyn is the organization's chairperson and U.S. advisor, and several NC State engineering students serve as volunteers.

"I think having a hands-on and visual demonstration of really interesting science is a great way to engage students. This seemed like a good place to start collaborating with African universities because the students there need access to materials, supplies and instruments," said Augustyn. "So even starting with an experiment kit would be a way to grow the collaboration into something larger in the future."



One of these experiment kits involves making dye-sensitized solar cells.

Students in Africa are using the kits to screen local fruit dyes in order to lower the cost and improve the efficiency of the solar cells. A recent instrument donation from Ocean Optics will allow students to better quantify their results.

"Because the technology and electronics have come so far, you can do a lot of stuff with very little," said Chris Boggs, an NC State doctoral candidate in mechanical and aerospace engineering and SciBridge volunteer. "That's the interesting thing for me, is making these kits that demonstrate these really complex scientific concepts, but on a very fundamental level."

Materials for the experiment kits are purchased with grants from a variety of organizations, including the Materials Research Society and NC State's Office for Institutional Equity and Diversity. Students volunteer their time for the project by developing, building and shipping experiment kits. While the supplies in the kits may be common in American laboratories, it is a boon for the universities in Africa to have access to these materials. Developers, though, have to consider a number of usability factors for each experiment kit before shipping them out.

"The big challenge is coming up with experiments because the large part of our costs is shipping the lab kits over to Africa," said Alexandria Cruz, an MSE graduate student and volunteer. "And some of the challenges are making lab kits light-weight, non-toxic, potentially reusable and making lab kits that are focused around renewable energy."

More information about the project can be found at [www.scibridge.org](http://www.scibridge.org). ■

## Researchers show that metal foam can block radiation

Dr. Afsaneh Rabiei, a professor of mechanical and aerospace engineering, and her colleagues are working on research that shows lightweight composite metal foams are effective at blocking X-rays, gamma rays and neutron radiation, and are capable of absorbing the energy of high impact collisions.

"This work means there's an opportunity to use composite metal foam to develop safer systems for transporting nuclear waste, more efficient designs for spacecraft and nuclear structures and new shielding for use in CT scanners," said Rabiei.

She first developed the strong, lightweight metal foam for use in transportation and military applications, and later, she wanted to determine whether the foam could be used for nuclear or space exploration applications, where it could provide structural support and shielding against high impacts and radiation.

Rabiei and her colleagues decided to conduct multiple tests to see how effective the foam is at blocking X-rays, gamma rays and neutron radiation. The material's performance was then compared to the performance of bulk materials that are currently used in

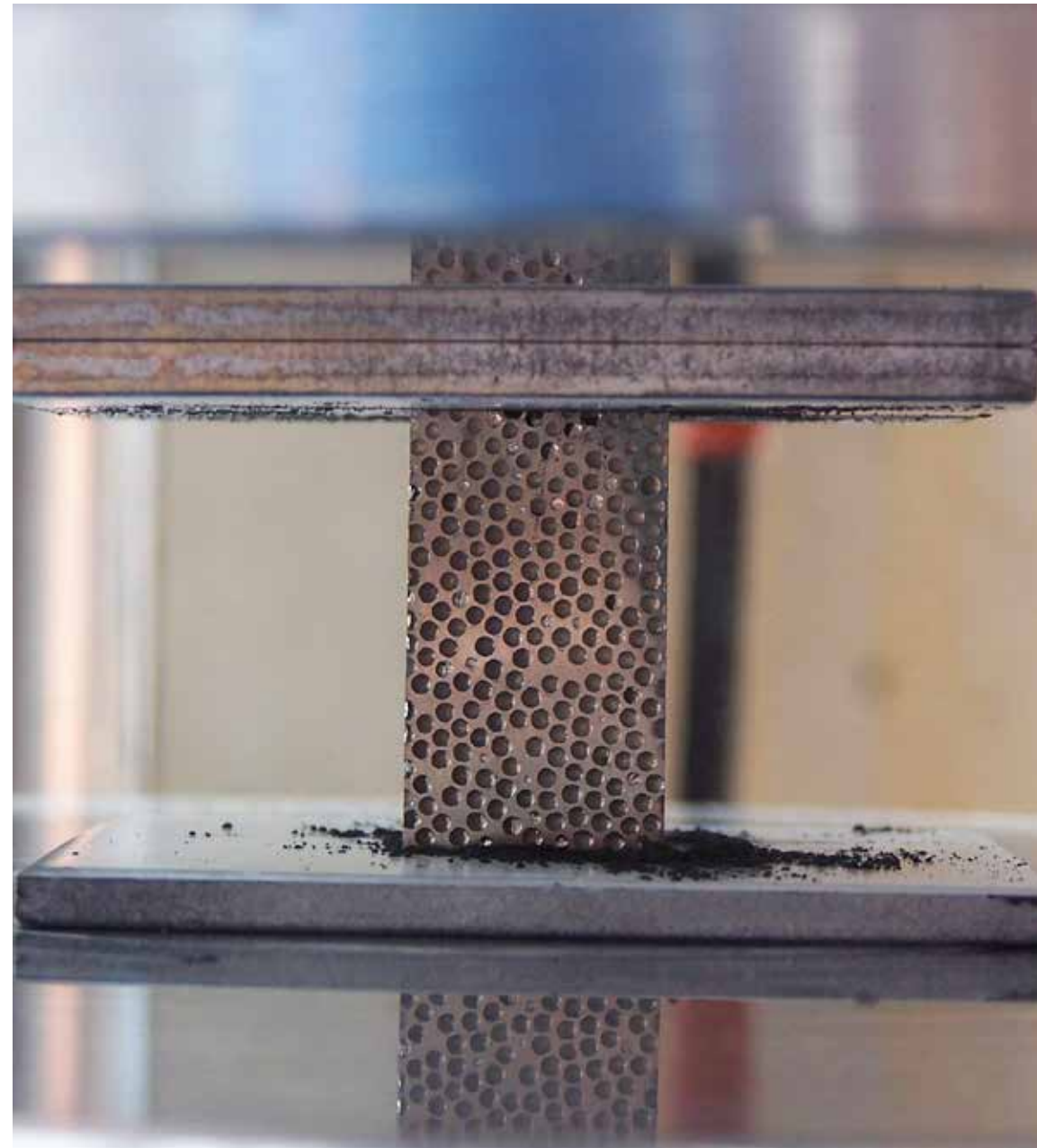
shielding applications by the use of samples of the same areal density – meaning that each sample had the same weight but varied in volume.

The most effective composite metal foam against all three forms of radiation is called "high-Z steel-steel" and was made up largely of stainless steel but incorporated a small amount of tungsten. However, the structure of the high-Z foam was modified so that the composite foam that included tungsten was not denser than metal foam made entirely of stainless steel.

Through testing on various kinds of gamma radiation, researchers found

that the high-Z foam was comparable to bulk materials at blocking high-energy gamma rays but was much better than bulk materials – even bulk steel – at blocking low-energy gamma rays and it outperformed other materials at blocking neutron radiation. Though when it came to blocking X-rays, it still could not beat lead.

"However, we are working to modify the composition of the metal foam to be even more effective than lead at blocking X-rays — and our early results are promising," said Rabiei. "And our foams have the advantage of being non-toxic, which means that they are easier to manufacture and recycle. In addition, the extraordinary mechanical and thermal properties of composite metal foams, and their energy absorption capabilities, make the material a good candidate for various nuclear structural applications." ■





## Women and Minority Engineering Programs win diversity award



FROM LEFT, DR. LAURA BOTTOMLEY, ANGELITHA DANIEL AND DR. K.J. (JAMIE) ROGERS.

**D**r. Laura Bottomley, director of the Women in Engineering Program (WIE), and Angelitha Daniel, director of the College's Minority Engineering Programs (MEP), accepted the Claire L. Felbinger Award for Diversity for the College's Women and Minority Engineering Programs from ABET in October.

The Claire L. Felbinger Award for Diversity recognizes U.S.-based educational units, individuals, firms and associations for extraordinary success in achieving diversity and inclusiveness or for facilitating diversity and inclusiveness in the technological segments of our society. The Women and Minority Engineering Programs were one of two award recipients for 2015.

Bottomley and Daniel were recognized for their years of research in developing programs in MEP and WIE that would

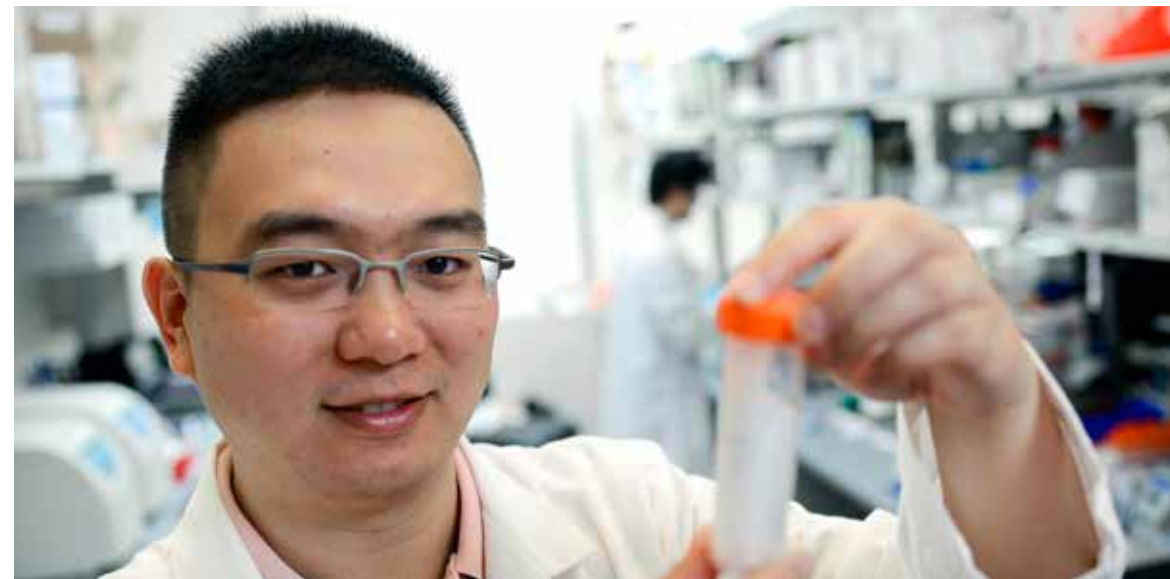
entice underrepresented groups to pursue engineering and to follow the programs to graduation. Since 2004, the percentage of female students in the College's first-year class has nearly doubled. NC State ranks ninth nationally in the number of bachelor's engineering degrees awarded to African-American students among schools that are not historically black colleges and universities.

"This award acknowledges our tireless dedication to creating an environment that makes everyone feel welcomed and appreciated for who they are and what they bring to the table," said Daniel. "It allows our current students to know that the depth of the programmatic support here at NC State is recognized at a national level."

MEP develops and maintains programs that assist in the recruitment, retention

and graduation of African-American, Native-American and Hispanic students within the College. MEP does this with the creation and sponsoring of early intervention programs, tutorial programs and counseling with the objective of increasing the number of minority students entering and successfully completing engineering and computer science degrees.

The Women in Engineering Program's vision is to foster an environment for female students in the College that encourages, supports and challenges them to ever-higher levels of success. WIE makes representatives of the College's academic departments available to female students choosing a major and provides an opportunity for female engineering students to meet informally in an inclusive atmosphere. ■



## Young researchers earn national recognition

**D**r. Alper Bozkurt, an assistant professor of electrical and computer engineering, and Dr. Zhen Gu, an assistant professor in the Joint UNC/NC State Department of Biomedical Engineering, have been recognized as young innovators in two of the nation's top science publications.

Bozkurt was named one of *Popular Science's* "Brilliant 10" for his work establishing the foundations of the "internet of bionic things" in areas ranging from human-animal communication to insect biobots to human health monitoring devices. Gu was named one of *MIT Technology Review's* "Innovators Under 35" for his work on developing novel drug-delivery

systems for treating cancer and diabetes.

"This is very exciting, because my work is based on outside-the-box thinking, and I didn't know what other people might think of it," said Bozkurt. "Knowing that the work is exciting to others makes me want to work even harder."

Bozkurt's research includes using cyborg cockroaches, also known as biobots, to locate the sources of sounds; electronically manipulating the flight muscles of moths and monitoring the electrical signals they use to control those muscles; research that assesses sleep physiology; and the development of smart fabrics with sensors integrated

into textile fibers to monitor health and wellness. Bozkurt also works alongside the National Science Foundation's Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST) Center at NC State to develop prototypes that advance the ideas of wearable health-monitoring technologies.

Gu's research includes the development of "smart insulin patches" to help regulate insulin for diabetics and new approaches to targeting the delivery of anticancer drugs directly to tumors. Gu and his research team use nanoscale "daisies" and graphene "flying carpets" that deliver anti-cancer drug cocktails directly to cancer cells.

Their "nano-cocoons," nanocapsules and a delivery system activated

by the presence of the "energy molecule" ATP trick a cancer cell into absorbing them before they trigger the release of anti-cancer drugs.

"It is very exciting to be recognized for my innovation and passion for using science and technology to help people and – hopefully, eventually – to both improve people's quality of life and save lives," said Gu.

The "Brilliant 10" is an annual feature profiling 10 young scientists and engineers who are doing truly groundbreaking work in their fields, and the "Innovators Under 35" was created to highlight exceptionally talented young innovators from around the world in a variety of fields. ■





## Fake vomit tracks air spread of viruses

When a person vomits, we all jump out of the way to avoid the spray. Now, it looks like that won't be enough.

Dr. Francis de los Reyes III, a professor of civil, construction and environmental engineering and other researchers from NC State and Wake Forest University have direct evidence showing that vomiting can aerosolize virus particles, like those of the human norovirus. This means that even if you avoid the vomit altogether, the aerosolized virus particles from it can end up on you and surrounding objects and even inside your mouth.

"Epidemiological evidence has pointed to virus aerosolization during vomiting as a likely route for spreading norovirus, and our work here confirms that it's not only possible

but probable," said Dr. Lee-Ann Jaykus, a professor of food, bioprocessing and nutrition sciences at NC State, co-author of a paper on the work and director of the USDA-NIFA Food Virology Collaborative initiative (NoroCORE).

The norovirus is a group of more than 30 related viruses and affects more than 20 million people a year in the U.S. In about a quarter of cases, people become infected via contaminated food or water, but it is most often spread due to close contact between people. Infections from the norovirus can cause vomiting and diarrhea and, in the worst case, hospitalization or death, especially in the elderly.

For their experiments, the researchers used a vomiting machine. This machine is designed to resemble

a scaled-down version of a mouth, esophagus and stomach by using tubes and a pressure chamber that passes through a clay face to give it the correct vomiting angle. It allows researchers to control the pressure and volume of the vomit and is enclosed in a sealed Plexiglas box and placed under a biosafety hood.

The vomiting machine was used to determine if fake vomit containing MS2 bacteriophage, a harmless alternative to the norovirus, would aerosolize during a simulated vomiting event and, if so, how much of it became airborne.

"In terms of overall percentage, not a lot of the virus is aerosolized," de los Reyes said. "But in absolute terms, it is a lot compared to the amount of virus needed to cause infection." ■

## New metamaterial manipulates sound to improve acoustic imaging

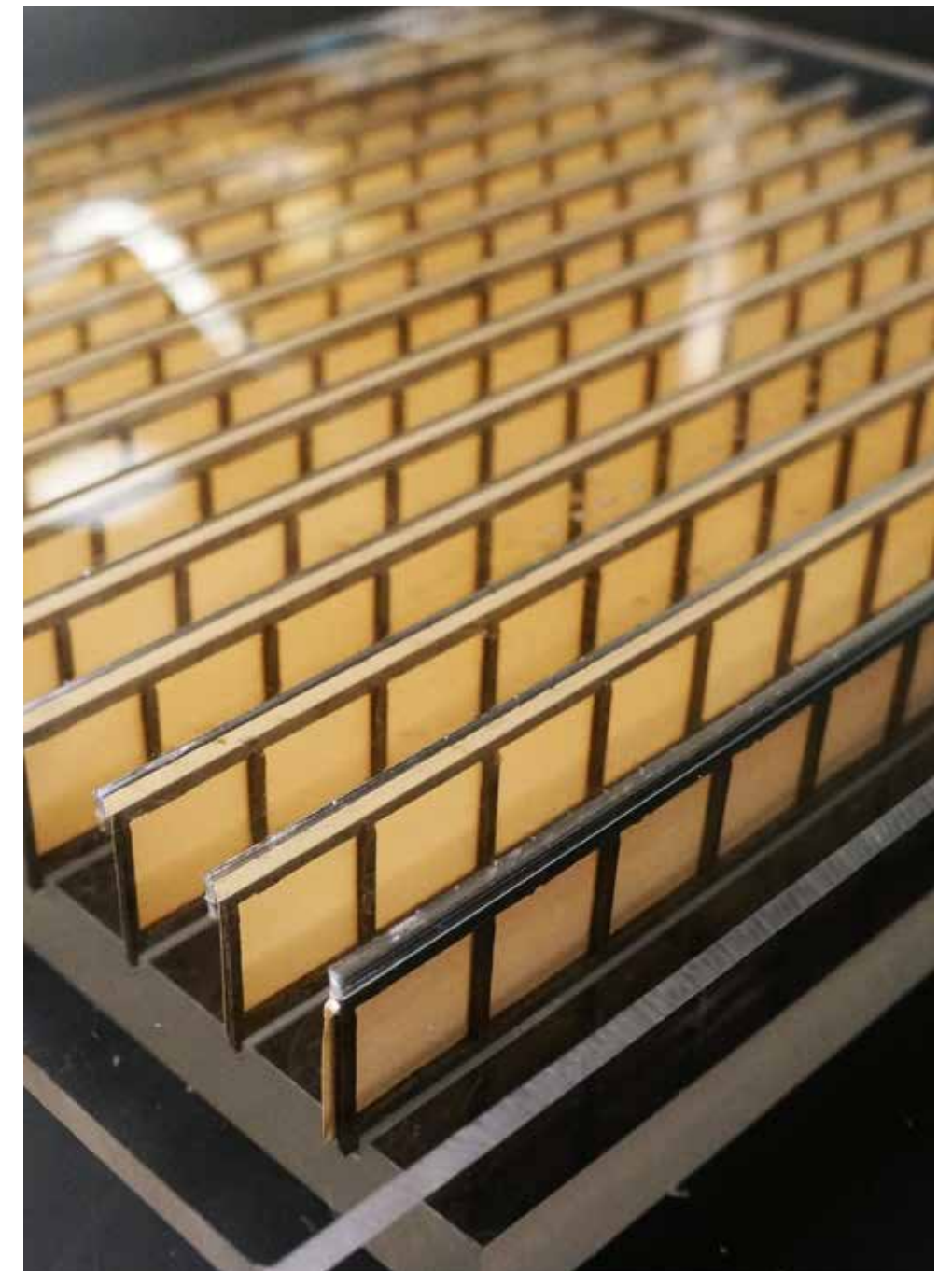
Researchers from the College working with colleagues at Duke University have developed a metamaterial made of paper and aluminum that can manipulate acoustic waves to more than double the resolution of acoustic imaging, focus acoustic waves and control the angles at which sound passes through the metamaterial. Acoustic imaging tools are used in both medical diagnostics and in testing the structural integrity of everything from airplanes to bridges.

"This metamaterial is something that we've known is theoretically possible, but no one had actually made it before," says Dr. Yun Jing, an assistant professor of mechanical and aerospace engineering (MAE) and corresponding author of a paper describing the work.

Metamaterials are simply materials that have been engineered to exhibit properties that are not found in nature. In this case, the structural design of the metamaterial gives it qualities that make it a "hyperbolic" metamaterial. This means that it interacts with acoustic waves in two different ways. From one direction, the metamaterial exhibits a positive density and interacts with acoustic waves normally – just like air. But from a perpendicular direction, the metamaterial exhibits a negative density in terms of how it interacts with sound. This effectively makes acoustic waves bend at angles that are the exact opposite of what basic physics would tell you to expect.

The practical effect of this is that the metamaterial has some very useful applications.

For one thing, the metamaterial can be used to improve acoustic imaging.



Traditionally, acoustic imaging could not achieve image resolution that was smaller than half of a sound's wavelength. For example, an acoustic wave of 100 kilohertz (kHz), traveling through air, has a wavelength of 3.4 millimeters (mm) — so it could not achieve image resolution smaller than 1.7 mm.

"But our metamaterial improves on that," says Chen Shen, an MAE Ph.D. candidate and lead author of the paper. "By placing the metamaterial between the imaging device and the object being imaged, we were able to more than double the resolution of the acoustic imaging — from one-half the sound's wavelength to greater than one-fifth." ■



## Ultrasounds may be used to detect signs of preterm labor

**D**r. Marie Muller, an assistant professor of mechanical engineering, and a team of researchers worked alongside the Institut Langevin and Paris-Descartes University in France to conduct a proof-of-concept study that raises the possibility of using ultrasound techniques to detect cervical stiffness changes that indicate an increased risk of preterm labor in pregnant women.

Premature births can result in low birth weights and other medical problems for newborns, but there are steps that doctors can take to reduce the chances of premature birth if early warning signs are detected. One of these early symptoms is the softening of the cervix, which can be assessed by doctors manually palpating the cervix.

“But that’s a subjective measure, and we wanted to determine if ultrasound could be used to quantitatively assess how stiff the cervix is – and, by extension, whether a woman is at risk of

going into labor prematurely,” said Muller.

Muller and her colleagues decided to try a technique called shear wave elastography (SWE), which was developed to assess tissue stiffness for cancer diagnosis. They reasoned that if SWE worked for detecting changes in other body tissues, it might also work for detecting changes in the cervix.

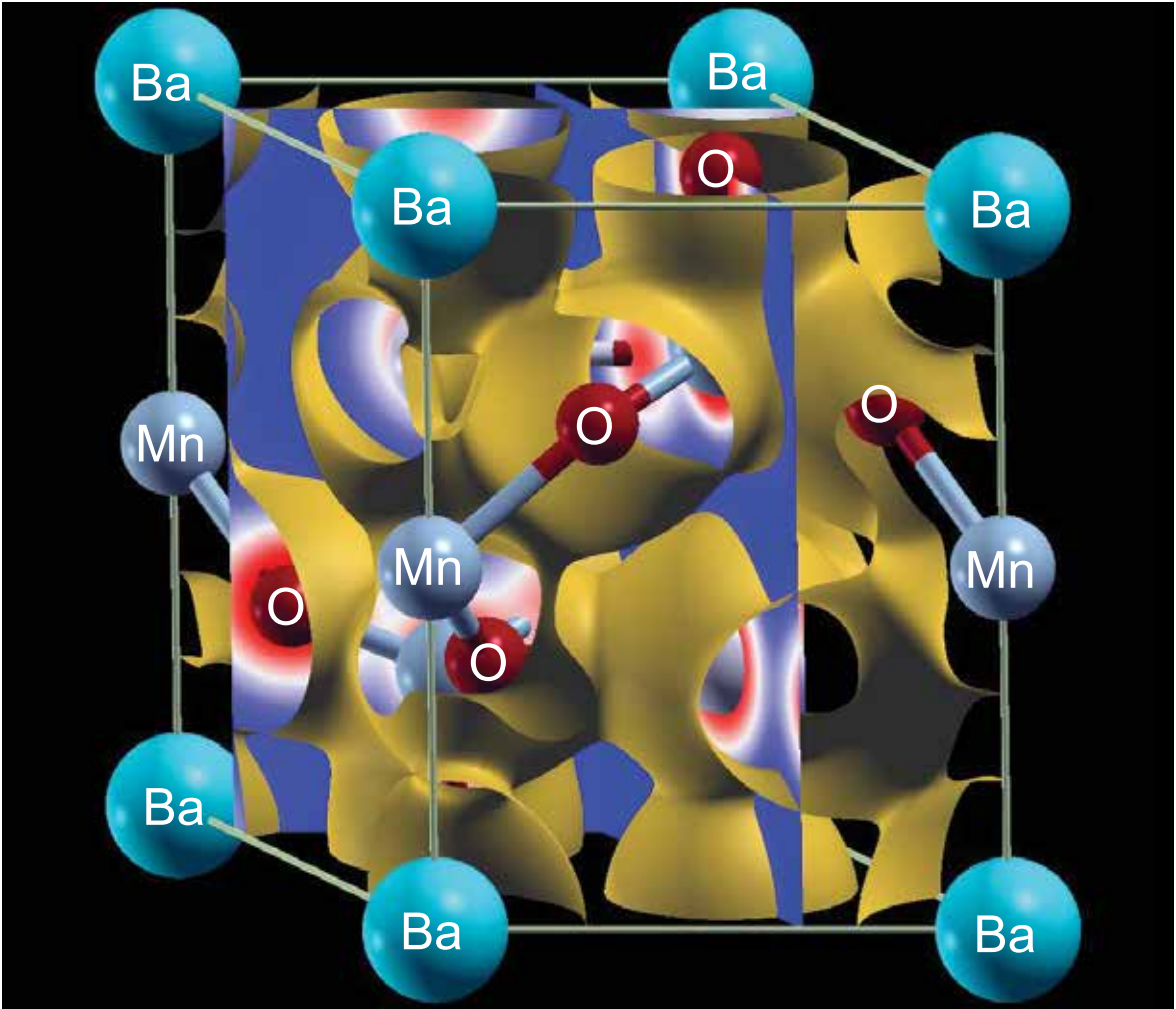
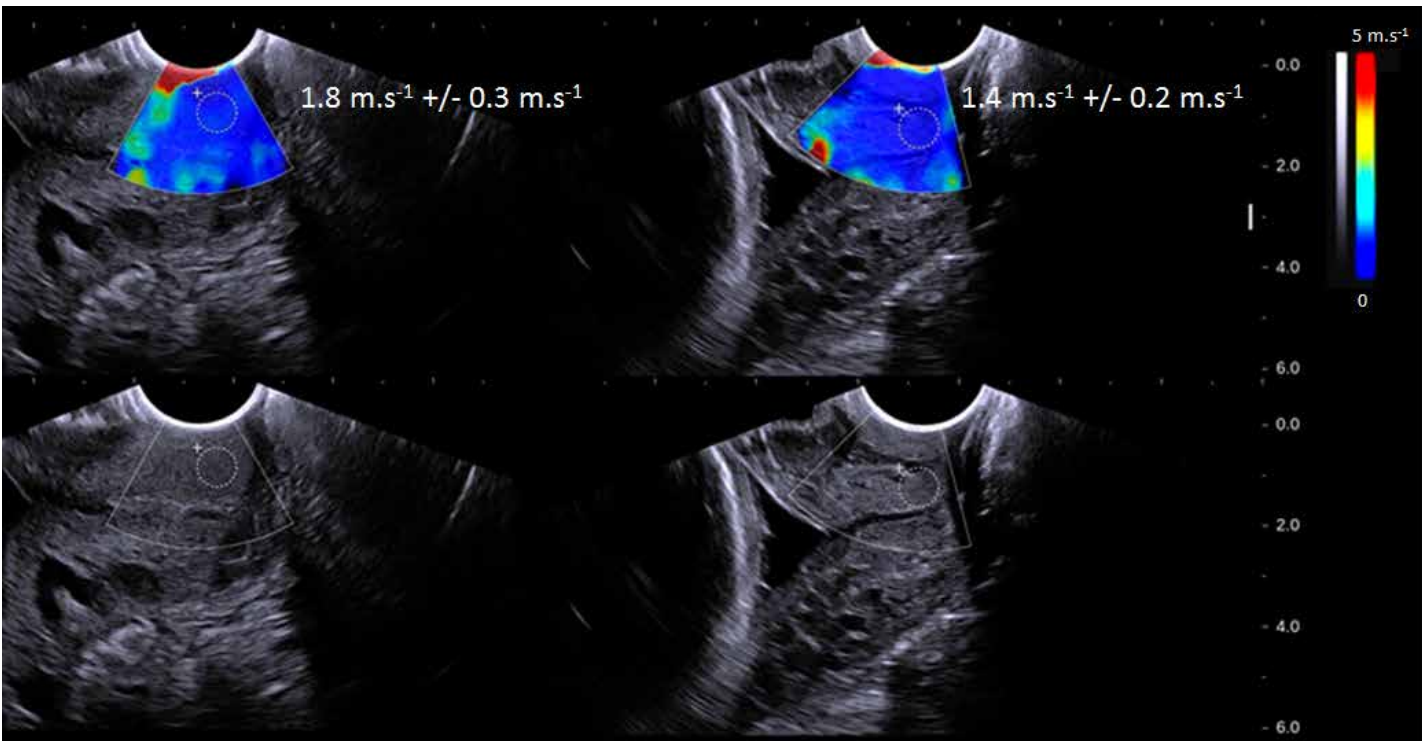
In SWE, stiffness is measured based on how fast a mechanical shear wave propagates through the tissue. What the researchers found was that if the wave was more than one meter per second below the baseline for a woman’s gestational age, or how far along she is in her pregnancy, the woman was more likely to have a preterm birth.

Working with a maternity hospital in Paris, the researchers did SWE measurements of 157 pregnant women who were already scheduled for ultrasounds. The researchers then followed each patient’s pregnancy and

determined that patients between 24 and 35 weeks pregnant who had below average cervical stiffness were at higher risk of going into preterm labor.

“This work is only a first step,” Muller says. “We know the technique is reproducible. We know we can measure these changes in cervical stiffness. However, we need to do a longitudinal study that follows patients throughout pregnancy. That would give us a better understanding of how cervical stiffness changes over the course of pregnancy – and that would help us determine which changes are likely indicative of early onset labor.”

Muller also notes that, while the SWE technique uses high-end ultrasound equipment, the equipment can be used for normal prenatal examinations as well as SWE assessments of cervical stiffness, which would possibly mitigate any additional cost. ■



## Universities collaborate to develop new alloys

**D**r. Don Brenner, Kobe Steel Distinguished Professor of Materials Science and Engineering, is helping NC State take the lead in a new initiative aimed at addressing fundamental scientific questions that could lead to the development of so-called “entropy-stabilized alloys” that can withstand extremely high temperatures.

“The Defense Department has a need for materials that are mechanically and chemically stable at ultra-high temperatures – meaning temperatures of 2,000 degrees Celsius or more,” said Brenner. “These materials can have significant aerospace applications, but the number of usable materials is

currently small, and those materials rely on strong chemical bonding to remain stable. At high temperatures, most materials are simply no longer stable.”

The University will be working alongside Duke University, the University of Virginia, and the University of California, San Diego to complete this research with funding from a five-year, \$8.4 million grant from the Office of Naval Research (ONR).

To address the shortage of ultra-high temperature materials, ONR has tasked Brenner and the rest of the research team with investigating the viability of creating entropy-stabilized alloys that withstand these temperatures. Entropy-stabilized alloys

are materials that consist of four or more elements in approximately equal amounts.

They have garnered significant attention in recent years because they can have remarkable properties. These alloys are of interest for use in ultra-high temperature applications because of their unique ability to “absorb” disorder in a material’s crystalline structure that otherwise would lead to the breakdown of a material.

The ONR grant is tasking the research team to develop the scientific concepts needed to determine whether it’s possible to create ultra-high temperature high-entropy alloys — and, if it is possible, how. ■



Baliga elected to the National Inventors Hall of Fame

**Dr. Jayant Baliga**, Distinguished University Professor of Electrical Engineering, will be inducted into the National Inventors Hall of Fame.

Baliga is being honored for his invention of the Insulated-Gate Bipolar Transistor (IGBT), a power semiconductor device used as an electronic switch around the world in all sectors of the economy, ranging from transportation to consumer appliances to factory robots and medical devices in hospitals.

The improved efficiency gained by using the IGBT in a wide range of applications has resulted in saving more than 1.5 trillion gallons of gasoline and reducing electrical energy consumption

by more than 75,000 terra-watt-hours (equivalent to not having to build 1,366 one-gigawatt coal-fired power plants). Since its invention, the IGBT has saved consumers \$24 trillion while reducing carbon dioxide emission by more than 100 trillion pounds.

The National Inventors Hall of Fame was launched in 1973 to inspire the next generation of inventors by celebrating the achievements of visionary U.S. patent holders who, through their innovations, have changed the world.

Baliga's induction ceremony will be held in May 2016 at the Smithsonian American Art Museum and the National Portrait Gallery in Washington D.C. ■



DR. JAYANT BALIGA

Zikry wins R.J. Reynolds Award

**Dr. Mohammed Zikry**, Zan Prevost Smith Distinguished Professor in the Department of Mechanical and Aerospace Engineering, is the 31<sup>st</sup> recipient of the R.J. Reynolds Tobacco Company Award for Excellence in Teaching, Research and Extension.

The award was established in 1981 within the College of Engineering to honor a member of the engineering faculty who has demonstrated superiority in several areas of activity that relate to the University's three-fold mission of teaching, research and extension. The annual award is supported by the R.J. Reynolds Tobacco Company through the NC State Engineering Foundation

to recognize scientific and educational achievements in fields of engineering. The recipient is given a \$25,000 prize distributed over five years.

Zikry's work has led to his being internationally recognized as an expert in the area of computational mechanics and modeling and has led to the development of new three-dimensional dislocation-density-based crystalline constitutive formulations and computational schemes that account for microstructural effects, such as grain boundary orientations and distributions, grain-size, and slip impedance and transmission at grain boundary interfaces in polycrystalline aggregates. ■



DR. MOHAMMED ZIKRY

Barlaz, Vouk named Distinguished Professors

Dr. Louis-Martin Vega, dean of the College of Engineering, has recognized two faculty members as Distinguished Professors.

**Dr. Morton A. Barlaz**, head of the Department of Civil, Construction, and Environmental Engineering (CCEE), has been named a Distinguished University Professor and **Dr. Mladen A. Vouk**, head of the Department of Computer Science and founding director of the NC State Data Science Initiative, has been named a Distinguished Professor of Computer Science.

Barlaz has been a part of the NC State faculty for 26 years and has served as

the department head for CCEE since 2010. He is internationally recognized for establishing a research program that covers several aspects of solid waste engineering and management.

Vouk, who also serves as associate vice chancellor for research development, has spent more than 30 years on the NC State faculty. He co-invented NC State's Virtual Computing Laboratory (VCL) cloud solution and served as the founding co-director of the Computer Science Software Systems and Engineering Laboratory and of the NC State Multimedia and Networking Laboratory. ■



DR. MORTON A. BARLAZ



DR. MLADEN A. VOUK

Grant honored for leadership by AAAS and AIChE

**Dr. Christine Grant**, associate dean of faculty advancement for the College of Engineering and professor in the Department of Chemical and Biomolecular Engineering, has been honored with the American Association for the Advancement of Science's (AAAS) Mentor Award and is one of the first recipients of the new American Institute of Chemical Engineers (AIChE) Pioneers of Diversity Award for her distinguished service to the organization.

The AAAS Mentor Award recognizes AAAS members who have mentored significant numbers of underrepresented students (women, minorities and persons with disabilities) working toward a Ph.D. in science, technology, engineering and mathematics fields,

and who have also demonstrated scholarship, activism and community building on behalf of underrepresented groups in STEM fields. This award is directed toward individuals in the mid-stage of their careers, defined by roughly 25 years of mentoring experience.

The Pioneers of Diversity Award recognizes individuals who pioneered the formation of the AIChE Minority Affairs Committee (MAC) and/or rendered continuous services to the committee. The Minority Affairs Committee selected Grant as a recipient of the inaugural award, citing her role as a former chair of the committee, her distinguished service to AIChE and her leadership in helping to create a more inclusive institute and profession. ■



DR. CHRISTINE GRANT





DR. JAGDISH NARAYAN, CENTER, WITH HIS RESEARCH GROUP.

# THE NEXT PHASE

DR. JAGDISH NARAYAN CREATES A NEW PHASE OF CARBON THAT CAN BE CONVERTED TO DIAMOND AT ROOM TEMPERATURE

Dr. Jagdish Narayan announced the discovery of a new phase of carbon in 2015 but offered a preview of that discovery in a paper published in the journal *Science* in 1991.

The new phase, dubbed Q-carbon, was created by melting carbon and then quenching it with high-power nanosecond laser pulses. Q-carbon can be converted to diamond at ambient temperatures and pressures and could offer a lower-cost way to produce diamond that would serve a wide range of uses.

"This has been a big challenge for scientists all over the world to convert carbon to diamond at low pressures," Narayan, John C. C. Fan Distinguished Chair Professor in the Department of Materials Science and Engineering (MSE), said. "We've always been hampered by thermodynamics."

Narayan began working on the question 40 years ago, but understanding the thermodynamics — science said

that carbon could only be a vapor or a solid, not a liquid — has taken decades.

Narayan wrote in that 1991 *Science* paper that the new carbon phase was possible, but exactly how it could be created was not yet known. Now it is.

"We said that under certain conditions we would be able to convert carbon into diamond," he said. "We could not control those conditions."

The discovery has made headlines worldwide. Narayan has given lectures on the discovery at five international conferences and four universities over the last three months. An easier, cheaper way to create diamond will have wide-ranging impacts, from energy exploration to healthcare.

"The response has been overwhelming," Narayan said. "People are so excited about the possibilities ranging from diamond high-power devices for Internet of power highway to biomedical applications."

## HARDER THAN DIAMOND

Phases are distinct forms of the same material. Graphite is one of the solid phases of carbon; diamond is another.

Q-carbon has some unusual characteristics. For one thing, it is ferromagnetic — which other solid forms of carbon are not.

"We didn't even think that was possible," Narayan says.

In addition, Q-carbon is harder than diamond and glows when exposed to even low levels of energy.

"Q-carbon's strength and low work-function — its willingness to release electrons — make it very promising for developing new electronic display technologies," Narayan says.

But Q-carbon can also be used to create a variety of single-crystal diamond objects. To understand that, you have to understand the process for creating Q-carbon.

Researchers start with a substrate, such as sapphire, glass or a plastic polymer.

The substrate is then coated with amorphous carbon — elemental carbon that, unlike graphite or diamond, does not have a regular, well-defined crystalline structure. The carbon is then hit with a single laser pulse lasting approximately 200 nanoseconds. During this pulse, the temperature of the carbon is raised to 4,000 Kelvin (around 3,727 degrees Celsius) and then rapidly cooled. This operation takes place at one atmosphere — the same pressure as the surrounding air.

The end result is a film of Q-carbon, and researchers can control the process to make films between 20 nanometers and 500 nanometers thick.

By using different substrates and changing the duration of the laser pulse, the researchers can also control how quickly the carbon cools. By changing the rate of cooling, they are able to create diamond structures within the Q-carbon.

Because it is harder than diamond,



Q-carbon will open up new horizons for super-hard coatings, deep-sea drilling and biomedical applications.

"We can make Q-carbon films, and we're learning its properties, but we are still in the early stages of understanding how to manipulate it," Narayan says.

"We know a lot about diamond, so we can make diamond nanodots, microdots, nanoneedles, microneedles and large-area single crystal thin films. We don't yet know how to scale up and make Q-carbon and other structures inexpensively. That's something we're working on."

## GLOBAL IMPACT

Narayan has received dozens of phone calls since publishing papers

co-authored by MSE research assistant Anagh Bhaumik on the discovery in *APL Materials* and *Journal of Applied Physics*.

One of those calls was from a magazine that covers the cutting tool industry, including the diamond-tipped drills used in deep sea drilling. It's possible that those drills could be sharpened with Q-carbon.

Diamond wheels are used to polish diamond with diamond, and those wheels wear out easily. Q-carbon, because it is harder than diamond, may offer a solution.

The possible applications go on from there.

"We can create diamond nanoneedles or microneedles, nanodots or large-area diamond films, with applications for drug delivery, industrial processes and for creating high-temperature switches and power electronics," Narayan says. "These diamond objects have a single-crystalline structure, making them stronger than polycrystalline materials. And it is all done at room temperature and at ambient atmosphere — we're basically using a laser like the ones used for laser eye surgery. So, not only does this allow us to develop new applications, but the process itself is relatively inexpensive."

The most impactful area for Q-carbon, because it is expected to be a better electric conductor, may be in diamond electronics, which Narayan describes as the "holy grail" for high powered switches. These switches would power the next-generation power grid being developed by the Future Renewable Electric Energy Delivery and Management (FREEDM) Systems Center, a National Science Foundation Engineering Research Center based on NC State's Centennial Campus.

NC State has filed two provisional patents on the Q-carbon and diamond creation techniques.

Narayan, for his part, will continue his work to learn more about this new form of carbon, the culmination of 40 years of work. ■





“We need help from the alumni in a way that we’ve never needed help from them before.”

BRIAN CAMPBELL

# A SIGNIFICANT step

A statewide bond package would help make the Engineering Oval building a reality

Faculty members and students in the Edward P. Fitts Department of Industrial and Systems Engineering (ISE) are bringing innovations that save money, time and lives to fields that range from manufacturing to healthcare.

Their counterparts in the Department of Civil, Construction, and Environmental Engineering (CCEE) are improving roads and buildings and ensuring our air and water are cleaner than ever before.

Both are doing this vital work in buildings that are more than 50 years old.

ISE and CCEE are located in Daniels and Mann halls, respectively, along Stinson Drive on the university’s North Campus. Mann Hall was built in 1964, and Daniels Hall in 1926.

Nearby, the Department of Nuclear Engineering — home of the first nuclear research reactor designed, built and operated by an academic institution anywhere in the world — is still using

the same facility built to house that reactor. Burlington Labs opened in 1950.

In the last decade, the College has grown in national rankings and enrollment. Research expenditures have increased, and the College has been able to attract faculty members who are leaders in their fields.

Much of that growth has been predicated on the College’s move to NC State’s Centennial Campus, which puts university faculty members and students together with top businesses and government agencies and has been recognized nationally as a model of what the 21st-century research campus should look like.

Yet, only six of the College’s nine academic departments have made the move.

“We still have one third of our College that does not benefit from having state-of-the-art infrastructure to do

world-class research,” said Dr. Louis Martin-Vega, dean of the College. “We have great people in the departments that haven’t gone over to Centennial, but we don’t have the infrastructure that they need to have.”

The College is planning a new Engineering Oval building that would house ISE and CCEE and some of the College administration now located on North Campus. A statewide bond package that will go before North Carolina voters on March 15 includes \$75 million that would help make the building a reality.

## NO ONE IS STANDING STILL

Engineering Building I opened on Centennial Campus in 2004 and was followed by Engineering Building II in 2005 and Engineering Building III in 2010.

And that’s only part of the College’s footprint on Centennial. Centers and labs associated with the College occupy parts of several other buildings.

State bond funds built Engineering Buildings I through III. Plans have been in place to build a fourth and fifth building but were sidetracked by the 2008 recession.

Meanwhile, colleges of engineering across the country are making significant investments, realizing the kind of impact that engineering education has on a state’s workforce and economy.

Texas A&M University plans to double its student enrollment and

faculty size by 2025 and is building a new 600,000-square-foot engineering building. Purdue University will hire more than 100 new engineering faculty members in the next three to four years.

Engineering Oval will be a big step toward making the College’s move to Centennial a reality. But it won’t be the only step.

“The vision that we have and the goals of our College are highly dependent upon completing our move to Centennial Campus, and this is a very significant step toward that,” Martin-Vega said. “It will not take us all the way, but it will take us very close.”

Engineering Oval plans call for a 227,000-square-foot building. The College has 450,000 square feet of current classroom, laboratory and administrative space still to relocate to Centennial.

The Department of Nuclear Engineering will remain on North Campus and will be part of a fifth engineering building, along with the rest of the College administration.

Moving the entire College to Centennial is essential in order to keep NC State Engineering in position to compete with peer institutions for the best students and faculty members.

First though, the College must complete Engineering Oval. And that will require passage of the Connect NC bond.

## MAKING A CONNECTION

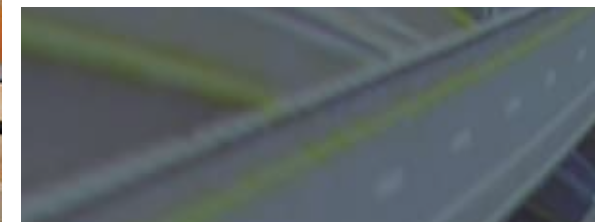
Two-thirds of the \$2 billion Connect NC bond package would go to higher education in North Carolina, including capital improvements to the North Carolina Community College System and the 16-campus University of North Carolina System. Along with Engineering Oval, the bond package includes \$85 million for a new Plant Sciences Research Complex that would be part of NC State’s College of Agriculture and Life Sciences.

While passage of the bonds would be a big step toward making Engineering Oval a reality, it would not be the only step. The university has committed funding, and the College will raise \$60 million in private donations to help fund construction. Commitments of a little more than \$20 million have been made, and the NC State Engineering Foundation will be working hard after the bond vote to secure more.

Private money for campus facilities is a fairly new phenomenon for NC State, but is standard procedure for most universities around the country, Martin-Vega said.

It will take significant investment from alumni and friends of the College, said Brian Campbell, assistant dean for development and college relations and executive director of the Foundation.

“In terms of the history and the trajectory of the College, this is one of those watershed moments,” Campbell said. “Once the entire College moves to Centennial, then we will be able to reach our full potential. We need help from the alumni in a way that we’ve never needed help from them before.” ■





# MAKING ENGINEERING OVAL A REALITY

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

## Edward P. Fitts Department of Industrial and Systems Engineering

Ranked as one of the top 10 public programs in industrial engineering by *U.S. News and World Report* in 2015, the Department of Industrial and Systems Engineering (ISE) had a fall 2015 enrollment of 340 undergraduates and 215 graduate students (135 MIE/MS students and 80 doctoral students).

### DEGREE PROGRAMS

- Bachelor of Science in industrial and systems engineering
- Accelerated BS/MS in industrial and systems engineering
- Master of industrial engineering (MIE): residential and online
- Master of Science in industrial engineering (MSIE)
- Dual Master of industrial engineering/Master of business administration (MIE/MBA)
- Doctorate (Ph.D.) in industrial engineering

### RESEARCH AREAS

Advanced Manufacturing | Ergonomics | Health Systems | Production/Service Systems and Logistics | Operations Research and Analytics

## Department of Civil, Construction, and Environmental Engineering

The Department of Civil, Construction, and Environmental Engineering (CCEE) embraces state-of-the-art research to support the development and operation of sustainable and resilient infrastructure for society. The department's highly ranked undergraduate and graduate programs include 48 faculty members who lead 156 ongoing research projects that represent \$18.6 million in research expenditures. As of the fall 2015 semester, the department had 754 undergraduate students, 336 master's students and 121 doctoral students.

### DEGREE PROGRAMS

- Bachelor of Science in civil engineering
- Bachelor of Science in construction engineering
- Bachelor of Science in environmental engineering
- Master of Science in civil engineering (MSCE)
- Master of Science in environmental engineering (MSENE)
- Master of civil engineering (MCE)
- Master of environmental engineering (MENE)
- Doctorate in civil engineering (Ph.D.)

### RESEARCH AREAS

Computing and Systems | Construction Engineering | Environmental, Water Resources and Coastal Engineering | Geotechnical/Geoenvironmental Engineering | Mechanics and Materials | Structural Engineering and Mechanics | Transportation Systems and Materials

### THE BUILDING

- The Engineering Oval building will be the fourth academic engineering building on Centennial Campus. Plans are in place for a fifth building to be constructed after Engineering Oval is completed.
- The building will measure 227,000 square feet.
- It will house more than 100 classrooms and state of the art laboratories.
- The estimated cost of Engineering Oval is \$154 million.

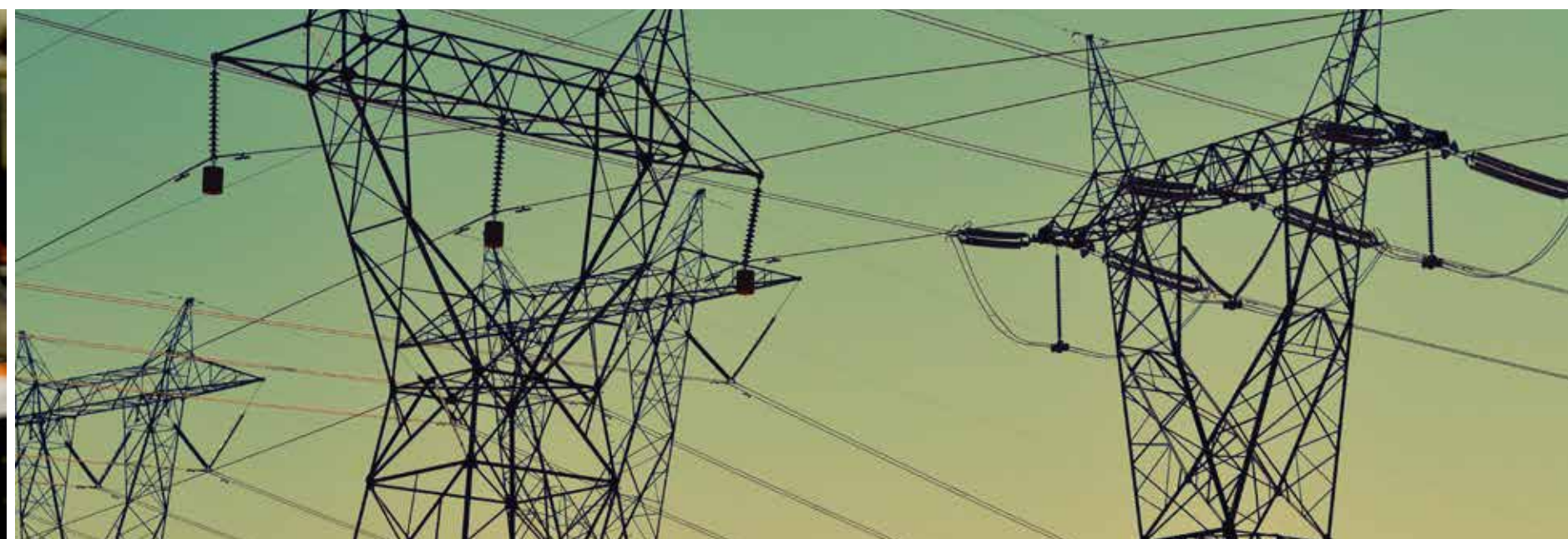
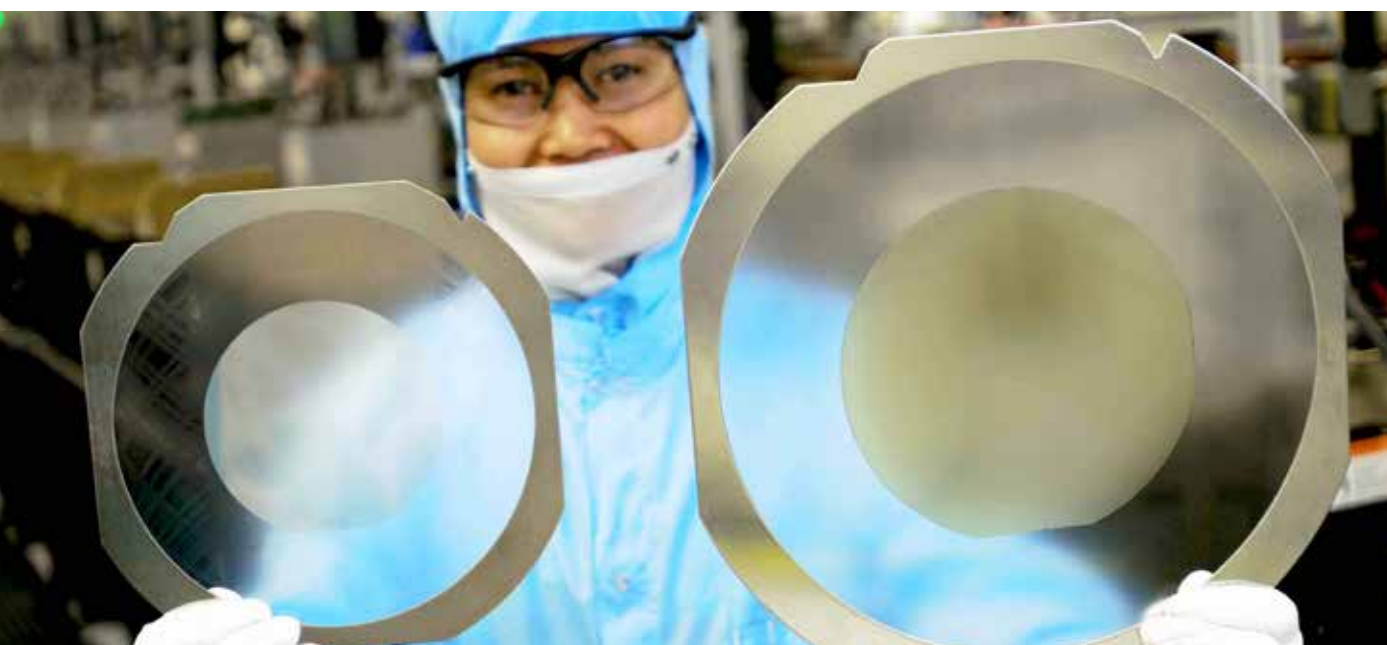
### HOW YOU CAN HELP

While passage of the Connect NC public bond referendum on March 15 would provide \$75 million for the Engineering Oval project, it would not fund all of the projected construction costs. The NC State Engineering Foundation has committed to raising \$60 million in private donations to help pay for construction. Commitments of about \$20 million have already been made. Early donors of \$50,000 or more to the project will be part of the Cornerstone Society, a select group of donors who will:

- Receive named recognition inside the Engineering Oval building
- Be invited to a special groundbreaking ceremony on Centennial Campus when construction is set to begin
- Receive an invitation to other VIP events and receive special insider information about the project.

If you are ready to help the College of Engineering make the Engineering Oval building a reality, contact: **Lora Bremer**, executive director of major gifts and campaign planning | **919.513.0983** | **[lora\\_bremer@ncsu.edu](mailto:lora_bremer@ncsu.edu)**





PowerAmerica will  
strengthen U.S.  
manufacturing and  
help meet global  
energy demand

# Power station

The International Energy Agency's 2015 World Energy Outlook estimates that mankind's appetite for electricity will increase by more than 70 percent between now and 2040 as the global population grows and advances in developing countries mean more demand for power.

Making more efficient use of energy goes hand in hand with the development of new resources as the global community wrestles with how to meet this demand.

President Barack Obama came to NC State in January 2014 to announce that the university would lead the Next Generation Power Electronics

Manufacturing Innovation Institute tasked with furthering development and manufacturing of wide bandgap (WBG) semiconductor-based power electronics.

The institute, now called PowerAmerica, has already helped U.S. companies bring new products to market and is spurring the development of new technologies on NC State's Centennial Campus. And that's only in the institute's first year of existence.

This ambitious project funded by the Department of Energy's Advanced Manufacturing Office brings together academia, industry and government to create solutions that close the gap between energy demand and resources

while helping to stem the tide of advanced manufacturing leaving the United States for other countries. That's not to mention providing the College of Engineering, and the university as a whole, with new educational and research opportunities while changing the national conversation about energy and our renewable future.

The National Network for Manufacturing Innovation concept is a new effort for the 21st century and is a national investment in strategic technologies to improve U.S. economic competitiveness. But the idea behind it, that the public and private sectors can work together to spur innovation, is not.





Retired Army Major Gen. Nick Justice, PowerAmerica's executive director, points to the land-grant college program that led to the founding of several public research universities in the United States in the 19th century as one previous example.

"Trying to shape and lead and bring connections between industry and government and academia is really what the focus of these institutes is, and if you look back at the history of the land grant colleges, I would say that's the model that the institutes take on today," he said.

Established as a land grant college in 1887, NC State has carried on that tradition with its innovative Centennial Campus, where industry, government and academics work side by side to bring about solutions for the challenges facing humanity in the 21st century. Add to that the College's long history of innovation in the semiconductor field and its lead role in a National Science Foundation (NSF) Engineering Research Center that is building a smarter power grid and it's no surprise that the University was tapped as the home for PowerAmerica.

#### **SMALLER, FASTER, MORE RELIABLE AND MORE EFFICIENT**

WBG semiconductors switch faster and can operate at higher temperatures and

voltages than the silicon semiconductors that have been widely used for the last 50 years. That technological leap forward will help the next generation of everything from consumer electronics, electric vehicles and electric motors to data centers and renewable energy applications like wind turbines and solar arrays to be smaller, faster, more reliable and more efficient.

But because it's a fairly new technology and engineers across the country are just starting to learn how to put it into commercial applications, PowerAmerica's aim is to help reduce the barriers to commercial adoption. The institute will do that by funding a mix of more than 25 industry and university projects per year that will lower the cost of WBG power devices and demonstrate the size, weight and power efficiency advantages of WBG power electronics in commercial applications. As the institute's collaborations with industry grow, new connections will be made leading to new manufacturing facilities and research collaborations that will also improve the U.S. supply chain for WBG power electronics.

"Ultimately, this technology will end up being inherently more reliable than silicon," said Dr. John Muth, PowerAmerica's deputy director and a

professor in the Department of Electrical and Computer Engineering. "Silicon has been around for many years, but with these wide bandgap semiconductors we will significantly improve power electronics and will be able to cut the power losses in many systems by about half."

The institute is spending more than \$30 million in its first year, with 75 percent going to partners outside NC State and half of that money being supplied by industry and other cost matching.

By March 2015, industry partner Arkansas Power Electronics International (APEI) released a new generation of power modules that contain WBG semiconductors with the institute's help. The new product is expected to be widely used because of its very low inductance and superior thermal properties. By May, APEI, which is now part of CREE spinoff Wolfspeed, had released a second product.

"Our purpose is to accelerate the new products," Muth said. "We're assisting them in being able to move faster and to increase their opportunities in the international marketplace."

Institute leaders anticipate a cluster of companies that will partner with and support PowerAmerica growing in the Research Triangle area, similar to the way

in which a cluster of clean technology companies has interacted with the NSF Future Renewable Electric Energy Delivery and Management (FREEDM) Systems Center, also led by NC State and based on Centennial Campus.

The institute has plans for a power electronics assembly and teaching manufacturing laboratory in the Varsity Research Building on Centennial Campus that would provide opportunities not only for NC State students and researchers but also for industry.

Entrepreneurs and small companies with a need to produce small batches of a circuit board for a new product often run into problems finding a contract manufacturer willing to work at low volumes, Muth said. This line could help solve that problem and would keep the work in this country instead of China or somewhere else overseas.

"To get them from initial hand-built prototype to something that's manufacturable, the teaching manufacturing laboratory would greatly aid that transition," Muth said. "We can aid in the design and will have better tools for them to build their initial prototypes but then we can also show them what they would need to do to make their prototypes manufacturable at higher volumes."



#### **STATEWIDE BENEFIT**

Dr. Srdjan Lukic is an associate professor in the Department of Electrical and Computer Engineering who is associated with both PowerAmerica and the FREEDM Center. As part of his FREEDM research, Lukic has imagined a wireless charging system for electric vehicles (EV) that would involve several modules stationed along a highway that would charge the battery in an EV as it cruised by.

Now, with support from PowerAmerica, he is working on an EV fast charger that, because it uses WBG semiconductors, is 10 times smaller than current EV charging stations. These smaller chargers — which also don't require a low-frequency step-down transformer to convert power from a utility line to a lower voltage and are thus much smaller and easier to install — could one day be installed anywhere along a power network, including at gas stations or homes.

FREEDM, like the NSF Nanosystems Engineering Research Center for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST) that is developing self-powered and wearable health monitoring systems and is also led by

NC State, has offered transformative research and educational opportunities for faculty members and students. PowerAmerica will do the same with similar summer programs for undergraduates, community college instructors and high school teachers but will be unique nationally by offering a teaching manufacturing laboratory.

The laboratory will have an emphasis on teaching design for manufacturing, design for reliability and design for cost. This will give NC State students a competitive advantage over their peers who learn these design for "X" principles on the job when they join industry and start manufacturing products.

As NC State students and faculty members benefit, so too will the state as a whole. As a land grant university, NC State has a long tradition of improving the lives of North Carolinians by educating their sons and daughters and transferring that knowledge into a stronger, more prosperous state.

This will only continue with PowerAmerica, Justice said.

"The things that this university produces — students number one but research and the technologies number two — are going to be a vibrant part of growing the state's economic future." ■



One of the goals of NC State's strategic plan is to "enhance interdisciplinary scholarship to address the grand challenges of society."

While faculty members are already working across disciplinary boundaries to conduct impactful research, the university's Chancellor's Faculty Excellence Program has taken that collaboration a step further by creating new faculty positions joined together in interdisciplinary clusters that look at problems in a new way.

Provost Warwick Arden announced the formation of 12 cluster programs in 2012 and a second round of eight more was announced in 2015. Of those eight, five are led or co-led by College of Engineering faculty members.

Those five clusters will make NC State a leader in the development of carbon electronics, improve sanitation and access to clean water in the developing world

and further research into microbiomes in plants and animals. The clusters will close the gap between development and implementation of new renewable energy technologies and use digital media to transform how we produce, consume and understand narrative content.

Interdisciplinary research is a popular concept on university campuses, but NC State is turning concept into reality by taking a grass roots approach that allows faculty members to explore new research areas that might be missed with a top-down program, said Dr. John Gilligan, executive associate dean of the College of Engineering.

"The cluster hiring program has gained national attention because we have done it in an organized, deliberate way and it has succeeded, whereas at many other universities it has not," Gilligan said. "It demonstrates our adaptability, our flexibility and our ability to work together.

It is really the theme of the College on Centennial Campus."

FINDING THE RIGHT FIT

By the time hiring for the second round of clusters is complete, the program will have added more than 70 new faculty positions across campus. Deciding which academic departments will house those new faculty members is part of the process.

Dr. Francis de los Reyes, professor in the Department of Civil, Construction, and Environmental Engineering (CCEE), is the coordinator of the new Global Water, Sanitation and Hygiene (WASH) cluster. He will work with a cluster search committee to fill four positions.

The cluster, which is seeking practical, scalable solutions to provide clean water and improved sanitation across the globe, has a need for expertise in

the fields of engineering, sociology, anthropology, political science, public health, environmental science and entrepreneurship. Who those hires will be, and which departments will house them, will be determined in the hiring process.

As the cluster committees and coordinators conduct hiring searches, they must think not only about how these faculty members will fit within the cluster, but also how they will fit within academic departments.

Support from faculty members helped make the first round of clusters a success, said Dr. Margery Overton, vice provost for academic strategy and coordinator of the cluster program.

Asking faculty members to submit cluster proposals rather than having university leaders mandate which research areas would form clusters has been key, Overton said. So has the way in

which new faculty members are recruited and hired.

Dr. Binil Starly, associate professor and director of the Laboratory for Engineering Biological Tissue Systems in the Edward P. Fitts Department of Industrial and Systems Engineering (ISE), came to Raleigh thinking that he would collaborate only with other new hires within his Translational Regenerative Medicine cluster. He soon found collaborators in several existing ISE faculty members and in Dr. Xipeng Shen, an associate professor of computer science and first-round Data-Driven Science cluster hire. The two met at a reception for cluster hires and were soon collaborating on a National Science Foundation grant.

"One of the best unintended consequences that we didn't anticipate was that engagement across clusters as we are hiring people who are keenly interested in interdisciplinary work," said

Dr. Duane Larick, senior vice provost for academic strategy and resource management.

FILLING A RESEARCH GAP

Dr. Joe DeCarolis, CCEE associate professor, and Dr. Laura Taylor, professor in the Department of Agricultural and Resource Economics and director of the Center for Environmental and Resource Economic Policy in the College of Agriculture and Life Sciences, saw a gap between the NC State engineering and science research on renewable energy systems and a broader understanding of the economic and social barriers to adoption of those new technologies.

"What we really lacked was the broader perspective," said DeCarolis, who is co-coordinator with Taylor of the Sustainable Energy Systems and Policy cluster. "We really want to be able to

tie that research to broader economic, environmental, social and political considerations. Simply developing new technology is no guarantee that it's going to be taken up by energy markets."

Similarly, Dr. Chase Beisel, assistant professor in the Department of Chemical and Biomolecular Engineering, saw that faculty members across the university were interested in the study of microbiomes and their impacts on plants, animals and the environment. Because of a lack of expertise on microbiomes at NC State, though, those researchers might have to go off-campus to collaborate. That was the impetus for Beisel and Dr. Michael Hyman, a professor of plant and microbial biology, to form the Microbiomes and Complex Microbial Communities cluster.

The Chancellor's Faculty Excellence program takes interdisciplinary research to a new level

Collaborative effort



“I feel like this is the right time, and NC State is the place to do it.”

DR. FRANCIS DE LOS REYES

A NEW WAY TO COLLABORATE

Taylor said the old way of collaborating with an economist meant a researcher would need to bring an economist into a research project at the last minute to meet funding requirements.

“That’s not at all what’s happening,” she said of today’s interdisciplinary environment. “It’s sitting down with our colleagues and trying to figure out our common language. Sometimes we are talking about the same thing but we use different phrases; we may approach the same question in different ways. It takes a while to figure out how your colleagues ask their questions and how they approach finding answers. It’s not only intellectually challenging, it’s energizing to learn these new ways of thinking.”

Faculty members leading these clusters have a chance to fill gaps in research that university leaders or department heads might not see and, in so doing, leave a lasting mark on their department and the university.

De los Reyes saw a way to further his research on global sanitation with a cluster that might one day lead to a center based at NC State.

“I feel like this is the right time, and NC State is the place to do it,” he said. ■

DR. CHASE BEISEL

DR. LAURA TAYLOR, LEFT, AND DR. JOE DECAROLIS

DR. BINIL STARLY

ENGINEERING INTERDISCIPLINARY SOLUTIONS

College of Engineering faculty members are coordinators or co-coordinators of five Chancellor’s Faculty Excellence clusters announced in 2015.

Carbon Electronics

**Dr. Harald Ade – Department of Physics**

**Dr. Franky So – Department of Materials Science and Engineering**

Carbon and carbon hybrid electronics offer fundamentally new avenues to solve some of the most important grand challenges of the 21st century. This cluster will work to develop international prominence in carbon-based energy, display and detection technology and computation platforms. It envisions a revolution of interrelated technologies, fostering advances in computing, renewable power sources and energy storage.

Global Water, Sanitation and Hygiene

**Dr. Francis de los Reyes – Department of Civil, Construction, and Environmental Engineering**

A staggering 2.5 billion people across the globe do not have access to adequate sanitation and almost 750 million people do not have access to safe drinking water. Inspired and anchored by international community-based projects, this cluster will explore the scientific, social and policy issues associated with providing sustainable water and sanitation in the developing world.

Microbiomes and Complex Microbial Communities

**Dr. Chase Beisel – Department of Chemical and Biomolecular Engineering**

**Dr. Michael Hyman – Department of Plant and Microbial Biology**

Life on Earth is sustained by innumerable microbial communities ranging in scale from huge oceanic systems to the gut of an insect. This cluster will focus on research concerning communities associated with crop plants, farm animals, insect pests and the environment. Faculty members will create a center of excellence in the analysis and engineering of plant, animal and insect microbiomes and microbial communities.

Sustainable Energy Systems and Policy

**Dr. Joe DeCarolis – Department of Civil, Construction, and Environmental Engineering**

**Dr. Laura Taylor – Department of Agricultural and Resource Economics**

The challenge of sustainable energy will not be met by technology alone; society must also simultaneously consider broader economic, public policy and environmental impacts. This cluster will address such societal challenges related to energy sustainability, with a vision to transform NC State into a hub for transdisciplinary research that informs key energy decisions at state, federal and international levels.

Visual Narrative

**Dr. Matthew Booker – Department of History**

**Dr. Michael Young – Department of Computer Science**

Narrative is a central mode of understanding the world around us. As narrative has expanded into digital media, new possibilities arise for the creation and analysis of powerful visual narratives that increasingly pattern our world. This cluster will enable new forms of scholarship and communication, bridging the expertise of engineers, humanists and designers to establish next-generation applications in visual media.



NSF-funded network to  
boost nanotechnology  
research and outreach

The new Research Triangle Nanotechnology Network (RTNN) is an interdisciplinary innovation hub that hopes to speed the development of new nanotechnology-based products, research, fabrication and education.

NC State will lead the network in partnership with UNC-Chapel Hill and Duke University. RTNN is funded by a \$5.5 million grant from the National Science Foundation (NSF) and is one of 16 sites chosen as part of NSF's new National Nanotechnology Coordinated Infrastructure (NNCI).

"We are the only site in the entire national network that has three major research universities partnering in this way. So our network really provides access to a tremendous amount of resources for not just North Carolina, but for anyone across the country," said Dr. Jacob Jones, a professor of materials science and engineering at NC State and principal investigator of the grant.

# A NATURAL FOR NANO



## BUSINESSES AND ENTREPRENEURS

Large and small companies and entrepreneurs will benefit from the enhanced access to university resources that RTNN will provide. Reaching out to these developers and researchers to let them know what is available is part of the network's current focus.

"The whole premise of the National Infrastructure Network is that universities have exceptional resources at their disposal related to nanotechnology – including clean rooms, deposition systems, scanning electron and transmission microscopes," said Jones.

"But the world doesn't readily know how to access that equipment – so the National Nanotechnology Coordinated Infrastructure is the entity that opens doors and facilitates people using university nanotechnology resources."

Jones said that companies would be provided access to resources at all three universities to facilitate fabrication of nanotechnology and devices, and to facilitate characterization of those devices. In some cases, that equipment already exists and in others the RTNN is in the process of acquiring it.

Access to these resources isn't the only benefit for businesses and entrepreneurs. Education and outreach activities are also being planned and executed. In November, a half-day workshop on *in situ* characterization was held at NC State with 20 participants from companies attending.

Participants learned some of the theory and examples through two lectures given by university faculty members. Afterwards, participants toured several different laboratories that had *in situ* experiments running in real time.

## SKY'S THE LIMIT

So what types of products might be improved by RTNN working with companies and entrepreneurs?

"Everything around you is made of materials, and everything could be enhanced or reengineered in some way that uses nanomaterials — the world is the limit," said Jones.

Concrete, coatings on glass windows and capacitors and circuitry in iPhones all use nanotechnology. At the level of nano, the physics of materials changes — electrical properties like resistivity and the strength of materials, for example — so there are implications everywhere. Jones says that with the types of resources provided by RTNN, nanotechnology will be enhanced in a diverse range of economic sectors, from soil science and textile engineering to animal science.

In the area of textile engineering, Jones and the RTNN are helping to develop atomic layer deposition on textiles with Dr. Greg Parsons' research group in NC State's Department of Chemical and Biomolecular Engineering. Adding atomic layers of materials would create textiles that absorb or repel water, textiles that are conductive or ones that change color under certain conditions.

"If you want to brainstorm, consider about something that has been around for a long time and then think about how its function or properties could be modified or enhanced using nanotechnology. The RTNN is enabling access to the resources that enable fabrication of these new materials and devices and their characterization," Jones said.

## EDUCATION OUTREACH

One way that RTNN is pioneering education and outreach programs involves new uses of technology. K-12 students often visit college campuses to tour labs and watch demonstrations of high-powered microscopes. These tours often take at least a day of class time, so RTNN pioneered a plan to bring

lab demonstrations to the students in their home classrooms over Skype.

"It's always assumed you must come to the university, but why doesn't the university go to them?" Jones said.

The first demonstration occurred on December 9, hosted by the Chapel Hill Analytical and Nanofabrication Laboratory (CHANL), an RTNN member facility. Middle school students at Orange Charter School in Hillsborough, NC were encouraged to collect hair samples from their homes.

The samples were then sent to CHANL, where UNC-Chapel Hill graduate students used a high-magnification scanning electron microscope to image the supplied samples in real time through a Web demonstration with the students. The program is now being extended to NC State and Duke labs.

RTNN is taking a conscientious approach to assessment and evaluation to ensure an impact is being made. To that end, David Berube, a professor of communication at NC State, is the lead of the social science component of the grant.

Berube is coordinating the assessments and evaluations of RTNN's impact by conducting surveys of users, evaluating demographics, performing assessments of the user experience and assessing the education and outreach programs. It is, according to Jones, a necessary way to show the value of RTNN and also keep everyone accountable.

"We want to sustain the RTNN for a long time. We have huge potential to influence economic growth and impact the public in a positive way — assessment and evaluation is one way through which we're going to do it. To sustain our efforts in the long term, we will remain competitive, adaptable and aggressive toward innovative programs and technologies." ■





PEGGY AND ED WOOLARD

## Woolard led Apple, Inc. back from the brink

It's hard to remember a time when Apple, Inc. was in trouble.

Now one of the world's largest technology companies and a paragon of both form and function for millions of rabid fans, in 1996 the company was on its third CEO in three years. Apple's stock price was flat, and its market share had shrunk to less than five percent of all personal computers sold.

Today, Apple is among the world's most popular brands, and its late co-founder Steve Jobs is remembered in movies and books as one of the great American visionaries of the last century and one of the country's greatest business leaders. The fortunes of Jobs and Apple might have turned out much differently if not for the diligent work of an NC State engineering alumnus.

Ed Woolard, a 1956 industrial engineering graduate who had just retired as CEO of DuPont in 1995, was

looking for a new challenge, and he found one when a friend suggested he take a position on Apple's board of directors.

Besides his time leading DuPont as both CEO and chairman, Woolard had been a director for Citigroup, IBM and the New York Stock Exchange. Joining Apple's board presented a different kind of challenge.

"When I went on the board, everybody said I was crazy because most analysts thought that Apple was history," Woolard said.

Steve Jobs, Steve Wozniak and Ronald Wayne started Apple in 1976 to produce and sell personal computers. The company found success and a cult following for its Macintosh computer but went into a long decline when Jobs was fired as chairman in 1985.

Lacking Jobs' vision, Apple moved into consumer products that weren't

successful. When Woolard joined the board, many experts believed that Apple had gotten too far away from its many strengths and was no longer a player in the personal computer market.

Woolard had one condition for taking over as board chairman: that he be given full access to the chief financial officer and to the human resources director.

The Washington, NC, native set out to learn as much as he could about Apple and CEO Gil Amelio's plan to turn it around. Woolard went further than the average board member, visiting Apple's headquarters in Cupertino, Calif. and meeting with employees at all levels.

### THE DECISION TO CHANGE

Woolard found Amelio to be a capable leader but not the right fit for this company. It soon became apparent that his plan to turn Apple around would

not be successful. Revenues were continuing to decline, stockholders were rebelling and key employees were leaving.

Woolard, using information he obtained from employees, convinced the board in 1997 that a change was needed to avoid a potential bankruptcy. As conversation turned to the search for a new CEO, one longtime board member suggested contacting Jobs about coming back.

After leaving Apple, Jobs had been involved with the computer animation studio Pixar and founded a new computer company called NeXT Inc., which Apple had purchased in 1997. After the sale of NeXT, Jobs was serving as an advisor for Amelio.

During a family trip to England to attend the Wimbledon tennis tournament, Woolard called Jobs, whom he had never met and had spoken to on the telephone only once, and asked him to return to the leadership of Apple.

Jobs had hard feelings about how his previous tenure at Apple had come to an end and put the blame on the board of directors at the time. He said he would not return as CEO or chairman but only as an advisor and would lead the company for a limited period of time. He would not accept a salary or even stock compensation.

He had one more unusual demand: that the entire board of directors, save for Woolard, resign immediately. Woolard convinced Jobs to let one other board member remain. The rest resigned and Jobs returned.

"I won't say trying to get Steve to come back was a hard job," Woolard said of that fateful phone call. "He wanted to come back, but he also played coy with me."



### THE ROAD BACK

Within a year Apple was on a solid footing. In less than three years, the stock price went to a record of more than \$100 from a low of \$12 and the total value of the company rose from \$2 billion to \$18 billion.

"Within six or nine months the stock tripled because people said 'he's back, and he's going to fix it,'" Woolard said.

Woolard and Jobs worked together closely to bring Apple back, so much so that Woolard's wife, Peggy, would joke that "your son's on the phone" when she picked up a call at home and found Jobs on the other end of the line.

Jobs, who has been the subject of two movies and an exhaustive biography titled simply "Steve Jobs"

since his death in 2011, sometimes had a reputation for being a difficult boss. Woolard found him to be extremely easy to work with and said Jobs seemed to be respectful of company employees.

Woolard, a longtime supporter of the College who was named a Distinguished Engineering Alumnus by the College in 1988 and received the Watauga Medal from the university in 2001, deflects any praise for his role in saving Apple, saying only that he was in the right place at the right time to help bring about the change the company needed.

"I was extremely pleased and proud to have helped Steve Jobs build a strong board, talented management team and a great company," Woolard said. "It was exciting, terrific fun and resulted in an outstanding business success story." ■





## College's homecoming celebration is growing by leaps and bounds

The College's annual homecoming celebration has grown significantly since the inaugural event in 2012, just not the way Brian Campbell expected it to.

The 2015 edition of homecoming included a second reunion of Engineering Operations graduates and several departmental events along with the main homecoming program.

Campbell, assistant dean for development and alumni relations and executive director of the NC State Engineering Foundation, cut his teeth in the world of university development at the University of Virginia, which has several homecoming and reunion events for alumni. He didn't see the same kind of engagement events while working at Iowa State and NC State.

While the university's annual homecoming weekend includes a student parade down Hillsborough Street and other events before the Saturday football game, the College had no events of its own.

Campbell, director of the Foundation since October 2011, set out to change that.

The kind of face-to-face engagement that on-campus events for alumni generate is invaluable for development,

but pays other benefits for universities by making alumni feel welcome and informed about what is going on now at their alma mater.

"My impression is that it's ultimately hard to raise money from a group of people who are not systematically engaged," Campbell said.

### ALUMNI ENGAGE WITH THEIR DEPARTMENT

The growth of departmental events in conjunction with the College's homecoming festivities has been a welcome surprise, Campbell said.

Five of the College's academic departments held events as part of the 2015 homecoming weekend on Oct. 30 and 31.

The Department of Electrical and Computer Engineering (ECE) started with an open house Friday morning, followed by an inaugural alumni hall of fame lunch that saw 34 ECE alumni inducted.

"It was a very enjoyable event and was a great opportunity for me to meet many alumni for the first time, as well as renew old acquaintances," said Dr. Daniel Stancil, ECE department head. "I am continually impressed by the success and accomplishments of our alumni, and

staying in touch is a high priority for the department."

The Department of Materials Science and Engineering (MSE) held its first hall of fame brunch on Friday, followed by an MSE tech talk with guest speaker Dr. Matteo Seita from the Massachusetts Institute of Technology and an open house.

The Edward P. Fitts Department of Industrial and Systems Engineering program on Friday included a distinguished alumni ceremony and luncheon, student poster presentations and a panel discussion on energy.

The Department of Civil, Construction, and Environmental Engineering held a homecoming luncheon on Friday.

Events in the Department of Mechanical and Aerospace Engineering (MAE) began on Friday with a hall of fame luncheon and continued on Saturday with a homecoming brunch.

"The main benefit to the department is the reconnection with our alumni and showcasing our new building on the Centennial Campus and sharing with them what the department is doing now," said Dr. Richard Gould, department head in MAE.

For the second year, a reunion of graduates of the Engineering Operations

program was held in the James B. Hunt Jr. Library on Centennial Campus. Since discontinued, the Engineering Operations curriculum taught students practical skills and introduced them to real world experiences that would help them thrive in a variety of fields, including production, sales and management.

It made for a busy day on Friday. Dr. Louis Martin-Vega, dean of the College of Engineering, quipped that it was a five-ring circus.

But it gave engineering alumni plenty of chances to reconnect with the College and their departments. No other college at NC State had so many events planned for their alumni, Campbell said.

### THE MAIN EVENT

The main homecoming program, held Friday afternoon in the Hunt Library auditorium, gave alumni a glimpse of the kind of groundbreaking work going on in the College.

Martin-Vega started with an overview that touched on the College's strong academics and research, the growth in student enrollment and faculty numbers and plans to construct an Engineering Oval building that will expand the College's footprint on Centennial Campus.

Next up, General Nick Justice and Dr. John Muth, director and deputy director, respectively, of PowerAmerica, gave an update on the NC State-led Department of Energy National Manufacturing Innovation Institute that will further advances in the manufacture of wide bandgap semiconductor-based power electronics (see story on page 22). The growth in use of these semiconductors, which are faster, smaller, more reliable and more efficient than traditional silicon-based semiconductors, will spark a revolution in industries ranging from solar power and electric vehicles to industrial motors and consumer electronics.

The four MSE alumni who started the company Undercover Colors told the audience how their NC State experience led to the creation of their company that is developing a clear fingernail polish designed to detect the presence of a date-rape drug in a woman's drink with a quick stir of her finger. The company has received international notoriety and investor backing and is almost ready to bring its first product to the marketplace.

Dr. Laura Bottomley, the College's director of women in engineering and outreach, showed the audience how The Engineering Place – the College's

award-winning K-20 engineering education and outreach program — teaches children as young as elementary-school age about the impact of engineering and how the work of engineers can be found all around us as we go about our day. Bottomley showed a rapt audience how she brings engineering to life by talking to children about their shoes, how they are made and what makes each pair different.

John DuPlessis, who graduated in 1958 with bachelor's degrees in metallurgical engineering and nuclear engineering and in 1961 with a master's in metallurgical engineering, has been returning to NC State for homecoming for 40 years to meet up with fraternity brothers and roommates from his time as a student.

While he had maintained connections to his home department, including serving on the departmental advisory board, he didn't know as much about what was happening in the rest of the College. That's why DuPlessis liked the idea of an event that would bring alumni back to the College.

"It was a 'welcome home' for me," DuPlessis said of homecoming. "I have since attended this event each year. I look forward to coming back again." ■



Engineering Homecoming 2016 will be held Oct. 28.



## Four honored with College's Distinguished Engineering Alumnus Award

The College bestowed the Distinguished Engineering Alumnus Award on four deserving graduates during a ceremony on Friday, Oct. 30.

Dr. Michael Creed, Elin Gabriel, General Raymond Odierno and Jeffrey Williams were honored during a ceremony at the Park Alumni Center on NC State's Centennial Campus.

The award honors alumni whose accomplishments further their field and reflect favorably on the University.

**DR. MICHAEL W. CREED** earned a bachelor's degree in civil engineering in 1973 and a master's degree in engineering in 1984 from NC State. He went on to earn a Ph.D. in urban planning from UNC-Chapel Hill.

Creed is a co-founder of McKim & Creed, an engineering, planning and surveying firm. He has retired from his position as CEO of the company but continues to serve as chairman of the board.

Creed and his company have provided vital financial support for NC State and the Department of Civil, Construction, and Environmental Engineering (CCEE), including funds to provide internship opportunities for NC State students at McKim & Creed. He was one of the original members of the CCEE advisory board and served three years as chair of the department's Zia Distinguished Lecture Series.

**ELIN E. GABRIEL** earned a bachelor's degree in chemical engineering from NC State in 1985. She went on to earn an MBA from the College of William & Mary.

Gabriel is vice president of global operations for H.B. Fuller, a \$2.1 billion global corporation that focuses on adhesives, sealants and other similar specialty chemicals. She currently serves as an executive officer of the



PICTURED, FROM LEFT, GEN. RAYMOND ODIERNO, DR. MICHAEL CREED, ELIN GABRIEL, DR. LOUIS MARTIN-VEGA AND JEFFREY WILLIAMS.

company with direct responsibility for manufacturing plants in the United States, Latin America, Europe and Asia.

She is a member of the university's Wallace Carl Riddick Society and created the Elin E. Gabriel Scholarship in Chemical Engineering. Gabriel has also given of her time, speaking to senior design students in the Department of Chemical and Biomolecular Engineering.

**GENERAL RAYMOND T. ODIERNO** earned a master's degree in nuclear engineering in 1986 from NC State. He is also a graduate of the United States Military Academy at West Point, Army War College and Naval War College.

He was Chief of Staff of the U.S. Army from 2011 to 2015. During more than 38 years of service, he has commanded units at every echelon, from platoon to theater, with duty in Germany, Albania, Kuwait, Iraq and the United States. After his assignments with U.S. Army Europe and at Fort Bragg, NC, Odierno served as a

commander during deployment for Operations Desert Shield and Desert Storm. He later served as a commander during Operation Iraqi Freedom and in subsequent operations in Iraq.

**JEFFREY E. WILLIAMS** earned a bachelor's degree in mechanical engineering in 1985 from NC State. He later earned an MBA from Duke University's Fuqua School of Business.

Williams worked for IBM from 1985 to 1998 and joined Apple in 1998 as head of worldwide procurement. Williams was named Apple's chief operating officer in December 2015.

Williams has been a generous supporter of NC State, providing funding for the Caldwell Fellows program's Center for Creative Leadership and hosting students from the Engineering Entrepreneurs Program and the university-wide Entrepreneurship Initiative for visits to Apple's headquarters during their trips to California. ■

## Foundation strengthens leadership

dean for development and college relations and executive director of the Foundation, said. "So the fact that we have got people who have been here for long periods of time is invaluable. You just can't buy this stuff. You can't hire people who are that smart."

Bremer joined the Foundation in 2009 as director of development for the Department of Civil, Construction, and Environmental Engineering.

She worked previously as senior associate director of alumni relations and the Lawrenceville Fund at the Lawrenceville School in Lawrenceville, N.J. and director of development for Villa Victoria Academy in Ewing, N.J.

Bremer oversees the development officers and coordinates departmental development activities and prospect strategy sessions. She also manages major gift strategy and fundraising for the Engineering Oval building project.

Hughes retired as executive director of the Foundation in September 2011 after an 18-year-career with the College. Since rejoining the Foundation in March 2015, he has reached out to alumni and friends he had a prior relationship with and has assisted with some discovery work. He is also a mentor and advisor to the rest of the Foundation staff and is working closely with Russ O'Dell in assisting the Department of Chemical and Biomolecular Engineering with major gift development.

Bremer and Campbell agree that the current Foundation staff is one of the strongest that the organization has enjoyed in many years.

"I think we do have one of the best teams I've ever worked on in my career," Bremer said. "They are focused and dedicated professionals who truly care about each other and our cause. It is a great combination and a nice working environment." ■



The NC State Engineering Foundation strengthened its leadership team in 2015 with two hires of senior-level development professionals with years of valuable experience and relationships with NC State Engineering alumni.

Lora Bremer took over as the Foundation's executive director of major gifts and campaign planning, and former Foundation director Ben Hughes returned to the organization as a special development advisor.

"Continuity is important, and we lack continuity in development, institutionally," Brian Campbell, the College's assistant

## Hassan Lecture Series honors MAE professor

The Dr. Hassan A. Hassan Distinguished Lecture Series, the first lecture series for the Department of Mechanical and Aerospace Engineering (MAE), was established in 2015 through the generosity of Hassan's former students and fellow faculty members.

Dr. Richard Gould, MAE department head, thought of the idea for the lecture series in early 2015 as a way to honor Hassan's contributions to the department and his impact on the aerospace program.

Hassan was surprised by the announcement of the lecture and is hopeful that it will grow. "I wasn't aware that the lecture series was something in the pipeline," Hassan said. "But I am excited to see where it will go and the

mix of technical and informational presenters that will be joining us in the future."

The first Hassan lecture was held in November with speaker Dr. John D. Anderson Jr., the curator for aerodynamics at the Smithsonian National Air and Space Museum and professor emeritus of aerospace engineering at the University of Maryland.

Anderson's lecture, "Breaking the Sound Barrier: The intellectual breakthroughs in aerodynamics that made it possible," focused on the Bell X-1, the first piloted airplane to fly faster than sound with Captain Chuck Yeager, and examined the breakthroughs in the intellectual understanding of high-speed aerodynamics that made it possible.



Generous former students, faculty members and alumni established the lecture series to honor Hassan's legacy. To help sustain the lecture, Hassan has created an endowment for \$25,000 for the series.

To learn how you can support the Dr. Hassan A. Hassan Distinguished Lecture, please contact Michael Walsh at mpwalsh2@ncsu.edu or 919.515.7237. ■



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

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

If you have already made your 2015-2016 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](mailto:angela_stallings@ncsu.edu).

## WAYS TO GIVE

- Make your gift online at [go.ncsu.edu/engineering-giving](http://go.ncsu.edu/engineering-giving)
- Use the return envelope included in this magazine to pay by check 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. Visit [www.engr.ncsu.edu/foundation/deanscircle](http://www.engr.ncsu.edu/foundation/deanscircle) for more information.

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## FOUNDATIONS

## Four join Engineering Foundation



ERICA FULLER

**ERICA FULLER** joined the Foundation as a temporary employee last March and became a permanent administrative support associate in May 2015. In her support capacity, she handles a variety of tasks ranging from thank you notes and mass mailings to special project tasks. Prior to joining the Foundation, Fuller worked for Young Life, a non-profit organization, where she mentored high school students, raised funds and performed administrative tasks. Fuller joined Young Life right after graduating from the University of Tennessee in 2011 with a bachelor's degree in exercise science.

**KYLE GRAY** joined the Foundation in January 2016 as the director of development for the Joint UNC/NC State Department of Biomedical Engineering (BME). He most recently served as director of development for UNC-Chapel Hill's Department of Allied Health Sciences (AHS) in the School of Medicine. During his tenure, the AHS donor base tripled, increasing cumulative donations by more than \$10 million from 2006 to 2015. Gray came to AHS from UNC-Chapel Hill's School of Government, where he served as assistant dean for development and communications. Previously, he was a career specialist for Boston Private Industry Council at Boston Latin School and senior program instructor for the Close-Up Foundation in Washington, D.C. Gray received a master's degree in public administration from UNC-Chapel Hill in 1997 and a bachelor's degree in political science with a minor in urban studies from The Colorado College in 1989.



KYLE GRAY



LINDSAY SMITH

**LINDSAY SMITH** joined the Foundation in November 2015 as the director of development for the Department of Civil, Construction, and Environmental Engineering. Smith comes to the Foundation from Guilford College in Greensboro, NC, where she was senior director of annual giving. Prior to that, she was assistant director and then director of the Quaker Club, which is the unrestricted annual fund for Guilford College's athletics department. In 2011, Smith received her bachelor's degree in communication studies with a concentration in interpersonal and organizational communication from UNC-Chapel Hill. After graduation, she worked for the United Way.

**KAREN WELTON** joined the Foundation in June 2015 as a business services coordinator after working as a temporary employee for various departments at NC State. She manages incoming gifts, ensuring that they have the proper gift transmittals and are allocated to the correct funds in accordance with the donors' wishes. She also assists with scholarships, making certain they are set up accurately in the College's online scholarship portal. An alumna, Welton received her bachelor's degree in accounting from NC State in 1988. Before returning to North Carolina, Welton and her husband ran their own structural engineering firm in Virginia. Husband Steven Welton is a lecturer in the Department of Civil, Construction, and Environmental Engineering at NC State. ■



KAREN WELTON



# FOUNDATIONS



## 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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Sam McCachern CE '85  
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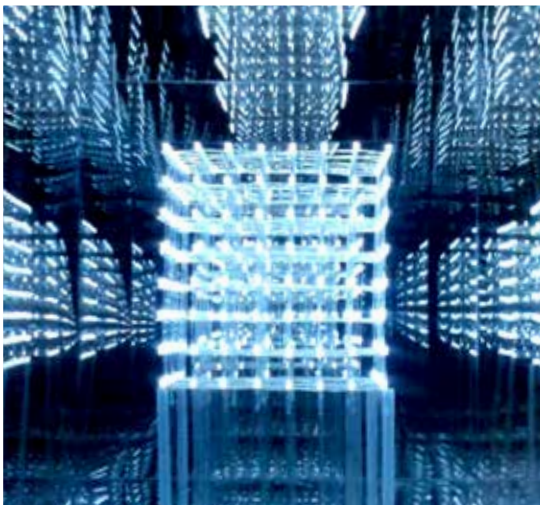
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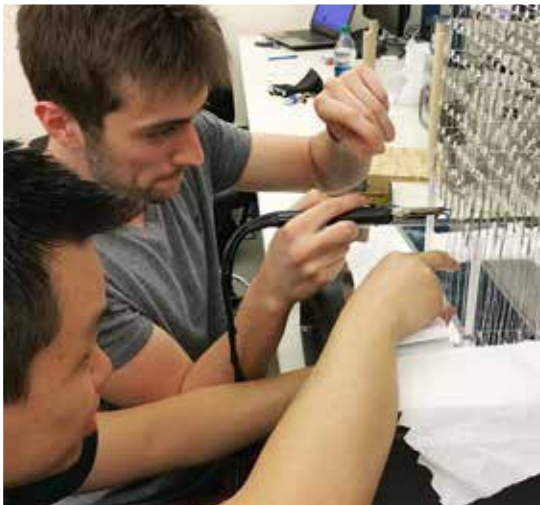
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## ART, ENGINEERING AND INFINITY: FOUR NC STATE STUDENTS DISPLAY THEIR WORK WITH ESCHER AND DA VINCI



of having engineers use electronics to create a visual display that tied together the works of da Vinci and Escher. The resulting student exhibition, Engineering Infinity, opened in October to coincide with the opening of the museum’s exhibitions: “The Worlds of M.C. Escher: Nature, Science, and Imagination” and

essentially trapping and reflecting light from the LEDs. “This was a collaboration with NCMA to develop a display that both expressed the STEAM concept and was consistent with the subjects of Escher’s work, such as infinity, fireworks and tessellations,” Heiman said. “The LED cube makes the first image, but it is reflected repeatedly – back and forth between the mirrors – making the images appear to retreat into infinity. Much like Escher did in his work,” said Jamison.

Team members documented their work according to the so-called “design cycle” (ask, imagine, plan, create and improve). The cube was displayed alongside sketches, schematics and other materials documenting the process. These process-oriented artifacts connect to da Vinci’s Codex Leicester, a 500-year-old notebook featuring the artist’s notes, sketches, and observations, and providing a glimpse into the artist’s scientific mind. ■

**THE CONCEPT OF INFINITY AND THE DESIRE TO ILLUSTRATE** the creative process gave a team of engineering students the opportunity to showcase an electronic display they developed alongside the works of M.C. Escher and Leonardo da Vinci.

The opportunity stems from collaboration between NC State and the North Carolina Museum of Art (NCMA), as part of a series of STEAM initiatives that combine science, technology, engineering and math (STEM) with art and design to promote innovation.

Because of its interest in STEAM, NCMA came to NC State with the idea

“Leonardo da Vinci’s Codex Leicester and the Power of Observation.” Four electrical engineering undergraduate students – Evan Heiman, Andy Tong, Robert Jamison and Jesse Davi — took on the project as part of their senior design course. The four earned their degrees in May 2015. They developed a cube made of 512 light-emitting diodes (LEDs), 64 on each side, which is suspended on translucent columns. The LEDs are programmed to display 19 different visual routines. That LED cube is surrounded by a second cube made of two-way mirrors, allowing viewers to see inside but

Video of the cube in action can be seen at <https://youtu.be/j5fhjTrBzoM>.





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