NC STATE Engineering

FALL/WINTER **2015**

AN ENTREPRENEURIAL EDUCATION

How College of Engineering startup companies are changing the world | 14

ENGINEERING ENERGY

NC State electrical engineering students have always spent a lot of time in the lab.

In the top photo, Dr. Wilhelm F. Gauster, professor of electrical engineering, performs a rod-gap experiment with a student in the College's High Voltage Laboratory in 1952.

Started under the leadership of Engineering Dean J. Harold Lampe and overseen by Gauster and Dr. Cornelius Godfrey Brennecke, head of the Department of Electrical Engineering from 1945 to 1954, the lab was located in the lower level of the southwest corner of Riddick Engineering Laboratories on North Campus.

In the bottom photo, students work in a lab on the ground floor of the Keystone Science Center on the university's Centennial Campus. The one-megawatt lab is part of the Future Renewable Electric Energy Delivery and Management – FREEDM – Systems Center, a National Science Foundation (NSF) Engineering Research Center (ERC) led by NC State that is developing the next-generation smart grid that works seamlessly with renewable energy technologies.

On pages 26 and 27, learn more about FREEDM and the NSF Nanosystems Engineering Research Center for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST), the other ERC led by NC State that is developing wearable health systems powered by the human body. Both centers are fresh off positive site visits by NSF officials this spring and are making advances that will change the way our national energy grid works and empower consumers to take charge of their own health.

NC State is the only university in the country to lead two ERCs simultaneously and one of only two schools (along with Carnegie-Mellon University) to ever be awarded the lead role for three Centers.

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FEATURES

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Q&A

QUESTIONS FOR **MICHAELA RIKARD**

Michaela Rikard, a senior in biomedical engineering, visited the White House in March to discuss the Grand Challenge Scholars Program, an effort undertaken by 120 deans of engineering to train students who can tackle the most vexing issues facing mankind in the 21st century.

Tell us about the College's Grand Challenge Scholars Program.
It is a national program that aims to develop engineers uniquely qualified to tackle the Grand Challenges of Engineering, as described by the National Academy of Engineering (NAE). The idea is to develop engineers with the appropriate technical and research experience, but also with exposure to business, entrepreneurship and service learning.

Which of these challenges have you been most focused on?
I am focused on engineering better medicines. I spent a summer at Walter Reed National Military Medical Center researching better methods to prevent and treat heterotopic ossification, a complication commonly developed in soldiers with amputations. I also participated in research in a pharmacoengineering lab at NC State, using nanomaterials to develop better drug delivery systems for cancer treatment.

How was your White House visit?
What a whirlwind of a trip and once-in-a-lifetime opportunity! I met many incredible leaders in NAE, the Office of Science and Technology at the White House and President Obama! I attended the White House Science Fair, which showcased K-20 science and engineering projects, and participated in a meeting of more than 60 deans of engineering from around the country on the future of the Grand Challenge Scholars Program.

You are also part of the College's Engineering Ambassadors program. Tell us about that.
Honestly, it has been the most rewarding experience of my college career. I am surrounded by such dedicated, passionate and inspirational people. I can only imagine the tremendous impact that each of my peers will have in their future careers. It has also given me the opportunity to get to know the wonderful faculty members and administrators who make this university the great place that it is!

What are you most looking forward to in your senior year?
I am definitely looking forward to senior design. The biomedical engineering department has a unique senior design experience that allows you to take the process all the way from identifying a problem in local hospitals and clinics to developing a solution and prototype. The focus on design, innovation and entrepreneurship often leads to start-up companies that spin out of senior design.

You also work as an emergency medical technician. Why were you interested in that?
My interest in becoming an EMT started with a medical service trip to Ecuador. I wanted the skills to be able to treat patients, and why wait until medical school to start? The trip also sparked a passion for global health that I hope to incorporate as a significant part of my career. I'm excited about leading a team back to Ecuador next spring!

FROM THE DEAN

Louis A. Martin-Vega

As we begin a new academic year, we have much to celebrate in the College of Engineering. The National Science Foundation (NSF) recently announced that NC State will be the lead institution on a $5.5 million National Nanotechnology Coordinated Infrastructure grant that will bring together expertise and facilities from NC State, Duke University and UNC-Chapel Hill to develop new nanotechnology-based products and educational opportunities. Led by NC State materials science and engineering professor Dr. Jacob Jones, this new partnership provides an important platform for economic development in North Carolina and the nation.

We also received news that our two NSF Engineering Research Centers, ASSIST and FREEDM, have been unconditionally renewed — a distinction that is rarely bestowed on ERCs. When we add to this the 20 new faculty members joining us this year, the unprecedented demand for our programs, which has taken our enrollment to more than 10,000 students and many more accomplishments of our outstanding faculty, students and staff, it is easy to see why we continue to view our future as bright.

We are also excited about the progress being made on Engineering Oval, the proposed new engineering building on Centennial Campus. We are optimistic that the public-private partnership model that has been developed for financing this project will soon bear fruit and take us very close to unifying almost all of our college on Centennial Campus. More details on this project are provided on page 32 of this magazine.

In this issue, you will meet the students behind the Undercover Colors nail polish that has caused a nationwide stir. It is part of a special section that focuses on making entrepreneurship a vital part of engineering education. You will also learn about the first engineering summer camp organized for students with visual impairments or blindness and about our other exciting endeavors.

Finally, please receive my appreciation for all your support and our commitment to continue to do all we can to make you proud of "your College" at NC State.

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

Martin-Vega serves as president-elect of American Society for Engineering Education (ASEE)

DR. MARTIN-VEGA SPEAKS DURING THE AWARDS CEREMONY AT ASEE'S ANNUAL CONFERENCE IN JUNE

Dr. Louis A. Martin-Vega, dean of the College of Engineering, began a term as president-elect of the American Society for Engineering Education (ASEE) in June.

He will serve in the position for one year before assuming the presidency of the organization in 2016.

Martin-Vega has led NC State's College of Engineering since 2006. During his tenure, the College has made significant strides in research, education and innovation to become one of the top colleges of engineering in the United States and in the world. It is the only college of engineering in the nation currently leading two National Science Foundation (NSF) Engineering Research Centers and is playing a leading role in PowerAmerica – a Department of Energy power electronics National Manufacturing Innovation Institute being led by NC State.

He has held several prestigious positions at the National Science Foundation (NSF), including acting head of its Engineering Directorate and director of its Division of Design, Manufacture, and Industrial Innovation. He currently serves on the Advisory Committee for the Engineering Directorate at NSF and on NSF's Foundation-Wide Committee on Equal Opportunities in Science and Engineering (CEOSE), charged with broadening participation by women, underrepresented minorities and persons with disabilities in all of the sciences and engineering.

ASEE was founded in 1893 and is the only national engineering education organization concerned with all engineering disciplines. ▪

Adding a little spring to your step

Researchers in the College have worked with colleagues at Carnegie Mellon University to create an unpowered exoskeleton that adds an extra spring to each step a person takes and modifies the structure of their ankles.

These findings may benefit both able-bodied people who are frequently on their feet – think of the military infantry or athletic baby-boomers – as well as those who have been victims of stroke or who have other gait impairments.

Use of this device can also result in a reduction of metabolic energy consumption by 7 percent compared to walking in normal athletic shoes.

To gain an advantage over nature, researchers tested the efficacy of a lightweight lower-leg device that uses a spring and clutch system working in tandem with calf muscles and the Achilles' tendon while people walk. The streamlined, carbon-fiber device weighs about as much as a normal loafer – 500 grams, or a bit more than a pound – and is not motorized, so it requires no energy from batteries or an external fuel source.

"The unpowered exoskeleton is similar to a catapult. It has a spring that mimics the action of your Achilles' tendon, and works in parallel with your calf muscles to reduce the load placed upon them," said Dr. Gregory Sawicki, associate professor in the Joint NC State/UNC Department of Biomedical Engineering. "The clutch is essential to engage the spring only while the foot is on the ground, allowing it to store and then release elastic energy. Later, it automatically disengages to allow free motion while the foot is in the air."

The study participants, nine able-bodied adults, strapped the exoskeleton devices on both legs and walked at a normal speed on a treadmill after completing some practice training. The same subjects also walked without exoskeletons for a baseline comparison.

The researchers tested exoskeletons with springs that varied in stiffness. Like Baby Bear's bed in the Goldilocks story, the spring that provided the most benefit was moderately stiff. Walking with exoskeletons with springs that were too stiff or too compliant resulted in normal or higher-than-normal energy costs for participants.

"A 7 percent reduction in energy cost is like taking off a 10-pound backpack, which is significant," Sawicki said. "Though it's surprising that we were able to achieve this advantage over a system strongly shaped by evolution, this study shows that there's still a lot to learn about human biomechanics and a seemingly simple behavior like walking." ▪

MES program produces homegrown engineers Down East

Ramsey Davis has gone from helping his family's boat-building business as a teenager to performing structural analysis on Marine Corps AV-8B Harrier jets, and he was able to stay in eastern North Carolina the entire time thanks to the College's Mechanical Engineering Systems (MES) program.

The College established the MES distance degree program in partnership with Craven Community College in Havelock, NC 10 years ago to give students in the eastern part of the state a chance to earn an NC State engineering degree without having to leave family and work obligations to study in Raleigh.

Havelock is home to the U.S. Navy Naval Air Systems Command's Fleet Readiness Center East (FRC East), which provides support for aircraft operated by the Navy and Marine Corps and has a need to recruit engineers who want to live in the area. Because that is not always an easy task, two NC State engineering graduates working at FRC East asked the College to help produce home-grown engineers who are already in that part of the state and want to stay.

"This was the only way that I would have been able to complete an engineering program," said Davis, who graduated in May. "By the time I had started, I was married with a child on the way, so attending school full time in Raleigh was not an option."

Faculty members from the departments of Mechanical and Aerospace Engineering and Electrical and Computer Engineering in Raleigh teach using a live synchronous feed to special classrooms in Havelock. To allow flexibility for working students, the classes may be replayed in the evening with a facilitator in the room who can help answer questions.

MES students typically take five to six years to complete their degrees. Balancing work and family obligations with classes is a tall order.

"The students in the MES program are very busy due to the rigorous curriculum and working at their jobs," said Dr. Linda Krute, director of the College's Engineering Online program. "Many of the students work all day and then go to classes in the evening. Family time becomes limited along with any type of social life. The families of the students are just as involved in the program as the students. This is not an easy way to get a degree, but the students are extremely motivated and dedicated to what they are doing."

Dr. Bill Fortney, director of the MES program, taught Kevin Tierney his first Introduction to Engineering class. Tierney is a retired Marine Corps Master Sergeant with a family, a job at FRC East and one more year in the MES program.

"After this class I was hooked and was impatient to begin my next engineering classes," Tierney said. "I was struck by not just the depth of practical knowledge, but the patient and friendly way that all of the NC State faculty and staff would interact with current and prospective students. I knew that this was a great place to learn and develop." ▪

More accurate readings without the goop

A new wearable sensor that uses silver nanowires to monitor electrophysiological signals such as electrocardiography (EKG) or electromyography (EMG) offers improved vital sign readings.

Dr. Yong Zhu, associate professor of mechanical and aerospace engineering and senior author of a paper describing the work, said the sensor is as accurate as the "wet electrode" sensors used in hospitals, but can be used for long-term monitoring and is more accurate than existing sensors when a patient is moving.

Long-term monitoring of electrophysiological signals can be used to track patient health or assist in medical research and may also be used in the development of new powered prosthetics that respond to a patient's muscular signals.

Electrophysiological sensors used in hospitals, such as EKGs, use wet electrodes that rely on an electrolytic gel between the sensor and the patient's skin to improve the sensor's ability to pick up the body's electrical signals. However, this technology poses problems for long-term monitoring because the gel dries out – irritating the patient's skin and impacting the sensor's accuracy.

The new nanowire sensor is comparable to the wet sensors in terms of signal quality, but is a "dry" electrode – it doesn't use a gel layer, so it doesn't pose the same problems that come with wet sensors.

"People have developed other dry electrodes in the past few years, and some have demonstrated the potential to rival the wet electrodes, but our new electrode has better signal quality than most – if not all – of the existing dry electrodes. It is more accurate," says Zhu. "In addition, our electrode is mechanically robust, because the nanowires are inlaid in the polymer."▪

PARRY, FIFTH FROM LEFT, WAS ONE OF 14 AWARD WINNERS

Engineering Place's Parry receives Presidential Award

Elizabeth Parry, a partnership coordinator with The Engineering Place, was one of 14 to receive the Presidential Award for Excellence in Science, Mathematics, and Engineering Mentoring (PAESMEM) during a visit to the White House in June.

The PAESMEM award was established by the White House in 1995 and is administered by the National Science Foundation (NSF) on behalf of the White House Office of Science and Technology Policy (OSTP).

Individuals and organizations that receive the award are recognized for their role in mentoring students from elementary to graduate level, as well as early career scientists, and preparing them to be the next generation of scientists, engineers and mathematicians. Recipients also receive a cash award of $10,000 from the NSF.

"These educators are helping to cultivate America's future scientists, engineers and mathematicians," President Barack Obama said. "They open new worlds to their students and give them the encouragement they need to learn, discover and innovate. That's transforming those students' futures and our nation's future, too."

The Engineering Place is the College's K-20 engineering education and outreach program.

Parry holds a B.S. degree in engineering management with a minor in mechanical engineering from the University of Missouri-Rolla. She worked previously as a manager at IBM before resigning to focus on being a mom and doing engineering outreach.

"I absolutely love being an engineer, and I love that I have so many opportunities to share that passion with NC State students as well as teachers, students and parents from preschool through 12th grade," she said. "I have been so fortunate to have had strong mentors in my life, beginning as a child and continuing to this day. So I know the importance of mentoring. To be recognized at this level is simply amazing."▪

VIB CAMPERS (L-R) ZOE GROVES, ELIJAH ANDERSON AND LEWIS JACKSON PRESENT ONE OF THEIR ENGINEERING ACTIVITIES TO FELLOW CAMPERS.

Campers with visual impairments showcase their engineering talents

In a camp closing ceremony on July 24, nine high school students with visual impairments presented their engineering capstone projects to an impressed audience.

Choosing themes from the National Academy of Engineering's Grand Challenges of Engineering, four teams enthusiastically demonstrated that they had learned how to apply the engineering design process to solve problems. The topics were liquid filtration, solar panel efficiency, the use of vibrations to cancel out sounds such as loud music from speakers and a tool to make self-administering eye drops easier.

The capstone projects were the culmination of a weeklong residential engineering camp at NC State. The camp, the Summer Engineering Experience for Students with Visual Impairments or Blindness (VIB), marked the first time the College has offered a summer camp like this one.

The idea for the camp grew from discussions between Leyf Starling, program coordinator for The Engineering Place — the College's K-20 engineering education and outreach program — and Ed Summers, software engineer and accessibility specialist at SAS. Summers is blind.

"Ed was a champion of the cause," Starling said. "He sent emails about the camp to his colleagues across the country."

Soon, a group of experts from North Carolina and different parts of the country wanted to be part of the camp, some serving as instructors, others as speakers and advisers.

On the first day of camp, Starling met a confident and eager group of teenagers, which didn't surprise her.

"I had very high expectations for the students coming in," she said. "I've worked with a number of students with diverse backgrounds and strengths, and I expected the (VIB campers) to come in with the same level of enthusiasm. They were willing to try new things — everything from living in dorms to having to work in groups with people they had never met."

In camp, the students participated in hands-on activities related to current engineering research at NC State and the themes of the Grand Challenges. They toured labs and spent time with NC State students and faculty members to learn about some resources and tools to help them better navigate college.

Starling announced a surprise during the closing ceremony. Dr. Shayn Peirce-Cottler, a professor of biomedical engineering at the University of Virginia who was a guest speaker at the camp and directed the eye drop tool team, was going to help the team file for a provisional patent. The team members are Zoe Groves and Hershel Wathore of North Carolina and Matt Gilbert of Massachusetts. The patent-worthy summer camp project is a first.

Starling is planning another VIB camp next summer, and if funding allows, she would like to hold more than one camp, opening them up to students with multiple disabilities.

She also would like to mainstream many of the students who attended this camp into the other engineering camps next summer.

"People don't always think of students with disabilities as being capable," Starling said. "They think of them as being disabled, but really they are very abled. Especially this group. Their only disability is low vision." ▪

SUPPORT THE K-20 SUMMER CAMPS

Donations can be made online at **go.ncsu.edu/engineering-giving** or by mail to the address below. Be sure to reference the Engineering Place K-20 Summer Camps.

NC State Engineering Foundation, Inc.
Campus Box 7901
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Engineering partners with NC Central to create dual degree program

A new 3-plus-2 degree gives students the opportunity to earn a bachelor's degree in physics from NC Central University and a bachelor's degree in electrical engineering from NC State.

The dual degree was developed in March through a memorandum of agreement between the Department of Electrical and Computer Engineering and NC Central's Department of Mathematics and Physics. In the dual degree format, students attend NC Central for three academic years following the physics curriculum. Then, the students would transfer to NC State for two academic years following the NC State electrical engineering curriculum.

"This program is a great opportunity to broaden the opportunities for students to pursue STEM degrees, which provides an inviting chance for the student to receive two degrees," said Dr. Caesar Jackson, interim dean for the school of graduate studies at NC Central.

The goal of the five-year program is to provide graduates with knowledge of mathematics, science and engineering in order to broaden career opportunities while also increasing access, diversity and enrollment in a STEM discipline at both institutions.

"My hope is that this program will provide a mechanism to recruit bright and ambitious students to NC Central and NC State in support of our shared goals around access and student success," said Dr. Jerome Lavelle, associate dean of academic affairs in the College of Engineering.

Dr. Johnson Akinleye, provost and vice chancellor for academic affairs at NC Central, and Dr. Warwick Arden, provost and executive vice chancellor at NC State, signed the memorandum at NC Central in June.

Courses taken at either university will be transferred toward fulfilling degree requirements in both programs. The dual degree students will be eligible to apply for graduation from either or both institutions. ▪

DR. JOHNSON AKINLEYE, LEFT, PROVOST AND VICE CHANCELLOR FOR ACADEMIC AFFAIRS AT NC CENTRAL, SHAKES HANDS WITH DR. WARWICK ARDEN, PROVOST AND EXECUTIVE VICE CHANCELLOR AT NC STATE.

Recently discovered proteins may lead to new methods in creating biofuels

Researchers have found a very heated relationship between bacteria and newly discovered proteins.

These proteins are called tapirins and are capable of attaching themselves to plant cellulose, which could potentially provide more efficient methods of converting plant matter into biofuels.

Their name is derived from the Maori verb "to join." Like their namesake, these proteins bind tightly to cellulose, a key structural component of plant cell walls, enabling the bacteria from which they originate to break down cellulose. The conversion of cellulose to liquid biofuels, such as ethanol, is paramount to the use of renewable feedstocks.

In a paper published online in the *Journal of Biological Chemistry*, researchers from NC State, Oak Ridge National Laboratory and the National Renewable Energy Laboratory report the structure and function of tapirins produced by bacteria that live in hot springs across the globe, including Yellowstone National Park. These bacteria, called Caldicellulosiruptor, live in temperatures as high as 70 to 80 degrees Celsius – or 158 to 176 degrees Fahrenheit.

"These hot spring scavengers make proteins that are structurally unique and that are seen nowhere else in nature," said Dr. Robert Kelly, Alcoa Professor of Chemical and Biomolecular Engineering and the paper's corresponding author. "These proteins bind very firmly to cellulose. As a result, this binding can anchor bacteria to the cellulose in plant biomass, thus facilitating the conversion to fermentable sugars and then biofuels."

In the study, the researchers showed that tapirins bind to Avicel, a cellulose powder that served as a test compound. The researchers also expressed the tapirin genes in yeast. Yeast cells with the expressed proteins attached to cellulose, while normal yeast cells could not. The paper also reports the tapirins' crystal structure.

Kelly theorizes that, in places like the hot springs at Yellowstone National Park where food sources are rare, the heat-loving bacteria use tapirin proteins to scavenge plant matter that washes into the hot springs after heavy rains or snow melt. ▪

Scheduling energy a key to the smart grid

A new technique for "scheduling" energy in electric grids moves away from centralized management by tapping into the distributed computing power of energy devices. The approach advances the smart grid concept by coordinating the energy being produced and stored by both conventional and renewable sources.

Currently, power infrastructure uses a centralized scheduling approach to forecast and coordinate the energy produced at the thousands of large power plants around the country. But as renewable energy systems – such as rooftop solar panels – proliferate and are incorporated into the power grid, the infrastructure will need more advanced systems for tracking and coordinating exponentially more energy sources. Addressing this issue is essential to the idea of a smart grid that can make efficient use of widespread renewable energy resources.

"A key challenge for renewable energy generated onsite, by home solar panels, for example, is determining how much of that energy needs to be stored on site and how much can be shared with the larger grid," says Mo-Yuen Chow, professor of electrical and computer engineering and senior author of a paper describing the new power scheduling technique.

The existing approaches to scheduling are highly centralized, with power plants sending data to a control center that crunches the numbers and then tells plants how much they'll be expected to contribute to the grid.

"This approach doesn't scale up well, which is a problem when you consider the rapid growth of on-site renewable energy sources," says Navid Rahbari-Asr, an electrical engineering Ph.D. student and lead author of the paper.

"The rise of on-site energy storage technologies presents an additional challenge, since that means energy can be stored for use at any time – making power scheduling calculations significantly more complex," Rahbari-Asr says. "In addition, the centralized approach is vulnerable. If the control center fails, the whole system falls apart."

To address these problems, the researchers developed technology that takes advantage of distributed computing power to replace the traditional control center with a decentralized approach.

The technology has been validated in simulations and the researchers are in the process of implementing it in an experimental smart grid system at the National Science Foundation FREEDM Systems Center on NC State's campus. ▪

DR. JAYANT BALIGA

Baliga receives Global Energy Prize

Dr. Jayant Baliga, Distinguished University Professor of Electrical Engineering and founding director of NC State University's Power Semiconductor Research Center, joined Dr. Shuji Nakamura, a professor at UC Santa Barbara and a 2014 winner of a Nobel Prize for Physics, as 2015 winners of the Global Energy Prize.

The Global Energy Prize annually honors outstanding achievements in energy research and technology from around the world that are helping address the world's pressing energy challenges. Baliga traveled to the International Economic Forum in St. Petersburg, Russia in June to receive the award and a cash prize of 33 million rubles, which is equivalent to $645,000.

Baliga is internationally recognized as an expert on power semiconductor devices. His research led to the creation of the insulated gate bipolar transistor, which has been used in various sectors of the economy and has led to a reduction in gasoline and electrical energy use and an overall reduction in worldwide carbon dioxide emissions. ▪

DR. ERIC KLANG

DR. ANDREW HALE

Hale and Klang win Blessis Outstanding Undergraduate Advisor Awards

Dr. Andrew Hale, professor and coordinator of undergraduate academic programs in the Department of Biological and Agricultural Engineering, and **Dr. Eric Klang**, an associate professor and faculty advisor in the Department of Mechanical and Aerospace Engineering, were named the 2015 winners of the Blessis Outstanding Undergraduate Advisor Award.

The award recognizes faculty members who consistently and willingly give their time and effort to advising, counseling and mentoring students and assisting student groups.

Candidates are nominated by the departments and selected by the College's Engineering Teaching and Advising Awards Committee. Winners receive $1,000, a certificate and their name engraved on a permanent plaque in Page Hall, the administrative building for the College of Engineering. ▪

DR. SARAH HECKMAN

DR. CHIH-HAO CHANG

Outstanding Teacher Awards given to Chang and Heckman

Dr. Chih-Hao Chang and **Dr. Sarah Heckman** received Outstanding Teacher Awards during the College's spring faculty meeting.

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

Chang is a teaching assistant professor in the Department of Mechanical and Aerospace Engineering with a research interest in multifunctional nanostructured materials and nanomanufacturing.

Heckman is a teaching assistant professor in the Department of Computer Science and has a research interest in undergraduate education with a focus on communication across the curriculum and software engineering that uses static analysis alert prioritization and program analysis tools. ▪

Alcoa Foundation Engineering Research Awards go to Zhu and Kim

Dr. Yong Zhu, associate professor in the Department of Mechanical and Aerospace Engineering, and **Dr. Youngsoo "Richard" Kim**, Distinguished University Professor in the Department of Civil, Construction, and Environmental Engineering, were presented with the 2015 Alcoa Foundation Engineering Research Awards.

Zhu was awarded the Alcoa Foundation Engineering Research Achievement Award, which recognizes young faculty members who have accomplished outstanding research achievements during the preceding three years. He is a pioneer and leading expert in the field of experimental nanomechanics and developed a miniaturized material testing system using microelectromechanical system technology to conduct in-situ transmission and scanning electron microscopy testing of nanostructures.

Kim was awarded the Alcoa Foundation Distinguished Engineering Research Award, given to a senior faculty member for research achievements over a period of at least five years while at NC State. He is an international leader in characterization and performance modeling of asphalt pavements and pavement preservation, and his approach for Visco-elastic damage is now considered the best and most effective method to estimate fatigue damage of mixture and pavements. ▪

DR. RICHARD KIM

DR. YONG ZHU

DR. CARL ZOROWSKI

Zorowski awarded first Faculty Distinguished Service Award

Dr. Carl Zorowski, Reynolds Professor Emeritus in the Department of Mechanical and Aerospace Engineering (MAE), was the recipient of the College's inaugural Faculty Distinguished Service Award.

Zorowski has served as head of the MAE department and associate dean for academic affairs in the College of Engineering and is the co-founder and director of the Integrated Manufacturing Systems Engineering Institute.

He also created the MAE 415 (Analysis for Mechanical Engineering Design) and MAE 416 (Mechanical Engineering Design) classes in order give students a chance to find solutions to real problems by applying their engineering knowledge.

He was selected as the R.J. Reynolds Professor of Mechanical Engineering (1969) and is a Fellow of ASME (1987) and Fellow of the American Society of Engineering Education (ASEE) (1997). ▪

ENGINEERING ENTREPRENEURSHIP

FROM LEFT, STEPHEN GRAY, TYLER CONFREY-MALONEY, TASSO VON WINDHEIM AND ANKESH MADAN

MORE
THAN A NAIL POLISH

A POWERFUL TOOL FOR PREVENTING SEXUAL ASSAULT BEGINS WITH A SENIOR DESIGN PROJECT

Four engineering students started with a problem: how could they help prevent the use of date rape drugs to commit sexual assault, a crime that has impacted several of their closest friends.

After thinking about ways to ensure that perpetrators are caught and prosecuted, one had an idea: why not try to prevent the crime in the first place by giving women a discreet and fast-acting way to test their drink at a bar or college party before taking that first sip?

Their idea is to develop a clear fingernail polish that changes color when put in contact with a date rape drug. A woman at a party could simply stir her drink with her finger to check that it hasn't been altered.

Started from a senior design project in the Department of Materials Science and Engineering (MSE) at NC State, Undercover Colors is now a company with seven full-time employees, investor backing and worldwide attention. It's a company that offers survivors hope that others won't have to go through the same trauma. As one sexual assault survivor told the team, "I know it won't make my daughter invincible to the risk of sexual assault, but it will at least provide a little peace of mind to every woman in the entire world."

The story of Undercover Colors' growth from idea to company offers a glimpse at how NC State, and specifically the College of Engineering, teaches entrepreneurship and then supports its students' and faculty members' efforts to build companies that create jobs and change lives.

"We wouldn't be here," said Tyler Confrey-Maloney, CEO of the company and one of those four MSE senior design students. "Our company simply wouldn't exist if it wasn't for NC State."

AN ENTREPRENEURIAL ECOSYSTEM

MSE students hadn't been allowed to participate in the Engineering Entrepreneurs Program (EEP) before. But Confrey-Maloney and partners Stephen Gray, Tasso Von Windheim and Ankesh Madan pushed to complete their senior design project as part of the program, established at NC State in 1993 by Dr. Tom Miller to provide an immersive entrepreneurial education experience for engineering students.

Once they settled on an idea, the group began spending 40 hours a week working in the library during the middle of the night. That was on top of their busy senior year class loads.

A breakthrough came at the 2014 LuLu eGames, an annual business start-up competition that's part of the Entrepreneurship Initiative (EI), a university-wide entrepreneurship program that grew out of EEP.

Undercover Colors won eGames, along with $13,000 to put toward a product. They were also introduced to their first investor, an NC State alumnus and entrepreneur who was one of the judges. That investor would later introduce the students to a community of investors tied to NC State.

Invigorated by their eGames victory, the team kept working. Miller served as an advisor. So did Dr. Nathaniel Finney, a former chemistry professor at the university who is now a member of the company's Technical Advisory Council.

After graduation, all four had job offers or chances to attend graduate school. Was it worth it to continue pursuing this dream?

Miller created a bridge program that provided a small stipend (Miller refers to it as "rent and Raman noodles" money) to keep the company going as it sought further funding. The EI had taught them how to craft a business plan and pitch to potential investors. Those skills paid off and they continued to improve. They learned about patent law and received help in securing the exclusive rights to create and manufacture the product.

"It was clear that they had the smarts to do this, that they had the motivation and drive to do it, that they had enough of the basic science figured out to have a plausible chance of getting there," Miller said.

That's when a story about the company posted on a Triangle business website went viral. Undercover Colors and the idea behind it were on every major news website and all over social media. Just a few months after winning eGames, their company was being discussed on ABC's "Good Morning America."

Confrey-Maloney said it was as "exciting as it was frightening. One moment we were students with an idea and some promising research, and the next we had the attention of the entire world."

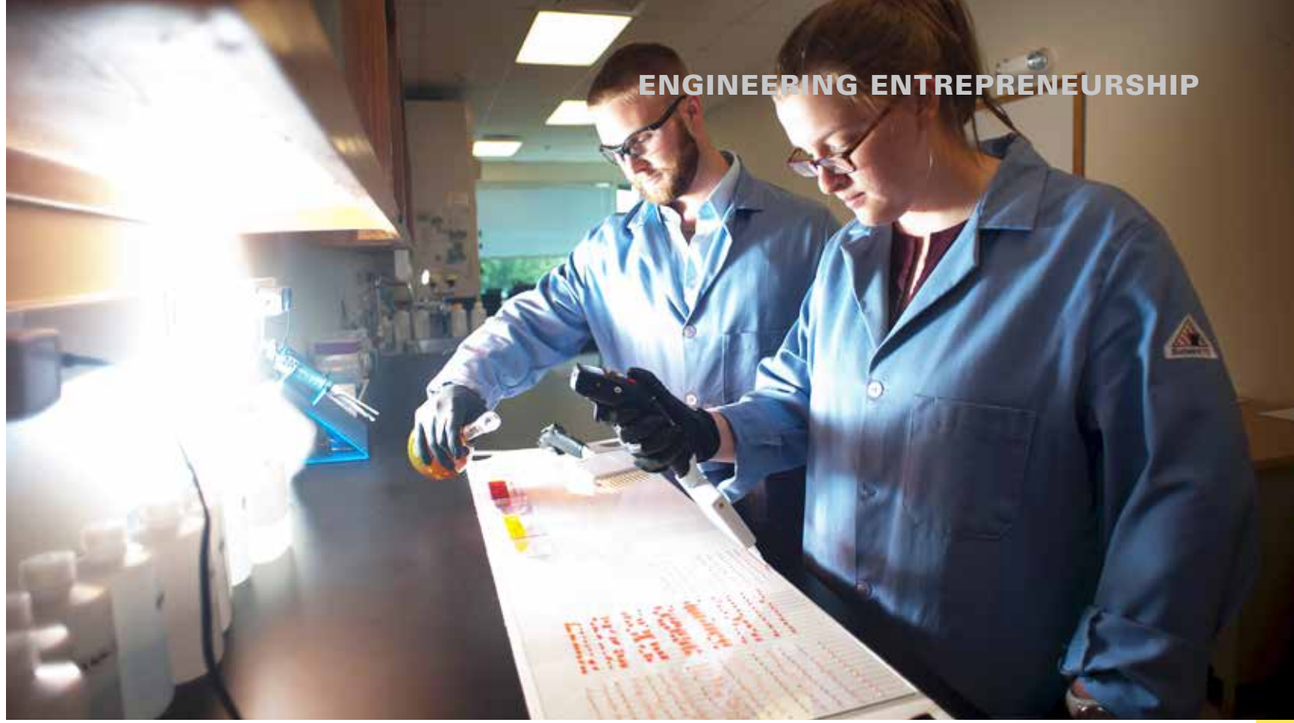
The company was still in its infancy and not looking for attention, but the exposure led to survivors of sexual assault and others reaching out with messages of encouragement. They knew they were on the right track.

Today, Undercover Colors is located in the university's Technology Incubator on Centennial Campus. Confrey-Maloney is the company's CEO. Gray is its COO. Madan and Von Windheim, both engineering Ph.D. candidates at Duke University, are working part-time.

They have developed several color-changing compounds and are now testing them first in a tube and then on a nail surface. Confrey-Maloney said the company will likely partner with an established cosmetics manufacturer to get the product into users' hands as quickly as possible.

The company has been approached by most major cosmetics players, who have expressed interest in manufacturing and selling the product. Undercover Colors is backed by individual angel investors (rather than venture-capital firms) and the vast majority of those investors have been NC State alumni or have some connection to the university.

ENGINEERING ENTREPRENEURSHIP



ONE PART OF A LARGER EFFORT

Statistics show that 18 percent of women will fall victim to sexual assault during their lifetime. So, along with their business duties, Confrey-Maloney and Gray spend several hours every week volunteering with InterAct of Wake County, a Raleigh nonprofit that provides services to survivors of domestic violence and sexual assault. Confrey-Maloney is a sexual assault emergency responder trained to assist survivors as they talk to police and are treated by a nurse. Gray volunteers on the agency's 24-hour telephone crisis line.

Confrey-Maloney says Undercover Colors is but "one small part of a larger effort to combat sexual violence." That effort includes outreach, prevention, victim services and culture-shifting. He hopes the company's product will serve as a deterrent to those who use date rape drugs, shifting a sense of fear potential victims might feel and putting it on the perpetrators.

"As a community, we need to come together and put an end to this epidemic. That change has to start by talking about the issue and providing survivors with the services they need to heal."

Von Windheim is the son of an entrepreneur. It wasn't until he grew older and saw the impact his father's work could have that he began to see starting a new company as more than a path to wealth.

"You can make money a thousand different ways. But, having the opportunity to make such a huge difference in people's lives – to prevent such extreme pain – that's a rare opportunity. It's something I'm very proud to be a part of."

When he's not volunteering, working in the lab or speaking three or four times a week on sexual assault prevention, Confrey-Maloney serves as a mentor to other NC State student entrepreneurs working their way through business plans and seeking investment. They work, learn and hang out together. On Sunday nights, they gather to watch "Silicon Valley," a television comedy about life in a technology startup.

His friends are working on ways to help smokers quit, use infrared light to detect food pathogens and bring bee hives to urban areas.

"Those are the kind of people I want to spend my time around," he said. "Entrepreneurs with bright ideas and the ability to execute can have a tremendous impact on the future of society, and NC State's really at the forefront of developing and supporting these kinds of people."▪

HOW NC STATE STARTS UP

NC STATE AND THE COLLEGE PUT AN EMPHASIS ON ENTREPRENEURSHIP

Statistics from the Ewing Marion Kauffman Foundation make the case for entrepreneurship as the lifeblood of job creation in the United States.

Companies that were five years old or younger at the time created 1.5 million to 3 million jobs per year between 1988 and 2011, the foundation said in a 2014 report. Firms five years or older mostly held steady during the same period or even lost more jobs than they created.

"Startup companies are the engine of job creation. Period," said Dr. Tom Miller, senior vice provost for academic outreach and entrepreneurship and founder of the Engineering Entrepreneurs Program (EEP) and Entrepreneurship Initiative (EI) at NC State. "If you took the startups out of the equation, most years we would have negative job growth and that would be devastating."

Miller, then a professor in the Department of Electrical and Computer Engineering, started the EEP in 1993 to give students a hands-on education in entrepreneurship. Miller founded the campus-wide EI in 2008 in response to NC State's strategic objective to "develop an educated entrepreneurial work force."

Today, entrepreneurship is a focus across NC State's campus, with more than 100 companies launched from NC State ideas. (Turn to pages 20 and 21 to learn more about the programs and tools the university has put in place to help our students and faculty create new businesses.)

A survey of business startup impact across the University of North Carolina system showed that in 2012-13, 86 percent of the total impact from all 16 universities in the system came from NC State. That totals $1.2 billion in annual impact in North Carolina from NC State startups.

"NC State really has been very supportive of such entrepreneurship efforts in the last few years," said Dr. Orlin Velev, INVISTA Professor in the Department of Chemical and Biomolecular Engineering and co-founder of two startup companies based on research from his lab. "Essentially, we want to mentor our graduates on how to create their own jobs by venturing into new technologies and then learning how to scale them up and commercialize them. Hopefully, that trend will continue and expand."

FROM IDEA TO COMPANY

EEP students take original ideas and turn them into a real product or service through design and implementation. If they want to start a company, the university can provide the resources to help, including assistance with licensing and intellectual property disclosure from the Office of Technology Transfer and through Miller's connections with the Triangle's burgeoning startup community.

It's those connections that make entrepreneurial education more than just a lecture.

"It's not so much about the classes you do," Miller said. "It's about experiential learning. It's about mentoring. It's about connecting."

Each year, Miller takes EI students to California's Silicon Valley to tour companies like Google, Apple and Facebook. EI alumni working for those companies often serve as hosts.

In the spring, entrepreneurial teams compete in the EI's LuLu eGames, an annual student design competition that proved to be the launching pad for NC State startup Undercover Colors.

The EI took a big step forward in 2010 with the opening of The Garage, a work space that offers students the tools needed to develop their products and a collaborative setting that allows them to build on each other's ideas.

Nearly 75 percent of EI members come from the College of Engineering, followed by the Poole College of Management. Membership in the EI program has taken off since The Garage opened, increasing by 132 percent in the last year alone to a total of 634 student members.

The Garage is now part of the Albright Entrepreneurs Living and Learning Village on Centennial Campus, allowing EI students to live in the same building where they work on their ideas.

Putting entrepreneurially minded students together can lead to what Miller calls "beneficial collisions." Students with similar ideas and useful skill sets bump into each other and form relationships that can take a project from dream to doable.

It's the idea behind the Albright Village and what Miller hopes will be the next step in the university's entrepreneurship efforts – a new Center for Leadership and Entrepreneurship.

The proposed center would be housed in a new building on Centennial Campus that would bring the EI and Garage under the same roof with the university's General Hugh Shelton Leadership Center, a values-based leadership development center that offers programs for youth as well as college students and executives, and the Tech Incubator, a program that helps NC State's early-stage technology entrepreneurs thrive.

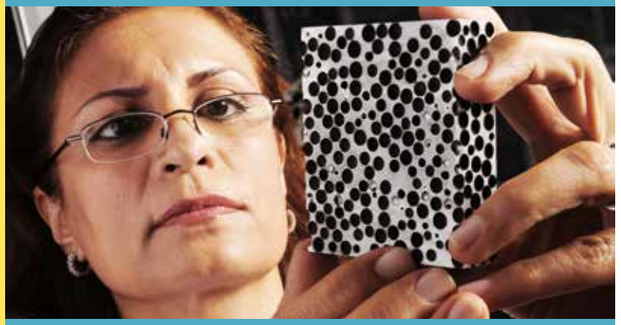
"What an opportunity for NC State to have these great programs and then put them together and leverage the synergies," Miller said. ▪

"Startup companies are the engine of job creation. Period."

DR. TOM MILLER

AN **ENTREPRENEURIAL** ECOSYSTEM

NC State does more than just teach entrepreneurship in the classroom. The university has developed a range of programs to expose students to entrepreneurs, help students develop their own ideas and then push those ideas into the marketplace. These are a few of the most important parts of our entrepreneurial ecosystem.



CHANCELLOR'S INNOVATION FUND (CIF)

The CIF assists NC State innovators with reduction to practice or technology/product development needed to strengthen the commercial potential of intellectual property disclosed to the Office of Technology Transfer. Applicants for the funds are innovators actively engaged with OTT who wish to enhance the commercial potential for promising technologies.

OFFICE OF TECHNOLOGY TRANSFER (OTT)

More than 100 startups and 400 commercialized products have come out of NC State with the help of this office. OTT's mission is to protect and promote university research discoveries and intellectual property, working with and guiding industry partners and promoting the acceleration of startups.

ENTREPRENEURSHIP INITIATIVE (EI)

This umbrella organization for many of the entrepreneurship programs offered on campus was started in 2008, taking the EEP concept university wide. The EI's offerings include a spring trip to Silicon Valley to visit leading tech companies and talk to NC State alumni and a local entrepreneurs tour each fall, along with an Entrepreneurs Lecture Series.

LULU EGAMES

Each spring, the Entrepreneurship Initiative gives away tens of thousands of dollars in this business idea competition in four categories: New Venture Challenge, Design and Prototype Challenge, Arts Feasibility Study Challenge and Verizon Student Innovator Challenge. Undercover Colors got its start by winning the New Venture Challenge at the 2014 eGames.

POOLE COLLEGE OF MANAGEMENT

The Poole College of Management offers an entrepreneurship and technology commercialization MBA concentration and entrepreneurship concentration for undergraduate students.

Inspired by the university teaching hospital model that integrates research, teaching and real world experience, the College's Entrepreneurship Clinic provides a place where faculty, students, entrepreneurs and service providers go to teach, learn and build the next generation of businesses in Raleigh. Located inside the HQ Raleigh downtown startup space, the clinic provides access to NC State's team of technology commercialization experts who consult with leading companies and universities around the world.

ENTREPALOOZA

This inaugural entrepreneurship and innovation festival hosted by the Entrepreneurship Initiative was held in early September on Centennial Campus. The event included a Minute to Win It Pitch Competition, in which students pitched their business ideas in one minute for the chance to win $1,000.

ENGINEERING ENTREPRENEURS PROGRAM (EEP)

Dr. Tom Miller's first-of-its-kind entrepreneurship program, started in 1993, allows seniors in the College of Engineering an alternative to their department's senior design project in the form of a two-semester entrepreneurial track. Students form teams and start with a blank sheet of paper to create an entrepreneurial company and product.

TECHNOLOGY INCUBATOR

The university's Technology Incubator is a nonprofit organization managed by Industry Expansion Solutions, formerly the Industrial Extension Service. The goal: bringing private and university-based entrepreneurs together in a creative, results-driven environment to activate growth and economic vitality. More than a dozen companies are located in the Centennial Campus facilities, which are not limited to NC State companies.

THE GARAGE

This collaborative space in the Albright Entrepreneurs Living and Learning Village offers all the tools NC State student entrepreneurs need to collaborate, from 3-D printers and laser cutters to video equipment, plus a comfortable setting to talk about their ideas. The Garage was established in 2010 with a gift from Red Hat to NC State.

From concept to commercialization

BENANOVA wants to take NC State research into the marketplace

The model that led to the formation of NC State startup company BENANOVA is a positive one coming out of U.S. higher education, said Dr. Orlin Velev. Not necessarily a common one, though.

Velev, INVISTA professor in the Department of Chemical and Biomolecular Engineering (CBE), began work in 2010 on an effective and environmentally benign method to combat bacteria by engineering nanoscale particles that add the antimicrobial potency of silver to a core of lignin. The process could lead to more efficient, and greener, antimicrobial products for use in the agricultural and personal care markets.

With assistance from the university's Office of Technology Transfer and advice from seasoned professionals from industry and academics, Velev and Ph.D. candidate Alexander Richter formed a startup company called BENANOVA. Located in the Technology Incubator on Centennial Campus, BENANOVA is working with a Fortune 500 personal care products company on commercializing its technology. A recent Lemelson-MIT award and a paper on BENANOVA's technique published in the journal *Nature Nanotechnology* further raised the discovery's, invention's and company's profile.

"It has all the components of research, patenting, licensing and scaling up," Velev said of the process that is taking NC State research out of the lab and into the marketplace.

A GREENER CLEANER

The collaborative study published in *Nature Nanotechnology* details a method to synthesize silver-ion infused lignin nanoparticles coated with a charged polymer layer that helps them adhere to a targeted microbe and showed that the particles were able to wipe out a wide range of harmful bacteria, including E. coli.

As the nanoparticles kill the bacteria, they are depleted of silver, leaving behind a core made of lignin, a substance found in all plant cells. Those lignin cores biodegrade easily, minimizing their potential to impact the environment.

Richter, who came to NC State for Ph.D. studies in chemical engineering after earning an undergraduate degree at MCI University in Austria, was interested in starting a company based on his Ph.D. research at the time he joined the CBE graduate program. He is now BENANOVA's CEO.

Richter has followed an unusual path to earning his Ph.D., doing much of the lab and commercial work for BENANOVA alongside his studies. Since this approach did not leave time to take time-demanding classes on campus that did not directly contribute to the Ph.D. or company, he took selected entrepreneurship classes online.

Richter then led a team of motivated engineering students to the Charlotte Venture Challenge business plan competition, winning 3rd place in the Graduate category. The company, too, has taken a different path by holding off on acquiring dedicated laboratory space until securing a revenue-bearing contract, rather than raising money and setting up a lab before engaging with potential customers. BENANOVA hired its second full time employee, a project development engineer with an undergraduate degree in chemical engineering from NC State, this year.

While BENANOVA's first focus is working in the personal care product market, applying the company's nanoparticle technology for agricultural uses might be the ultimate goal. As shown with silver as an active component, the particles could potentially also be used to improve the efficacy of pesticides.

Pesticide clumping, drying and runoff make agrochemicals less effective, costing farmers money and crop yields. BENANOVA"s particles could offer a "stickier" solution, pesticides that are more likely to attach to the plants and get the job done.

"By making the particles stick to plants, one could potentially reduce pesticide runoff to enhance the crop-protection function on the plant where it's needed. Pesticide runoff in the ground doesn't protect the plant, but instead creates environmental burdens," Richter said.

BENANOVA believes its solution could potentially reduce the chemicals used in certain plant protection applications by as much as 90 percent and save farmers more than 25 percent on pest-control initiatives.

The promise of those agricultural applications led to Richter being awarded a prestigious 2015 Lemelson-MIT Student Prize in the "Eat It" category for technology-based inventions that can improve food and agriculture.

ENTREPRENEURSHIP AS EDUCATION

More than a decade ago, a postdoctoral researcher in Velev's lab was making polymeric spheres, but the spheres were stretching and becoming thinner, forming polymer rods inside the liquid. As the researchers examined the process, they discovered it could be pushed further to make nanofibers, a potentially valuable industrial material. Xanofi, a Raleigh company that produces nanofibers for use in a variety of industrial applications, was born. Miles Wright, an experienced local entrepreneur, is the company's CEO.

Both Xanofi and BENANOVA were helped by resources on campus, including assistance with patenting from the Office of Technology Transfer.

Velev sees encouraging and mentoring technology entrepreneurship as one component of his work as an educator, going so far as to include it in his statement of mutual expectation, a written description of a faculty member's responsibilities.

"Educating our students only in engineering is not going to create jobs on its own," Velev said. "We need to also educate them to be entrepreneurial, to make their own business and once they have it, work with a focus on making it successful." ▪

MORE NAMES TO KNOW

Some of these College of Engineering startups are barely out of the gate. Others are bringing innovative products to the marketplace and creating jobs. All are taking the research and teaching that goes on in the College and making a local, and even global, impact.

AUGMENT MEDICAL, INC.

Based on a Joint NC State/ UNC Department of Biomedical Engineering (BME) design project, engineering graduates Timothy Martin, Richard Daniels and Daniel Bieber are developing an emergency communication platform for patients with disabilities that can be controlled with the flex of a muscle or raise of an eyebrow.

OFFLINE MEDIA

Chemical engineering graduate David Shaner's Offline Media wants to inspire people to unplug from electronics and connect with their communities. The company's application uses proprietary technology to collect and curate thousands of things to do in Raleigh, Durham, Charlotte and Nashville with more cities coming soon.

LUMEOVA

LUMEOVA is a start-up company based in the Technology Incubator on Centennial Campus. Founded by Dr. M. Ali Khatibzadeh, a graduate of the Department of Electrical and Computer Engineering (ECE) and veteran of the wireless semiconductor industry, LUMEOVA is focused on the development of a novel solution for next-generation, ultra-high-speed communication systems. The company is collaborating with ECE's Dr. Salah M. Bedair, Dr. Robert J. Trew and Dr. Mehmet Ozturk.

HEXATECH

Morrisville, NC-based HexaTech is creating next-generation wide bandgap semiconductor devices based on aluminum nitride for use in power conversion devices and ultraviolet LEDs. Dr. Zlatko Sitar, Kobe Steel Distinguished Professor in MSE, and Dr. Raoul Schlesser, a former research assistant professor in the department, are co-founders. MSE alumni Gregory Mills, Dr. Baxter Moody and Dr. Rafael Dalmau also hold senior positions in the company.

CREE

Engineering alumni Calvin Carter Jr., John Palmour, Neal Hunter, John Edmond and Eric Hunter took their idea from an MSE lab and turned it into a Durham, NC-based company with thousands of employees that creates lighting-class LEDs, LED lighting and semiconductors for use in wireless and power applications.

ATMOSPHERIC PLASMA SOLUTIONS

Founded in 2005 by MSE graduate Peter Yancey, Atmospheric Plasma Solutions, Inc. (APS) develops advanced plasma technologies and solutions for environmentally friendly paint removal, surface modification and cleaning and plasma-enhanced deposition for the advanced materials, defense and medical markets. The APS PlasmaFlux technology brings the benefits of plasma processing to industrial processes without the need for expensive vacuum chambers and pumps.

NOVOCOR MEDICAL SYSTEMS

Dr. Andrew DiMeo, associate professor of the practice, in BME and five of his students designed a device that instantly cools saline to induce therapeutic hypothermia. Their invention is the lead product of Novocor, a company providing solutions for emergency first responders. Their life-saving product is ready on demand, attaches in-line to standard IV tubing and cools saline for up to 30 minutes without any external power. It is easily stored in ambulances, fire trucks and helicopters and can be carried anywhere EMS personnel go.

WARPSPEC DIAGNOSTICS

MSE Ph.D. candidate Jordan Moering and Jenkins MBA student Rafael Estevez are using a plasma energy field and advanced optics developed by the US Navy to scan processed food to ensure pathogens such as salmonella and E. coli. will not make it to grocery store shelves. The team won first place in the New Venture Challenge at the 2015 Lulu eGames and is a semifinalist for the 43North business plan competition.

ITST-LLC

Dr. Jerry Cuomo is a Distinguished Research Professor in MSE. ITST-LLC is a research and consulting company he founded that has negotiated the exclusive rights to a patent filed by NC State and ITST-LLC on a method and process for the low temperature capture and transformation of CO_2, NH_3, SO_2, H_2S, $CS2_2$ and Thiophenes as well as the alkylation of hydrocarbons that will improve the octane in fuels. All of these processes are at low temperatures with the renewal of the activating medium.

TRIBOFILM RESEARCH, INC.

Based in Raleigh, TriboFilm Research is an independent research and development center bringing together materials scientists, chemists and engineers focused on novel medical devices and pharmaceutical packaging. TriboFilm holds multiple worldwide patents licensed to several pharmaceutical companies and medical device manufacturers. Vice-Presidents Vinay Sakhrani and Robert A. Mineo have NC State degrees in materials science and engineering and aerospace engineering, respectively, and Dr. Jerry Cuomo, Distinguished Research Professor in MSE, is chairman of the company's board of directors.

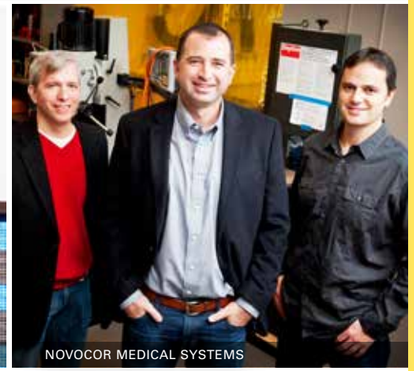
IMAGINEOPTIX CORP

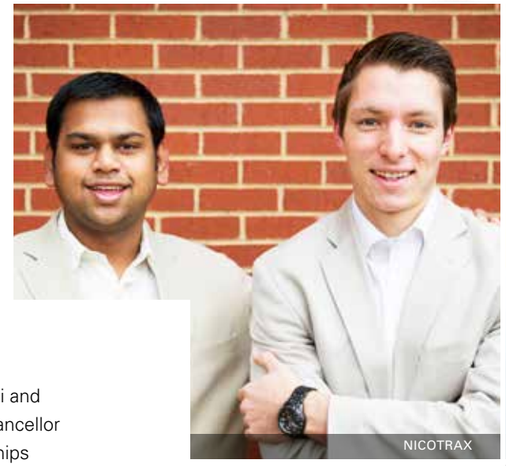
ECE professor Dr. Michael Escuti and Dennis Kekas, associate vice chancellor for Centennial Campus partnerships and director of the university's Institute for Next Generation IT Systems, are co-founders of this Cary, NC company commercializing patented optical thin-films and specialty optical components.

NICOTRAX

First called Track2Quit and developed in the Engineering Entrepreneurs Program, Nicotrax has developed a smart cigarette case, mobile application and web dashboard that help smokers quit. The technology analyzes individual triggers for smoking and provides direct support to overcome and replace the addiction. Electrical engineering graduate Suraaj Doshi has stayed on from the senior design team and is the company's chief technology officer. NC State computer science alumnus Kenneth Jennings runs the company's software development.

CREE


NOVOCOR MEDICAL SYSTEMS


NICOTRAX


WARPSPEC DIAGNOSTICS

SMART MATERIAL SOLUTIONS, LLC

This Raleigh-based company specializes in research and development of smart material and precision engineering technology, including optics and structured surfaces. Founder Dr. Stephen Furst, a graduate of the Precision Engineering Center (PEC) under the direction of Distinguished Professor Thomas Dow, works extensively with the PEC on mechanical design, fabrication of optics and basic research on measurement and precision fabrication processes. The company is working on a National Science Foundation-funded project to develop Nanocoining — a novel nano-manufacturing process developed at the PEC that is capable of creating large anti-reflective and self-cleaning surfaces quickly and inexpensively. ▪


IMAGINEOPTIX CORP

FILLING THE WEARABLES GAP

ASSIST excels at moving wearable technology from novelty to necessity

Wearable technologies, including smart watches and fitness bands, have become one of the hottest sectors in the technology business.

While these monitors are popular in the consumer market, healthcare applications for these technologies function as a stylish pedometer to count steps. Researchers at the Nanosystems Engineering Research Center for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST) – a National Science Foundation (NSF) Engineering Research Center (ERC) led by NC State – are working to pull these wearables into the future through dramatic reduction in power consumption and novel sensor and low-power computing technologies.

Now entering its fourth year, the ASSIST Center was visited by NSF officials in the spring and has successfully been unconditionally renewed for five additional years of funding.

"They were impressed with the vision and direction the Center has taken and are happy with the advances we're making," ASSIST Center Director Dr. Veena Misra said of the feedback from the visit. "It showed up in our review."

ASSIST research is built around two platforms or testbeds – a health and environmental tracker that measures vital signs and environmental exposures running on a long-lasting battery and a self-powered, adaptive sensing platform that takes electrocardiogram readings and is powered by energy harvested from the human body. ASSIST's research on advanced sensors, ultra-low-power radios and electronics and energy harvesting fits within these two testbeds.

This research will create wearable sensors that go beyond activity level and provide valuable information about what is happening in a user's body and what is going on within the surrounding environment.

"That's really the gap right now in all wearable devices," Misra said. "What's actually happening to your stress levels, what's happening to your sugar levels, what's happening to your inflammation in the body."

One example can be found in the pinprick blood test diabetics use to check their insulin level. A sweat pump being developed by ASSIST researchers uses no applied power and can extract sweat to be tested for key biomarkers such as lactates, cortisol and, yes, glucose.

Center researchers have created energy harvesting technology, a low-power system on chip and low-power wireless radios with performance that is superior to the technology available commercially. ASSIST already owns 17 pieces of intellectual property, and Misra sees those technologies moving into the marketplace in the coming years, either through the formation of startup companies or in partnership with ASSIST industry members.

"The wearables space exploding is actually very good because these companies can take our technologies and put it right into their wearables," Misra said. ▪

SUCCESS IN A PIVOTAL YEAR

FREEDM Systems Center readies for field testing and looks to long-term sustainability

Year seven was an exciting one for the Future Renewable Electric Energy Delivery and Management (FREEDM) Systems Center led by NC State.

FREEDM, a National Science Foundation (NSF) Engineering Research Center (ERC) headquartered on Centennial Campus, received positive feedback from NSF during a spring site visit and learned that the center will be fully funded through year 10.

At the same time, a $1.5 million gift made by the Duke Energy Foundation will help establish an endowment to ensure FREEDM's future sustainability. The center is also ready to deploy its smart-grid technologies for field testing.

The NSF established FREEDM in 2008 to develop technology that will seamlessly integrate distributed renewable sources and energy storage into the electric grid infrastructure. The addition of the Nanosystems Engineering Research Center for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST) in 2012 made NC State the only university in the country to lead two ERCs at once and one of only two schools (along with Carnegie Mellon University) to be awarded the lead role in three.

The center's ultimate goal is to create a power system in which electricity will be generated close to the loads and managed with a distributed control system that is responsive to price signals, customer preferences and situational considerations flowing both ways. Instead of the current system that is based on centralized generation and one way power flow that only allows electricity to move from a utility's power plant into a home or business, electricity produced by a residential solar installation or a commercial wind farm would also be able to flow back into the grid or to a nearby community through the grid.

It's a key part of moving the country from a centralized, static system to a smart, plug- and-play distributed generation system, giving us a more robust power infrastructure.

"Why is distributed generation good and important?" said FREEDM Director Dr. Iqbal Husain. "Because that is the way to improve the resiliency and reliability of the power system so we don't plunge into blackouts or are not affected by accidents like the meltdown at Fukushima. With FREEDM technologies, a single point of failure will not cause widespread catastrophic effects."

A major next step is the testing of a small version of a FREEDM system in the field, possibly at a Duke Energy facility later this year. There are also plans to deploy an energy cell developed by FREEDM researchers in a microgrid (a small power system that can run autonomously but is also connected to a larger energy grid) in the Dominican Republic.

Within that system are components that represent significant advances and can be used by power utilities today, including novel power transistor technologies that can help existing power converter technologies be more efficient and a solid state transformer that allows two-way power flow with improved power quality and efficiency.

"We have a vision for changing the world with this advanced electric distribution system, but then within this we have technologies that would enhance pieces of the power grid or could go into various other applications," Husain said. ▪

"This is about creating a transformative inter-institutional model, not two separate halves"

DR. NANCY ALLBRITTON

DEPARTMENT OF BIOMEDICAL ENGINEERING **establishes joint undergraduate degree**

Dr. Nancy Allbritton calls NC State and UNC-Chapel Hill home.

As a professor and chair of the Joint NC State/UNC Department of Biomedical Engineering (BME), Allbritton works with faculty members and students from both universities on a daily basis.

The joint graduate degree program in BME was established in 2003, bringing together the College of Engineering at NC State and the School of Medicine at UNC Chapel Hill. The BME Department extended into the College of Arts and Sciences at UNC in 2013, making it a three-way partnership. The joining of these institutions has provided biomedical engineering students with an opportunity to grow their knowledge and interest in the field while developing innovative opportunities in the pursuit of biomedical problems being faced.

An average of 20 students complete the graduate program each year. With the success and popularity at the graduate level, the BME department has established a joint undergraduate degree program.

"This is the first truly joint department between two higher learning institutions. Everything is joint," said Allbritton.

"This is bringing the undergraduate department in line with the department and helps everyone feel they belong while promoting cohesiveness."

Many universities have joint degree programs, but none give privileges to the other campus' students, Allbritton said. The plan for the new undergraduate program would allow students at both universities to take classes on the partner's campus while also giving students access to labs and other privileges only afforded to a student on that campus.

INDUSTRY APPEAL

Allbritton said the growing department is studying how other departments operate and talking to universities overseas on growing a global impact and making opportunities for students and faculty. The dean from Purdue University's College of Engineering has visited to work with the department to develop ideas to do just that.

"This is about creating a transformative inter-institutional model, not two separate halves," said Allbritton. "We are creating a true, single department and developing a model all universities will follow across the country and, one day, the world."

Creation of entrepreneurial initiatives is one of the ways the joint department is looking to make an impact. These entrepreneurial opportunities are currently in the development stage as the department works to identify ways

to interface and build relationships with industries. Preston Linn, industry academic coordinator for the department, said the goal of these initiatives is to make BME an asset to industry while establishing great new relationships and opportunities to connect and collaborate.

"Hopefully, this leads to industry internships and ultimately to jobs for graduates of the BME department, both undergraduate and graduate programs," said Linn.

Building industrial partnerships is one way that these initiatives can be made. With the development of an industrial advisory board, the relationship and interaction between BME students and faculty members with industry will grow and improve. One of the focal areas for building these relationships is the Research Triangle Park (RTP).

"We believe that this becomes a great opportunity, halfway between the two campuses, where we can have students meet together as well as faculty and staff to establish relationships with the entrepreneurial culture that is in the RTP."

The department has had some success with industry, with multiple startup companies coming from department faculty members and research.

Faculty members within the department have spun off more than 25 companies, while about 10 percent of the graduate students are involved in startups. Undergraduate students in the department have also created three spinoff companies based on departmental research.

Some of these companies include: SonoVol, Intellego, Plexigen, NDIMO, Cell Microsystems, BioFluidica, Mercury Science, Cortial Metrics, Protein Simple, Surgicorp and Novocor Medical Systems — a former senior design project, created in a class where students are encouraged to work on real problem solutions. Novocor uses its patented product, HypoCore, a rapid chilling device that cools saline during the infusion process to induce therapeutic hypothermia, to help Emergency Medical Service first responders save lives.

DEPARTMENT NUMBER GROWTH

As the popularity of the department increases, so too will the number of students. More than 40 undergraduate students have signed up for the program at UNC Chapel Hill beginning this fall. An undergraduate degree in BME is already in place at NC State and sees 65-70 students graduate each spring.

Allbritton said the joint department is anticipating at least 80 new undergraduate students a year at each university.

"With NC State's background in engineering and UNC's medical school, students no longer have to choose between engineering or medicine, they can have both," she said. "This undergraduate degree is a great opportunity to take a step back and start from scratch to grow the department and a program that brings the brightest to these powerhouse universities."

The jointly conferred diploma for the degree will have both NC State and UNC listed as the represented universities. ▪

FOCUS AREAS

The department's five research focus areas were chosen to build upon the strengths of the two universities.

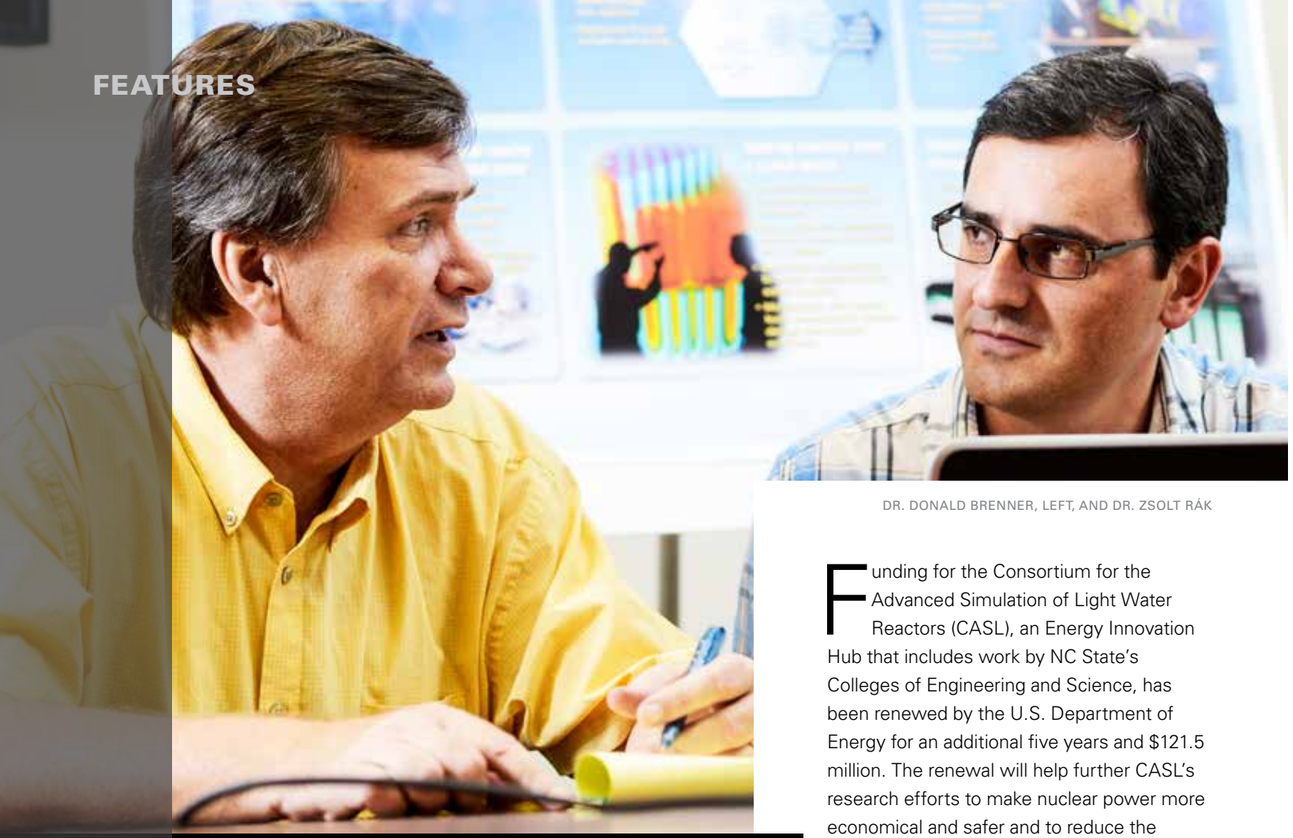
REGENERATIVE MEDICINE builds new body parts for the aging and impaired and includes tissue engineering, stem cells, scaffolds and mechanobiology

BIOMEDICAL MICRODEVICES enables disease diagnosis that is faster, less expensive, more reliable and includes lab-on-chip devices, microfluidics devices and sensors

PHARMACOENGINEERING, interfacing engineering and pharmaceutical sciences to develop safer and more effective medicine enhanced therapeutic delivery systems

MEDICAL IMAGING ENGINEERING permits non-invasive monitoring of the body with technologies such as ultrasound, PET, SPECT, MRI and photonics

REHABILITATION ENGINEERING links engineering and medicine to restore lost function with body biomechanics, artificial limbs and assistive devices



DR. DONALD BRENNER, LEFT, AND DR. ZSOLT RÁK

CASL renewal will drive research across the COLLEGE

Funding for the Consortium for the Advanced Simulation of Light Water Reactors (CASL), an Energy Innovation Hub that includes work by NC State's Colleges of Engineering and Science, has been renewed by the U.S. Department of Energy for an additional five years and $121.5 million. The renewal will help further CASL's research efforts to make nuclear power more economical and safer and to reduce the amount of radioactive waste produced.

CASL was established in 2010 to develop advanced modeling and simulation capabilities that serve as a virtual version of operational and future light water reactors. NC State is a founding partner of CASL, which is headquartered in the Oak Ridge National Laboratory. Other founding partners include: Westinghouse, the Electric Power Research Institute, Tennessee Valley Authority, MIT, the University of Michigan and the Idaho, Los Alamos and Sandia National Laboratories.

"What we thought we were going to do a year from now, we have expanded on and have researchers working on collaborations," said Dr. Paul Turinsky, chief scientist of CASL and professor of nuclear engineering at NC State. "At NC State we have faculty and researchers working in varying technical disciplines, including applied mathematics, computer science, and materials, mechanical and nuclear engineering, in addition to education and business assessment components. It's these collaborations that will help us reach the CASL goal of providing simulation capabilities to support showing how nuclear energy can be a dependable and affordable energy source in the U.S."

RESEARCH ACROSS DISCIPLINES

CASL research to ensure the safest production of nuclear energy in the coming decades can be seen across several departments within the College of Engineering.

Predicting steam bubbly flows

Most operating nuclear reactors use water to both cool the reactor and transfer the heat from the nuclear fuel to use in electricity generation. Dr. Igor Bolotnov, assistant professor in the Department of Nuclear Engineering, is using high-performance computing to study bubbly turbulent flows in reactor geometries, which is important for the design of safe and efficient reactors.

According to Bolotnov, steam bubble distribution in coolant channels is important to predict since it greatly affects the heat transfer parameters. In nuclear reactor cores, the heat transfer occurs through the surface of a fuel rod to the flowing liquid around it. The presence of boiling water enhances the rate of heat removal from nuclear fuel rods. If too much steam is created and it concentrates near the fuel rod surface, it can lead to the phenomena known as departure from nucleate boiling (DNB). In nuclear reactors this process would occur at high temperatures (up to 315 °C / 600 °F) and is challenging to study experimentally.

"If this happens, the fuel rod becomes insulated by steam, and this may lead to the overheating of the fuel and serious safety issues," said Bolotnov. "The accurate prediction of DNB is one of the challenge problems for CASL."

With the help of detailed simulations, Bolotnov and a graduate student have contributed to the development of new engineering models to predict the bubble behavior on a large scale, such as a whole reactor code.

Defining CRUD

Dr. Donald Brenner, associate department head and Kobe Steel Distinguished Professor in the Department of Materials Science and Engineering, is focusing on theoretical and computational investigations of the chemistry within reactor coolants.

Brenner and postdoctoral scholar Zsolt Rák are working to define the thermodynamic driving force for the creation of oxide deposits on fuel rods. These deposits – Chalk River Unidentified Deposits, or CRUD (no, really) – are named after Canada's Chalk River nuclear power plant where they were first observed. As CRUD formations lead to local fuel rod temperature increases and more deposits, there is a risk of localized corrosion-induced failures of the fuel rod cladding (tubing that contains the nuclear fuel and hence radioactive material).

In order to define those driving forces, Brenner is using quantum-mechanical methods to calculate the formation energies of various species that are known to form in CRUD, including nickel ferrite (a compound of iron, nickel and oxygen) and nickel oxide (a compound containing nickel and oxygen).

"Emphasis in CASL with respect to CRUD chemistry has shifted away from why CRUD forms to the question 'Where do the ions in solution that form CRUD come from?'" said Brenner. "Because of this, we have shifted our emphasis to calculating the stability of the other materials, like stainless steel, that are also in contact with the coolant, to try to estimate the extent to which these materials may dissolve into the coolant."

Modeling crystals

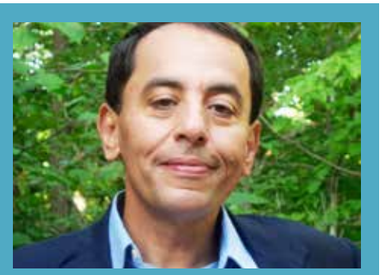
Dr. Mohammed Zikry, Zan Prevost Smith Professor in the Department of Mechanical and Aerospace Engineering, is modeling the high temperature behavior and failure of irradiated materials and systems found inside a reactor.

Zikry and his student researchers are developing computational finite-element models on the crystal (or grain level) and sub-crystal level – what is classified as the meso scale.

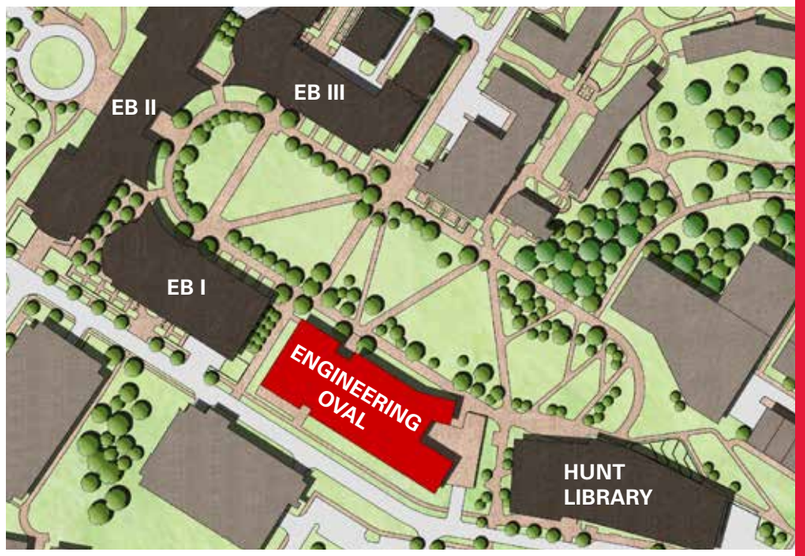
This modeling work involves physically representing the crystal and then relating this behavior to crack nucleation or failure in reactor structures and subcomponents. Because experiments related to these high temperature and irradiated conditions are difficult, if not impossible, to conduct, accurate modeling of fracture and failure are essential for fail-safe design of light-water reactors. Zikry's research will lead to computational predictive tools that will further our understanding of how materials and systems fail.

"Our work is part of an integrated effort between universities, industries and national laboratories to provide accurate predictions of how material and systems behave under extreme loading conditions related to high temperature, irradiation, and fracture," said Zikry. ▪

DR. IGOR BOLOTNOV



DR. MOHAMMED ZIKRY



College prepares next step in move to Centennial

The College of Engineering made its first move toward a new home on Centennial Campus in 2004, with the opening of Engineering Building I.

Engineering Building II opened in 2005 and Engineering Building III in 2010. Now, the College is prepared to take the next step toward a home on Centennial with the construction of the Engineering Oval building.

Engineering Oval will house the Edward P. Fitts Department of Industrial and Systems Engineering; the Department of Civil, Construction, and Environmental Engineering; and the College administration as well as an Engineering Education Center that includes student advising and other student services. This new marquee building will help move the College closer to unification on Centennial and leverage the power of convergence across disciplines. Having the College centered on Centennial Campus provides an atmosphere for College of Engineering students and faculty members unmatched anywhere in the nation, one that will foster and facilitate innovation in research and education through partnership opportunities.

"The Engineering Oval building is a vital next step as our College continues this journey to educate the engineers of tomorrow and maintain its status as one of the leading public colleges of engineering in the country," said Dr. Louis Martin-Vega, dean of the College. "No one is standing still. Many of our peers and aspirational peers are receiving significant commitments to grow even more their resources in engineering."

Six of the College's nine academic departments – the departments of Materials Science and Engineering, Chemical and Biomolecular Engineering, Electrical and Computer Engineering, Computer Science, Mechanical and Aerospace Engineering and Electrical and Computer Engineering, and the Joint NC State/UNC Department of Biomedical Engineering – are already housed on Centennial.

Since land for this innovative campus, located south of NC State's main campus on the other side of Western Boulevard, was first designated in 1984, it has become a model for the 21st-century university campus that combines academics, research, government and industry in one livable complex. The original plans included moving the College of Engineering to Centennial Campus to serve as a centerpiece for research and education. Engineering Oval brings NC State closer to its dream of a campus that drives North Carolina's high tech economy.

Located between Engineering Building I and the James B. Hunt Jr. Library, Engineering Oval is designed to marry the brick-and-mortar architecture of Engineering Buildings I, II and III with the modern glass look of the James B. Hunt Jr. Library, creating a light-filled and vibrant space that encourages collaboration. This 232,000-square-foot building housing more than 100 classrooms and state-of-the-art laboratories will be a hub for advancing knowledge and excellence in areas such as biomanufacturing, advanced manufacturing, rapid prototyping, health systems engineering, construction engineering and management, environmental engineering, transportation systems and other fields of great societal impact.

A DIFFERENT FUNDING MODEL

The university will use the state flexibility for public-private partnerships to finance construction. The College and the NC State Engineering Foundation, Inc. are developing lead philanthropic commitments, with about $20 million in gifts and conditional pledges given so far.

Word on expected commitment from the state of North Carolina was being worked out late this summer as the North Carolina Legislature continued its budget negotiations.

With the university initiating strategies to save on infrastructure costs, the overall project is expected to cost $137.7 million.

"This will go down as a significant project in the history of NC State," said Brian E. Campbell, assistant dean for development and college relations and executive director of the NC State Engineering Foundation, Inc. "It will be the first time in our history in which we've had a public-private partnership of this scope. That's not to mention the fact that it will be one step closer to unifying the College on Centennial Campus." ▪

Interested in supporting the Engineering Oval project? Contact **Lora F. Bremer** with the **NC State Engineering Foundation, Inc.** at **lora_bremer@ncsu.edu** or **919.513.0983**.

View an online video about the Oval building project at **https://youtu.be/FDEgyH-ResU**

CHRISTOPHER PHILLIPS

DR. FRANCES AND DR. GEORGE LIGLER

BRANDI WEAVER

MEET THE DEAN'S CIRCLE

Dean's Circle members make the College of Engineering the best it can be and ensure opportunity for all

Alumni. Friends. Faculty members. Sons and daughters. Spouses. Members of the Dean's Circle, the College's signature annual giving fund, are connected to NC State engineering in different ways. But by giving $1,000 or more annually to support the College, they all play a major part in making it strong. Gifts help fund scholarships and fellowships, which are used to attract and retain top students, and support innovative programs in the College's academic departments. Meet four Dean's Circle donors and learn why they give.

CHRISTOPHER PHILLIPS

It was apparent early on that Chris Phillips would study civil engineering, and that he would do it at NC State.

"I was born into it," said Phillips, who earned his undergraduate degree in 1985 and graduate degree in 1988 from the Department of Civil, Construction, and Environmental Engineering. "My dad's a civil engineering graduate, class of 1960, who had a long distinguished career with the DOT. So from the time I was old enough to speak, I knew who the Wolfpack was."

Phillips started with Hazen & Sawyer, a national environmental engineering firm with a Raleigh office, after graduation and is now the corporate head of the firm's structural engineering department. He keeps in touch with his former professors, including for help when seeking new candidates for employment.

"I can't lie to you to you, when it comes time to add staff, that's where I look," he said. "Especially for positions in this area."

A season ticket holder for Wolfpack football, basketball and baseball, Phillips lends financial support to athletics as well as academics. He chooses to support the College because of the opportunities his degree has afforded him: to work on projects that interest him and provide for his family while staying close to his native Garner, NC.

"I think that they've given a lot to me and they deserve something back."

The youngest of Phillips' three children will start at NC State this fall, providing yet another reason for him to stay close to the university. As if he needs one.

Phillips describes his loyalties as "God, family, country and the Wolfpack."

DR. FRANCES AND DR. GEORGE LIGLER

No strangers to supporting higher education, and taking leadership roles while doing so, Frances and George Ligler made a commitment to support the College upon their arrival in Raleigh.

Dr. Frances Ligler was named the inaugural Lampe Distinguished Professor of Biomedical Engineering at NC State in 2013 after a distinguished career with the US Naval Research Laboratory that included election to the National Academy of Engineering (NAE) in 2005. Dr. George Ligler is a computer systems engineering consultant with more than 40 clients on three continents.

A pioneer in the fields of biosensors and microfluidics, Frances Ligler mulled several options when she decided to retire from the Naval Research Laboratory and turn to academia. The leadership of engineering Dean Dr. Louis Martin-Vega was one of the things that drew her to NC State. That leadership is also one of the reasons she and her husband support the College financially.

George Ligler serves on the National Academies' Standing Committee on Reengineering Census Operations with Martin-Vega and the Joint NC State/UNC Department of Biomedical Engineering's industrial advisory board. Both Liglers have held volunteer leadership positions with Furman University, where they earned undergraduate degrees.

Frances Ligler is a member of the Council of the NAE, the organization's governing body. The couple has endowed the Ligler Challenge, matching donations to fund NAE activities.

After successful careers, the Liglers say they are in the "give back phase" of their lives. That includes giving to the College.

"It's basically an obligation of being part of the community," George Ligler said.

BRANDI WEAVER

Ask Brandi Weaver for a favorite memory from her student days at NC State and you will get more than one thing. A lot more.

Weaver, a 2003 graduate of the Department of Electrical and Computer Engineering, was involved in the College's Minority Engineering Programs (MEP) and student chapter of the National Society of Black Engineers.

She was part of the MEP mentoring program for minority engineering freshmen and was a teaching assistant for an Introduction to Engineering class. MEP helped her take a study abroad trip to Vienna and Budapest. She even played violin in a hip-hop band.

Weaver, who is also a member of the university's Chancellor's Circle giving society, went to work as an electrical design engineer at Duke Energy's McGuire Nuclear Station in Huntersville, NC, and is now part of a multidisciplinary team in the company's corporate offices in Charlotte, NC doing Probabilistic Risk Analysis for nuclear reactors.

After studying at the North Carolina School of Science and Math, Weaver knew she wanted to be an engineer. Exposure to STEM education in high school and having an older brother who is an engineer guided her decision.

"I knew early on in life that it was an option," she explained. "A lot of people didn't even know it was an option."

Now, through mentoring and tutoring, she is teaching younger students that engineering is an option for them as well and that, thanks to Dean's Circle donors, financial concerns don't have to hold them back.

"That's a lot of the reason I want to give," Weaver said. "I had so many opportunities while I was there. I'm very adamant about giving back." ▪

Endowed professorships **help recruit top researchers**

If the College of Engineering is to sustain its position as one of the leading public colleges of engineering in the country, it is critical to have the best faculty in the country.

"You can't have a great College of Engineering without great faculty," said **BRIAN E. CAMPBELL**, assistant dean for development and college relations, and director of the NC State Engineering Foundation.

The support of an endowed professorship – a position permanently paid for with the revenue from an endowment fund – is one of the best tools to recruit and retain great faculty members.

"With the help of endowed positions, the College can compete with other high-ranking engineering schools, such as Georgia Tech and Purdue, in appealing to the top engineering faculty," said Campbell.

The funds in these professorships provide salary support, research flexibility, program development, graduate assistant funds, equipment and course development.

DR. MICHAEL STEER

DR. ROSS LAMPE JR.

DR. JUSTIN SCHWARTZ

DR. FRANKY SO

DR. ROSS LAMPE JR., president of SiteLink Software, is among 15 members of the Lampe family who have attended NC State over the past 65 years and is the grandson of J. Harold Lampe, the College's longest serving dean. Lampe has endowed two professorships, one in the Joint NC State/UNC Department of Biomedical Engineering (BME) and another in the Department of Electrical and Computer Engineering (ECE). With strong family ties to the university, he felt professorships were an effective way to help the College grow.

"The NC State College of Engineering is a core institution of education and engine of job growth in North Carolina. We hope to see continued improvements in college rankings, in the North Carolina economy, and the quality of life we enjoy," said Lampe.

Lampe is also motivated by the kind of world-changing research that an endowed professorship allows a researcher to accomplish, a benefit that goes beyond helping the College.

"These endowments provide the possibility that the research we help support will benefit society," said Lampe. "There is no certainty that any research will make a difference, but in the case of our first endowed professorship, the Lampe family was privileged to be associated with **DR. MICHAEL STEER** and his outstanding contributions."

Steer, the Lampe Distinguished Professor in ECE, developed technology for detecting improvised explosive devices (IEDs), which acted as a game changer in the wars in Iraq and Afghanistan by effectively ending the use of radio-controlled IEDs against American soldiers. Steer received the U.S. Army Commander's Award for Public Service, one of the highest honors that can be bestowed on a civilian.

"I believe that with the professorship comes the responsibility to provide leadership and undertake efforts for the betterment of NC State University and its students. I see the need to train our students at both the graduate and undergraduate level to be better suited to support our national security through engineering and research," said Steer.

Endowed professorships are not only a recruiting and retention tool for gaining new faculty members, but they also add prestige to the position. Through the creation of distinguished professorships, the donor's name becomes the title for the position.

"It's an added recognition that gives credibility to the position," said Campbell. "The donor's name is forever attached to the position and acts as an institutional reminder that brings recognition to the donor and the university."

In attracting faculty members from other universities, these professorships help in getting the best researchers to the College, especially researchers who are already in endowed positions.

FRANKY SO, the Walter and Ida Freeman Distinguished Professor in the Department of Materials Science and Engineering, joined the department this year after leaving the University of Florida, where he was the Rolf E. Hummel Professor of Electronic Materials.

"Without endowed professorships, we wouldn't have Franky So," said **DR. JUSTIN SCHWARTZ**, MSE department head. "These professorships are critical in enabling departments the ability to hire exceptional faculty, elevate the visibility of the College, and in retention and recruiting."

Currently, the College has 40 named endowed professorships. Campbell said peer colleges of engineering aren't standing still when it comes to recruiting excellent faculty members.

"The goal is to create two to three times as many endowments in the next five to seven years to keep up with other leading schools."

For a full list of endowed professorships and how you can donate, visit: **www.engr.ncsu.edu/foundation/** ▪

Alumnus makes the College a **part of his estate plans**

VAN DELK

When it came time to make estate plans, setting up a way to support the College of Engineering made sense for Van Delk.

Attending Ragsdale High School in Jamestown, NC, Delk enjoyed his classes in mathematics, chemistry and the physical sciences. He decided in junior high school to pursue engineering and settled on chemical engineering when he arrived in Raleigh in 1969 because of its usefulness.

"If you can be a chemical engineer you can do anything for anyone because it's such a broad field," he said.

Delk has fond memories of his time on campus living in Bragaw Residence Hall, including playing men's intramural basketball along with a lot of golf and tennis.

As a student, he worked a couple of summers back home at the Phillips-Foscue Corporation flexible foam plant in High Point, NC. It would be the start of a career in the polyurethane business that would lead him to the Dow Chemical Company.

Dow was looking for someone with experience working with the components to produce the polyurethane foam the company manufactures for furniture and bedding.

Today, Delk works closely with more than 40 Dow customers in the United States and Canada. It's a job that keeps him on the road a lot visiting clients. He lives in Freeport, Texas, site of a Dow manufacturing facility.

Delk is also a member of the NC State Alumni Association and the Wolfpack Club. A lifelong bachelor, he thought of the College of Engineering when it came time to make estate plans. He saw a way to pay back what was given to him.

"Looking back, I wouldn't be where I am without my education at NC State," Delk said. ▪

THE **PERFECT** FIT FOR YOU

The NC State Engineering Foundation, Inc. makes several options available for meeting your long-term financial goals while also supporting the College.

For more information, visit **www.engr.ncsu.edu/foundation/ways-to-give** or contact **Lora Bremer** at **919.513.0983** or **lora_bremer@ncsu.edu**.

NC STATE Engineering

ANNUAL GIVING

ENGINEERING FOUNDATION

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

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

WAYS TO GIVE

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

JOIN THE DEAN'S CIRCLE

Annual gifts of $1,000 or more qualify for membership in the Dean's Circle, the College's leadership annual giving program. Visit **www.engr.ncsu.edu/foundation/deanscircle** for more information.

INCREASE YOUR IMPACT

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

If you have already made your 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.

Foundation board changes leadership

ROB E. MANNING

THOMAS R. MCPHERSON JR.

Robin (Rob) E. Manning, who holds a bachelor's in electrical engineering from NC State and a master's in business administration from Queens College in Charlotte, took over as president of the NC State Engineering Foundation, Inc.'s board of directors in January. He replaces Thomas R. McPherson Jr., who has two degrees in electrical engineering from NC State and is a Distinguished Engineering Alumnus.

McPherson, who remains on the board, completed his two-year term as president in fall 2014. He is most proud of two accomplishments: the board's focus on stewardship and the development and implementation of the Foundation's strategic planning process. In addition, the value of the endowment assets that benefit the College crossed the $100 million threshold.

As incoming president, Manning chaired the strategic planning committee. The strategic plan identified key initiatives:

- Major gift fundraising strategies, benchmarking and staffing
- Business of the Foundation: funding operations and stewardship
- Broadening the base: engagement, participation and the annual fund
- Tools-technology-data science
- Staying the course

Those key initiatives were assigned to committees.

"I think Rob did an outstanding job leading the strategic plan process," McPherson said. "I think the whole board was engaged and very impressed with the work."

As president, Manning has three main objectives, which are part of the strategic plan.

> "People need to know that they have a way of staying engaged with NC State that goes beyond graduation, even beyond their careers..."
>
> **ROB E. MANNING**

One is making sure people understand the importance of what the Foundation does through better communication. Many do not know that the Foundation secures private financial contributions to improve the College and that those contributions support scholarships, fellowships, professorships, academic programs, faculty research and other important initiatives that enable the College to recruit top students and faculty.

His first objective dovetails with his second objective of reaching more faculty members, students and alumni.

"People need to know that they have a way of staying engaged with NC State that goes beyond graduation, even beyond their careers, but we have got to do more to get that word out," Manning said.

His third objective is to support College priorities such as rankings and completing the College's move to Centennial Campus.

Both Manning and McPherson credit their education at NC State for their successful careers. Manning is vice president of transmission for EPRI's Power Delivery and Utilization research sector. Prior to that, he served as executive vice president and chief external relations officer for the Tennessee Valley Authority (TVA), and before joining TVA, he enjoyed a long career at Duke Energy. McPherson led the founding and building of several successful high-tech companies, including Network Equipment Technologies, Rapid City Communications and Cognio, Inc. He now serves on several non-profit boards, including the advisory board for NC State's Engineering Entrepreneurs Program.

Both men have been generous donors and have established endowments in the College, and both have enjoyed their time on the Foundation board and are pleased to advocate for and support the College.

Referring to board meetings, Manning said, "Under Tom's leadership, we expanded them to include a presentation from a professor or a department head, sometimes even from students. And each of those board members connected. It kind of stirs those passions you remember from your college days. It gets people excited about what NC State is still doing. It reminds you that it is important to support those folks who are experiencing what some of us experienced many, many years ago." ▪

Foundation **Year in Review**

The NC State Engineering Foundation, Inc. had another record-setting fundraising year with $21,741,828.00 in private gifts and new commitments for fiscal year 2014-15 in support of students, faculty and programs in the College of Engineering. These numbers do not include a significant number of pledges dedicated to the Engineering Oval Project. The accompanying charts illustrate the sources and uses of this private support.

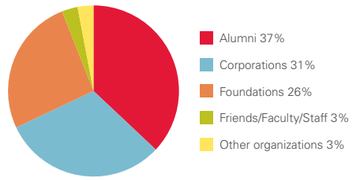
In addition to the Engineering Oval Project, priority has been given to building the endowment of the College, with $9.2 million in new commitments to that area. Those gifts are the most important and enduring investments donors can make in the College, and they have a profound impact on our ability to attract and retain people — the students and faculty members who define the College. There is a strong correlation between the growth in endowment giving and the growth in giving by alumni. Endowment is one of the most important ways donors can establish a legacy at NC State. The permanence of endowment provides us the opportunity to recognize our endowment donors through named funds, preserving legacy for the donor and leadership examples for other prospective donors.

In the coming years, facilities will also play an important role in our fundraising priorities. The Engineering Oval Project not only unifies almost all of the College on Centennial Campus, but also provides a public-private blueprint for future capital needs. While the State of North Carolina has generously funded all of our capital needs historically, new funding models will include philanthropy, along with state support.

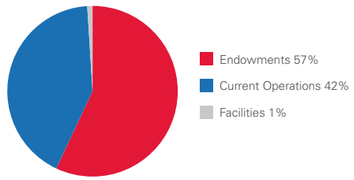
On behalf of the students, faculty and staff, the Foundation expresses its sincere appreciation to all who continue to give so generously.

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

GIFTS AND NEW COMMITMENTS BY GIFT SOURCE, FISCAL YEAR 2014-15



GIFTS AND NEW COMMITMENTS BY GIFT USE, FISCAL YEAR 2014-15



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FROM GALILEO TO STEER

THE ADVENT OF THE INFORMATION AGE has made it much easier to track one's family history, turning days spent poring over dusty vital records into a few hours online.

The same can be said of tracing one's academic history.

The Mathematics Genealogy Project at North Dakota State University compiles an online database of mathematicians with doctoral degrees in a wide range of associated disciplines and allows users to trace a lineage by doctoral advisor. The database led a student to trace Dr. Michael B. Steer's doctoral forebears back nearly five centuries. Steer, Lampe Distinguished Professor in the Department of Electrical and Computer Engineering, has some remarkable ancestors, as the illustration below shows.

A doctoral graduate of the University of Queensland in 1983 under the advisement of Dr. Peter Khan, Steer shares an ancestor with Dr. Paul Franzon, Distinguished Professor of Electrical and Computer Engineering and a doctoral graduate of the University of Adelaide. ▪

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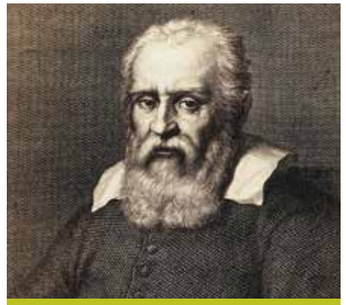
OSTILIO RICCI
UNIVERSITÁ DI BRESCI 1590-1603



GALILEO GALILEI
UNIVERSITÁ DI PISA 1585

VICENZO VIVIANI
UNIVERSITÁ DI PISA 1642

ISAAC BARROW
UNIVERSITY OF CAMBRIDGE 1652

SIR ISAAC NEWTON
UNIVERSITY OF CAMBRIDGE 1668

ROGER COTES
UNIVERSITY OF CAMBRIDGE 1706

ROBERT SMITH
UNIVERSITY OF CAMBRIDGE 1715

WALTER TAYLOR
UNIVERSITY OF CAMBRIDGE 1723

STEPHEN WHISSON
UNIVERSITY OF CAMBRIDGE 1742

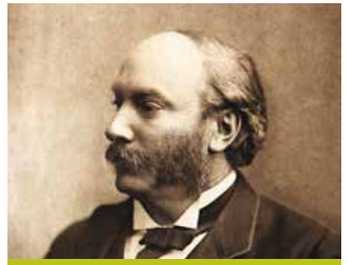
THOMAS POSTLETHWAITE
UNIVERSITY OF CAMBRIDGE 1756

THOMAS JONES
UNIVERSITY OF CAMBRIDGE 1782

ADAM SEDGWICK
UNIVERSITY OF CAMBRIDGE 1811

WILLIAM HOPKINS
UNIVERSITY OF CAMBRIDGE 1830

EDWARD ROUTH
UNIVERSITY OF CAMBRIDGE 1857



JOHN STRUTT (LORD RAYLEIGH)
UNIVERSITY OF CAMBRIDGE 1868

JOSEPH THOMSON
UNIVERSITY OF CAMBRIDGE 1883

JOHN TOWNSEND
UNIVERSITY OF CAMBRIDGE 1903

VICTOR BAILEY
UNIVERSITY OF OXFORD 1923

RONALD ERNEST AITCHISON
UNIVERSITY OF SYDNEY 1948

PETER KHAN
UNIVERSITY OF SYDNEY 1964

MICHAEL B. STEER
UNIVERSITY OF QUEENSLAND 1983

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U.S. Army Major General (Ret.) Nick Justice, the executive director of PowerAmerica, will be the featured speaker

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- **Join fellow alumni for a BBQ dinner in the atrium of Engineering Building I (EBI)**