NC STATE Engineering

SPRING/SUMMER **2018**

BROADER REACH

Nanofabrication and instrumentation facilities take innovation beyond the laboratory

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BREAKING MAJOR GROUND

Groundbreaking, the ceremonial kick-off to a building's construction, usually involves several dignitaries lined up with shovels in hand and cameras at the ready.

When the College broke ground on Riddick Engineering Laboratories in 1949, Engineering Dean J. Harold Lampe took things a little further, taking a seat in the cab of a steam shovel being used to begin grading work for the project.

Completed in 1950 and first referred to simply as the Engineering Laboratories Building, the 103,000-square-foot structure of sand finish brick with limestone trim and granite entrances cost $1.3 million to build.

The building was later named after Wallace Carl Riddick, who served as president of NC State, dean of the School of Engineering and the first football coach. NC State's first football stadium, once located nearby, also bore his name.

The College will hold another significant groundbreaking this spring, when it begins work on a building that is just as important to the future of NC State engineering as Riddick Engineering Laboratories was in the late 1940s.

Engineering Building Oval (EB Oval), will be the new Centennial Campus home of the Edward P. Fitts Department of Industrial and Systems Engineering; the Department of Civil, Construction, and Environmental Engineering; and the dean's administrative offices.

It will be the College's first building groundbreaking on Centennial Campus since a ceremony was held to mark the beginning of work on Engineering Building III on Feb. 27, 2008.

Learn more about the planning for EB Oval on page 32.

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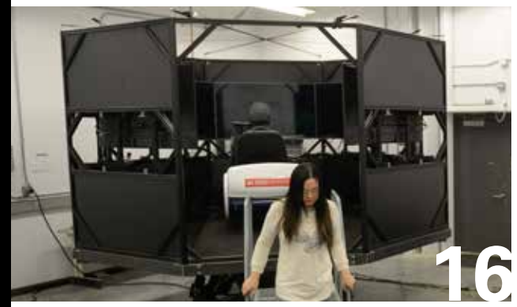

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Q&A

QUESTIONS FOR **SUZANNE S. GORDON**

This spring, Suzanne S. Gordon will become the first woman to serve as president of the NC State Engineering Foundation Board of Directors. She holds bachelor's degrees in computer science and mathematics and a master's degree in statistics, all from NC State. She retired from SAS Institute in 2012 as chief information officer.

What goals do you have as president?

First, I would like to continue the great tradition of good leadership and support for the College. Second, I would like to see the Oval Building fully funded. Third, I would like to find out more about present programs like Women in Science and Engineering and where we can help them be more successful and recruit more women to engineering.

Why is it so important for you to give back to the College?

I have always been a giver. It is just so rewarding. My father taught us from an early age if you don't give when you have a little you won't give when you have a lot. I received a great education from NC State, and by participating on different boards, I continued to benefit and learn from others. It's also good to have a network outside of the company you are working for. I have found that when my career had bumps the NC State people I was working with at the time helped me stay confident and motivated.

What is the board doing to get more alumni involved?

We are working to get young alumni more engaged so that it is just a continuous activity. You graduate, you serve on a young alumni group, you serve on your department board, you move to the Engineering Foundation Board. Young alumni, however, are frequently in the most intense part of their career so finding the balance between involving them and overwhelming them is the key. I would just reiterate to them how beneficial the network can be to your career and your self confidence.

You enjoy speaking to groups about building a trusting atmosphere as a leader. Why is that important?

I always felt that way that trust was key to having a successful team, trust in each other and trust in the leader. A good book I read and recommend sums it up called *The Speed of Trust* by Stephen M. R. Covey. If you have trust, there are so many other problems you don't have to deal with, so you can get things done much quicker.

You're a pioneering woman in a STEM field. How can we encourage more girls and young women to take an interest in STEM?

(Former NC State) Chancellor Marye Anne Fox and I decided you have to start at a very early age. If you wait until high school, you may have lost them, and they are already behind their male counterparts. So whatever we can do to expose young women to STEM early on is key. NC State Engineering has some very great summer programs. I would like to get the word out to more students like the Computer Science students about these programs. ▪

FROM THE DEAN

LOUIS A. MARTIN-VEGA

Welcome to the spring 2018 *NC State Engineering* magazine. As you read through this issue, I want you to think back on your days at NC State and how exciting it was to be a part of this University and the College of Engineering. For some of you, the memory may be of Riddick, Broughton, Mann, Daniels or Burlington Labs. For others, the memories may be more recent and focus on the newer engineering buildings I, II and III on Centennial Campus. Whether you are among the most recent or the not-so-recent graduates, you are all part of something very special — the College of Engineering at NC State University.

Since the very first student, Walter J. Matthews, enrolled in mechanic arts (engineering) in October 1889, our students, faculty and staff have been an important force in the direction of our state, nation and world. For 128 years, we have worked together to develop new ideas, create new tools and technologies, and educate tomorrow's engineers and computer scientists. As alumni of this College, you are a part of this great legacy — a legacy that is constantly evolving to meet the needs of society, to improve our lives and drive our economy.

Today our campus is a vibrant and exciting place. Our faculty members are among the best in the world, and through their hard work, we have achieved another important milestone — reaching more than $200 million in annual research expenditures. This puts us in an elite group of engineering colleges — among them are MIT, Texas A&M, Purdue, and Stanford — and ranked 10th in the nation* in annual research expenditures.

Just as exciting is the public-private partnership that is coming together to construct Engineering Building Oval, our newest building on Centennial Campus. Thanks to more than 100 dedicated alumni and friends who have donated more than $31 million, we have surpassed the halfway mark in raising the $60 million in private funds needed to fully fund EB Oval. To add to the excitement, large earth-moving equipment crews recently began preparing the site for construction. And while this is also an important milestone, we continue to need financial support for this effort from our alumni and friends.

In this issue we share with you a sampling of other exciting news in your college, from flexible electronics, cancer treatments and new manufacturing processes for power electronics to international aid work in Sierra Leone and animal conservation efforts in Namibia. From our front door to around the globe, NC State's students, faculty and staff apply Think and Do to improve our world and "engineer a better tomorrow" for us all.

If it has been a while since you've been to NC State, I invite you to come and visit. I know you will be inspired by what you find. In the meantime, please enjoy this issue of *NC State Engineering*, and thank you for your continued support.

Sincerely,

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

**Data from the American Society for Engineering Education*

College of Engineering moves up in *U.S. News* rankings

The College of Engineering has made big strides in rankings compiled by *U.S. News & World Report.*

The College has moved up to 24th in the latest *U.S. News & World Report* rankings of graduate engineering programs. In addition, the College's online graduate program in computer science moved up two spots to No. 4 on the latest *U.S. News & World Report* rankings of the top online graduate-level information technology programs.

NC State's ranking among graduate engineering programs is its highest in the last 15 years. Among public colleges of engineering, the College is ranked 12th in the nation.

In addition to the College's higher ranking, several disciplines also improved, including aerospace engineering, biological and agricultural engineering, biomedical engineering, mechanical engineering and nuclear engineering. The College has two programs in the top 10: biological and agricultural engineering and nuclear engineering. Four programs are in the top 20: industrial and systems engineering, materials science and engineering and the two top 10 programs.

Dr. George Rouskas, professor and director of graduate programs in the Department of Computer Science, says the online degree program appeals to nontraditional students and mid-career adults seeking new skills.

"Our online courses are identical to our on-campus courses," he said. "We try to make it possible for nontraditional students to take courses, but we don't water down the quality of the courses or our admissions criteria. The students appreciate that." ▪

COLLEGE OF ENGINEERING PASSES $200 MILLION IN RESEARCH EXPENDITURES

THE COLLEGE OF ENGINEERING posted more than $200 million in research expenditures in budget year 2016-17, placing NC State Engineering in elite company among engineering schools in the United States.

The College had $206,369,918 in research expenditures in 16-17, an increase of $17,409,803 from the fiscal year 2015-16 total of $188,960,115.

According to the American Society for Engineering Education (ASEE), only seven engineering schools posted more than $200 million in research spending in the previous year, fiscal 2015-16. Those schools were Massachusetts Institute of Technology, University of Michigan, Texas A&M University, Purdue University, University of Illinois at Urbana-Champaign, University of California-Berkeley and Stanford University.

NC State ranked 10th among engineering schools in research expenditures in the United States in 15-16, according to ASEE, and seventh among public colleges of engineering.

ASEE has not posted expenditure totals for 16-17.

The College leads or is heavily involved in 24 national centers, institutes and laboratories and leads two National Science Foundation Engineering Research Centers (ERC). NC State is one of only two schools in the United States currently leading two ERCs and one of only two schools to ever be awarded the lead role in three ERCs.

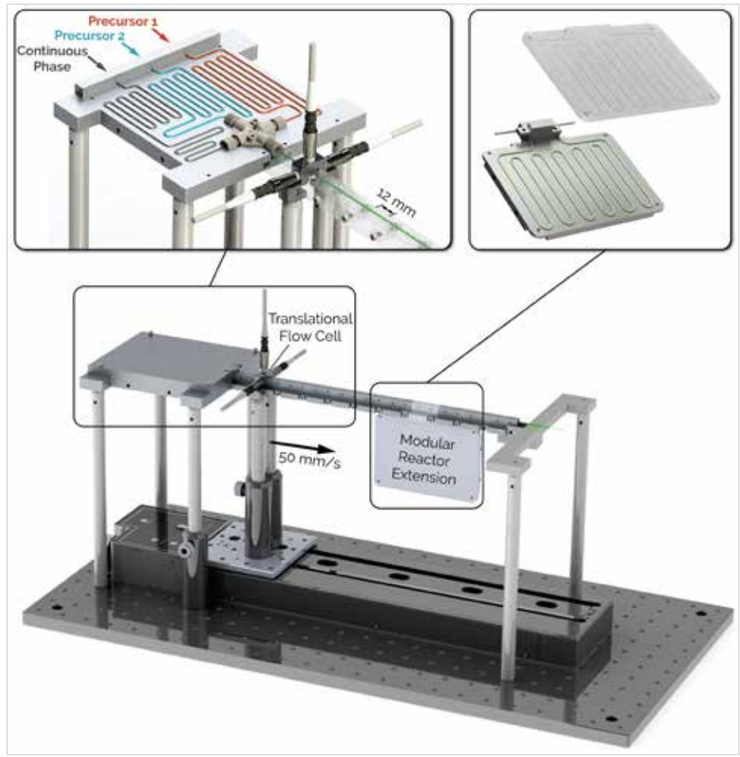
The Future Renewable Electric Energy Delivery and Management Systems Center (FREEDM) is developing a next-generation power grid that allows bi-directional flow and integrates renewable energy sources. The Nanosystems Engineering Research Center for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST) is making wearable, self-powered health-monitoring systems.

The College and NC State are also:

- The lead institution in the Consortium for Nonproliferation Enabling Capabilities, a National Nuclear Security Administration effort to develop the next generation of technologies and leaders in the field of nuclear nonproliferation.
- The lead institution in PowerAmerica, a National Manufacturing Innovation Institution (NMII) that is furthering the development of wide-bandgap semiconductor-based power electronics.
- The Southeast lead institution in the Clean Energy Smart Manufacturing Innovation Institute, an NMII that will advance national manufacturing across several industry sectors.
- A member of the Consortium for Advanced Simulation of Light Water Reactors, a Department of Energy hub working to improve the operation and safety of the current generation of light water nuclear reactors.
- Home of one of four National Security Administration Science of Security Lablets, which are conducting research on cybersecurity.
- A partner in the National Institute for Innovation in Manufacturing Biopharmaceuticals, an NMII that is working to accelerate U.S. innovation in biopharmaceuticals. ▪

TECH INCREASES MICROFLUIDIC RESEARCH DATA OUTPUT 100-FOLD

RESEARCHERS HAVE DEVELOPED a technique that allows users to collect 100 times more spectrographic information per day from microfluidic devices, as compared to the previous industry standard. The novel technology has already led to a new discovery: the speed of mixing ingredients for quantum dots used in LEDs changes the color of light they emit — even when all other variables are identical.



> "This challenge has led to an interest in continuous nanomanufacturing approaches that rely on precisely controlled microfluidic-based synthesis"
>
> **DR. MILAD ABOLHASANI**

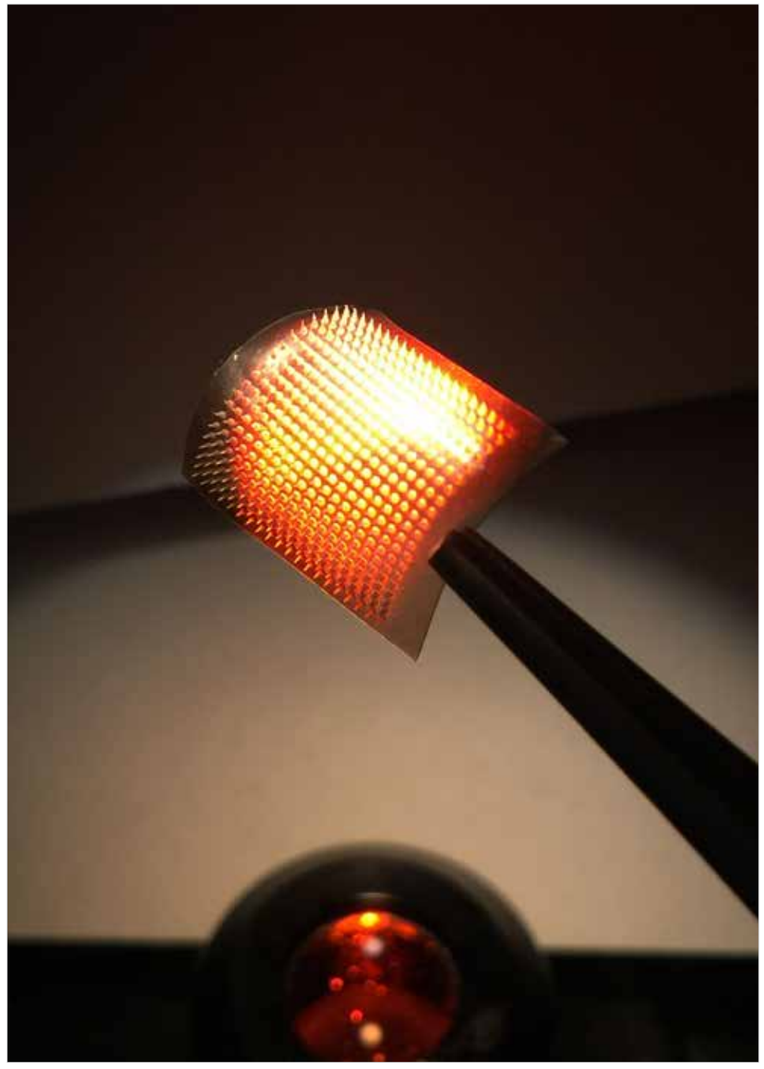
"Semiconductor nanocrystals are important structures used in a variety of applications, ranging from LED displays to solar cells. But producing nanocrystalline structures using chemical synthesis is tricky because what works well on a small scale can't be directly scaled up — the physics don't work," says Dr. Milad Abolhasani, an assistant professor of chemical and biomolecular engineering and corresponding author of a paper based on this work.

"This challenge has led to an interest in continuous nanomanufacturing approaches that rely on precisely controlled microfluidic-based synthesis," Abolhasani says. "But testing all of the relevant variables to find the best combination for manufacturing a given structure takes an extremely long time due to the limitations of the existing monitoring technologies — so we decided to build a completely new platform."

Currently, microfluidic monitoring technologies are fixed in place and monitor either absorption or fluorescence. Fluorescence data tells you what the crystal's emission bandgap is — or what color of light it emits — which is important for LED applications. Absorption data tells you the crystal's size and concentration, which is relevant for all applications, as well as its absorption bandgap — which is important for solar cell applications.

To monitor both fluorescence and absorption, you'd need two separate monitoring points. And, because the monitoring points are fixed in place, people would speed up or slow down the flow rate in the microfluidic channel to control the reaction time of the chemical synthesis: the faster the flow rate, the less reaction time a sample has before it hits the monitoring point. Working around the clock, this approach would allow a lab to collect about 300 data samples in 24 hours. ▪

CANCER IMMUNOTHERAPY USES MELANIN AGAINST MELANOMA



WORK IN BIOMEDICAL ENGINEERING has led to a melanin-enhanced cancer immunotherapy technique, applied via a transdermal patch, that can also serve as a vaccine, based on early experiments done in a mouse model.

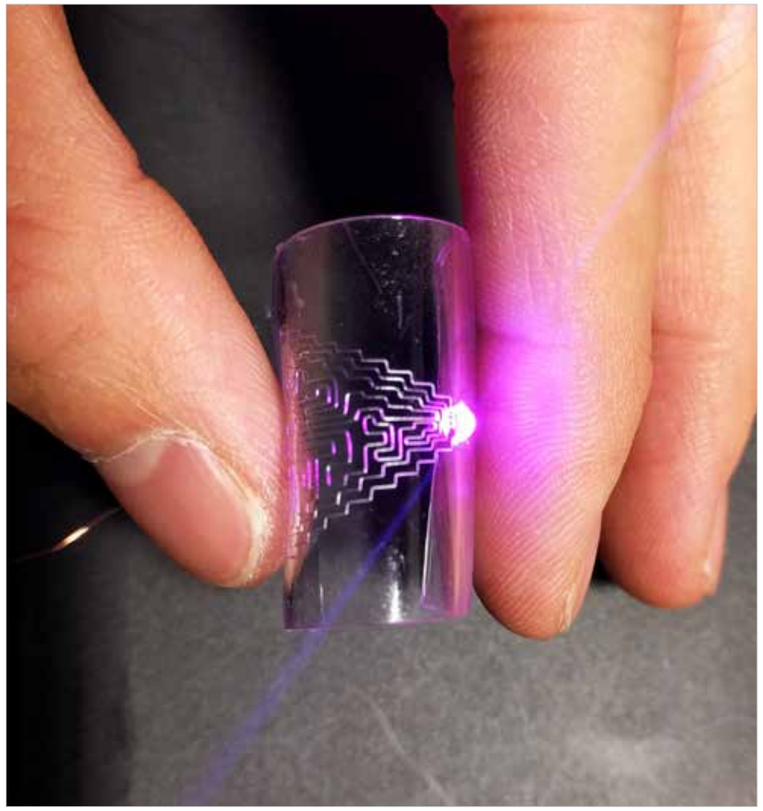
"Melanin is a natural pigment that can efficiently transform absorbed sunlight energy into heat," said Dr. Zhen Gu, corresponding author of a paper on the work and an associate professor in the UNC/NC State Joint Department of Biomedical Engineering. "We demonstrated that melanin, which is found at high levels in melanoma, can actually be used to help treat melanoma. We do this by shining near infrared (IR) light on a therapeutic skin patch, which promotes the systemic immune response that fights cancer."

The new technique starts with a lysate — a tumor puree, made up of ruptured melanoma cells — that is used to fill an array of microneedles, embedded in a polymeric transdermal patch. By itself, the lysate is inactive and harmless. But when the patch is applied to the skin, the largest immune organ of the body, the immune system knows that, whatever the lysate is, it shouldn't be there. This triggers an immune response, and that response allows the immune system to "remember" the melanoma lysate, improving its response time and efficiency should it encounter melanoma again.

Because melanoma contains high levels of the pigment melanin, the lysate-filled microneedles are fairly dark in color. They absorb light. The researchers take advantage of that in their new technique, shining near IR light onto the transdermal patch. The light is then largely absorbed by the melanin in the microneedles, which quickly raises the temperature of the skin where the patch is applied.

The local heat causes a fever-like environment in the skin and promotes the release of lysate from the microneedles, effectively attracting and activating immune cells. The increased temperature also contributes to the locally increased blood and lymphatic flow that facilitates the migration of immune cells. This increased immune response amplifies the ability of the body to remember — and respond to — the lysate, better protecting against incursions of melanoma. ▪

METAL PRINTING OFFERS LOW-COST WAY TO MAKE FLEXIBLE, STRETCHABLE ELECTRONICS



RESEARCHERS IN THE COLLEGE have developed a new technique for directly printing metal circuits, creating flexible, stretchable electronics. The technique can use multiple metals and substrates and is compatible with existing manufacturing systems that employ direct printing technologies.

"Flexible electronics hold promise for use in many fields, but there are significant manufacturing costs involved — which poses a challenge in making them practical for commercial use," says Dr. Jingyan Dong, corresponding author of a paper on the work and an associate professor in the Edward P. Fitts Department of Industrial and Systems Engineering.

"Our approach should reduce cost and offer an efficient means of producing circuits with high resolution, making them viable for integrating into commercial devices," Dong says.

The technique uses existing electrohydrodynamic printing technology, which is already used in many manufacturing processes that use functional inks. But instead of ink, Dong's team uses molten metal alloys with melting points as low as 60 degrees Celsius. The researchers have demonstrated their technique using three different alloys, printing on four different substrates: one glass, one paper and two stretchable polymers.

"This is direct printing," Dong says. "There is no mask, no etching and no molds, making the process much more straightforward."

The researchers tested the resilience of the circuits on a polymer substrate and found that the circuit's conductivity was unaffected even after being bent 1,000 times. The circuits were still electrically stable even when stretched to 70 percent of tensile strain.

The researchers also found that the circuits are capable of "healing" themselves if they are broken by being bent or stretched too far.

"Because of the low melting point, you can simply heat the affected area up to around 70 degrees Celsius and the metal flows back together, repairing the relevant damage," Dong says.

The researchers demonstrated the functionality of the printing technique by creating a high-density touch sensor, fitting a 400-pixel array into one square centimeter.

"We've demonstrated the resilience and functionality of our approach, and we're open to working with the industry sector to implement the technique in manufacturing wearable sensors or other electronic devices," Dong says. ▪

ROUGH MICROPARTICLES CAN LEAD TO BIG PROBLEMS

NEW RESEARCH FROM NC STATE, Massachusetts Institute of Technology and the University of Michigan finds that the surface texture of microparticles in a liquid suspension can cause internal friction that significantly alters the suspension's viscosity — effectively making the liquid thicker or thinner. The finding can help address problems for companies in fields from biopharmaceuticals to chemical manufacturing.

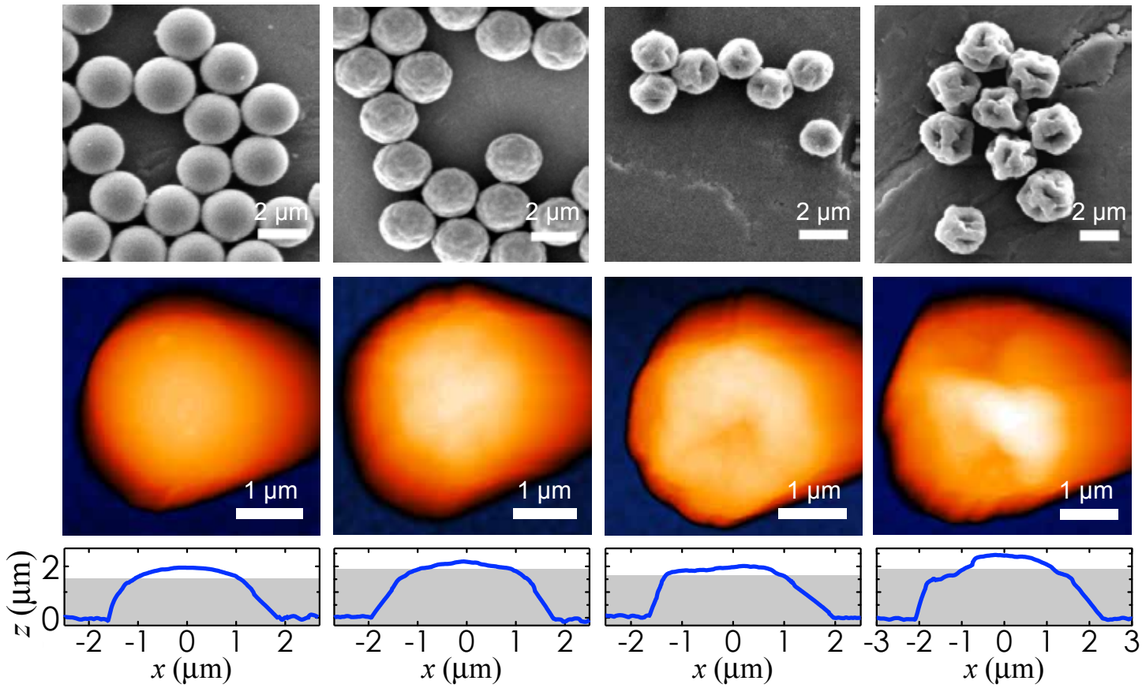
"We heard about problems companies were having with pumping suspensions and became curious about what was causing these problems," says Dr. Lilian Hsiao, an assistant professor of chemical and biomolecular engineering at NC State and lead author of a paper on the work. "Given the ubiquity of these types of fluids in the industry, we were surprised that no one had systematically looked at the role of surface roughness before. That turns out to be a really important factor in how these particle-laden fluids flow."

Using a combination of simulations and laboratory experiments, the researchers found that what was slowing down the suspensions was friction. Specifically, the friction becomes significant when enough particles suspended in the liquid bump into each other. And the rougher the surface of the particles, the more friction they generate when they come into contact.

"It takes energy to pump a liquid suspension through a pipe or tube, and the friction created by interaction between particles dissipates a lot of that energy," Hsiao says. "This dissipation slows down the movement of the suspension or, if the particles are very rough, can even stop it completely."

This insight gives industries a couple of options: They can reduce friction by engineering the particles to have smoother surfaces, or they can increase the amount of energy devoted to moving the suspension through the pipe.

However, the researchers also found that adding energy to a suspension that contains rough particles can also cause the suspension to expand. This is because rough particles simply take up more space than smooth ones when tumbling in suspension. The end result is that putting more shear stress into the system can cause catastrophic clogging if the suspension expands too much. ▪



STUDENTS RETURN TO SIERRA LEONE TO FINISH WHAT THEY STARTED

FOR MORE THAN 30 YEARS, the Dele Village Learning Center in Lower Allentown has provided an education for hundreds of children in the growing community outside Sierra Leone's capital. And for years, the school has struggled to provide affordable clean water for its students and staff.

The school's current rainwater catchment system is able to provide water for sanitation uses, but is only useful during the area's six-month rainy season. Purchasing bagged water or well water from a nearby community was the only way to provide what was needed for drinking, cooking and washing.

"It was a financial strain and became a burden to the school's budget," said John Merrill, a senior studying environmental engineering and a member of the NC State chapter of Engineers Without Borders (EWB).

An NC State EWB team first traveled to Sierra Leone in 2011 to begin assessment for the project. Following discussions with the school, it was agreed that a mechanically drilled well would best provide a reliable, long-term water supply.

With volunteer assistance from Smith Gardner Inc., a Raleigh-based environmental engineering firm, the team gathered information on the aquifer and soil profiles at the site while building relationships with local government officials, members of the community and charitable agencies working in the region.

Then Ebola hit.

The outbreak in West Africa meant that no one from NC State could travel to the country for nearly two years. By spring 2016, the last student who had visited the school, as a freshman in 2014, had graduated. "We lost some valuable institutional knowledge that comes from spending time in the community," said Merrill, who is the chapter's lead on the water project.

During the travel ban, the team signed a contract with relief and development organization World Hope International for drilling. They continued work on the design of a distribution system that would be constructed following the well drilling and maintained communication with the school through email.

NC State EWB also has projects to build a renewable energy system at the same school in Lower Allentown and rainwater catchment systems in a small community in Guatemala.

"Despite the challenges, we were still very engaged in the project," Merrill said.

Once the travel ban was lifted, a team of five students and two mentors were able to return to Sierra Leone in December of 2016 to oversee drilling of the well to a depth of 62 meters and installation of a hand pump, while assessing for the future distribution system. By the time they left, the well was providing clean water for the students and staff at the school, and school personnel had been fully trained on handpump operation and maintenance.

The NC State EWB team plans to return to Sierra Leone in May 2018 to install a solar-powered submersible pump, treatment system, storage tank, distribution lines and handwashing stations.

The second NC State EWB team working at the Dele School also plans to travel in May 2018 to install a solar photovoltaic and battery storage system that would provide clean, reliable electricity to students and staff and replace a noisy, expensive diesel generator. ▪

RESEARCH OFFERS WIRELESS CONNECTION THAT CHARGES WITHOUT SACRIFICING STREAMING

HAVE YOU EVER wanted to wirelessly charge your mobile device and watch Netflix at the same time? Researchers in the Department of Electrical and Computer Engineering (ECE) may have you covered.

They have developed a system that can simultaneously deliver watts of power and transmit data at rates high enough to stream video and charge the device over the same wireless connection. By integrating power and high-speed data, a true single "wireless" connection can be achieved.

"Recently wireless power has re-emerged as a technology to free us from the power cord," says Dr. David Ricketts, an associate professor of electrical and computer engineering and senior author of a paper on the work. "One of the most popular applications is in wireless cell phone charging pads. As many know, these unfortunately often require almost physical contact with the pad, limiting the usefulness of a truly 'wireless' power source. Recent work by several researchers has extended wireless power to 'mid-range,' which can supply power at inches to feet of separation. While encouraging, most of the wireless power systems have only focused on the power problem — not the data that needs to accompany any of our smart devices today. Addressing those data needs is what sets our work apart here."

Wireless power transfer technologies use magnetic fields to transmit power through the air. To minimize the power lost in generating these magnetic fields, you need to use antennas that operate in a narrow bandwidth, particularly if the transmitter and receiver are inches or feet apart from each other.

Because using a narrow bandwidth antenna limits data transfer, devices incorporating wireless power transfer have normally also incorporated separate radios for data transmission. And having separate systems for data and power transmission increases the cost, weight and complexity of the relevant device.

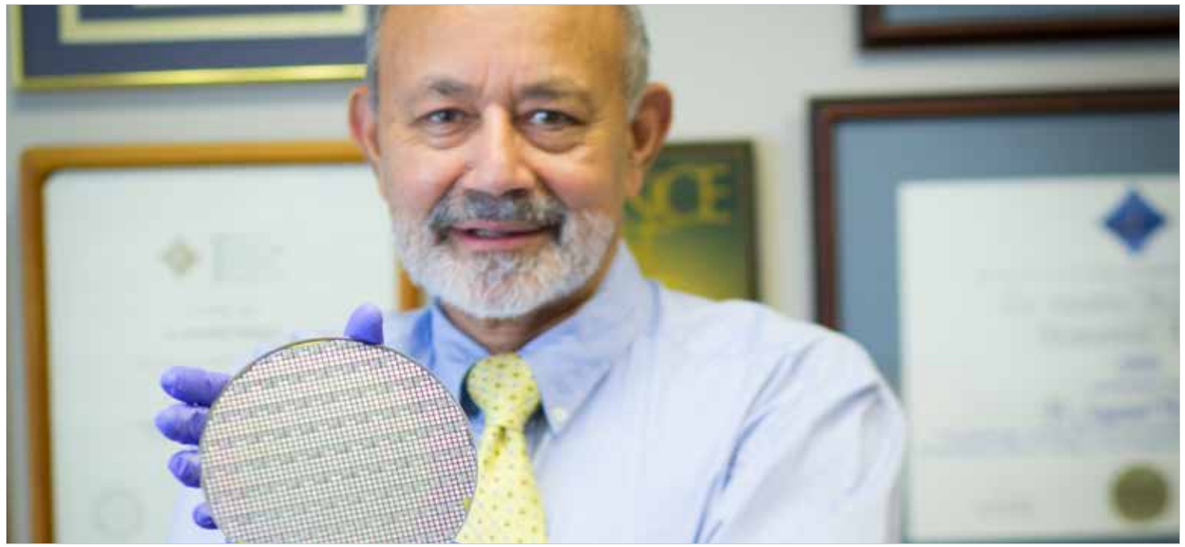
The NC State team realized that while high-efficiency power transfer, especially at longer distances, does require very narrow band antennas, the system bandwidth can actually be much wider.

"People thought that efficient wireless power transfer requires the use of narrow bandwidth transmitters and receivers, and that this, therefore, limited data transfer," Ricketts says. "We've shown that you can configure a wide-bandwidth system with narrow-bandwidth components, giving you the best of both worlds."

With this wider bandwidth, the NC State team then envisioned the wireless power transfer link as a communication link, adapting data-rate enhancement techniques, such as channel equalization, to further improve data rate and data signal quality.

The researchers tested their system with and without data transfer. They found that when transferring almost 3 watts of power — more than enough to power your tablet during video playback — the system was only 2.3 percent less efficient when also transmitting 3.39 megabytes of data per second. At 2 watts of power, the difference in efficiency was only 1.3 percent. The tests were conducted with the transmitter and receiver 16 centimeters, or 6.3 inches, apart, demonstrating the ability of their system to operate in longer-distance wireless power links. ▪

NEW MANUFACTURING PROCESS FOR SiC POWER DEVICES OPENS MARKET TO MORE COMPETITION



NC STATE RESEARCHERS are rolling out a new manufacturing process and chip design for silicon carbide (SiC) power devices, which can be used to more efficiently regulate power in technologies that use electronics. The process, called PRESiCETM, was developed with support from the PowerAmerica Institute funded by the Department of Energy to make it easier for companies to enter the SiC marketplace and develop new products.

"PRESiCETM will allow more companies to get into the SiC market, because they won't have to initially develop their own design and manufacturing process for power devices — an expensive, time-consuming engineering effort," says Dr. Jay Baliga, Distinguished University Professor of Electrical and Computer Engineering and lead author of a paper on PRESiCETM. "The companies can instead use the PRESiCETM technology to develop their own products. That's good for the companies, good for consumers and good for U.S. manufacturing."

Power devices consist of a diode and transistor and are used to regulate the flow of power in electrical devices. For decades, electronics have used silicon-based power devices. In recent years, however, some companies have begun using SiC power devices, which have two key advantages.

First, SiC power devices are more efficient, because SiC transistors lose less power. Conventional silicon transistors lose 10 percent of their energy to waste heat. SiC transistors lose only 7 percent. This is not only more efficient but means that product designers need to do less to address cooling for the devices.

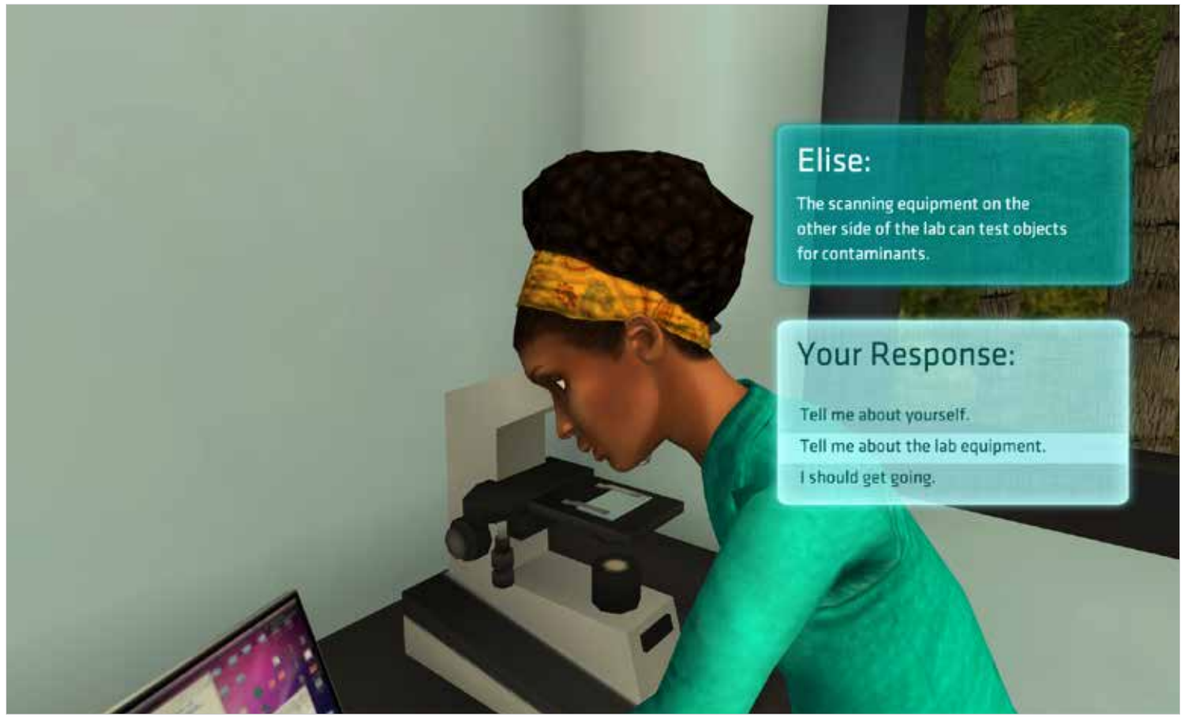
Second, SiC devices can also switch at a higher frequency. That means electronics incorporating SiC devices can have smaller capacitors and inductors — allowing designers to create smaller, lighter electronic products.

But there's a problem.

Up to this point, companies that have developed manufacturing processes for creating SiC power devices have kept their processes proprietary — making it difficult for other companies to get into the field. This has limited the participation of other companies and kept the cost of SiC devices high.

The NC State researchers developed PRESiCETM to address this bottleneck, with the goal of lowering the barrier of entry to the field for companies and increasing innovation.

The PRESiCETM team worked with a Texas-based foundry called X-Fab to implement the manufacturing process and have now qualified it — showing that it has the high yield and tight statistical distribution of electrical properties for SiC power devices necessary to make them attractive to industry. ▪



GAMING TO INSPIRE FUTURE GENERATIONS OF HEALTH SCIENTISTS

IF THE UNITED STATES wants to remain a leader in health sciences, it needs to interest young people from diverse backgrounds in the field. With that in mind, a team of researchers, supported by a $1.3 million grant from National Institutes of Health, is developing an online adventure game designed to inspire future generations to pursue health-related careers.

"We have more than a decade of experience in designing and developing educational games, and have a lot of data demonstrating their effectiveness," said Dr. James Lester, principal investigator on the grant and Distinguished Professor of Computer Science.

"Our new game, called Health Quest, will be aimed at middle school students," Lester said. "We want students from all backgrounds to know more about health-related careers — from clinical medicine and public health to molecular biology and pharmacology. And by working this educational content into an ongoing adventure, we can raise awareness in diverse audiences, help teachers achieve their educational goals and get students engaged by keeping them entertained and motivated."

The new program will build on the Crystal Island educational curriculum, a game-based initiative aimed at middle schoolers that Lester's team rolled out in 2015.

"But whereas Crystal Island focused on microbiology and literacy, Health Quest will look at broader areas specific to health sciences, and relevant careers will be incorporated into the plot and gameplay," Lester said.

The project involves experts in K-12 education, game development, health sciences and public outreach programs.

"In addition to NC State, we're collaborating closely with researchers and the Office of Diversity and Outreach at the University of California, San Francisco, as well as engaging others from Stanford, the North Carolina Museum of Natural Sciences and community based afterschool programs," Lester said. ▪

PIONEERING NASA ENGINEER WELCOMES INCOMING ENGINEERING STUDENTS TO CAMPUS

DR. CHRISTINE MANN DARDEN had several bits of sage wisdom to share with first-year students during the 2017 NC State College of Engineering Welcome.

Darden, a retired member of the Senior Executive Service of the NASA Langley Research Center, was the keynote speaker for the 17th annual College Welcome, held in August in the Talley Student Union on the NC State campus.

She ran through a long list of tips for a successful career as a student and engineer.

Perceive of yourself where you want to go. Take good notes and keep them organized. The night before a test, make sure you have put the work in so that you can get a good night's sleep rather than trying to cram all night. Learn to write well and gain the ability to explain the dense engineering topics you study to a lay audience.

"A number of engineers don't write very well," Darden said, getting a laugh from the roughly 1,457 first-year engineering students in attendance.

After nearly 40 years of service, she retired in March 2007 from NASA Langley Research Center as director of the Office of Strategic Communications and Education. In that position, she was responsible for the center's external and internal communications, community outreach, governmental relations and educational outreach.

Prior to her career at Langley Research Center, Darden served as a mathematics instructor at Virginia State College and taught high school mathematics. During her time at NASA, she authored more than 57 technical papers and articles, primarily in the areas of sonic boom prediction, sonic boom minimization and supersonic wing design and is recognized as an international expert in these areas. She has received dozens of awards and honors including two NASA Medals, one for her work and leadership of the Sonic Boom Program, and the other for her active involvement in working with and encouraging students to pursue careers in math and science. In addition, she received the Black Engineer of the Year Outstanding Achievement in Government Award and the Women in Science and Engineering Lifetime Achievement Award.

She was recently included in the book, "Hidden Figures: The American Dream and the Untold Story of the Black Women Mathematicians Who Helped Win the Space Race" by Margot Shetterly. The book was adapted into the 20th Century Fox film "Hidden Figures," based on the NASA "human computers" who, as members of the segregated West Computers, contributed to the NASA Space Program in the early 1960s. ▪

Gu receives **Young Investigator Award** from Controlled Release Society

DR. ZHEN GU

Dr. Zhen Gu, associate professor in the UNC/NC State Joint Department of Biomedical Engineering, has received the Young Investigator Award from the Controlled Release Society.

The Controlled Release Society (CRS) is a not-for-profit organization devoted to the science and technology of controlled release, which encompasses scientific and technical efforts to regulate the spatial and temporal effects of agents in diverse areas including human and animal health as well as non-pharmaceutical areas such as agriculture, cosmetics and consumer products, and the environment.

Gu has created dozens of technologies and techniques aimed at delivering the right drug to the right place at the right time to maximize the impact of therapeutic medications. ▪

Williams named **Fellow of Institute of Electrical and Electronics Engineers**

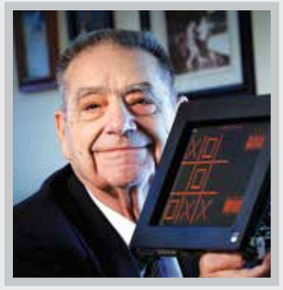
Dr. Laurie Williams, professor and interim head of the Department of Computer Science, has been elected as a Fellow of the Institute of Electrical and Electronics Engineers (IEEE).

The IEEE Fellow is one of the most prestigious honors of the IEEE, and is bestowed upon a very limited number of Senior Members who have contributed importantly to the advancement or application of engineering, science and technology bringing significant value to the society.

Williams is internationally known as one of the foremost researchers in agile software development and the science of cybersecurity. She leads the NSA-sponsored Science of Security Lablet and the Software Engineering Realsearch research group at NC State. Her research focuses on the development of reliable and secure software in collaboration with high-tech companies such as IBM, Cisco and Microsoft. ▪

DR. LAURIE WILLIAMS

Bitzer named **Fellow of National Academy of Inventors**



DR. DONALD L. BITZER

Dr. Donald L. Bitzer, Distinguished University Research Professor of Computer Science, has been named a Fellow of the National Academy of Inventors.

The academic inventors and innovators elected to the rank of NAI Fellow are named inventors on U.S. patents and were nominated by their peers for outstanding contributions to innovation in areas such as patents and licensing, innovative discovery and technology, significant impact on society, and support and enhancement of innovation.

Bitzer co-invented the flat plasma display panel in 1964. The technology was eventually applied to television screens, and millions of plasma TVs have been sold to the public since they were introduced in the 1990s. His work on the plasma display monitor earned him an Emmy Award in 2002. He also invented and co-developed Programmed Logic for Automated Teaching Operations, or PLATO, the first computer system to combine graphics and touch-screen displays. ▪

Westmoreland wins **AIChE Award for Excellence** in Industrial Gases Technology

Dr. Phil Westmoreland, professor in the Department of Chemical and Biomolecular Engineering, was named the 2017 recipient of the American Institute of Chemical Engineers (AIChE) Institute Award for Excellence in Industrial Gases Technology.

The award, sponsored by Praxair, Inc., recognizes an individual's sustained excellence in contributing to the advancement of technology in the production, distribution and application of industrial gases.

Westmoreland's research focuses on reaction kinetics and reaction engineering. Results are obtained from using flame and pyrolysis experiments, molecular-beam mass spectrometry, computational quantum chemistry and reactive-flow modeling. ▪

DR. PHIL WESTMORELAND

Zikry receives **Robert Henry Thurston Lecture Award**

DR. MOHAMMED ZIKRY

Dr. Mohammed Zikry, the Zan Prevost Smith Professor in the Department of Mechanical and Aerospace Engineering, has been named the recipient of the 2017 Robert Henry Thurston Lecture Award from the American Society of Mechanical Engineers (ASME).

The award was established in 1925 in honor of Robert Henry Thurston, ASME's first president and a leader in engineering and science.

Zikry is known as an international leader and pioneer in micromechanics modeling, where he has developed formulations that account for microstructures such as grain boundary orientation, size and distribution. His work and publications have led to the development of new three-dimensional dislocation-density-based crystalline constitutive formulations and computational schemes that account for microstructural effects, such as grain boundary orientations and distributions, grain-size and slip impedance and transmission at grain boundary interfaces in polycrystalline aggregates.▪

College bestows **R.J. Reynolds Tobacco Company Award for Excellence** on Velev

Dr. Orlin Velev, INVISTA Professor in the Department of Chemical and Biomolecular Engineering, is the thirty-third recipient of the R.J. Reynolds Tobacco Company Award for Excellence in Teaching, Research and Extension. Velev delivered an award lecture in November entitled, "Engineering of Dynamically Reconfigurable Soft Matter: Smart Particle Gels, Biomimetic Actuators and Self-Propelling Microbots."

The award honors a member of the engineering faculty who has demonstrated superiority in several areas of activity that relate to the University's three-fold mission of teaching, research and extension.

Velev is an established research leader in colloid science and engineering. He leads an active and multidisciplinary research group at NC State that focuses on colloids, microfluidics and nanoscience with an emphasis on controlled assembly of colloidal particles into advanced materials and microscopic functional structures. ▪

DR. ORLIN VELEV

IN OUR LABS

THESE ARE THE SPACES THAT ENABLE
GROUNDBREAKING RESEARCH

TRANSPORTATION HUMAN FACTORS RESEARCH GROUP LABORATORY

EDWARD P. FITTS DEPARTMENT OF INDUSTRIAL AND SYSTEMS ENGINEERING

NC STATE RESEARCHERS have long had access to driving simulators that measure test subject response time, level of distractedness and how they prioritize assigned tasks.

But those simulators don't move.

"They're useful for getting some general insights into driver visual behavior and performance under different roadway conditions and stimulus conditions but, unfortunately, the observations on steering behavior and braking can deviate from what occurs in the real world," said Dr. David Kaber, Distinguished Professor in the Edward P. Fitts Department of Industrial and Systems Engineering (ISE).

A new simulator housed in ISE, funded by the department and the NC Department of Transportation (DOT), the Department of Psychology and NC State's Institute for Transportation Research and Education (ITRE), offers a more realistic experience for test subjects and more generalizable research results. Beyond that, using a moving simulator reduces the potential for motion sickness some participants feel in a static simulator when their mind thinks their body should be moving but it isn't.

Sitting in a realistic car cab, the test subject is surrounded by ultra-high-definition television monitors, which don't exhibit time lag in presenting a driving scene that is experienced with projection systems.

"There's no separation of the visuals from the motion," Kaber said. "It's really about very accurate simulation of real vehicle behavior."

Cameras measure all of a subject's physical movements, including how they shift in the seat under certain conditions and where their eyes go.

ITRE AND THE DOT are using the new simulator to model how drivers deal with certain road configurations and traffic signs and plan to use the data to help design roadways.

Dr. Jing Feng, an assistant professor in the Human Factors and Applied Cognition Program within the Department of Psychology, conducts research on driver mind wandering, automated driving, and aging and driving. She is part of a collaborative research effort with ISE and ITRE that is examining attentional demands of in-vehicle messaging systems, which will become more common in new vehicles and may subtract from driver roadway awareness.

The simulator was designed with an open cab rather than a closed one that closely resembles being in a car. The hope is that the set up will also be used for simulations outside of driving, including for pilots or utility plant operators.

ISE HAS BEEN STUDYING driver distractedness since 2005, starting with tests of drivers using handheld cell phones behind the wheel.

Then ISE researchers looked at how distraction affected the capabilities of drivers of different ages in dealing with roadside hazards. They tested drivers to see whether monetary motivations (e.g., pay per shipment delivery) during simulated driving affected driving habits, specifically risk-taking behaviors. The drivers were compensated in different ways to make for a realistic simulation and safety margins varied with compensation.

A lengthy study done for the DOT examined whether increasing the number of business logos presented on "blue" highway signs, identifying businesses located at a next exit, would be more distracting to drivers and cause a safety hazard. The manner of driver use of logo signs was found to be a major factor in an absence of additional distraction.

As manufacturers add more and more automation to vehicles with an eye toward fully autonomous driving, research in the field will gravitate toward examining risks associated with these systems, Kaber said. How effective would a driver riding in a semi-autonomous vehicle and reading a book be if they needed to suddenly take the wheel because of an accident in the road?

"People during driving start to rely more and more on the automation, and they become complacent," he said. "Then when something bad happens, they are less prepared than they would be otherwise if they weren't relying on the automation. Future research needs to map the design of advanced vehicle automation to driver behaviors in order to support safe and effective vehicle control." ▪

TROUBLED WATERS

Engineering research is helping lead to cleaner tap water for North Carolina communities

WHILE COLLECTING SAMPLES for research on bromide occurrence in North Carolina, a team of undergraduate and graduate students led by Dr. Detlef Knappe, a professor of civil, construction, and environmental engineering, found something more in the water.

Sampling campaigns across the state led the team to collect surface water samples from the Cape Fear River, located in central and eastern North Carolina, where they encountered high levels of 1,4-dioxane and fluorochemicals, including a compound called GenX.

Surface water in the Cape Fear River basin serves as a source of drinking water for approximately 1.5 million North Carolinians.

1,4-DIOXANE

The U.S. Environmental Protection Agency (EPA) classifies 1,4-dioxane as a likely human carcinogen. Dioxane is an industrial solvent and a byproduct generated in the production of plastics, laundry detergents and shampoos.

According to a national survey of drinking water quality, some of the highest concentrations of dioxane in the United States were found in North Carolina. Knappe and his group found high levels of 1,4-dioxane in large stretches of the Cape Fear River basin and estimated that more than 1 million of the 1.5 million people who use the river as a drinking water source are impacted by the water pollution.

To develop an analytical method for detecting dioxane in river water and to identify sources of dioxane, Knappe and his team applied for a National Science Foundation (NSF) RAPID Grant.

"Although small in size, the RAPID Grant was really impactful and helped bring national visibility to emerging contaminants in drinking water," said Knappe, who also received funding from the North Carolina Urban Water Consortium.

Knappe's group research efforts have helped to identify sources of dioxane and led state environmental regulators to develop plans for reducing the discharge of dioxane into waters of the Cape Fear River basin.

The research team worked with the NC Department of Environmental Quality (DEQ) and public water utilities to identify communities where industrial sources of dioxane are located. The collaboration involved coordinated sample collection between DEQ staff and NC State researchers and shared responsibilities for sample analysis. With a limited budget and no in-house capability to measure dioxane, DEQ could only send a small number of samples each month to a commercial laboratory. NC State's ability to analyze large numbers of samples greatly enhanced the spatial resolution of the dioxane occurrence data set.

GENX

In addition to dioxane, Knappe and his team are studying new fluorochemicals in collaboration with researchers at EPA's National Exposure Research Laboratory in the Research Triangle Park.

Fluorochemicals are used to make plastics, such as Teflon, stain repellents and firefighting foams. There is increasing evidence that traditionally used fluorochemicals are linked to adverse health outcomes including cancer and immunosuppression. In response, industry developed a wide array of fluorinated replacements, including the compound GenX, a polymer processing aid made by the Chemours Company at its Fayetteville Works facility, located approximately 90 miles upstream from Wilmington, NC.

Until the summer of 2017, wastewater from the facility contained high levels of fluorochemicals, including GenX and a number of structurally similar compounds.

"One problem with the GenX class of compounds is that they are not removed by conventional and many advanced drinking water treatment processes," says Knappe. "We measured GenX levels of up to 4,500 parts per trillion at the intake of Wilmington's water treatment plant, and the levels of other fluorochemicals were even higher. These compounds were on no one's radar. Without research like ours, nobody would know that these chemicals are in the water."

Knappe and his collaborators published their findings in a 2016 paper in *Environmental Science and Technology Letters*. Following the publication of an article in the *Wilmington Star News* in June 2017, local officials, residents in impacted communities and state regulators took notice.

Within a few weeks, Chemours agreed to stop discharging GenX and related compounds into the river. Chemours also stated that the Fayetteville Works plant had been releasing GenX as a manufacturing by-product for 37 years.

In November 2017, DEQ announced its intent to partially revoke Chemours' permit to discharge process wastewater into the Cape Fear River. Now, fluorochemical concentrations in Wilmington-area drinking water have dropped by approximately 99 percent from the levels observed in June 2017.

"I am pleased that actions were taken quickly and that the level of fluorochemical pollution in the Cape Fear River and in the Wilmington area has decreased dramatically," said Knappe. "But, it won't erase 37 years of pollution."

To determine potential health effects, Knappe is now part of a research team funded by the National Institute of Environmental Health Sciences that aims to study human exposure by measuring GenX concentrations in the blood and urine of Wilmington residents.

HOME FILTERS

Residents in communities impacted by emerging contaminants also wanted to know which home filtration options are effective. Home filters, such as pitcher filters, faucet filters, refrigerator filters and under-the-sink filters, are typically not tested for their ability to remove emerging contaminants.

To address this need, Knappe's group examined the removal of dioxane, GenX and other fluorochemicals from tap water with a focus on commercially available systems but also creating a custom filter.

"For the cocktail of emerging contaminants present in tap water derived from the Cape Fear River, I have recommended that residents install under-sink reverse osmosis filters to treat the water for drinking and cooking," Knappe said.

Filters containing activated carbon were not effective for dioxane and their performance for fluorochemical removal was mixed. With recent funding from the NSF, the team is now working on developing new materials for removing fluorochemicals from tap water. ▪

ENGINEERING BUILDING OVAL BY THE NUMBERS

THE SPACE

1,560 Students to be served

9 classrooms

137 Faculty and staff offices

227,546 square feet

13 Conference rooms

47 Labs

THE DONORS

327 **Alumni** and **friend** donors

47 Dean's **Engineering Building Oval Club** members

40 **Cornerstone Society** members

$31.8 million Private support raised

Work has begun on **Engineering Building Oval**, the College's newest building on NC State's Centennial Campus. The new home of the Department of Civil, Construction, and Environmental Engineering and the Edward P. Fitts Department of Industrial and Systems Engineering represents a new funding paradigm for the College and for NC State.

While the project received $75 million from a statewide bond issue in March 2016, the College hopes to raise $60 million in private funds to complete the project. On these pages, you'll learn more about the building, the alumni and friends who have pledged to help raise that money and how you can help.

WHERE YOU COME IN

To learn more about how you can support EB Oval, contact Lora Bremer, executive director of major gifts and campaign planning for the NC State Engineering Foundation, at **lora_bremer@ncsu.edu** or **919.513.0983**.

BY DESIGN

A life-saving idea receives funding, research collaboration from NC State

BEFORE THEY STARTED WORK on developing a medical device, the five women had a plan: to work together.

Students in Dr. Andrew DiMeo's senior design class in the UNC/NC State Joint Department of Biomedical Engineering (BME) fill out a survey early in the year-long class. The data gathered informs how students in the class will be divided into teams for the year.

Dr. Elizabeth Davenport, Alexandra Eller, Denise Witman, Laura Johnson and Ashley Hayes had connected during their sophomore year. So as their senior year began in fall 2010, they tried to figure out DiMeo's algorithm to self-select their group.

"We kind of worked the system a little bit because we had worked well together all through undergrad," Davenport, now a postdoctoral researcher at the University of Texas Southwestern Medical Center, said.

The team was assigned to shadow nurses and physicians at WakeMed Hospital in Raleigh, where they were introduced to Dr. Mark Piehl, a pediatric intensive care physician.

Piehl had identified a problem and had been thinking about solutions. Intraosseous infusion, the standard method for giving a large amount of saline or other fluids by using a syringe to push it into bone marrow rather than a vein, is slow, inefficient and carries a number of risks. What if there were a better way?

"I thought, why don't we take that concept of multiple strokes of a syringe and package it into something that's easy to understand, easy to use and gets the job done quickly by one provider anywhere, whether it's in a helicopter, an ambulance or in a hospital," he said.

A WIN for NC State

The Wolfpack Investor Network launched in fall 2016 as a way for alumni to connect with NC State-affiliated startup companies as angel investors.

Beyond the financial support, these young companies gain access to alumni's expertise and professional networks while WIN members receive promising investment opportunities that also support the NC State ecosystem.

Interested companies are screened by a selection committee before earning a chance to pitch to interested member investors. WIN staff then work with the company and investors to complete the investment.

WIN works in tandem with the Duke Angel Network and the Carolina Angel Network as the Triangle Venture Alliance (TVA).

Learn more about WIN at **www.wolfpackinvestornetwork.com**.

DR. ANDREW DIMEO

BY DESIGN

FROM LEFT, DR. ELIZABETH DAVENPORT, ASHLEY HAYES, ALEXANDRA ELLER, DENISE WITMAN AND LAURA JOHNSON IN 2011.

Piehl had been approached about working with senior design teams before but had felt that he was too busy. This time he decided to collaborate with the five women from the NC State design team to develop a new device based on his concepts. With Piehl's guidance and collaboration, the team set out to develop an initial prototype.

At the end of their senior year, the students presented a prototype of a device that would deliver the fluid faster and could be used by a single person instead of two.

As a result of the ideas generated from this collaboration and other work outside the University, Piehl founded a company called 410 Medical. The company ultimately developed and launched the LifeFlow® rapid infuser that includes some concepts from the original design. LifeFlow makes fluid delivery faster, simpler and more controlled. The Food and Drug Administration has cleared the device for saline delivery, and it is being tested in hospitals around the country.

In 2017, 410 Medical became the first company to receive funding from Triangle Venture Alliance, a new investment alliance joining NC State's Wolfpack Investor Network (*see box above*) and angel investor networks at Duke and UNC-Chapel Hill.

While the five students have moved on to careers in the medical device field and graduate studies, they say their senior design work provided valuable lessons that helped shape their careers and post-graduate studies and was an important experience.

"I was really proud of being able to work with women," Hayes, now a research and design (R&D) engineer with medical device maker Cook Medical, said. Johnson is also an R&D engineer with Cook.

Based in part on the work that was done by Hayes and her teammates, a patent application was submitted in 2014. Per University policy, the students' rights were assigned to NC State, but if the patent issues, both the students and the University will be compensated.

"I didn't know when I was a senior that I would help develop a medical device that would go to market five years later," said Eller, now a global product manager with Teleflex, an international medical device company.

A MEDICAL DEVICE "SWEET SPOT"

When the five students began talking to nurses at WakeMed about the existing method for intraosseous infusion, they knew they'd been given an important problem to solve.

"Everybody jumped in and said 'oh yes, it's so hard,'" Witman, who now works for device maker Ottobock HealthCare as a marketing manager in its orthotics division, remembers. "You had two nurses doing a job that was not very efficient."

The team surveyed WakeMed nurses and EMT technicians across the state. They conducted tests on pig legs, which provide a close model of the human tibia. They built a prototype using SolidWorks design software and a 3D printer.

Each year, DiMeo has senior design students shadow medical professionals and question them about their problems and needs. The students then conceptualize, prototype and test devices that offer solutions.

DiMeo, an associate professor of the practice in the department, says the class' "sweet spot" is creating fairly simple, high-volume, single-use devices. Teams from senior design have developed a rapid chilling device that cools saline during the infusion process to induce therapeutic hypothermia, a communication platform for patients with disabilities and a urinary catheter that reduces the risk of patient infection.

In most cases, DiMeo said, the great ideas that come out of his course end with graduation. Most students, armed with a valuable degree from a rigorous biomedical engineering program, have graduate school or the opportunity for a great first job in industry on their mind.

"Somebody has got to keep the torch alive," he said. "Unfortunately, most often nobody does it."

BARRIERS TO ENTRY

The LifeFlow rapid infuser resembles a laser gun from a science-fiction movie. A single front line clinician can infuse 500 milliliters of fluid into a patient in 2.5 minutes.

It's a simple solution to a complex and important problem, which begs the question of why it hadn't been done before.

"That's the hallmark of a great idea," said Galen Robertson, 410 Medical's chief operating officer. "It's simple, and it works."

Piehl identified a tendency among medical professionals to assume that the tools available are the best that they could be. And there are several barriers to producing a new medical device, which Piehl discovered when he tried to push the idea forward.

After the five women presented their work and graduated, Piehl let the idea sit for about a year, undecided on how to move it forward. Eventually, he mentioned it to an acquaintance with experience in medical device development who offered help and encouragement. Piehl founded 410 Medical in 2013. Less than 12 months after hiring its first employee, the company had submitted its rapid infuser to the FDA for clearance.

LifeFlow is being used in more than 20 hospitals around the country and will soon be tested in ambulances. 410 Medical, based in the Research Triangle Park, has 14 employees. Piehl works part-time as the company's chief medical officer and part time as a practicing physician.

Robertson, who brought 15 years of medical device operations and research experience with him to the company, said it's very unusual for a practicing physician to found a medical device company. The barriers to entry are often too high.

Piehl identified the work put in by those five BME seniors as an important turning point that helped turn an idea into a life-saving product.

"The work required to develop the initial prototype was daunting. The NC State team was instrumental in getting there."

From SOLDIER to STUDENT

Veterans and active duty members of the military are making the transition to college life

VETERANS AND ACTIVE DUTY MEMBERS of the armed services arrive as students in the College of Engineering with life experiences often unlike many of their peers.

Some have deployed to Iraq and Afghanistan, others have hands-on experience in roles such as aircraft mechanics, and at least one recently had the responsibility of managing more than 200 subordinates.

This group brings a unique perspective to campus. They're a little older than the average undergraduate, and they bring a sense of order, respect for others and duty from their military life.

DEVON HARRIS

Devon Harris learned important lessons about responsibility, prioritization and professionalism during his time in the U.S. Marine Corps.

It's something he's carried forward with him as a student in the College of Engineering, where he knows to treat professors with respect, work hard to accomplish his goals and make time for what's important.

It was a few months after the Sept. 11, 2001, terrorist attacks when Harris enlisted in the United States Marine Corps. He served as an F-18 mechanic and ejection seat mechanic before being medically discharged in 2012.

Harris immediately pursued college opportunities, starting classes at Wake Technical Community College just four months after leaving the Marines. With an associate degree from Wake Tech, he enrolled at NC State in the summer of 2016.

"I was always interested in engineering and the STEM fields," Harris said. "My M.O.S. (military occupational specialty) really solidified in my heart that this was something I'd really be good at and something I'd enjoy doing."

He chose mechanical engineering for its broad engineering focus, but Harris said he's not sure yet what he wants to do when he graduates.

For now, he's focused on working hard in what he calls a challenging program. Like others who have come from the military to the University, he's balancing a family — with a wife and two kids at home — a mortgage and the responsibilities that come with home ownership, while pursuing his degree.

Harris called his transition to academics at NC State, "seamless," but said he still searches for the structure and camaraderie he found in the Marines.

> "It's a way for other veterans who might be at the University to know that they have some place that they can go and feel comfortable and welcome and deal with any issues."
>
> **DEVON HARRIS**

NC State's Student Veterans Association has helped. Though he said he's only been to a few meetings, Harris feels comfortable and at ease with like-minded individuals.

"It provides a space for veterans to be their uncensored selves without fear of offending sensitivities," he said. "You have all races, genders, ages — but all with the same mind-set; they're laid-back but still disciplined.

"It's a way for other veterans who might be at the University to know that they have some place that they can go and feel comfortable and welcome and deal with any issues," he said.

TIM MOORE

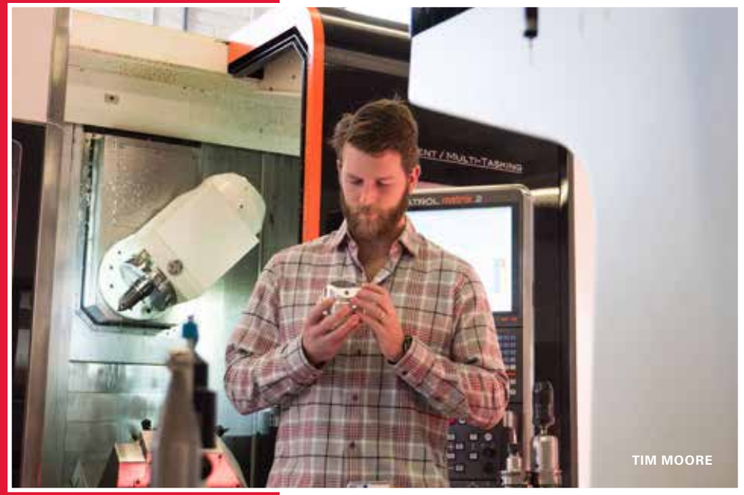
Some might look at Tim Moore's life and think it's pretty hectic.

He's enlisted in the Army, has a wife and two children, and is working toward his Master of Science in operations research on a thesis track. But to Moore, who left a command position with the Army where he was responsible for 275 people, life now seems less complicated.

In fact, ask him about the best part of his graduate school experience, and he'll say it's the freedom to spend more time with his wife and kids.

He received a scholarship option through the Army allowing him to serve locally for two years while pursuing his degree. Upon graduation, Moore's scholarship stipulates he spend two to three years teaching at the United States Military Academy, but he's fine with that as he plans to stay in the Army for 20 years.

Moore selected NC State for its reputation and its proximity to his family in Virginia. He reached out to a friend who was a year ahead at NC State who answered his questions prior to applying. The transition was made even easier for him thanks to NC State's Veterans Association.



TIM MOORE

ALYSSIA HARDY

"It was beneficial to me – I can imagine it would be even more beneficial to a younger soldier who was transitioning to academic and civilian life."

TIM MOORE

"They do a very nice job," Moore said, indicating the group reached out before he was even on campus and starting classes. "It was beneficial to me — I can imagine it would be even more beneficial to a younger soldier who was transitioning to academic and civilian life."

Moore chose to pursue a thesis track, with an interest in tying his research to something that might benefit the military. His research focuses on how to best integrate 3D printing into the Army's supply chain. Using a computer simulation, Moore determined what size parts can realistically be 3D printed for different echelons in the Army.

He presents his thesis research this spring and will graduate feeling grateful for the opportunities the Army has provided.

"The Army has been good to my wife and I," Moore said.

ALYSSIA HARDY

In her time in the College of Engineering, Alyssia Hardy has juggled her role as student, member of NC State University's cheerleading team, wife and active member of the Idaho Air National Guard.

Yes, she's an active member of the Idaho Air National Guard living in North Carolina. With a husband in active duty in the Army and stationed at Fort Bragg, North Carolina, Hardy received special permission to reside in North Carolina and travels to Idaho twice each year for training.

"We did long-distance for nine months because I was working full time (in Idaho)," Hardy said. "You can only do distance for so long."

She joined the Air National Guard out of high school. Unsure what she wanted to study in college, it offered her the opportunity to pursue something meaningful while she figured out her future.

Immediately following her initial training with the National Guard, her unit was deployed, and she was placed in a full-time technician position. She'd grown up fixing cars in her dad's garage, and her time in the Guard piqued her interest in electrical engineering.

"It gave me that hands-on experience with how things work," she said. "Knowing I enjoyed that, I wanted to further my education in that field."

For all the hard work and dedication she's put into her engineering degree, she's equally dedicated to the cheerleading team. She practices three hours a day, three days per week, and attends numerous athletic events, from basketball to gymnastics to football.

"It is a huge time commitment, but it's always been a passion for me and a sport that I loved," Hardy said.

It's also given her a sense of community similar to that of the National Guard.

"Like the military, you want to be a part of something bigger than yourself," she said. "Joining a sport at a big university gives you that opportunity."

RYAN POLLARD

Ryan Pollard entered the Air Force in 2003 with a plan to pay for college. But as plans sometimes do, his changed.

"It wasn't long after being in that I shifted from wanting to go to college to focusing on the career I had," Pollard said. "Even when I got out, I wasn't thinking too much about school."

He served as an aircraft mechanic in the Air Force and continued in aviation maintenance when he got out in 2013.

Then an accident changed his future. He and his wife were traveling on a rural North Carolina road when they were hit head-on by a driver who had fallen asleep.

Pollard broke 19 bones and sustained a traumatic brain injury. After months of physical and occupational therapy and three surgeries, he was told he wouldn't be able to perform a job like those he'd held previously.

But rather than give up, he created a new plan.

"I then decided to take back control of my future, and use my GI Bill to pursue a degree that relates to my passion and the 10-year career I had in the Air Force," Pollard said.

In high school, he'd thought about a career in aeronautical engineering. Now, he's looking toward a higher elevation.

"The 10 years in the Air Force solidified the idea that I do love this industry," Pollard said. "Despite being comfortable in aviation, I have more of an interest in the space industry — it's still somewhat unfamiliar to me and very exciting."

A senior pursing his Bachelor of Science in aerospace engineering, Pollard said he'd like to obtain a graduate degree. He's considering rocket design and propulsion systems, but said his options are open.

The workload has been challenging, but he expected this.

"I'm a problem solver and more often than not if something is very difficult, and I can make it through it, I've loved it," he said. "So far I'm very pleased with the education I've received at NC State."▪

RYAN POLLARD

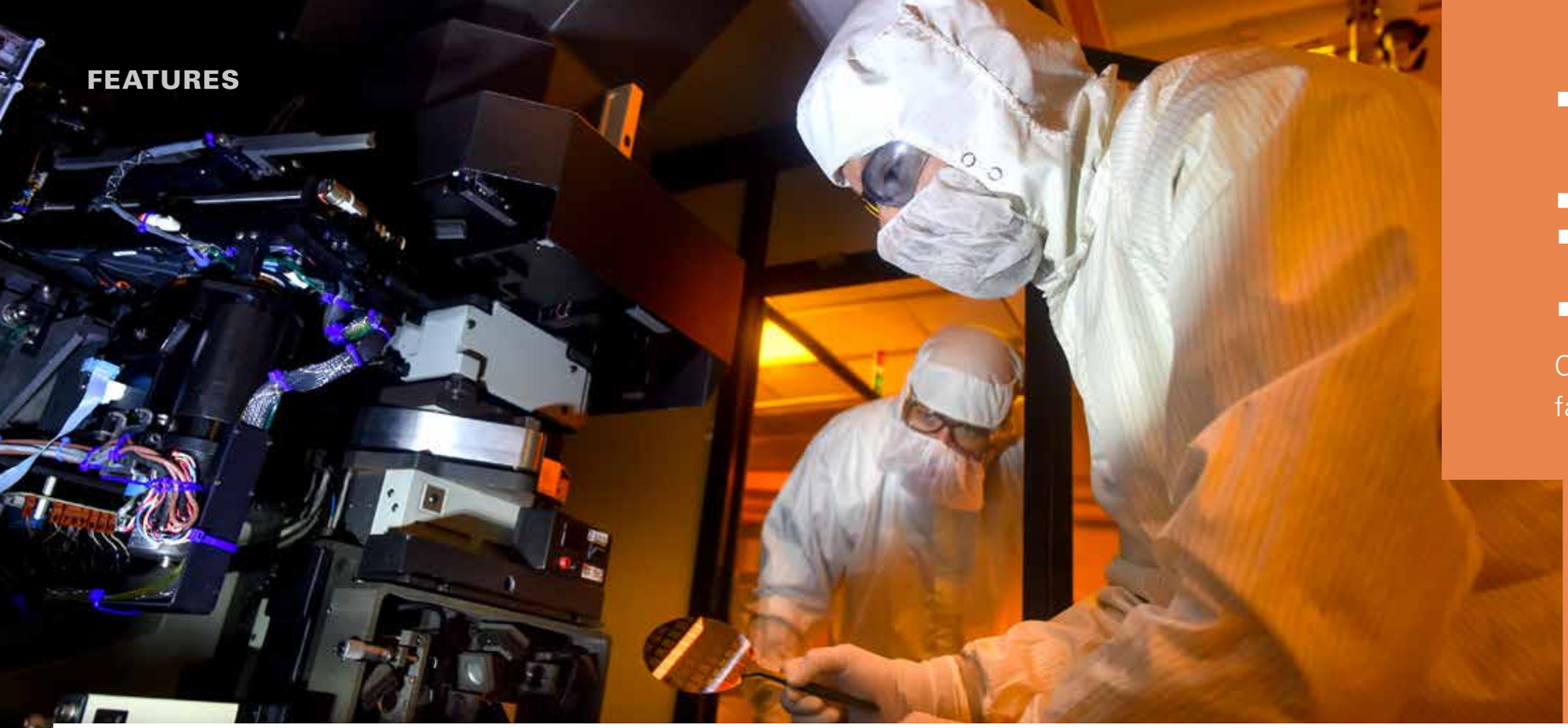
FEATURES

"Like the military, you want to be a part of something bigger than yourself... Joining a sport at a big university gives you that opportunity."

ALYSSIA HARDY

"I then decided to take back control of my future, and use my GI Bill to pursue a degree that relates to my passion and the 10-year career I had in the Air Force."

RYAN POLLARD



Broader reach

College's nanofabrication and instrumentation facilities offer a range of resources

THE NC STATE NANOFABRICATION FACILITY (NNF) and the Analytical Instrumentation Facility (AIF) provide the kind of core shared resources that help make a research-intensive university like NC State create innovation.

NNF is a Class 100/Class 1000 cleanroom that provides semiconductor processing capabilities, while the AIF is NC State's primary shared facility providing access to major analytical and materials characterization instrumentation like scanning electron microscopes and X-ray units.

While both facilities are part of the College of Engineering and are used regularly by students and faculty members in the College, they also provide important capabilities to researchers in textiles, physics, chemistry and other programs on campus. NNF and AIF are two of five such research centers identified by NC State as vital Shared Core Research Facilities that are central to the University's mission.

"Facilities like NNF and AIF are set up so that there is one facility where all professors in the University, all students and post docs, can go to share the equipment and not have to shoulder the burden of maintenance, infrastructure and tool upkeep," said NNF Director of Operations Dr. Philip Barletta. "It also serves as a melting pot where researchers from a number of disciplines and backgrounds can work together, share ideas and inspire each other."

Along with on-campus users, the two centers are made available to clients in business and at other academic institutions. Growing that client base is a revitalized focus for NNF, which has recently upgraded its equipment and space and has grown the size and expertise of its staff, thanks to new investments from the Department of Electrical and Computer Engineering (ECE), the College of Engineering and the University. Barletta, hired in 2017, is NNF's first full-time director.

At the same time, leaders of both AIF and NNF are working to expand access to their centers, transforming them into resources that are broad in scope and global in reach.

"It's not just about having such facilities that are available for use," said Dr. Jacob Jones, AIF director and professor in the Department of Materials Science and Engineering. "It's about reaching out and promoting these state-of-the-art capabilities to global researchers."

A WIDE RANGE OF CLIENTS

NNF possesses a full range of micro- and nano-fabrication capabilities, including photo and electron beam lithography, wet and dry etch, chemical vapor deposition, vacuum metallization, rapid thermal anneal and various characterization tools. The center is capable of processing on a broad range of substrates such as semiconductors, ceramics, plastics and glass with sizes from small pieces to six-inch wafers.

For clients that range in size from small start-ups to large international companies, NNF offers vital capabilities that would be cost-prohibitive to have in-house. Their projects include micro-electro-mechanical machines for sensing, microfluidics for biomedical applications and non-silicon-based microelectronics.

Of 107 individual users of NNF's facilities during the 2016-17 fiscal year, 15 were from outside NC State. That's a number Barletta hopes to increase.

AIF offers users state-of-the-art scanning and transmission electron microscopes, X-ray scattering and spectroscopy instruments, mass spectrometry, scanning probe and Raman microscopy, nanoindentation and extensive sample preparation facilities.

Its advanced capabilities include chemically sensitive atomic-scale imaging, extreme-resolution SEM of insulating and soft materials, in-situ high-temperature and electric-field-dependent X-ray diffraction and cryogenic SEM of biological and soft materials.

In addition to the several hundred NC State researchers served by AIF during fiscal 2016-17, the center served 127 external government, industrial and academic researchers, or 25 percent of all AIF lab-use hours during that period.

AIF has created a Corporate Affiliates Program to help strengthen ties to outside academic and business clients. Through financial support of the center, members of the program receive increased access to the AIF's services and expertise.

AIF and NNF are also part of a National Science Foundation-supported National Nanotechnology Coordinated Infrastructure (NNCI). The local site in the NNCI, the Research Triangle Nanotechnology Network (RTNN), has many programs geared toward serving outside clients. For example, RTNN's Kickstarter program provides facility access to members of the nanotechnology and greater scientific communities who would otherwise not have the financial resources to use RTNN facilities.

BEYOND THE LAB

ECE offers two classes that take place in NNF — one undergraduate level and one graduate level — in which students learn to make transistors. Education is also central to the mission of AIF. During 2016-17, the facility offered training workshops and short courses on topics including vacuum technology, surface analysis and sample preparation.

For the two centers, the next step is to further expand their reach to those outside the Research Triangle area of North Carolina and outside of technical fields.

Through RTNN — an NC State-led initiative designed to provide public access to University facilities, tools and expertise within all disciplines of nanoscale science, engineering and technology — faculty members in the College of Engineering, Duke University and UNC-Chapel Hill are offering a free online course called Nanotechnology: A Maker's Course.

The course, available through the Coursera online platform, opens a wealth of opportunities for students, entrepreneurs and business people to learn about and use machinery involved in making high-tech products and studying materials on a molecular scale.

In the first few months after the course was released, it had seen more than 10,000 visitors and several thousand students were enrolled. The creators hope to have tens of thousands enrolled students annually.

"We've got a large swath of wonderful resources here at NC State that are available to the world," Jones said. ▪

BREAKING **NEW GROUND**

The College begins work on a **new building** as fundraising continues

SINCE ITS ESTABLISHMENT in the mid-1980s, Centennial Campus has represented the bold future of NC State University and the College of Engineering. Over the last 15 years, the campus has experienced rapid growth. One of the most exciting areas on the campus is the Engineering Complex on the Oval.

In the early 2000s engineering buildings I, II and III started the College's move from main campus to Centennial and sparked new energy into the faculty, staff and students. Over the last 10 years, the College has moved up in the *U.S. News and World Report* graduate rankings to 12th among public engineering colleges, the annual research expenditures have doubled to more than $200 million and our faculty members and students have created more than 40 new startups and spinoff companies.

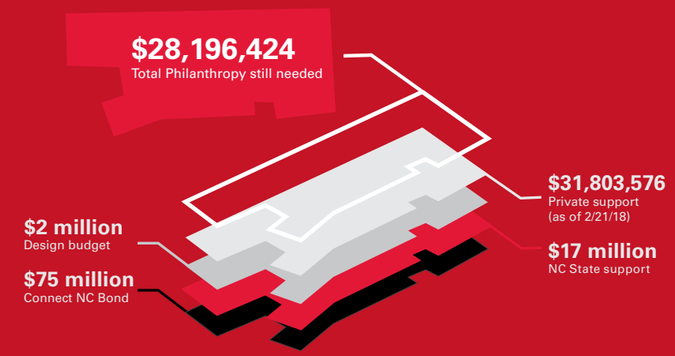
In late February, contractors began site work for Engineering Building Oval, the College of Engineering's newest academic and research building. The future home of the Department of Civil, Construction, and Environmental Engineering; the Edward P. Fitts Department of Industrial and Systems Engineering; and the dean's administration marks the next step in the unification of the College on Centennial Campus. EB Oval is scheduled to open to students and faculty members in June 2020.

A NEW WAY TO BUILD

EB Oval represents a first-of-its-kind infrastructure project for NC State, using a public-private partnership to fund the construction of an academic building. The $154 million project received $75 million from the people of North Carolina through the 2016 bond referendum. The NC Legislature provided $2 million, and the University will provide $17 million, leaving the remaining $60 million to be raised from private donors. So far, the College has raised $31.8 million.

"We are very grateful to the more than 300 people who have stepped forward to help us reach our funding goal for EB Oval," said Dr. Louis A. Martin-Vega, dean of the College. "We reached out to our alumni and friends, and they have really come through for us."

Investing in EB Oval is an **investment** in the **future** of engineering at NC State



KEEP TRACK OF OUR PROGRESS

You can watch work being done at the EB Oval site by checking out our webcam at **camera.ehps.ncsu.edu/eboval.html**.

GET INVOLVED

Learn how you can support the College's work on EB Oval by contacting Lora Bremer, executive director of major gifts and campaign planning with the NC State Engineering Foundation, at **lora_bremer@ncsu.edu** or **919.513.0983**.

With a little more than $28 million left to raise, the College continues to need the help of its alumni and friends. To aid the fundraising effort, the NC State Engineering Foundation (NCSEF) has developed a portfolio of giving opportunities for donors.

"We wanted to give our donors multiple opportunities to feel included in this important project," said Lora Bremer, executive director of major gifts and campaign planning for the NCSEF. "These giving societies allow donors to participate at various levels, knowing that their gift is supporting the future of engineering at NC State."

The **Cornerstone Society** comprises the lead donors who give $100,000 or more to the project and offers donors naming rights in EB Oval as well as in other engineering buildings.

Dean Martin-Vega and his wife, Maggie, made a leadership gift to initiate the **Dean's Engineering Building Oval Club** (DEBOC) for donors who want to give between $50,000 and $100,000 over five years.

To encourage participation by the College's young alumni, the **Dean's Young Alumni Oval Club** was established for donors who have graduated within the last 15 years and pledge $25,000 over five years.

Donors in all three societies will receive permanent recognition of their gift inside the building.

"There are many different ways in which you can contribute," Martin-Vega said. "We are excited that so many of our alumni and friends have already contributed and encourage others to help us reach our goal."▪

AARON ISBELL

When Aaron Isbell visited NC State's campus for the first time, he felt he could easily transition from his magnet high school in Gastonia, NC, to the University.

"I selected NC State for the engineering reputation, and the fact I could see myself easily interacting with people," said Isbell, a 2007 graduate with a bachelor's in computer science.

During his time as a student, Isbell held the position of technical intern with the analytics software company SAS Institute, which led to a full time position after graduation as an individual contributor. After a few years, he was given the opportunity to build a team to deliver support and IT services to SAS hosting customers. After 11 years at SAS, Isbell is now a senior solution consultant with ServiceNow — an enterprise cloud software company — where he is responsible for supporting pre-sales activities for major accounts in the US South region.

Isbell's connection to the College continued post-graduation, as he participated in several alumni panels, attended student events such as E-Day (Engineering Day) hosted by the Engineering Council and served as chair on the engineering young alumni council.

"The innovative ideas that are coming out of the College, especially from the students, are inspiring," said Isbell. "I like to make engaging relationships and help how I can."

Isbell recalls a phone call from Angela Martin with the Engineering Foundation asking for his help in sharing his skills and engaging with students by giving his time rather than his money. But, Isbell said, "some things can't happen without money."

As the first member of the Dean's Young Alumni Oval Club, Isbell and his wife, Dr. Lauren Isbell, saw an opportunity to continue making engaging relationships.

"When you think about your experiences on a college campus, you make the most transitions in a short amount of time, places you spend a lot of your time at stay with you," said Isbell. "During my time at NC State, I was always in Harrelson, the library and Centennial Campus. It's important for students to have nice places where they can not only make memories but can also innovate. It's so much more than a building."

DAVID WHITLEY

David Whitley had an interest in all things electronic from an early age.

"Whether it was the very first Atari game system, the first electronic calculator that my father brought home from work or my very first computer (a Radio Shack TRS-80), it completely fascinated me how these devices worked," said Whitley, a 1992 graduate with a bachelor's degree in electrical engineering.

Through a recruiting event held by Eta Kappa Nu electrical and computer engineering honor society, where Whitley served as recording secretary, he was offered a job as a consultant for Andersen Consulting (now Accenture). It was here he worked with software development as a programmer on large-scale custom applications development programs.

Whitley left Andersen Consulting in the late 90s and worked at several different start-up companies that led to "fantastic technical and business experience — a real-life MBA."

For the past 12 years, he has worked with private-equity software companies as the software development leader responsible for product development.

Thinking back on his time at NC State and how it affected his career, Whitley thought back to two main questions, why and how.

"My engineering degree has been fundamental to everything that I've achieved in my career. As an engineer, answering the two questions of "Why?" and "How?" forms the basis for learning and for solving problems," said Whitley. "Being exposed to many different facets of the engineering field helped me to develop the confidence that I am able to learn anything. It also opened my mind to many different answers or possibilities, and that there may not always be one right answer."

Early in 2017, Whitley and his wife, Karen, funded the David and Karen Whitley Engineering Scholarship and did not have plans of contributing toward the EB Oval. But after hearing Dean Louis Martin-Vega speak at a lunch event in Atlanta, the Whitleys felt the dean's message really spoke to them and they wanted to be part of this once-in-a-lifetime opportunity.

"All of my professional success is completely attributable to the knowledge, experience and life-changing events which happened while at NC State. To be able to give back to my beloved university, after it has afforded me so much, is beyond satisfying for us both."

"I give to the College of Engineering because of what they do for the community and how they prepare students for future success."

CHUCK WILSON

CHUCK WILSON, JR.

Chuck Wilson grew up in construction; the first office of his father's business was out of the family home.

"I started working with my father at a young age, mostly due to the fact that my mother wanted me out of the house" laughed Wilson, a 1965 graduate with a bachelor's in civil engineering.

After graduation, Wilson enrolled in graduate school.

"This was during the Vietnam War," said Wilson. "I decided to go to Officer's Candidate School in the Navy prior to completing my graduate degree to help where I could."

FOUNDATIONS

After being commissioned as an Ensign in the Navy, he became a Damage Control Officer on one ship and a Chief Engineering Officer on another. In 1969, Wilson left the Navy and began working for his father's company, C.T. Wilson Construction, where he is now CEO.

For Wilson, NC State was his only choice. "I spoke with a rep from MIT. Even though I could get in to MIT, I didn't think seriously about going anywhere else but NC State."

When his father passed away in 1995, Wilson and his mother set up an endowed scholarship in his father's name, the Charles T. Wilson Sr. Scholarship. Chuck Wilson and his wife, Jean, have also endowed program funds for the C.T. Wilson Construction AGC Student Chapter – the same student chapter of which Wilson's father was a founding member.

"There's a long history between NC State and the Wilson family," said Wilson, who is one of three generations of the family to have graduated from the civil engineering program at NC State.

Reflecting on his family legacy, Wilson feels that the College prepared and trained all three generations for their careers in construction.

"A majority of the success that C.T. Wilson Construction Company, Inc. has reaped over the past 66 years can be attributed to the firm foundation we have received at NC State," said Wilson. "When you have the advantages my family has, you need to give back and help others."

Chuck and his wife, Jean, have also contributed toward EB Oval.

"I am really impressed with Dean Louie and the amazing job he is doing for the College of Engineering," said Wilson. "I give to the College of Engineering because of what they do for the community and how they prepare students for future success."▪

"IT'S **MORE THAN A BUILDING**"

Alumni share why they donated toward the new **Engineering Building Oval**

ENGINEERING BUILDING OVAL (EB Oval) — the crucial next step in unifying the College on Centennial Campus — is a top-priority project for the University. Meet three NC State Engineering alumni who have donated toward EB Oval and are helping the College continue to provide excellence in engineering to its students, faculty and the world.

MICHELLE LISHNER, LEFT, AND CHRISTINA HAMMOCK KOCH.

Engineering graduates return for **homecoming**

LEN HABAS, immediate past president of the NC State Engineering Foundation, received several nods of agreement from the faces in the audience.

Opening the College's 2017 homecoming program on NC State's Centennial Campus, Habas recalled the message he received from an engineering faculty member as an engineering freshman in 1962.

"Look to your left and look to your right," the familiar refrain went. "Those two students won't finish their engineering degree.

"It's not that way anymore," Habas told the audience of engineering alumni and their family members. "Now it's a collaboration among the students, the faculty and the University as a whole."

Each year during the University's homecoming weekend, engineering graduates are invited to a Friday lunch and presentation to catch up with classmates and see the progress the College has made and the cooperative atmosphere that the College strives for.

After hearing from Habas, the audience met **CHRISTINA HAMMOCK KOCH**. An NC State electrical engineering bachelor's and master's alumna, Koch is a NASA astronaut from the class of 2013 currently assigned to the International Space Station (ISS) Crew Operations Branch.

As an astronaut, she has gone through wilderness survival school and military flight school. She has trained in a weightless environment, has become fluent in Russian and has served as a capsule communicator (the crew member back on Earth talking to astronauts in space).

Training for a spot on the ISS or even a trip to Mars has been rigorous, Koch said, and has included learning how to eat in a weightless environment and how to fix a space toilet. A six-hour simulated spacewalk provided a particularly memorable challenge in a life that's been full of them.

"This by far is the most mentally and physically challenging task," she said.

Next, **RAHUL KATHARD** and **MICHELLE LISHNER** of the NC State student chapter of Engineers Without Borders (EWB) gave the audience a peek inside the group's work improving the lives of people in Sierra Leone and Guatemala.

The non-profit, humanitarian organization has 17,000 members impacting 3.1 million people around the world. The group is focused on sustainable development through community-led change. EWB volunteers work on infrastructure projects that local residents have identified as a need and that they can take ownership of.

At NC State, EWB volunteers are working on water supply and renewable energy projects for a school in Sierra Leone and a water supply project for a remote community in central Guatemala.

Dean Louis Martin-Vega wrapped up the program with an overview presentation on the current state of the College. As he ticked off achievements in rankings, research expenditures, growth and faculty hiring, the theme of collaboration Habas talked about shone through. NC State Engineering is a place where students, faculty and staff all work together to make themselves, and the College, the very best that they can be.

"It's a very big College that tries very hard to be personal," Martin-Vega said. ▪

Hassan, Icenhour **receive DEA awards**

The College bestowed the Distinguished Engineering Alumnus award on **DR. BASIL HASSAN** and **DR. ALAN S. ICENHOUR**.

Dr. Louis A. Martin-Vega, dean of the College, recognized Hassan and Icenhour at a banquet on Nov. 1.

Hassan earned his bachelor's (1988), master's (1990) and doctoral (1993) degrees in aerospace engineering from NC State. Upon completing his doctoral degree, he joined Sandia National Laboratories in Albuquerque, New Mexico, and has held a variety of management and staff positions, overseeing all aspects of engineering sciences research, development and applications work. Currently, he holds the title of senior manager of the Thermal, Fluid, and Aero Sciences Group. He helped support NASA to determine the cause of the Space Shuttle Columbia accident in 2003 and was part of the team to support the shutdown of the Deepwater Horizon Oil Well after the explosion and spill in 2010.

He is a Fellow of the American Institute of Aeronautics and Astronautics, including serving on its Board of Directors from 2008-17, where he held the roles of director and vice president. He has also served on review boards for the National Academies, NASA, and Air Force Office of Scientific Research. He currently serves on the NC State Mechanical and Aerospace Engineering Educational Advisory Board and has served on similar boards for New Mexico State University, Texas A&M University, University of Texas at Austin and University of New Mexico.

Icenhour earned his bachelor's degree in nuclear engineering in 1986 from NC State. He also holds M.S. and Ph.D. degrees in nuclear engineering from the University of Tennessee, where he is an adjunct professor of nuclear engineering. He was a commissioned officer in the U.S. Navy on a nuclear-powered submarine and continued his service with the Navy as a reservist until retiring in 2010 at the rank of captain. He joined the Oak Ridge National Laboratory in 1990, serving in various roles, including principal investigator, research group leader, director of three research divisions and his current role as associate laboratory director for the Nuclear Science and Engineering Directorate.

He has more than 30 years of experience in nuclear reactor operations and R&D on topics such as enrichment, radiochemical processing, radioisotope production and applications, nuclear fuels, radiation effects on materials, radioactive waste management and nuclear security. He was elected a Fellow of the American Nuclear Society and chairs the NC State Nuclear Engineering Department Advisory Committee.

Under the leadership of the late Dean Ralph Fadum, the Distinguished Engineering Alumnus Award was established by the faculty of the College of Engineering at NC State in 1966 to honor engineering graduates who have been recognized for outstanding achievements in one or more of the following categories:

- Planning and direction of engineering work
- Fostering professional development of young engineers
- Contributing to knowledge in the field of engineering
- Bringing, in other ways, distinction to the University through engineering achievement. ▪

DEAN LOUIS MARTIN-VEGA, CENTER, WITH DR. ALAN ICENHOUR, LEFT, AND DR. BASIL HASSAN.

A **Wolfpack family** gives back

TONY SIGMON, FAR RIGHT, IS SHOWN WITH HIS FAMILY. IN THE FRONT ROW, FROM LEFT, ARE GRANDCHILDREN CARSON AND FINLEY CAPPS. IN THE SECOND ROW, FROM LEFT, ARE ERIN CAPPS, HANNAH ABERNETHY, SARA SIGMON AND NANCY SIGMON. IN THE BACK ROW, FROM LEFT, ARE CORY CAPPS, RICHARD TREVORROW, DANIEL SIGMON AND GRANDCHILD JUDE SIGMON.

DR. TONY SIGMON, founder and corporate president of Collegiate Capital Management headquartered in Raleigh; his wife, Nancy; their children; and children's spouses have donated to NC State with a gift of land, a donation at the Cornerstone Level to the College of Engineering's EB Oval Initiative and the gift of a life insurance policy to the College of Engineering and the greater University.

Pack loyalty prompted them to make the generous gifts.

Sigmon and his family are enthusiastic Wolfpackers. Sigmon received his bachelor's, master's and doctoral degrees in engineering science and mechanics from the College in 1974, 1975 and 1977, respectively. Both of his children, their spouses and his stepdaughter also graduated from NC State, and his stepdaughter's husband is currently in the Goodnight Scholars Program at NC State.

He has three grandchildren being primed for the Pack. A grandchild's t-shirt displaying the words, "Raised by a Pack of Wolves," could be a family motto.

An entrepreneur at heart, Sigmon started his company in 1994 after working as an engineer at RTI International for 12 years and receiving his M.B.A. from Duke University. His allegiance to NC State has never wavered.

His colleague Grant Walker (B.A. economics and accounting '91) is chief investment officer and corporate vice president of Collegiate Capital Management and a "proud NC State graduate (who) has been a 20-year trusted partner in growing our business," Sigmon said.

His two children and one son-in-law also hold positions in the company and, of course, are NC State graduates. His son, Daniel Sigmon (B.S. textiles management '08), is vice president of financial planning; his daughter, Erin Capps (B.S. biological sciences '04), is the firm's director of compliance; and her husband, Cory Capps (B.A. business management '03), is vice president of investment management.

"I think it's noteworthy that even though we all graduated in different disciplines, the problem-solving ability and perseverance we learned at the University has played an important part in helping us achieve a measure of success," Sigmon reflected.

Sigmon has fond memories of his years at NC State and gives special credit to John Edwards, a professor in the then Department of Engineering Science and Mechanics.

According to Sigmon, Professor Edwards "guided but didn't narrow the path. There was a lot of flexibility in being able to try different approaches."

He also found Yates Sorrell, now professor emeritus in the Department of Mechanical and Aerospace Engineering, equally helpful to him.

Explaining the family decision to invest in the College, Sigmon said, "I think (NC State) changed the trajectory of all of our lives. I think it's a debt in some respects that we would like to repay. Certainly, what we were taught there has helped us in so many ways to work through problems to arrive at a solution. So, it really has affected us professionally as well as personally."

Sigmon added, "I'm sure, as with all of our fellow alumni, our classroom experiences were only part of the texture added to our lives by our years at NC State. Our lives are continually enriched by our relationships with the University."▪

Alumna continues her **support of the College**

"I wanted to show women engineers and show African-American engineers that they have the skill set to have that earning potential to make that kind of contribution."

RASHIDA HODGE

When **RASHIDA HODGE** established a scholarship in the College of Engineering, she didn't name it after herself. Her recent pledge to help fund construction of the newest engineering building on NC State's Centennial Campus includes naming rights for a foyer in Engineering Building Oval. She won't put her name on that, either.

Hodge, who earned B.S. and M.S. degrees in industrial engineering from NC State, says that these gifts aren't about her. Instead, she is motivated to further the mission of the university that helped launch her career and to inspire young female and African-American engineers.

When she endowed the Real Hope for NextGen Engineers scholarship, Hodge was one of the youngest alumni to start a scholarship to build toward endowment for the College. When she made a decision to support EB Oval and began poring over naming opportunities, Hodge said, something stood out to her.

"They just didn't look like me," she said of the typical donor with a name on a university building. "I wanted to show women engineers and show African-American engineers that they have the skill set to have that earning potential to make that kind of contribution."

Hodge, who works for IBM as vice president for Watson embed and strategic partnerships, took advantage of a matching program for EB Oval donors made available by an anonymous donor to make a sizeable contribution.

Still, it's a donation that Hodge admits will require some sacrifice. She quotes her mother, Karen Hodge, who told her, "if it's easy for you, it's not really a sacrifice."

When EB Oval is completed in 2020, that foyer will bear Karen Hodge's name. As a teenage mother in the U.S. Virgin Islands, Karen Hodge gave up on her dream of becoming a lawyer to make sure that she could be a great mother for her daughter, Rashida. Karen Hodge, who eventually earned her degree and is now retired, still lives in her daughter's native U.S. Virgin Islands.

"My mom is such a bedrock of my life," Hodge said. "I named it after my mother because she gave up what she wanted so that I could have what I have."

Rashida Hodge didn't know much about North Carolina, or NC State, when she arrived in Raleigh in 1998. She had picked up an interest in industrial engineering after attending a summer program at the University of Illinois at Urbana-Champaign. A fateful call to an advisor in the industrial engineering department at NC State to talk about her options helped make her decision. It was a good one, she says.

While working on her master's degree, she completed an internship at IBM and began working full time for the company in 2002 as a development and research program manager. Along the way, she earned an MBA from Duke University and has been climbing to new positions of importance at IBM ever since.

Hodge recently moved to California, but she is an active member of the NC State Engineering Foundation Board of Directors and maintains close ties to the University and to Raleigh, her home for 20 years.

"NC State is special," she said. "It really helped give me my start. It really turned me into the professional I am today."▪

DORIS AND FRANK CULBERSON

Frank and Doris Culberson **name atrium** in Engineering Building I

Since he left campus in 1960 with a bachelor's degree in chemical engineering, NC State has called on **FRANK CULBERSON** many times for help.

He has always responded.

Culberson and his wife, **DORIS**, have donated to the College of Engineering to fund scholarships and named professorships. He has served on the NC State Engineering Foundation Board of Directors and as a chairman of a university-wide capital campaign.

Now, the Culbersons have donated to the College to help fund construction of Engineering Building Oval, NC State's newest planned engineering research and instruction facility on Centennial Campus. The atrium in Engineering Building I, home of Culberson's home Department of Chemical and Biomolecular Engineering (CBE), was dedicated as the Frank and Doris Culberson Atrium in November.

After graduation, Culberson worked with the Shell Oil Company/Shell Chemical Company and the Pace Company. He then joined and later led Rimkus Consulting Group, Inc., a forensic consulting company that performs engineering and business assessments concerning accidents, injuries and structural and mechanical failures.

The Culbersons established the S. Frank and Doris Culberson Academic Enhancement Fund to fund student scholarships and have endowed two professorships in CBE.

Culberson is a past president of the NC State Engineering Foundation and served four years as director of the NC State Achieve! fundraising campaign. He is now the College's chairman for the University's current Think and Do the Extraordinary campaign, which aims to raise $1.6 billion for the NC State endowment.

The Siler City, NC, native identified a need to help the College raise the funds necessary to complete EB Oval early on. The College has pledged to raise $60 million in private money to help fund construction of the building, which will be the new home of the Department of Civil, Construction, and Environmental Engineering (CCEE) and the Edward P. Fitts Department of Industrial and Systems Engineering.

As a member and later president of the Engineering Foundation Board of Directors, Culberson made several visits to the College's nine academic departments. He was struck by comparing Mann Hall, built in 1964 and the current home for CCEE, to the College's three engineering buildings on Centennial Campus.

"You can't believe the contrast between Mann and the kind of buildings you have on Centennial," he said. "The facilities are amazing over there."

Moving more of the College to Centennial will bring tremendous benefits, Culberson said, including in recruiting students and faculty members. Having the entire College together, instead of split on two campuses, will make it even stronger.

Culberson, a 2002 Distinguished Engineering Alumnus, entered what he refers to as semi-retirement from his most recent position with Rimkus as chairman of the board on July 31, 2017.

On a recent weekday morning, Frank Culberson was on a golfing trip in Pittsburgh. But his work helping the College was never far from his mind.

During a conversation about his commitment to the EB Oval project, he mentioned how much he enjoys going with members of the Engineering Foundation staff to visit alumni in the Dallas and Houston areas.

He had with him a list of people to call to talk about the campaign for EB Oval.

"They've given me four so far," he said. "I'm sure they'll give me more."▪

Praxair continues to be a **champion for the College**

STUDENTS AT TASTE OF ENGINEERING

Each year, the Taste of Engineering program ties engineering disciplines to food. It gives undecided female first-year students and others a chance to learn about the College's academic departments and to network with fellow students and faculty members.

And each year, Dr. Laura Bottomley, director of the Women in Engineering (WIE) program that hosts the event, works with the College's development staff to find private funding to pay for it.

"Sometimes I was just going on faith that I was going to get the money," Bottomley said.

WIE and the College's Minority Engineering Programs (MEP) rely on donations from alumni and businesses for support, as well as writing proposals and applying for grants. They have no bigger champion than **PRAXAIR**, one of the world's leading industrial gas producers and a proud sponsor of NC State since 2013.

Praxair and NC State have collaborated on sustainability efforts, graduate research symposiums and Ph.D. recruitment weekends, as well as scholarship funding.

The company and the College share a strategic commitment to providing educational opportunities for future STEM generations to address the growing need for available talent in these fields. Additionally, they both recognize the importance of recruiting and retaining women and minorities in the field of engineering.

> "EB Oval will provide an outstanding academic environment designed to help students prepare for successful careers in STEM-related fields."
>
> **LISA ESNEAULT**

Now, Praxair is sponsoring a student innovation lounge that will be located on the second floor of the new Engineering Building Oval and is broadening its support of both WIE and MEP.

"EB Oval will provide an outstanding academic environment designed to help students prepare for successful careers in STEM-related fields," said Lisa Esneault, vice president of communications and head of Praxair's Global Giving Program. "Praxair chose the innovation lounge because technology and innovation play a leading role at our company and within the field of engineering."

WIE and MEP work closely with Praxair's university relations department. MEP Director Angelitha Daniel said the team is always quick to help with the programs' needs.

Tragically, two students involved in MEP committed suicide in 2016. Thanks to funding from Praxair, Daniel was able to take students in the program on a midyear motivational retreat to take a break and learn ways to cope with stress. Daniel has another retreat planned for 2018.

Praxair supports WIE's Escape summer bridge program and MEP's Summer Transition Program. The programs bring female and minority first-year students to campus before the fall semester begins to network and get a head start on their academic careers.

"As one of our target schools, our relationship with NC State continues to be a bright spot for Praxair," Esneault said. "We are honored to be a source of support for these talented students. One of the greatest rewards for us is networking with them, and we are continually impressed by their high quality and enthusiasm to learn."

In addition to Praxair's contributions, Steve Angel, its chairman and CEO and a 1977 NC State civil engineering alumnus, has remained closely involved with his alma mater and continues to give back to the College through the Angel Family Foundation. ▪

Father and daughter help bring **STEM support** to North Carolina school

STEVENS, LEFT, AND COFFEY

A gift from a father-daughter team of NC State graduates is providing opportunities in science, technology, engineering and math (STEM) to a North Carolina elementary school.

TOM COFFEY is a 1963 civil engineering construction option graduate of NC State. His daughter **SUSANNA STEVENS** graduated from NC State in 1989 with a degree in economics and finance and lives in Wilmington, NC.

Stevens became connected with Amy Oots, principal at Mary C. Williams Elementary School in Wilmington and a fellow NC State graduate.

"Many of Amy's children are in families that haven't gone to college," Stevens said.

The student population at Williams is more than half Hispanic. Most of those students only hear English at school so language proficiency is a big focus of the school's curriculum.

"The students had not really had any exposure in engineering because there are only 7.5 hours in a school day and our focus is on language," Oots said.

Stevens and Coffey saw an opportunity to provide support for the school that would increase access to STEM curriculum.

That's where Dr. Laura Bottomley came in.

Bottomley leads the College's Women in Engineering program and The Engineering Place, its K-20 engineering education outreach program. With financial support from Coffey and Stevens, Bottomley and a team from The Engineering Place have visited Williams Elementary twice to begin work with teachers on an integrated STEM curriculum that incorporates not just science and math but also social studies and language arts using engineering as a platform.

"It's STEM-plus, if you will," Bottomley said.

The Engineering Place team is developing activities for each grade level that ask students to read, comprehend math, record data, learn about culture and interpret maps.

> "It's STEM-plus, if you will."
>
> **DR. LAURA BOTTOMLEY**

With one first-grade kit, students learn about festivals of lights native to different cultures around the world and are given a string of battery-powered lights to decorate with. The students learn about culture and geography but also engineering as they discover how the lights work.

As Bottomley points out, it's not enough to just hand kits to overworked teachers. To make the project a success, the NC State team needed to develop the curriculum and instructions that go along with it.

It's the first time The Engineering Place has written lesson plans that integrate so many areas. Bottomley hopes the kits can be adapted for other schools across the state.

Stevens, who has worked for North Carolina-based analytics and data firm SAS Institute for 24 years, wants to encourage more young women to seek degrees and careers in STEM.

In thinking about a way to give back, she hoped to encourage her alma mater to do more to support the people of North Carolina.

Coffey, who has endowed scholarships for the men's and women's golf teams at NC State and for civil engineering students at the undergraduate and graduate levels, saw another opportunity to make a difference.

"These types of programs that get young people involved in technical areas excite me," he said. "It's where they need to be into the future."▪

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

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

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

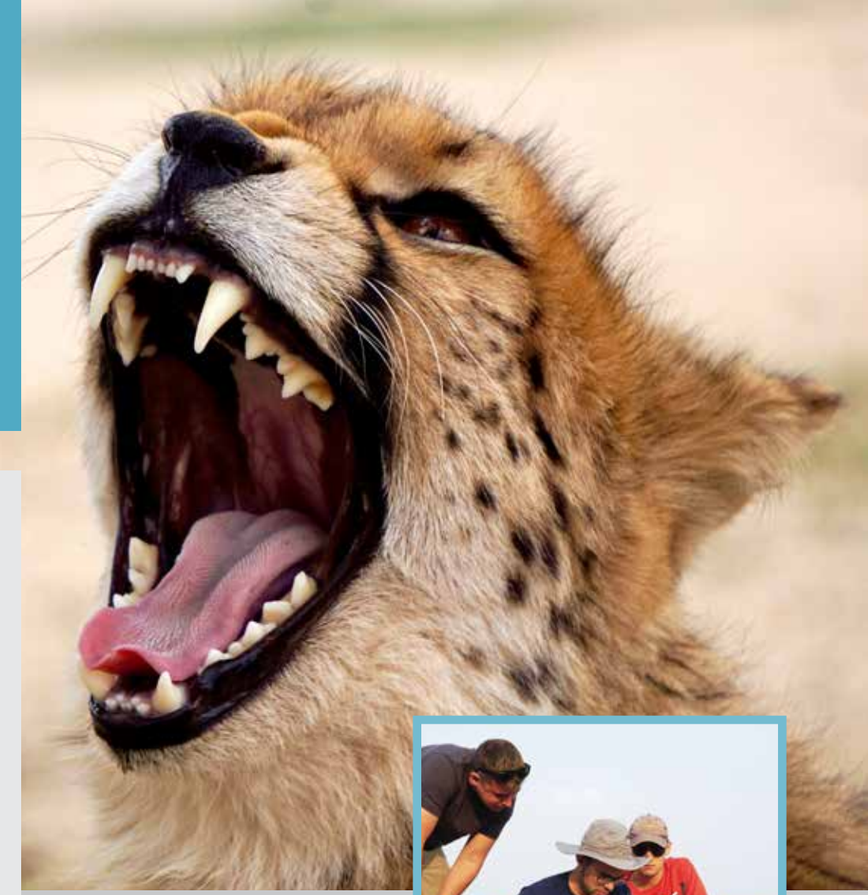
Planned Giving: Planned gifts can be as simple as a bequest (including us in your estate plans). Other options include trust vehicles and annuities, which have the potential to provide an income stream and significant tax benefits.

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

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

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

THE DRONES OF **NAMIBIA**



A NEW STUDY-ABROAD PROGRAM within the College gives students a chance to further their knowledge of unmanned aerial vehicle (UAV) technology while helping to protect some of the world's most majestic animals.

Dr. Larry Silverberg, professor in the Department of Mechanical and Aerospace Engineering, founded the Namibia Wildlife Aerial Observatory (WAO) Project to help protect rhinos, elephants, giraffes and other large African wildlife species using emerging aerial technologies. UAVs can help rangers in African conservation parks keep an eye on poachers, and they can be used to assess erosion damage to riverbeds, monitor controlled burns, keep an accurate census of park animals and survey land.

And aerial video footage and still photographs taken on the African plains can be used to help tell the story of conservation efforts and the uphill battle these efforts face.

NC State is working with three Namibian partners: Naankuse, a private wildlife sanctuary; the Namibia Ministry of Environment and Tourism, which manages the country's national parks; and the Namibia University of Science and Technology.

Much of the groundwork for the Namibia WAO Project will be performed by field units of eight to 12 undergraduate students, predominantly engineering and wildlife majors, who will spend a fall semester in Namibia as part of the study-abroad experience. Each field unit, under the on-site direction of a pair of trained graduate students, works on both a technical objective and a wildlife mission.

During the project's initial visit to Namibia, in fall 2017, a field unit of 10 undergraduate students studied the reactions of animal wildlife to UAVs. This information will inform how the WAO system will be deployed.

In coming years, the teams will assess vertical takeoff and landing UAVs that fly longer and quieter, and test autonomous battery exchange stations and wireless networks that more efficiently stream data into the cloud.

In 2018, the program is being opened to students and instructors from Europe and other countries, Silverberg said.

The program revolves around the desire of students to tackle a global problem and gain practical experience in solving on-the-ground problems, all while making progress toward their degrees.

"The project exemplifies the best aspects of the research community as a whole, of NC State's research community in particular and the power of our students," Silverberg said. "It shows how global partners can come together and help solve an important, real-world problem." ▪

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JOIN THE CLUBS

Donors who support the College's **Engineering Building Oval project** receive recognition and exclusive benefits as part of their important gift. To learn more about how you can support EB Oval and about membership in these groups, contact Lora Bremer, executive director of major gifts and campaign planning with the NC State Engineering Foundation, at **919.513.0983** or **lora_bremer@ncsu.edu**.

CORNERSTONE SOCIETY

For gifts beginning at $100,000

As a member of this exclusive society, you will have your name permanently associated with the space of your choosing, and your gift will be recognized in a central location in EB Oval along with a special recognition biography and photo. In addition, as a Cornerstone Society member, you will receive regular insider updates on the construction and information on the research and education that EB Oval will house and will be invited to exclusive events, including the groundbreaking ceremony, hard hat tours of the space and the dedication of the new building.

DEAN'S EB OVAL CLUB

For gifts of $50,000 to $100,000

Your gift gives you the honor of membership in this exclusive group of visionaries. As a member of the Dean's EB Oval Club, you will receive permanent recognition with a donor profile in a central location in EB Oval and regular insider updates about the progress of the construction and information about the education and research that will be conducted in the classrooms and labs. Club members are also invited to exclusive events, including the groundbreaking ceremony, hard hat tours of the space and the dedication of the new building.

DEAN'S YOUNG ALUMNI OVAL CLUB

For gifts of $25,000 over five years by young alumni up to 15 years after graduation

Young alumni who are members of the Dean's Young Alumni Oval Club will receive permanent recognition with a donor profile in a central location in EB Oval and regular insider updates about the progress of the construction. Members also receive insider information about the education and research that will be conducted in the classrooms and labs. Club members will be invited to exclusive events, including the groundbreaking ceremony, hard hat tours of the space and the dedication of the new building.