NC STATE Engineering

SPRING/SUMMER **2015**

BUILDING A COMMUNITY

The College has made great strides in attracting female students | 16

FROM THREE TO THOUSANDS

The number of female students enrolled in the College of Engineering has grown steadily from very humble beginnings.

More than a decade after Katharine Stinson became the first woman to graduate with an NC State engineering degree in 1941, the 1953-54 academic year saw only three female students.

In this photo, Jane Asbill Land of York, SC (seated); Emily Brown of Wilmington, NC (left); and Mary Ellen Short of Brevard (right), inspect an electron microscope used in chemical engineering research.

Brown graduated in 1954, becoming the first woman to earn a B.S. in civil engineering from the university and the first woman to be registered as a professional engineer in North Carolina.

Check page 16 to learn more about today's NC State female engineering students and about this year's freshman engineering class, which is nearly 25 percent female.

Q&A

QUESTIONS FOR **ALICE FORGETY**

Alice Forgety is the College's director of recruiting, enrollment management and educational partnerships. She talks about efforts to bring the best students to NC State's College of Engineering.

How much success are we having recruiting top high school seniors to the College?
We're having great success. The credentials of the incoming engineering freshmen keep getting better and better. NC State is on the map now. People are becoming much more aware of NC State's excellence, and they want to be a part of it.

What are your most successful recruiting tools?
The Friday engineering information sessions and tours of Centennial Campus have been extremely popular at attracting prospective students from all across the country. Also, our Engineering Open House has always been a big draw. Both events are easy ways for visitors to spend a few hours and learn a great deal about NC State engineering.

You've worked as a software designer and taught in the College. What made you want to get into recruiting?
When I came to NC State, I was an older student and had worked in other professions. Getting a degree in electrical engineering changed my life and afforded me opportunities I would have never had. I made the move into recruiting because I want to help change lives and give young engineers the opportunities I was given.

What does the College do to recruit female students and students from underrepresented minority groups?
Along with our usual recruiting events, we have special events for women and underrepresented groups. In the fall we have a recruiting day for prospective women and underrepresented students to encourage them to apply. In the spring we follow up with a more in-depth visitation day for accepted Women in Science & Engineering and minority students. We want all students to know that we highly value them. We believe that a diverse population is a richer population for everyone.

Which engineering schools are we most often competing with for students?
Virginia Tech, Georgia Tech, Clemson, University of Maryland and Purdue.

What are some things high school seniors are looking for in a university that might come as a surprise?
Today's students are looking for ways they can make a positive impact on the world. They're looking not only for great academics, but also to be a part of service projects, study abroad and internships. NC State engineering students can do all of those things and still graduate in four years. Moreover, they'll be better engineers for having taken part in all of it.

What's your 30-second NC State Engineering pitch?
NC State is not only a great value, but our College of Engineering is also highly ranked in all 18 of its majors. If you choose NC State engineering, you'll get an excellent education, be able to take part in the best career development anywhere and upon graduation (if not sooner) be extremely marketable. Professionally you'll be well prepared to help solve many of the challenges of the 21st century and in so doing, make the world a better place. ▪

FROM THE DEAN

Louis A. Martin-Vega

Assuring that the "E" in "Engineering" stands for "Excitement" is a daily commitment and top priority in our College of Engineering. This requires state-of-the-art classrooms and innovative learning environments for our students and cutting-edge labs and infrastructure to facilitate and enhance the groundbreaking research conducted by our outstanding faculty and students.

For many years we have been able to provide an outstanding educational experience at one of the lowest prices of any premier, research-extensive engineering college. This has been due primarily to the significant support provided to higher education by the state; however, this dynamic in North Carolina, as in many other states, is changing. These changes have required us, as well as many of our peers, to explore additional sources of revenue to maintain and enhance both the high quality and reputation of the College. One of these additional sources of revenue is the recently approved increase in our engineering enhancement fee. While our increased fee remains lower than engineering fees at almost all of our peer institutions, it will provide much needed support for the education of our students, the support of our faculty and the enhancement of our infrastructure and research environment. The fee will also support the creation of new, highly innovative educational experiences for all our students, allowing us to continue providing a top tier education to our students. Other sources of revenue include increases in federal awards and grants as well as private sector contributions that directly support the growth and development of our college. All of these efforts are required to assure that, at the very least, we are able to compete effectively with the many significant investments that are being made in peer engineering colleges nationwide.

In this spring issue, you will learn about the impact your college has both here and abroad with work that is helping grow the renewable energy economy in North Carolina and improving health and living conditions in the developing world. You will also meet researchers who are using daisies, cocoons and flying carpets to target cancer cells and using 3D printing to improve cochlear implant surgery. We are strongly committed to continuing to be a cradle for some of the most innovative and unique research in the world and look forward to sharing with you the "Excitement" created by a leading college of engineering such as ours.

Please receive my sincere thanks, as always, for your strong support of our many exciting endeavors as we continue to move forward to "engineer a better tomorrow" for each of the citizens of our state and nation. I also hope that you will continue to support our efforts as we strive to make you even prouder of this college that will be always your home.

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

Justice named to lead PowerAmerica

Retired U.S. Army Major General Nick Justice is the new executive director of PowerAmerica, the NC State-led Department of Energy center tasked with furthering the development of wide bandgap semiconductors. He succeeds Dennis Kekas, associate vice chancellor of the Centennial Campus Partnership Office, who had served as interim director since January 2014.

Justice comes to NC State with a 41-year career in the Army. In 2012, he retired as commanding general of RDECOM — the Army Research, Development and Engineering Command.

During his career, he previously led the Program Executive Office Command, Control and Communications Tactical at Fort Monmouth, New Jersey.

This is not Justice's first experience with the College. In 2010, he presented Dr. Michael Steer, Lampe Distinguished Professor of Electrical and Computer Engineering, with the U.S. Army Commander's award for Public Service. Steer's research helped American forces remotely counter roadside bombs — efforts that have helped save hundreds of soldiers' lives in Iraq and Afghanistan.

PowerAmerica will unite university and industry partners to build a new advanced manufacturing sector. The goal is to revolutionize energy efficiency across a wide range of applications including electronic devices, power grids and electric vehicles.

The College has been a leader in research on wide bandgap semiconductors since the early 1980s and will play a prominent role in the new center, which will be housed on Centennial Campus. ▪

The future of engineering education and research

The National Science Foundation (NSF) sees engineering education and research as two of the key building blocks in creating a sustainable and prosperous future. The goal of NSF's Engineering Research Center (ERC) Program is to combine discovery and technological innovation in engineering research and education to create advanced technology and produce graduates who will be creative innovators.

NC State has the distinction of leading two ERCs: the Future Renewable Electric Energy Delivery and Management (FREEDM) Systems Center and the Nanosystems Engineering Research for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST) Center. Both centers have facilities located on Centennial Campus and are paving the way in research and development in energy systems and nanotechnology, respectively.

During a two-day visit in November, Dr. Pramod Khargonekar, NSF's assistant director for engineering, toured the globally recognized James B. Hunt Jr. Library, spoke at a special seminar and received a personal tour of the ASSIST Center and the FREEDM Systems Center.

"I am excited to learn more about the kind of research they are doing," Khargonekar said during the visit. "I hope to meet some of the faculty involved and students as well. I just expect to learn a lot about what's going on here and get a hands-on feel for what NSF is sponsoring."

After touring the ASSIST and FREEDM facilities and Hunt Library and meeting with deans and department heads, Khargonekar delivered a talk on what NSF sees as the most important opportunities and challenges in engineering education and research.

"There are two parts to my visit," Khargonekar stated. "One is to share with the community here what we see as important issues that NSF is trying to address. We want to share our vision. We want to share what it is that we are seeking to achieve from an NSF point of view."

Khargonekar addressed the growing importance of nanotechnology in relation to the biomedical frontier and the role of the Internet in energy and production, among other important research issues.

He remarked, "(The Internet) is the factory of the future. We are on the cusp of a fourth industrial revolution because of the integration of cyber advancements."

But he did not see his visit exclusively as an opportunity to address the issues that are important to NSF.

"At the same time, we want to learn from the community of scholars here as to what they see as the most exciting research opportunities in the field of engineering. So it's a two-way dialogue where I hope to pick the brains of the best and brightest at NC State and at the same time communicate to them the larger picture from the National Science Foundation of what we see as the future."

This two-way discussion is vital to addressing what Khargonekar sees as an important issue: improving the public's understanding of science and technology in general. Students and researchers in science and technology must communicate with policy makers and the public on their level. This will create more opportunities for sufficient funding and support for these vital areas, he said.

"(This is) a very fine college of engineering and a great research university," Khargonekar said. "There is already great interaction with the community. I think the world is full of opportunities and challenges. And I think Lincoln said it best, 'The best way to predict the future is to create it.'" ▪

Airbus makes a "big" donation

Most "big" donations to the College involve five, six or even seven figures.

A recent big donation measured 28 feet long and weighed 209 pounds.

On Jan. 13, the Department of Mechanical and Aerospace Engineering (MAE) received an elevator from one of Airbus Americas' A330 commercial jets. The elevator, which controls the position of the nose of the aircraft and the angle of attack of the wing, was damaged and the company chose to donate it rather than make a repair.

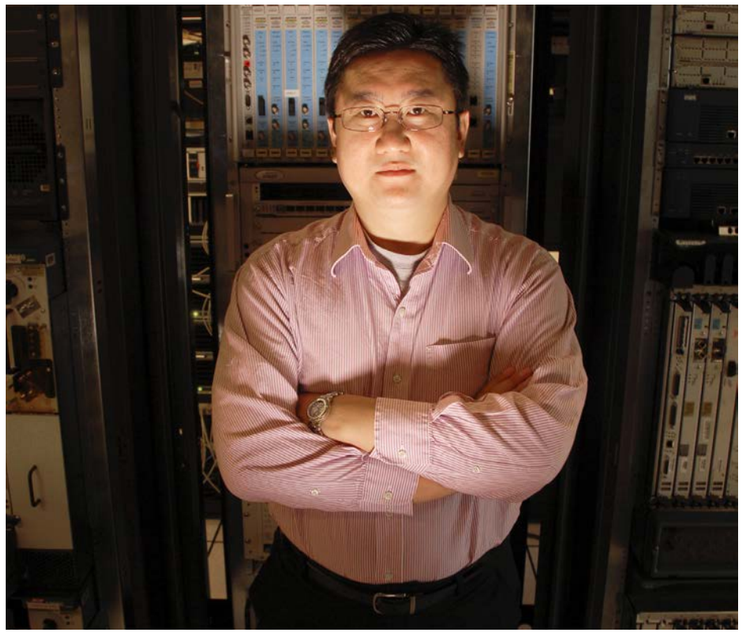
"Airbus is proud to donate this A330 elevator to North Carolina State University's Department of Mechanical and Aerospace Engineering," said Barry Eccleston, president of Airbus Americas. "Our partnership with NC State is an investment in our future and in the future of the aerospace industry in North Carolina."

The piece is valued at $750,000, if repaired. For NC State engineering students, it offers a look at the large scale and complexity in modern airframe components that can be achieved in aerospace manufacturing today through the use of composite materials, said Dr. Kara Peters, MAE professor and the primary faculty member who will be working with the elevator.

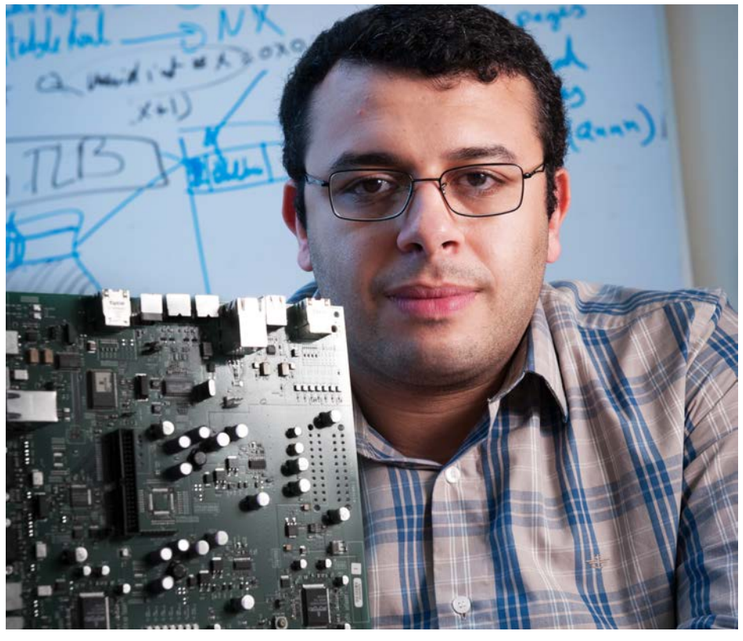
The elevator's new home is a research lab in Engineering Building III on Centennial Campus.

"We are extremely grateful to Airbus for their generous donation to the MAE department," said Dr. Richard Gould, R.J. Reynolds Professor and head of the MAE department. "These types of industry/academia partnerships provide our students important real-world exposure and experiences." ▪

Building a safer smartphone



DR. PENG NING



DR. AHMED AZAB

With so many businesses and individuals using smart phones and tablets to conduct important and often private business, security is a primary concern for manufacturers like Samsung. Researchers in the Department of Computer Science developed security technology called TIMA — or TrustZone Integrity Measurement Architecture.

TIMA was recently sub-licensed to Samsung through CellSentry, Inc., an NC State start-up supported by the university's Office of Technology Transfer. The TIMA technology is now one of the core security components for Samsung's Knox platform, which is installed in the company's tablets and mobile phones.

Security software — like the Linux kernel for Samsung — in tablets and phones can be bypassed. When this happens, other security mechanisms such as Security Enhancements for Android can be disabled. TIMA was developed to overcome this vulnerability by incorporating security features with continuous monitoring that is well isolated and protected by hardware-based mechanisms. This makes it difficult, if not impossible, to bypass.

"Embedding TIMA security into mobile devices is a shining example of how NC State faculty and students work with industry to translate research into real world value and impact," says Dennis Kekas, associate vice-chancellor for NC State partnerships and director of the Institute for Next Generation Information Technology Systems (ITng).

The TIMA technology is based on research led by Dr. Ahmed Azab, a former senior research associate in the Department of Computer Science, and Dr. Peng Ning, a professor in the department. The research was partially funded by the National Science Foundation and the U.S. Army Research Office through the Secure Open Systems Initiative based at ITng. ▪

'Biobots' to the rescue

In the wake of a hurricane, earthquake, or any kind of public health disaster, the top priority is immediate and effective emergency response. What if moths could be used as part of an emergency response system to identify survivors and aid in search and rescue operations?

Researchers in the College are one step closer to developing a 'cyborg moth biobot' that could be used during a disaster. Dr. Alper Bozkurt, an assistant professor of electrical and computer engineering, published a paper detailing a new technique he developed for electronically controlling the flight muscles of moths and monitoring the electrical signals moths use to control those muscles.

"In the big picture, we want to know whether we can control the movement of moths for use in applications such as search and rescue operations," Bozkurt said. "The idea would be to attach sensors to moths in order to create a flexible, aerial sensor network that can identify survivors or public health hazards in the wake of a disaster."

The technique developed through Bozkurt's research involves attaching electrodes to a moth when it is still a caterpillar in the cocoon undergoing the transformation into the winged adult stage of its life. This technique, along with new findings from Bozkurt's research team, allows for a better understanding of how a moth coordinates its muscle movements during flight.

While there is still a lot of work to be done before the development of an operational biobot, Bozkurt and his team are optimistic that this new information will lead to technology that can remotely control the movement of moths while in flight.

"That's essential to the overarching goal of creating biobots that can be part of a cyberphysical sensor network," Bozkurt says.

The research was funded through a grant from the National Science Foundation. A paper on the work was co-authored by Alexander Verderber and Michael McKnight, Ph.D. students in Bozkurt's lab. ▪

NC State engineer helps light up Amsterdam's 'Rainbow Station'

Dr. Michael Escuti, associate professor in the Department of Electrical and Computer Engineering, has been instrumental in creating the newest art installation at Amsterdam Central train station. The "Rainbow Station" project was created by artist Daan Roosegaarde in celebration of the 125th anniversary of the station's opening, and it serves to kick off UNESCO's International Year of Light 2015. The piece is a vibrant rainbow projected onto the large arch that spans above the station's platforms, and it was made possible by a "spectral filter" Escuti developed.

Escuti, in collaboration with ImagineOptix Corp., the company he founded to pioneer patterned liquid crystal optic technologies, adapted the spectral filter specifically for this project. The filter is based on a technology called geometric phase holograms, and works by taking in bright white light and turning it into a rainbow by dispersing the colors in a precise and controlled way.

"They wanted a rainbow pattern with a specific arched profile and dispersion of colors without leaked light blinding a passersby — which was determined to be impossible with existing technology. So we had to make something new," says Escuti, who also directs the Opto-Electronics and Lightwave Engineering Group at NC State.

In order to meet Roosegaarde's artistic vision, Escuti and his ImagineOptix team relied on their line of geometric phase holograms, thin films of liquid crystal that control the angle and color dispersion of lightwaves. Escuti and his team developed a modified polarization grating, in which the pattern of vertical, parallel lines normally found in a polarization grating was modified in the form of concentric circles. This geometric phase hologram directs the light in order to create the characteristic arch of a rainbow.

Escuti's technology not only limited light leakage — with 99 percent of the projected light going directly into the rainbow — but it allowed for a wide dispersion of the rich, saturated colors that Roosegaarde wanted for the project.

"We achieved a wide dispersion of clear, crisp colors by incorporating specific design characteristics into the geometric phase hologram," says Escuti. "Specifically, we used a two-dimensional pattern with a feature size of 1.5 microns, meaning the concentric rings are 1.5 microns apart. This really separates the different wavelengths of light, making them more distinct. One of the tools we used to create these features, a direct-write laser scanner, is something my students, postdocs and I created at NC State."

Escuti worked with graduate students Leandra Brickson and Kathryn Hornburg and postdoctoral scholar Jihwan Kim to create a "master" of the geometric phase hologram after the design work was completed at ImagineOptix. Then, ImagineOptix replicated the master, another unique process created at NC State, and created the final version for use at the Amsterdam Central station. ▪

New director leads Engineering Village

Chester Miller is the new director of the Engineering Village, a unique program designed to purposefully expand the First-Year Engineering program experience. The program combines an on-campus living environment with opportunities that support students' engagement in college life and their academic careers.

Miller is responsible for supporting student success by providing direction, strategic planning, learning outcome-based initiatives and workshop planning. He is also responsible for teaching a section of the E101 Introduction to Engineering and Problem Solving course provided for students living in the Village.

The Village continues to encourage student involvement and the development of individual skills necessary to become successful engineers. Students form supportive relationships with peers, solve complex problems by thinking globally and connect their academic and career goals. Since opening last year, the Engineering Village has grown from 95 enrolled students to 210 for the 2014-15 academic year.

Miller brings an extensive background in engineering and student affairs to the director position. He has 12 years of experience working in higher education supporting student development, retention and success. He worked at IBM for seven years as a design and verification engineer and has spent the last seven years working with University Housing at NC State in the apartment communities.

Miller holds a B.S. in electrical engineering from Morgan State University and an M.S. in electrical engineering from Binghamton University. ▪

More miles from a charge

Driving an electric vehicle can be a great alternative to traditional gas-powered versions. But knowing how many miles a battery charge will last worries some drivers and may keep buyers from purchasing an electric vehicle.

"People have a lot of 'range anxiety' in regard to electric vehicles — they're afraid they'll get stuck on the side of the road," says Dr. Mo-Yuen Chow, professor of electrical and computer engineering.

Chow, along with Dr. Habiballah Rahimi-Eichi, a postdoctoral researcher in the Department of Electrical and Computer Engineering, has developed technology that estimates how much farther electric vehicles can drive before needing a charge.

Electric vehicles already have software that can estimate this range, but the technique developed by Chow and Rahimi-Eichi takes a "big-data approach" to improve estimation accuracy. The software takes into account variables such as traffic data, weather, road grade and whether or not the car will be driving on a highway or in the city to come up with a range estimate.

The software also incorporates the performance history of the vehicle and the remaining charge of its battery using a patented "state of charge" technique Chow developed. This technique improves accuracy by incorporating all of these factors into the range estimate.

"This predictive, big-data approach is a significant step forward, reducing the range estimation error to a couple of miles. In some case studies, we were able to get 95 percent range estimation accuracy," says Rahimi-Eichi. ▪

Engineering a quicker trip

The NC State campus covers 2,090 acres, stretching from Central and North campuses to Centennial Campus and Centennial Biomedical Campus. The Wolfline Bus System provides a practical and convenient means of transportation for students, faculty and staff.

But what if a 16-minute bus ride from James B. Hunt Jr. Library on Centennial Campus to D.H. Hill Library on North Campus could be cut down even more?

That's one of the questions NC State engineers Marshall Brain and Dr. Seth Hollar asked themselves. Brain, director of the Engineering Entrepreneurs Program, and Hollar, a teaching assistant professor in the Department of Mechanical and Aerospace Engineering (MAE), decided to launch a project called ecoPRT, "eco" for economical and "PRT" for personal rapid transit, in 2013. ecoPRT is an ultra-light and low-cost transit system featuring autonomous two-person cars that would drive on a guideway railing system.

The cars measure 31" wide and 8' long yet are still large enough to seat two people comfortably, one person and a bike, or even a parent with a stroller. The vehicle would receive directions from the guideway rail in order to "drive" itself. A simple system in the railing would detect obstacles ahead and stop the vehicle to prevent a collision.

According to Brain and Hollar, two of the project's major selling points are low startup costs and space-saving design. That affordability, says Hollar, would make ecoPRT revolutionary in that it would not be reliant on government subsidies.

"The ecoPRT guideway cost is one million dollars per mile, whereas light rail is one hundred million per mile," he said.

Hollar and Brain describe ecoPRT as a multi-disciplinary effort that spans the College of Engineering.

- Undergraduate students from civil, electrical and mechanical engineering contributed to project research. Dr. John Stone's spring 2014 senior design class in the Department of Civil, Construction, and Environmental Engineering was tasked with choosing a technology and completing a limited feasibility study connecting main campus with Centennial.

- Nine mechanical engineering students explored how the system would work and how vehicles could interact at stations and investigated specialized vehicles for disabilities. Initial designs and parts were ordered. During the summer, students Doug Travis and Warren Henry made progress in building the frame. They have welded together the base and attached the wheels and differential and steering and braking actuators. Since then, seven mechanical engineering students have continued to build the vehicle.

- In fall 2013, student Kyle Bond worked on investigating sensor and computer solutions for the vehicle. He was joined by a team of five MAE senior design students who helped further develop the electronics. Since then, three teams made up of 11 students from the Department of Electrical and Computer Engineering senior design class have worked on different subsystems of the vehicle, including vehicle control, navigation and collision detection.

So when might we see an ecoPRT system in action? Brain says the team is focusing on funding first.

"If things go as planned, this first system will connect the Wolf Village dormitories to Dan Allen Drive," he said. "It is a very short system, approximately half a mile long, in order to minimize costs and also keep the entire system inside NC State property to ease the permitting process."

If money were available today, Brain added, the first ecoPRT system could be running in about two years.

Brain and Hollar hope this project will help connect the NC State campus and serve as a template for PRT projects in cities across the country. ▪

THIS ARTIST'S RENDERING IMAGINES AN ECOPRT SYSTEM RUNNING ALONG HILLSBOROUGH STREET NEAR THE D.H. HILL LIBRARY.

College sends NC State coin into space

When the new Orion spacecraft took off on a test flight from Cape Canaveral Air Force Station on Dec. 4, it carried a 3D printed NC State coin.

Dr. Richard Wysk, Dopaco Distinguished Professor in the Edward P. Fitts Department of Industrial and Systems Engineering (ISE), was contacted by Dr. Terri Lomax, former vice chancellor for research innovation and economic development at NC State, about making the coin.

After accepting the challenge of creating a coin for Orion's Exploration Flight Test, Wysk knew that time was of the essence. "Because of the accelerated timetable, we knew using our EBM machines was the best option," Wysk says.

Electron Beam Melting (EBM) machines use a high power electron beam to print metal objects. NC State's ISE department was the first in the world to have an EBM machine.

Two of the department's experts in 3D printing, research assistant professors Dr. Ron Aman and Dr. Tim Horn, took the lead on the project. Using Materialise's Magics software, Aman and Horn were able to create a 3D image of the university seal and use the EBM machine to print the image onto a coin made from titanium alloy, the same kind of alloy used in aerospace and biomedical applications.

"We used a torch to oxidize and change the color of the surface of the coin and then polished the raised surfaces to give the coin a unique look," Aman said.

The coin will be included in a commemorative framed montage that will be presented by the Orion team to NC State in early 2015. ▪

Industrial engineering student is Leader of the Pack

Ashley Taylor Eli, a junior industrial engineering student, won the university's Leader of the Pack Award for 2014.

The Leader of the Pack Program is a leadership and scholarship award that was created in 2002 to recognize students who make outstanding contributions to NC State in the areas of leadership, scholarship and community service.

Eli, of Mansfield, Texas, is also a forward on NC State's women's basketball team. She is the first student athlete to win the award.

She carries a cumulative GPA of 3.638, has two semesters on the Dean's List and appeared in 49 games in her first two seasons on the women's basketball team.

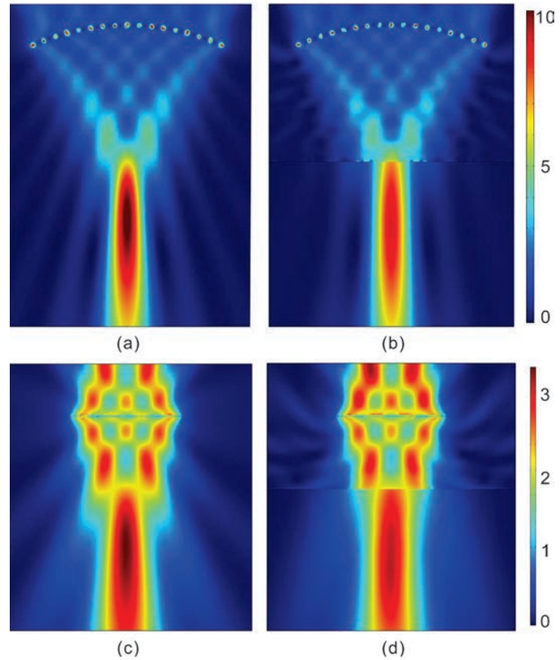
Beyond her academic and sports accomplishments, Eli volunteers as a peer instructor in NC State's MAGIC (Maximizing Academic Growth In College) program, which is designed to help incoming student athletes make a successful and smooth transition to NC State. Topics covered include time management, study skills, critical analysis, life events, confidence and team building and leadership. The program holds scheduled community service projects each week.

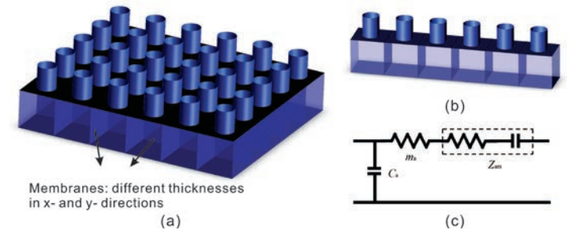
She was recently accepted into the Health Systems Engineering Certificate Program, which is designed to provide students with a learning experience in preparation for a career in the healthcare field, and hopes that it will provide her with the experience necessary to obtain a career in a hospital environment or in the manufacturing of medical equipment.

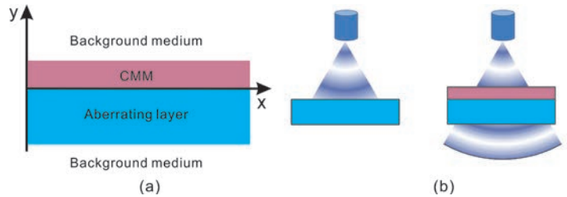
Taufik Raharjo, a materials science and engineering student, and Amanda Casey Dango, a mechanical engineering student, were also finalists for the award.

Eli received a $2,000 university scholarship to be applied to the fall 2015 semester. ▪

ASHLEY TAYLOR ELI RECEIVES THE LEADER OF THE PACK AWARD FROM CHANCELLOR RANDY WOODSON.







Deep impact: New technique allows ultrasound to pass through metal and bone

Ultrasound imaging is one of the most commonly used methods of medical diagnosis and treatment. It works by emitting high frequency audio waves; when these waves bounce off an object, they return to the ultrasound equipment. This equipment then translates the waves into an image. However, certain materials, such as bone or metal, have particular characteristics that block or distort ultrasound waves. The presence of these materials, known as aberrating layers, can decrease the accuracy and effectiveness of ultrasound imaging.

A new technique developed by researchers in the College solves this problem by using customized structures that compensate for the distortion usually caused by aberrating layers.

"In effect, it's as if the aberrating layer isn't even there," says Dr. Yun Jing, an assistant professor of mechanical and aerospace engineering.

In order to address the problem of aberrating layers, the researchers designed customized metamaterial structures that can account for and offset the acoustic properties of the aberrating layer. These metamaterial structures use a series of membranes and small tubes to achieve the desired acoustic characteristics.

This new technique has been tested by the researchers using computer simulations with impressive results. In these simulations, only about 28 percent of sound wave energy makes it past an aberrating layer of bone without the metamaterial structure in place. With the metamaterial structure, however, 88 percent of ultrasound wave energy passes through the aberrating layer.

This technique is a significant development for the use of ultrasound imaging in both medical and industrial settings.

"… (This) will make it easier for medical professionals to use ultrasound imaging for diagnostic or therapeutic applications, such as monitoring blood flow in the brain or to treat brain tumors. This has been difficult in the past because the skull distorts the ultrasound's acoustic field," says Tarry Chen Shen, a Ph.D. student in the Department of Mechanical and Aerospace Engineering and lead author of a paper on the work.

According to Jing, the technique can also be used in industrial settings by allowing for the detection of cracks in airplane wings under the wing's outer layer of metal. ▪

Three from College named AAAS Fellows

DR. NANCY ALLBRITTON

DR. JUSTIN SCHWARTZ

DR. MOHAMMED ZIKRY

Three faculty members in the College have been awarded the distinction of Fellow by the American Association for the Advancement of Science (AAAS).

Dr. Nancy Allbritton is professor and chair of the Joint NC State/UNC Department of Biomedical Engineering; **Dr. Justin Schwartz** is the head of the Department of Materials Science and Engineering and Kobe Steel Distinguished Professor; and **Dr. Mohammed Zikry** is Zan Prevost Smith Distinguished Professor in the Department of Mechanical and Aerospace Engineering.

AAAS elevates members to the rank of Fellow for their efforts toward advancing science applications that are deemed scientifically or socially distinguished.

Founded in 1848, AAAS is the world's largest general scientific society and includes 261 affiliated societies and academies of science serving 10 million people. AAAS is the publisher of the journal *Science*, among other publications, and began awarding the distinction of Fellow in 1874. ▪

DR. GREGORY N. PARSONS

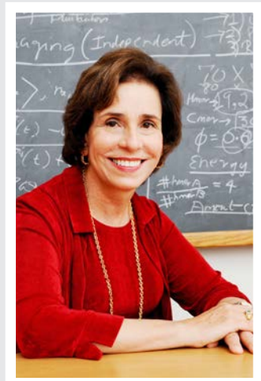
Parsons receives R.J. Reynolds Award

Dr. Gregory N. Parsons, Alcoa Professor of Chemical and Biomolecular Engineering and director of the Nanotechnology Initiative at NC State, was the 30th recipient of the R.J. Reynolds Tobacco Company Award for Excellence in Teaching, Research, and Extension.

This annual award is supported by the R.J. Reynolds Tobacco Company through the NC State Engineering Foundation to recognize scientific and educational achievements in the fields of engineering.

Parsons' work has led to recognition as a world leader in the field of thin film electronic materials and contributor to the basic understanding of new materials and thin film deposition processes. Research applications for his work have been used in fiber-based protective systems for the U.S. Department of Defense, improved performance of photoelectrochemical solar energy conversion systems and new approaches for semiconductor device manufacturing. ▪

Hall wins FOMMS Medal



DR. CAROL HALL

Dr. Carol Hall, the Camille Dreyfus Distinguished University Professor of Chemical and Biomolecular Engineering, has been selected to receive the 2015 Foundations of Molecular Modeling and Simulation (FOMMS) Medal.

Hall is the third recipient of the FOMMS Medal, which has been awarded every three years since it was first given in 2009. She is being recognized for her numerous contributions to the field of molecular theory, modeling and simulation. Hall has been a leader in several research areas, including phase separation in colloidal suspensions and equations of state for alkanes and polymers. She is also at the forefront of simulations–based research efforts to understand the aggregation of proteins of Alzheimer's disease.

A member of the National Academy of Engineering (NAE), Hall is the second NC State engineering faculty member to win the FOMMS Medal. Dr. Keith Gubbins, W.H. Clark Distinguished University Professor in the Department of Chemical and Biomolecular Engineering and fellow NAE member, received the medal in 2009. ▪

DR. JAY NARAYAN AND GOVERNOR PAT MCCRORY

Narayan receives North Carolina Award in Science

Dr. Jay Narayan, John C. C. Fan Family Distinguished Chair Professor of Materials Science and Engineering, was named winner of the 2014 North Carolina Award in Science.

The North Carolina Award is the highest civilian honor bestowed by the state and is awarded to up to nine individuals who are chosen by the North Carolina Awards Committee appointed by the governor and supervised by the North Carolina Department of Cultural Resources. Narayan received the award from Governor Pat McCrory at a special ceremony in November.

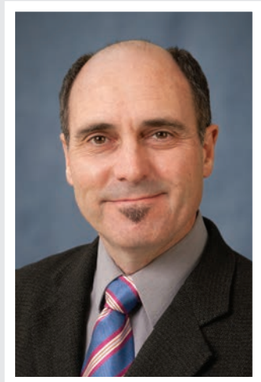
Narayan's research has contributed to the field of materials science, with a focus on domain matching epitaxy, the creation of microelectronics with increased functionality and the development of smart structures and sensors that can be used to detect bioterrorist threats, create smart grid technology and impact national security. ▪

Franzon named Innovator of the Year

The Office of Technology Transfer announced **Dr. Paul Franzon**, Distinguished Professor of Electrical and Computer Engineering, as the 2014 winner of the Innovator of the Year award.

The award recognizes members of the NC State community who work to promote the commercialization of university intellectual property, train future leaders and serve as champions of the university's culture of innovation and entrepreneurship. Franzon was announced as the winner in October during the Office of Technology Transfer's 25th Annual Celebration of Innovation and Entrepreneurship.

Franzon's teaching and research focuses on building microsystems and nanosystems. He specializes in the areas of design and computer aided design of 3D processors, interconnect structures and circuits, cognitive computing, application specific chips, microsystems and emerging devices and architectures. ▪



DR. PAUL FRANZON

BUILDING
a community

The College's First Year class is nearly 25 percent female

The Department of Nuclear Engineering brought hot wings.

At a table nearby, the Department of Biomedical Engineering offered large syringes full of fruit punch. A student in the Department of Chemical and Biomolecular Engineering served smoky punch made with dry ice.

Taste of Engineering, held in January in the Talley Student Center, felt like a party with great food. And it was.

But like all the programs presented by Women in Engineering (WIE) at NC State, Taste of Engineering serves multiple purposes. It makes representatives of the College's academic departments available to female students choosing a major. At the same time, it's an opportunity for female engineering students to meet informally in an inclusive atmosphere.

WIE programs are a large part of a successful effort at NC State to increase the number of female students studying engineering. The Women in Science and Engineering (WISE) Village, a living and learning community for first- and second-year female students in STEM fields, is another.

The 2014-15 first-year engineering class is nearly 25 percent female. That's an increase from 18 percent five years ago and 14 percent 10 years ago.

That number marks NC State as a leader among U.S. engineering schools. This year's First Year class sets the College well ahead of the national average, in which females accounted for 19.1 percent of engineering enrollees in 2013, according to the American Society for Engineering Education.

WIE Director Dr. Laura Bottomley was once speaking with someone about Taste of Engineering and was asked why she chooses to "put on a carnival."

Bottomley says she could organize a very staid event, at which faculty members sit quietly at tables to answer questions from students, a simple table of cookies and punch in one corner of the room. But that wouldn't get the results that she is looking for.

"It is supposed to be almost a carnival-like atmosphere because that breaks down barriers," Bottomley said of the event. "The professors are not intimidating when they are standing there making cotton candy. That's why we do it the way we do it."

Beyond their stated functions of relaying important information and teaching female students new skills, WIE programs encourage them to build a network of friends and mentors. From there, Bottomley says, they build a community, which research shows many females in engineering think is important. "Building a community is not about putting them in a room and telling them to build a community," Bottomley said. "You have to be more subtle."

STARTING WITH AN ESCAPE

The summer before Crystal Mountain began classes at NC State, she received a letter at her home in Austin, Texas. It was an invitation to attend the WIE Escape summer bridge program.

"It was the best experience I could have had," Mountain, an industrial and systems engineering major, said of the camp. Many of the female students who have attended the camp say the same thing.

A group of 50 incoming freshmen spent the week touring local companies like John Deere and ABB and meeting female faculty members from different academic departments. They engineered lip balm, talked to Girl Scouts about engineering and walked the campus looking for examples of engineering in the real world.

In that week, those students built a support system that will carry them through four years of school and beyond. And though they weren't told so specifically, part of their mission was to build that network with other female engineering students.

Marissa Grisham, a senior in industrial and systems engineering from Monroe, NC, attended WIE Escape and has gone on to serve as an Engineering Ambassador and complete a co-op with Eaton Corporation. And she's still studying at 2 a.m. with students she met at the camp.

"Little did I know that the girls I met there, four years later would be my best friends," she said.

Though the numbers are improving, the mix of males and females in most engineering classes on campus can be striking.

Grisham said she and a friend from engineering laughed when they took biology together and were finally in a class with a lot of women. She said that in engineering classes with just a handful of women, it helps to have some familiar faces.

Though female students often gravitate toward each other, WIE is designed to provide more opportunities for that to happen.

When Dr. Anita Vila-Parrish, teaching assistant professor, and Dr. Julie Ivy, associate professor, surveyed senior female students in the Edward P. Fitts Department of Industrial and Systems Engineering (ISE) during their senior design projects, the students told them they wished they had gotten to know each other earlier. The feedback they received is that the students wanted a chance to network with other women in their own department, and Vila-Parrish and Ivy are working to do just that in ISE.

Vila-Parrish says the College has done a lot to serve female students "when they come in the door." A next step could be to form more programs for upper-class females.

Kaelin Saul graduated from NC State with a degree in biological and agricultural engineering and is a graduate student at Kansas State University. She attended WIE Escape camp, participated in other WIE programs and was a resident and later resident advisor in the WISE Village.

"WIE opportunities provide a high level of support that allows women to excel in their fields of study," she said. "Many of the female engineering students I met became close friends and mentors I can rely on today. These experiences also helped me realize that we were all facing similar challenges and we could conquer anything if we stuck together."

CHANGING US INSTEAD OF THEM

When Bottomley took over the College's programs working with female students in 1997, she stopped creating a set of programs for an anonymous group of female students and began creating programs for her female students.

At its core WIE is an effort not to change female students, but to change the university and its culture.

WIE programs are guided by research Bottomley and Kesha Entzminger, associate director of the Women and Minority Engineering Programs, do themselves through surveying students. If a program isn't working, they drop it. If there's a need for a new program, they create one.

WIE once offered a mentoring program, but Bottomley found a lot of students who wanted to mentor and few who wanted to be mentored. Other programs on campus offered mentoring, and if female students make connections, then they will mentor each other informally. So that program ended.

This semester, WIE is trying a new program in which students learn to use laboratory tools like pipettes and soldering irons. High school laboratories aren't teaching the skills as much, yet college professors expect students to arrive on campus knowing them.

The class teaches practical skills but it also gives those female students increased confidence and engineering identity — the sense that they belong in engineering — as they pass on what they have learned to other females and to their male colleagues.

Having a feeling of community fights the imposter syndrome, in which a member of a group that is underrepresented in any endeavor looks around and doesn't see many people who look like her. That might lead to the question "Do I belong here?" It might lead to a lack of confidence or may even make the person leave.

WIE has won several awards recognizing its value for female students and, beyond Bottomley's and Entzminger's salaries, is run entirely with private money.

Students and members of the College's faculty and staff pitch in to make events like Taste of Engineering work.

"It can't be done by a Women in Engineering program, it can't," Bottomley said. "Real change comes when the entire College buys in."

WHY NOT 50 PERCENT?

Mountain said that she could sense a welcoming atmosphere when she was visiting campus and it was part of what guided her decision to choose NC State. Some schools she was considering only had 5 to 10 percent female populations in their engineering student bodies.

While the College puts a lot of effort into specifically recruiting female students, Mountain thinks making a supportive environment for them often sells itself.

Catrina Rateb, a First Year student from Waxhaw, NC, who plans to study biomedical or chemical engineering, found a close-knit community when visiting NC State.

"They focused on you and how you can succeed," she said of her impression of NC State.

Kayla Abrams, a First Year student from Macclesfield, NC, who plans to study chemical engineering, says her parents taught her that she can do whatever she wants to do. The dearth of female students studying engineering hadn't occurred to her until she saw the makeup of her classes at NC State and heard some of the statistics during Escape.

"To me, it didn't matter," she says. "If you want to be an engineer, be an engineer."

Mountain sees no reason why the number of females in engineering can't keep increasing, even to a 50/50 split. When you combine smart, driven female students and a College that supports them, why not?

"The women here want to change the world," she said. "They want to make a difference." ▪

THE WAY **WIE** DO IT

The College's Women in Engineering program has several ways of serving female students

ESCAPE BRIDGE PROGRAM
Fifty incoming students spend a week on campus the summer before their First Year establishing networks and getting started acquiring their engineering identity.

TASTE OF ENGINEERING
All departments in the College bring food or drink related to their major and students visit with faculty and ask questions about the majors, graduate school and employment.

TOOLS WORKSHOP
Students have a chance to learn tools and techniques they may need for labs, such as soldering, pipetting and pipe sizing and cutting.

SOCIETY OF WOMEN ENGINEERS/WOMEN IN COMPUTER SCIENCE/IEEE WOMEN IN ENGINEERING AFFINITY GROUP
Although these student organizations are not sponsored by WIE, the program supports and has partnerships with them.

COMPANY VISITS
Local companies sponsor visits to their locations for students.

ADVISING
Female students have access to the director and associate director for drop-in advising.

RESEARCH
The director is engaged in ongoing research to seek new and better ways to recruit and retain females.

DEPARTMENTAL OUTREACH/PARTNERSHIPS
The director and associate director work with departments and with the College's Office of Academic Affairs to incorporate the results of research.

A NUMBERS GAME

The stats on NC State's First Year engineering students

UNDERREPRESENTED MINORITIES MAKE UP

10.6 PERCENT OF THE FIRST YEAR CLASS

Degrees and Programs

(Intended Majors)

UNDECIDED
354 STUDENTS

INDUSTRIAL AND SYSTEMS ENGINEERING
27 STUDENTS

MECHANICAL AND AEROSPACE ENGINEERING
271 STUDENTS

CHEMICAL AND BIOMOLECULAR ENGINEERING
120 STUDENTS

BIOLOGICAL AND AGRICULTURAL ENGINEERING
17 STUDENTS

MATERIALS SCIENCE AND ENGINEERING
19 STUDENTS

ELECTRICAL AND COMPUTER ENGINEERING
135 STUDENTS

CIVIL, CONSTRUCTION, AND ENVIRONMENTAL ENGINEERING
99 STUDENTS

PAPER SCIENCE AND ENGINEERING
40 STUDENTS

NUCLEAR ENGINEERING
41 STUDENTS

COMPUTER SCIENCE
160 STUDENTS

TEXTILE ENGINEERING
16 STUDENTS

BIOMEDICAL ENGINEERING
166 STUDENTS

212 out-of-state students

1,224 in-state students

From Near and Far

281 STUDENTS **FROM WAKE COUNTY**

133 STUDENTS **FROM MECKLENBURG COUNTY**

86 STUDENTS **FROM GUILFORD COUNTY**

42 STUDENTS **FROM UNION COUNTY**

35 STUDENTS **FROM FORSYTH COUNTY**

29 INTERNATIONAL STUDENTS

Iman Fisher | Born in Long Island, NY, relocated to Charlotte, NC
Intended Major: Chemical Engineering

"At first I wanted to be a doctor, then someone brought up engineering because of my love for genetics. I realized I didn't have to be an MD — I could focus on the research side."

Student organizations
AYA Ambassadors, NSBE, Wise Village

Fun fact
Collects elephant trinkets

Manon MacAllister | Pittsboro, NC
Intended Major: Paper Science & Engineering and Chemical Engineering

"I have always been good at science and math, but I wasn't sold on engineering until the Engineering Orientation I attended as a junior. It showed me an option that was suited to my strengths."

Favorite professor
Dr. Byrd, paper science professor

Fun fact
Has a pet hedgehog named Reggie

Kobi Felton | Born in Illinois, relocated to Qatar, then to Nigeria
Intended Major: Chemical Engineering with a minor in Spanish

"I want to solve problems, and engineering is a way that I can do this. I am interested in research and getting involved in projects that make a difference in our world."

Plans after NC State
Leaning towards a Ph.D.

Fun fact
Has been playing trombone for six years

Alberto Quiroga | Born in Columbia, Md., relocated to Holly Springs, NC
Intended Major: Aerospace Engineering with a minor in Political Science

"I chose engineering because ever since I was young, I loved science, math and aeronautics. The science and physics behind how planes work fascinates me."

Career goal
Dream to be the first Hispanic president

Fun fact
Lived in Mexico for six years

Solar and beyond

NC Clean Energy Technology Center tackles all aspects of clean energy implementation

The Carolina Blue Skies & Green Jobs Initiative put more than 500 alternative-fuel vehicles on the roads in North and South Carolina and funded more than 100 charging stations for those vehicles.

Part of the American Recovery & Re-investment Act, the project led to questions for the NC Clean Energy Technology Center.

Did first responders like firefighters, police officers and EMTs know these kinds of vehicles would be on the roads? Did they know what to do when one was involved in a collision?

"They looked at us like deer in the headlights," said Richard Sapienza, a clean transportation specialist with the Center.

"These guys need to know they have these types of vehicles in their jurisdictions in case there's an accident."

Classes created by the Center looked at a range of alternative-fuel vehicles, from those powered by biodiesel and ethanol, propane and natural gas to all varieties of electric.

Part of the College, the Center has a mission to advance a sustainable energy economy in the state. It does so through training programs, fee-based client services, outreach and work on clean energy policy and economic development.

Founded in 1987 as the North Carolina Solar Center, a name change was made in 2014 to reflect its' work in other clean energy sectors, such as green building, smart grid and energy storage, clean transportation, wind, biomass and more.

ADDING POLICY TO ENGINEERING

When Steve Kalland arrived in 2001, the Solar Center's work was exclusively in solar energy and green building. It was also staffed almost entirely by engineers.

"What we've learned over time is that it's not an engineering question alone, that you really have to figure out policy and financial issues to go with the engineering piece in order to get anything done in the world of energy," said Kalland, the Center's director since 2007.

Renewable energy technology use is constantly expanding, and it's important for the Center to keep up with that technology and help train people across the state on how to use it. But just as important is helping to navigate the policy roadblocks that can stand in the way of building a renewable energy economy.

In recent years, that has meant working with the North Carolina Sustainable Energy Association, the North Carolina League of Municipalities, the North Carolina Farm Bureau and others to craft a model ordinance for county and municipal governments being asked to permit solar energy farms. Local code inspectors had no experience with solar farms, so the Center also developed training programs for them.

A few years earlier, the Center worked with the state utilities commission, electric utilities and the clean energy industry to create standardized procedures for the interconnection of different kinds of energy systems. The state previously had no set standards, causing uncertainty and impeding development of new systems. The Center worked to give companies and consumers a clear map for how to "hook up" to the grid.

Along with attacking these kinds of specific barriers faced by the clean energy industry, the Center's extensive activities include efforts to grow and train the state's cleantech workforce. Programs include 40-hour workforce development classes, conferences, webinars and industry training shows. The non-degree Renewable Energy Technology Diploma Series gives participants an in-depth understanding of renewable energy technologies and residential green building standards. The Certificate in Renewable Energy Management goes beyond the technical side to help participants look at the policy and financial aspects of managing a clean energy project.

The Center's policy analysts also maintain the Database of State Incentives for Renewables and Efficiency (DSIRE). Funded by the U.S. Department of Energy and run by the Center, DSIRE is the most comprehensive source of information on incentives and policies that support renewables and energy efficiency in the United States. It is a nationally respected resource that gives the Center's staff an up-close view of the policies around the country that work and don't work, making the Center a valued advisor on clean energy markets nationwide.

FILLING IN THE HOLES

An industry advisory board helps the Center stay on top of which technologies and energy sources are important and what industry needs to succeed in making projects work.

Kalland describes a constant ebb and flow in technologies. A few years ago, the Center started a crops development program for biofuel feed stocks. When the College of Agricultural and Life Sciences at NC State and others got more involved in biofuels, the Center turned its attention to something else.

One of the organization's roles, Kalland said, is to look at the markets for new technologies and work to eliminate barriers. Then do it again.

"We tend to fill the holes in the marketplace that need to be addressed, but that no one is focused on — usually because they can't build a business plan around it. But, when somebody else is able to build a business plan or the university has the right people to pick up that baton, there are plenty of things for us to focus on so we move to other areas," he said.

Kalland believes the establishment of the Solar Center in the 1980s is one of the reasons North Carolina remains a leader in solar. As the Center has expanded beyond solar, so has North Carolina. It's the only state in the Southeast with a Renewable Energy Portfolio Standard and is ranked fifth in the United States for clean energy development and second for solar capacity.

So while solar is still a focus, the Center is heavily involved in clean transportation along with smart grid technology and energy storage, which are important next steps toward integrating renewable sources into the national grid.

The College is the lead on the National Science Foundation FREEDM Systems Center, which is creating the next generation power grid. Not coincidentally, the area is home to the Research Triangle Cleantech Cluster, the largest smart grid industry cluster in the country.

As the state's clean energy economy continues to grow, the NC Clean Energy Technology Center will continue to lead the way forward. ▪

GLOBAL REACH

Engineering faculty members, students make a difference in the developing world

The World Health Organization's Millennium Development Goals set lofty, laudable targets.

Eradicate extreme poverty and hunger. Reduce child mortality. Improve maternal health. Combat HIV/AIDS, malaria and other diseases. Significant progress has been made.

Worldwide, the number of deaths of children under the age of 5 fell from 12.6 million in 1990 to 6.6 million in 2012. In developing countries, the percentage of underweight children under 5 years of age dropped from 25 percent in 1990 to 15 percent in 2012. Globally, new HIV infections declined by 33 percent between 2001 and 2012.

There is more to do, though. Tackling these important problems takes the work of engineers, and NC State engineering faculty members and students are doing their part.

From providing adequate sanitation for millions, to ensuring babies in rural areas can be treated for jaundice and figuring out ways for people in impoverished areas to prepare food without sacrificing health, NC State engineers are embracing the university's Think and Do attitude to solve problems in the developing world.

THE HUMAN RIGHT THAT NO ONE TALKS ABOUT

Celebrities often lend a hand to raise awareness about global health issues like access to clean water or HIV/AIDS prevention.

Talking about how we defecate, though, can be a different story, according to Dr. Francis de los Reyes, professor in the Department of Civil, Construction, and Environmental Engineering (CCEE) and University Faculty Scholar.

"The reality is the sanitation side has not gotten the same exposure, the same push into the public consciousness," de los Reyes said.

Access to adequate sanitation is a basic human right, de los Reyes says, but not a comfortable one to discuss.

The UN estimates that 2.5 billion people — a third of the global population — lack access to adequate sanitation like toilets or latrines. Of those, about 1 billion defecate in the open.

Open defecation is a huge environmental issue in developing countries and leads to a host of human health problems, including preventable diarrheal diseases that the UN estimates kill a child every 2 ½ minutes.

"If you're living in fecal matter, you're going to get sick," de los Reyes said.

As part of the post-2015 Sustainable Development Goals, the UN has called for an end to open defecation by 2030.

The UN defines adequate sanitation as access to a pit latrine on a concrete slab — a setup that provides separation between the waste and user.

Too often, the pits fill up and people begin to defecate on the floor or on the ground outside. Emptying the pits is a dirty, dangerous and undignified job that often requires crawling inside with no protective clothing or equipment.

Graduate student Tate Rogers and de los Reyes developed the Pit Excrevator, an auger that can empty a pit from the surface. The project has undergone tests in the field and is undergoing further development.

De los Reyes envisions an open source model that would allow the technology to be used by people who want to turn pit emptying into a business.

Solving the sanitation issue will be complex. Simply spending billions of dollars to install Western-style flush toilets in the developing world simply isn't feasible. There isn't enough money. Or water.

DR. ANDREW GRIESHOP WORKS WITH STUDENTS IN THE LAB.

AN NC STATE ENGINEERS WITHOUT BORDERS STUDENT WORKS TO ASSEMBLE A GUTTER TO A ROOF DURING A PROJECT IN BOLIVIA.

The solutions go beyond technology, and include cultural and policy components.

"We've got to rethink sanitation," de los Reyes argues. "We've got to reinvent the sanitation infrastructure."

OPENING ACCESS TO JAUNDICE TREATMENT

For their senior design project, biomedical engineering students Amber Buckalew, Lauren Chisholm, Taylor Cook, Spencer Lacy and Andy Taylor spent time in the neonatal intensive care unit at WakeMed Health & Hospitals in Raleigh. They were looking for a project with a global focus.

They found one watching the hospital staff use a phototherapy system — a machine that costs several thousands of dollars — to treat jaundice in newborns.

How, the team wondered, could that same therapy be made available to infants in poor, remote areas around the world? Their project, dubbed NeoTech Global, is developing a much more affordable version that takes advantage of natural sunlight.

Dr. Andrew DiMeo, associate professor of the practice in the Joint NC State/UNC Department of Biomedical Engineering, challenges his senior design students to find a problem and try to solve it.

His teams have taken on global health projects, including work to develop a low-cost source of hospital-grade oxygen, an early detection system for pediatric respiratory distress and a baby bottle that denatured HIV and other pathogens from human mother's milk while retaining the benefits of breastfeeding.

NeoTech Global's design uses UV filters to give infants the light therapy they need without the risk of sunburn. The team had to take cultural compliance, cost and ease of use into account during the process. Making sure that the mother can remain in close contact during the treatment is also important.

A doctor in the town of Flores, Guatemala, has offered to test a prototype with infants in his hospital this spring.

A CLUB THAT WORKS

Members of the NC State student chapter of Engineers Without Borders (EWB) are working in Bolivia and Sierra Leone to provide access to clean water and renewable energy.

EWB work starts with communities around the world identifying a need for engineering skills to help complete projects that will make a difference. Student chapters then apply for these projects and later visit the communities to assess need, build infrastructure and check whether existing infrastructure can be improved.

But there's a lot of hard work to be done at home before those visits can happen.

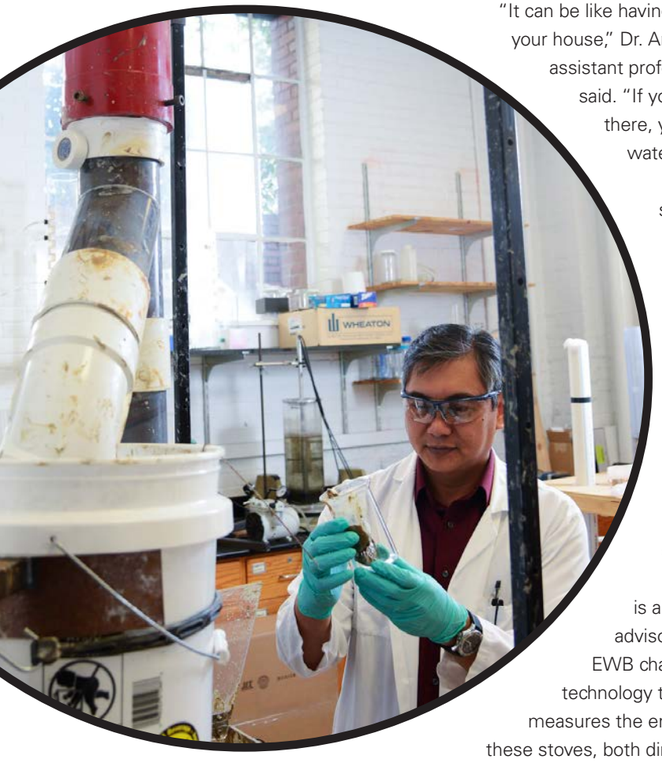
There's project planning and implementation. Seeking out engineering professionals as mentors. Ensuring that the projects meet U.S. standards. Planning a trip to one of the countries and getting the necessary equipment there.

The chapter's student officers say it's a rewarding club to join, and also one that means a lot of work.

The chapter first made contacts in the Asanquiri community in Bolivia in 2005 and identified a need for clean drinking water and a way to store it. Students have been working there since to improve a rainwater catchment system and increase storage capacity.

At the LemonAid Village Schools in Lower Allentown, Sierra Leone, students are working to develop a solar energy system for the school to provide a reliable power source and a mechanically bored well for clean drinking water.

Trips to Bolivia and Sierra Leone are planned this year, though travel bans related to the Ebola outbreak in Africa are complicating the prospects for a visit to the LemonAid Village Schools.



DR. FRANCIS DE LOS REYES WORKS WITH A PROTOTYPE OF THE EXCREVATOR IN THE LAB.

A SAFER WAY TO COOK

For billions of people in India, Africa and other parts of the developing world, cooking means an open fire inside the home. Fuel for these fires is wood, leaves, coal, crop cuttings or dung.

Ventilation is often poor. Because the smoke rises, it helps to crouch down, but only so much. The walls of the home are often black with soot.

"It can be like having a campfire in your house," Dr. Andrew Grieshop, assistant professor in CCEE, said. "If you are standing there, your eyes will water."

Breathing in that smoke causes health problems, from pneumonia in children to cardiovascular disease and cancer. The emissions have also been identified as a major contributor to global climate change.

Grieshop, who is also the faculty advisor for the NC State EWB chapter, developed technology that accurately measures the emissions from these stoves, both directly above the flame but also inside the home. He has done field tests in homes in India and is working with graduate students on more accurate ways to reproduce the same conditions in an on-campus laboratory.

It's research that could help lead to better cook stoves and more information on how the emissions from current uses impact human health and the environment.

New cook stove technology, including advanced stoves that burn biomass, is being developed. There is also a push to enhance the use of liquefied petroleum gas (propane) in poor settings. The challenges include determining which approaches work best, making them affordable for a population living in extreme poverty and changing cultural norms that have been in place for generations.

Grieshop is part of a group in the Triangle working on the problem that includes people from UNC-Chapel Hill, Duke, the Environmental Protection Agency, RTI International and the National Institute of Environmental Health Sciences.

"It's a tough set of problems to have to navigate in terms of the technology and the social aspect as well as the financial aspect and the fuel," he said. "My hope is that people don't expect a miracle fix."

A MODEL TO FIGHT HIV INFECTIONS

Without intervention, an HIV-positive mother has a 15- to 45-percent chance of passing the disease to her child during pregnancy, labor, delivery or breastfeeding, according to the World Health Organization (WHO). The infection rate can be reduced to less than 5 percent with effective treatment.

The Clinton Health Access Initiative (CHAI) sought the assistance of Dr. Julie Ivy, associate professor and Fitts Faculty Fellow in the Fitts Department of Industrial and Systems Engineering,

DR. JULIE IVY

AMBER BUCKALEW AND SPENCER LACY OF NEOTECH GLOBAL WORK WITH A PROTOTYPE.

for its program that supports HIV-positive mothers from pregnancy and delivery through breastfeeding. The foundation has developed a model that health officials in different countries can utilize by entering information about their HIV-positive populations.

Ivy worked on improving CHAI's model with the help of two graduate students, Karen Hicklin and Irem Sengul Orgut, and an undergraduate student and summer 2014 graduate, Elaine Chavis. Then she took it a step further, enlisting students in her master's level Applied Stochastic Models in Industrial Engineering class during the fall 2014 semester.

Ivy says that CHAI's model is entirely deterministic — enter set data inputs and get back results. It's a common way of doing modeling and one that identifies what a certain policy would cost and what the health outcomes would be.

Ivy and her students introduce stochastic elements, factoring in uncertainty, to the CHAI model. The class looked at several variables that might come into play, including how long a mother might breastfeed or how many children she might have.

Ivy says this model will provide decision makers with not only the results of a certain set of policies, but a chance to choose between different policies and select the best option.

Students in her master's class were able to work virtually with Elizabeth McCarthy, director of CHAI's applied analytics team, who is based in Zambia.

"She was impressed by how the class became, in about eight weeks, HIV experts and really learned a lot about WHO's policy and understood a lot about maternal-child transmission," Ivy said.

It was a great opportunity for students to work with a real client on a real problem, the kind of thing they'll be doing after graduation.

It's also an example of how NC State engineers are making a difference across the globe. ▪

PRINTING a safer surgery

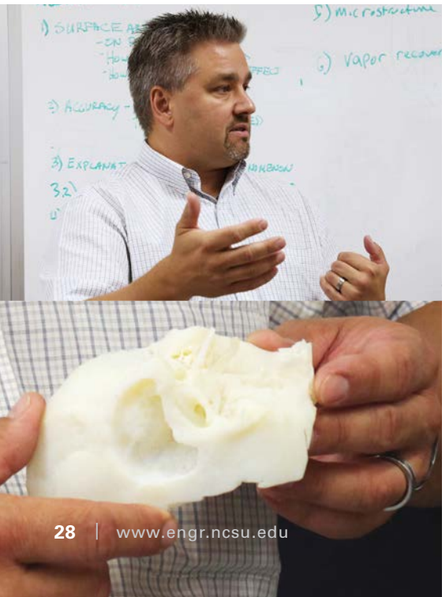
"...This was really not possible before and, although we are continually working to refine and improve our models, is a big advance."

DR. AUSTIN ROSE

A lab on the ground floor of Daniels Hall on North Campus is filled with 22 3D printers that can create everything from a plastic spoon to titanium airplane parts.

Dr. Ola Harrysson, a professor in the Edward P. Fitts Department of Industrial and Systems Engineering, sees applications that could change the medical field and how surgeries are performed.

For the past year, Harrysson has collaborated with Dr. Austin Rose, an associate professor at the UNC School of Medicine who specializes in Otolaryngology-Head & Neck Surgery (also known as Ear, Nose & Throat or ENT), and a team of engineers and physicians developing highly accurate 3D-printed models for pre-operative simulation of challenging ear surgeries, such as cochlear implantation.



DR. OLA HARRYSSON HOLDS A 3D PRINTED MODEL USED IN A SIMULATION OF A COCHLEAR IMPLANT PROCEDURE.

Medical students and ENT residents have been practicing on well-worn cadavers, most of them senior adults, even though the majority of ear surgeries are performed on pediatric patients.

The team created a model of a 10-month-old infant based on CT (computed tomography) scan data of the temporal bone, providing residents an opportunity to practice cochlear implant surgery on a model that resembles what they will most likely see in an operating room.

"Pediatric cases make up a big portion of the ear surgery done at UNC, as so many of our cases are cochlear implants for young children ... often less than one year of age," said Rose. "So (using the models) allows our physicians to practice pediatric ear surgery in the temporal bone lab before operating on actual children in the operating room. This was really not possible before and, although we are continually working to refine and improve our models, is a big advance."

Using printed models for surgical practice also provides the kind of uniformity that working on cadavers can't offer. In a lab in which 30 medical students receive 30 cadavers, it's hard for the instructor to control for the kind of abnormalities found in different bodies and accurately compare students' skill levels.

"With a database of models to choose from, the instructor could decide in advance that all of the students' models will have a tumor inside, for example, giving a uniform test for them that will give the instructor a better insight to their proficiency and competence in a given situation," said Harrysson.

Three-dimensional printing, or additive manufacturing, starts with a 3D digital image file. A printer uses that file as its model and creates an object by spraying one layer of material at a time until the object is complete.

The models printed in Harryson's lab can be made with different layers, materials and colors. These features have been utilized to help students learn by seeing color coded nerves and arteries for easy deciphering. Later, they will move on to more life-like models that better simulate actual surgical applications. The models can also be used to cast bone molds with a foam core material designed to have the look, feel and cutting resistance of real bone.

DR. AUSTIN ROSE WORKS IN A LABORATORY.

In a recent case involving an 11-year-old boy, Rose's team planned an operation to clear a cholesteatoma, a benign but locally destructive tumor, from the middle ear and mastoid space, and in doing so took the modeling technology out of the classroom and into the operating room. A patient-specific model was made based on the child's CT scan and given to the surgeons for practice the day before the procedure.

Rose said it was the first "pre-operative simulation" of an ear case using a 3D printed model that he is aware of.

"(It) allowed us to gain an excellent appreciation for the child's abnormal temporal bone anatomy prior to the actual surgery itself. In my opinion, it helped greatly with the success of the surgery."

This is not Harrysson's first time working with surgeons and bones. In 2005, he teamed up with Dr. Denis Marcellin-Little of NC State's College of Veterinary Medicine. Together, they attached the first osseointegrated titanium prosthetic implant to a cat's bone — fusing together the implant and the bone to create hind legs. Harrysson and Marcellin-Little continue to work together and, in 2008, built osseointegrated prosthetic implants for a German shepherd mix that was born with a defect in its rear leg and one for a cat that was missing a right hind foot.

WORLD-WIDE USE

Harrysson and Rose agree that additive manufacturing technology could lead to several advancements in the medical field.

"For rural hospitals that do not perform some surgeries as often or do not have the money for storing equipment or cadavers, the ability to print models and even surgical tools could be more cost and space efficient," said Harrysson.

An example can be found aboard the USS Essex, a U.S. Navy amphibious assault ship. Last year, the Essex was fitted with a 3D printer to create spare parts and medical tools, lowering the number of items stored onboard.

The crew on the Essex can print most of the surgical tools they need, minus a scalpel, Harrysson said. Even though 3D printing technology has been around almost 30 years, it is now hitting a peak of technological development and is becoming more cost-efficient.

Creating an environment in which surgeons can learn to practice complex inner ear procedures on different types of anatomy, representing patients of various ages, is just one way these 3D models are helping to shape the way pre-operative surgeries are done.

"Dr. Rose is envisioning a database filled with different cases; and he can probably think of hundreds of different types of labs — different parts of the body — where they can use 3D printed models instead of having to use cadavers," said Harrysson.

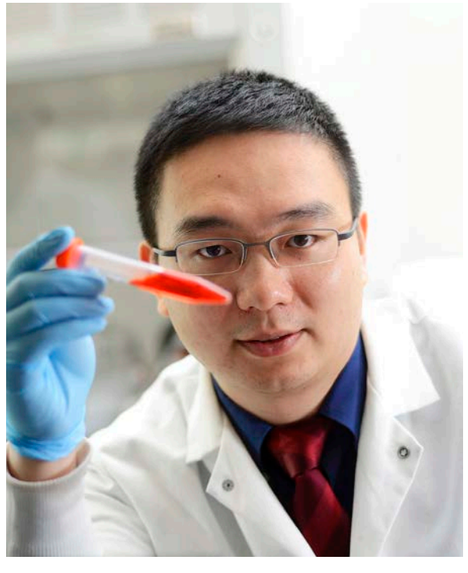
With access to a wide variety of imaging modalities including CT and magnetic resonance imaging (MRI) and the ability to create 3D models based on a number of anatomic variants and pathologic scenarios, instructors at medical schools will have the tools to create an exciting and diverse learning environment.

"I think that as the detail and accuracy of our 3D models improves, we will see them used commonly for teaching and standardized testing of resident physicians," said Rose. "I also think that their use in pre-operative simulation will increase over time — it offers great potential to reduce risk and increase patient safety." ▪

ATTACKING CANCER FROM WITHIN

DR. ZHEN GU'S RESEARCH SHOWS PROMISE FOR TREATING MALIGNANT TUMORS

DR. ZHEN GU, RIGHT, IS DEVELOPING NEW TECHNIQUES TO ATTACK CANCER CELLS.



Dr. Zhen Gu, assistant professor in the Joint NC State/UNC Department of Biomedical Engineering, is conducting nanoscale research with enormous potential.

Gu is developing anticancer drug delivery systems that respond to the unique environment within malignant tumors. Combining biomaterials design and biomacromolecular engineering, Gu's research team has created three "on-demand" drug delivery techniques specifically targeting cancer cells.

Two of the techniques, the "nanodaisy" and "nano-cocoon," feature bio-inspired delivery vehicles, meaning they're shaped or functionalized like objects that already exist in nature. While not bio-inspired, the third technique, called the "flying carpet," still takes a familiar form, traveling through the bloodstream like a nanoscale magic carpet.

"Using these nanosystems to treat cancer is an emerging and very promising area of research," says Gu. "It's enhancing the efficiency of killing cancer cells." Through different methods, Gu explains, all three techniques work to achieve the same goal — carry a large drug load, target the tumor site and release it quickly once inside the cancer cell, in a "programmed" fashion.

NANODAISIES

To make the "nanodaisies," Gu and his research team begin with a polyethylene glycol (PEG) solution. The PEG arranges itself into long strands with shorter strands extending from its sides. Researchers attach the anti-cancer drug camptothecin (CPT) onto the shorter strands while introducing the anti-cancer drug doxorubicin (DOX) into the solution.

PEG is hydrophilic, meaning it's attracted to water. CPT and DOX are hydrophobic, meaning they flee from water. This causes the CPT and DOX to cluster together in the solution, wrapping the PEG around themselves. This wrapping action results in a daisy-shaped drug "cocktail" only 50 nanometers wide that can be injected into cancer patients.

Once injected, the daisy-shaped structures simultaneously drive both drugs into cancer cells. Both the CPT and DOX attack the cell's nucleus and, combined, are more effective than either drug is by itself.

Gu says that this technique has proven much more effective than conventional drug-delivery techniques at discouraging growth of lung cancer tumors in mice and looks promising for use against leukemia, breast, prostate and other cancers.

NANO-COCOON

The second bio-inspired delivery technique is the "nano-cocoon" — a single strand of DNA that self-assembles into what looks like a cocoon, or a ball of string, measuring 150 nanometers across.

Like the nanodaisy, the core of the nano-cocoon also carries the drug DOX, but it differs in that the cocoon holds a protein called DNase at its core. DNase, an enzyme that would normally chew through the DNA cocoon, is cloaked in a thin polymer that protects the cocoon from the protein.

The nano-cocoon's surface is dotted with folic acid ligands. As the cocoon approaches a cancer cell, these ligands bind the cocoon to the cell's surface receptors, causing the cell to suck the cocoon inside. Once inside, the cancer cell's acidic environment destroys the polymer cloaking the DNase, allowing the DNase to quickly chew through the cocoon, releasing DOX into the cancer cell and destroying it.

> "Cancer is a horrible thing ... I feel really lucky to realize my dream through this research."
>
> **DR. ZHEN GU**

Because this technique is DNA-based, it is less toxic to patients than systems that use synthetic materials. Since the cocoon uses self-assembling DNA techniques, it is relatively easy to manufacture. Gu believes this biocompatible delivery system holds promise for administering a variety of drugs targeting not only cancer but other ailments including diabetes and inflammation.

FLYING CARPET

In the third technique, researchers attach two drugs, TRAIL and DOX, onto graphene "flying carpets" — flat sheets of carbon only one atom thick. TRAIL is bound to the surface of the graphene by a chain of amino acids called peptides, and is most effective when delivered to the external membrane of a cancer cell. DOX is tethered to the graphene because of similarities in their molecular structure and is most powerful when delivered to the cell's nucleus.

As the flying carpet contacts a cancer cell, cell surface receptors attach to the TRAIL. Meanwhile, enzymes on the cancer cell's surface cut through the peptides connecting the TRAIL and the graphene sheet. This allows the cell to absorb the DOX-heavy graphene and leaves the TRAIL on the surface, where it begins killing the cell.

Once the cell absorbs the flying carpet, the acidic environment inside the cell disconnects the DOX from the graphene, freeing DOX to attack the nucleus. The flying carpet technique is so effective because of this sequential "one-two punch," with each drug hitting a cancer cell where it will do the most damage.

INTERDISCIPLINARY RESEARCH

In Gu's lab, the professor and his students integrate knowledge from multiple disciplines to make strides in cancer, diabetes and regenerative medicine research.

"Not only do we have students from bioengineering, but also from chemistry, pharmaceuticals, biology and mechanical engineering," he said. "It's due to this interdisciplinary activity that we can more easily, smoothly and naturally assemble unique ideas."

Gu and his students are pursuing federal grant funding to continue their research and push it into clinical practice. Through collaborations with physicians at UNC-Chapel Hill and veterinarians at NC State, the three drug delivery techniques are being tested on animals that develop cancers that are similar to those found in humans.

In addition to being a promising area for nanosystem applications, cancer research has a personal connection for Gu. After losing his biological father to cancer at four months old, and later, watching his stepfather suffer from the disease, he felt compelled to act. These experiences propelled his research toward ending cancer, and gave him the opportunity to fulfill a personal goal.

"Cancer is a horrible thing," says Gu, "I feel really lucky to realize my dream through this research." ▪

Welcome home, graduates

As Chuck Davis walked through a building often referred to as the library of the future — the James B. Hunt Jr. Library on NC State's Centennial Campus — it became clear that the place he left in 1970 had undergone some major changes.

One big difference — he's one of only a thousand or so students who can say they hold an engineering operations (EO) degree from NC State. The program ended in 1987.

In November, Davis, of Beaufort, NC, and nearly 100 EO graduates gathered in the Multipurpose Room of the Hunt Library as part of the College's Homecoming weekend events.

"It brought up a lot of memories for me — things that I had forgotten because I've been out 40 plus years from this institution," Davis said. "The changes, they've just been really interesting and impressive."

Today, the College is home to more than 9,600 students, has added programs such as biomedical engineering and has plans to grow an already-booming Centennial Campus.

ROLL CALL

From the Class of 1967 to the Class of 1985, EO alumni reflected on their time at NC State and the promising careers that awaited them upon graduation.

They were also treated to a panel that included Professor William T. Easter, emeritus associate professor of electrical and computer engineering and long-serving director of the EO program, and EO alumni Tom Phoenix, Dr. Terri Helmlinger Ratcliff, Dr. Brian Wall and Ed White.

White, a 1978 graduate and former president and member of the NC State Engineering Foundation Board of Directors, led a promising career at Westinghouse. He also founded and later sold Utility Translation Systems, Inc., a worldwide leader in software-based energy measurement and management systems for electric and gas utilities.

"The reason I switched to EO had a lot to do with that I wanted some business courses … If you can't write a business letter or speak in front of a crowd, you limit yourself," White said.

The EO program's coursework was designed to equip students to become versatile engineers. In other words, students were given practical skills and introduced to real-world experiences that would help them thrive in a variety of fields, including production, sales and management. The diverse curriculum opened many doors for future career paths.

Ratcliff, also a 1978 graduate, is vice provost of outreach and engagement at NC State and executive director of the university's Industrial Extension Service. She previously led a 20-year career with Carolina Power and Light Company and was the National Society of Professional Engineers' first female president.

"The education I got perfectly equipped me for all those roles," she said.

Comments like these brought a smile to Easter's face. He was the program's advisor from 1970 to 1980 and helped students like Phoenix find a home in the College.

When Phoenix decided to take a break from school, he remembers the letter he received from Easter. The correspondence was personal and an indicator of Easter's care and concern for the program's students — and their future.

"That letter was the catalyst that got me back to school. Without Easter, I don't know if I'd be here today," said Phoenix, who returned to school and graduated in 1975.

Today he is principal and vice president of Moser Mayer Phoenix Associates, a full-service design firm in Greensboro, NC. He also serves as the 2014-15 president of the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE).

From inside jokes to walking down memory lane about courses, the EO program reunion reignited a desire to stay connected. A few hours later, a College-wide kickoff of Homecoming weekend would continue in the Hunt Library space.

INVENTION DISCLOSURE

Dr. Louis Martin-Vega, dean of the College, welcomed nearly 150 alumni and friends to the afternoon event and shared the state of the college. Later, Distinguished University Professor of Electrical and Computer Engineering Dr. B. Jayant Baliga and entrepreneurial team Track2Quit reminded alumni of the motivation and resources that power one of the largest colleges of engineering in the nation.

You can't turn on a light switch or drive a car without using Baliga's invention — the insulated gate bipolar transistor. The energy-saving semiconductor switch improved energy efficiency by more than 40 percent and is a critical component of modern compact cardiac defibrillators.

NC State's Entrepreneurship Initiative (EI) and the Engineering Entrepreneurs Program teach budding entrepreneurs how to write a business plan, create a prototype and pitch to investors. Just

> "Without Easter, I don't know if I'd be here today."
>
> **TOM PHOENIX**

ask the members of Track2Quit: Suraaj Doshi, Kyle Linton, Anirudh Mulukutla and Ian Rogers. Doshi, Mulukutla and Rogers are NC State engineering alumni representing the Department of Chemical and Biomolecular Engineering and the Department of Electrical and Computer Engineering. Linton is a graduate of the university's Poole College of Management.

Taking aim at smoking cessation, Track2Quit has created a sensor-lined plastic case that tracks the time and location of a user opening the box of cigarettes, removing a cigarette and inserting a new box. The data, collected in real time via a mobile app, will be recorded for analysis. The app also presents a smoker with a game or article to serve as a distraction from lighting the cigarette.

Creative and collaborative spaces like the Hunt Library and the EI Garage offer students the resources they'll need — in less time and with less expense. The Garage, a live and work space for EI students, has all the things you'd need to transform a sketch into a pitch-worthy prototype. A 3D printer, made available to Garage members at no cost, is among those tools.

Track2Quit's access to this in-demand tool helped them quickly and affordably create their prototype, Rogers said.

As alumni in the audience pitched questions to the freshly minted entrepreneurs, it became clear that a neighborhood pharmacy might one day include a product from Track2Quit. The team announced that they are looking for advisory and funding assistance. They didn't hesitate to thank the university for its continued support.

"The ability to use the resources (in the Garage) has been instrumental to our success," Linton said. ▪

MARK YOUR CALENDAR

The **College's 2015 homecoming celebration** will be held **Friday, Oct. 30**.

Anyone interested in future Engineering Operations reunions is asked to contact NC State Engineering Foundation Director **Brian Campbell** at **919.515.7458**.

Esteemed engineer honored by colleagues with scholarship endowment

CHUCK RUSHBY AND HIS DAUGHTER CHLOE

WILLIAM F. HORTON, RIGHT, WITH HIS PARENTS, BARRY AND LINDA HORTON

Alumnus Charles "Chuck" S. Rushby (BSME '99) was a high-energy, hands-on mechanical engineer who owned a successful building commissioning company, CxAnalytics, in Williamsburg, Va. On April 29, 2014, he passed away at the age of 43.

Robert "Bob" E. Carpenter Jr., vice president of Clark Construction Group, became friends with Rushby through their work. He wanted to find a way to ensure that Rushby's name lived on and started a memorial scholarship in the College of Engineering at NC State.

With the help of H. Gregory "Greg" Jaranko, director of MEP Technical Services for Clark Construction Group, Carpenter made a gift for the scholarship endowment and received funds from a number of sources, including his father, Robert E. Carpenter Sr.; Kiewit Infrastructure Co.; and Clark Construction Group.

The first Chuck Rushby Memorial Scholarship in Mechanical Engineering was awarded to Matthew G. Jeffries (BSME '14) in a ceremony on Nov. 14.

Carpenter and Jaranko worked with Rushby on projects both before and after he started CxAnalytics. Their recollections of their friend and colleague are filled with fondness and respect.

"He really was a fun-loving guy with a great sense of humor," Carpenter said. "Always had a smile on his face. He liked people and loved to challenge younger people and himself to learn about the right and wrong way of doing things. He had an uncanny ability to boil down something very complicated and be able to explain it to people who weren't as technically savvy."

Jaranko met Rushby several years ago when Rushby was working as a subcontractor for Clark Construction Group on a project in Quantico, Va. Both did similar work and joined forces to inspect building systems.

> "He was the best dad I had ever seen."
>
> **JEAN RUSHBY**

Jaranko said, "We believe systems are supposed to function correctly and that sometimes, even if the design is wrong, we are going to make it right so that ultimately things are doing what they are supposed to be doing for the end user."

According to Carpenter and Jaranko, Rushby had a number of interests, including competitive bicycling and tinkering with anything mechanical or electrical. He loved to talk about his family, especially his young daughter, Chloe.

"He was the best dad I had ever seen," said Rushby's wife, Jean, owner and manager of CxAnalytics. She explained how Chuck and Chloe would build things together — giant airplanes and rockets, for example. They both loved chess.

"They would bicycle to Panera Bread every Saturday morning with their chessboard and play chess."

Jean Rushby admitted that she was speechless when Carpenter and Jaranko told her about the scholarship.

"I thought a monument should be erected in his honor, but as a wife of course you would think that. But to have a team of guys he worked with feel the same way about him, I was completely overwhelmed."

She brought her daughter, parents and in-laws to Raleigh for the scholarship award ceremony last November and was joined by Carpenter, Jaranko and employees from CxAnalytics, as well as Lyman File and other colleagues from the Clark/Kiewit Joint Venture. Matthew Jeffries was impressive, she said.

"Bob was adamant that the person who receives the scholarship should be someone like Chuck, someone who problem solves, finds new ways to fix things. I think that young man seemed to have the same qualities."

She added, "I'm so happy about the scholarship and the fact Chuck's name is out there for that. He so much loved to learn. He would have been very happy being remembered in that way." ▪

DR. CHISA BROOKES

College alumni utilize ExxonMobil match program for endowments

Two young engineering alumni employed by ExxonMobil have started endowments within the College.

Dr. Chisa Brookes ('02), an engineer, and William F. Horton ('05), a joint venture advisor, participated in a match program through The ExxonMobil Foundation — which focuses on supporting math and science education, economic opportunities for women and malaria prevention. ExxonMobil matches an employee donation 3-1 up to a certain amount.

DR. CHISA BROOKES

When Brookes left her family and home on St. Croix in the U.S. Virgin Islands to attend NC State, she essentially had to start over.

Brookes was one of about five African American women in her chemical engineering classes. "Often times there are not a lot of women, much less African American women, in classic engineering fields," she said. "I feel blessed to have had some diversity in my engineering courses."

She also feels blessed to have gone through this experience of starting over in unfamiliar territory. Her international travels and her assignment in Southeast Asia required some of the same life skills she gained at NC State.

Brookes' endowment is her way of partially easing the financial constraints of individuals who are indeed a minority in engineering or those who have demonstrated their support of diversity in engineering. "I give because God consistently gives to me; this endowment is made possible through Him," Brookes said.

After graduating with a B.S. in chemical engineering from NC State in 2002, she went on to receive a master's in 2004 and a Ph.D. in 2007, both from Michigan State.

WILLIAM F. HORTON

Horton always felt appreciation and a sense of gratitude for his parents, Barry and Linda Horton.

"My parents paid tuition for my brother, who also graduated from NC State, my sister, who attended UNC-Charlotte, and myself," said Horton. "I saw the financial burden that puts on someone and wanted to do something to help relieve the stress from other students and parents."

Horton, a 2005 graduate of the Department of Mechanical and Aerospace Engineering, and his brother Joe have established an endowment in their parents' name to fund scholarships for mechanical and environmental engineering students.

The Charlotte native saw this as the perfect time to give back to the department where he grew as a person.

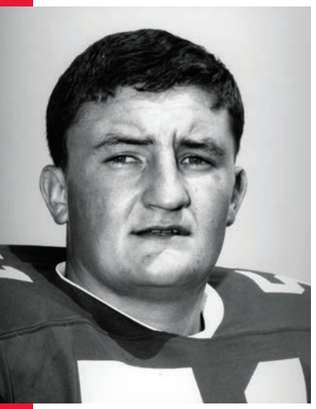
"I believe in the work engineers are doing, and to know I could help and be part of that really stuck out to me," said Horton, who also earned an MBA from the University of Texas at Austin ('11). ▪

Alumni make the College **a part of their estate plans**

Planned giving is an excellent way to help ensure that the College of Engineering is able to continue offering a top-flight education to its students and put them on a path to change the world.

Through planned giving, donors are often able to make larger charitable gifts than they thought possible with outright gifts. Planned gifts can help eliminate estate tax liability while also helping donors plan for the future financial needs of loved ones and provide sustained support for the College at the same time.

After distinguished careers in industry that started with NC State engineering degrees, John Norris and Alan Weinberg made arrangements that help benefit the College as part of their long-term plans.



JOHN NORRIS, IN HIS NC STATE FOOTBALL DAYS (LEFT), AND TODAY.

JOHN NORRIS

Norris played center on the freshman and varsity football teams at NC State for four years. He was involved in Air Force ROTC and, as a senior, was wing commander leading a group of 2,000 cadets.

He also studied nuclear engineering.

Norris, now retired after a career in the Air Force and then the energy sector, was recruited out of Knoxville, Tenn. to play football by schools like Vanderbilt and Clemson.

> "A relationship with a university is like a friendship — you either nurture it and it means something to you or it wastes away."
>
> **JOHN NORRIS**

Norris said he had a nuclear engineering professor tell him that it wasn't possible to play football and study nuclear engineering. Norris managed to do it anyway and earned his bachelor's degree in 1971.

"What I didn't get was a lot of sleep," he said.

After working in intelligence and later as a pilot flying F4s and A10s in the Air Force, Norris held executive positions with Duke Energy before joining the American Bureau of Shipping Group as president and COO. Later, he moved on to American Electric Power as senior vice president of operations and technical services. In 2006, he became president and CEO of Fuel Tech, a company that specializes in air pollution control and efficiency improvements for power plants and industrial combustion units. He retired in 2014 as chairman of the board of directors of Midwest Energy Emissions Corp.

Norris started with Duke working in nuclear licensing, but his career included work in most sectors of the power utility business.

"I think I've done every kind of energy plant, except for tidal," he said. "I've studied that but never did a project in it."

Over the years, Norris has kept close to NC State as a member of the Wolfpack Club and Varsity Club, and by serving on advisory boards for the Department of Nuclear Engineering and the NC State Engineering Foundation. The College honored him as a Distinguished Engineering Alumnus in 2009.

Those ties to NC State now include estate plans he and his wife, Sue, made to benefit the College and future NC State engineering students.

"A relationship with a university is like a friendship — you either nurture it and it means something to you or it wastes away," Norris said of his ongoing ties with the university. "I like having a relationship with NC State."

ALAN WEINBERG

Weinberg graduated from NC State in 1963 and took a job in New Jersey with Esso Research and Engineering.

He grew up in Greensboro, NC, and married Ellen Meiere from nearby Lexington. When they wanted to return to the South to start a family, Weinberg interviewed with a small perishable food-packaging manufacturer called Cryovac in Greenville, SC.

Cryovac's basic process was extruding polymers and creating thin films, something Weinberg had never done at NC State or for Esso. He had only recently seen an extruder for the first time prior to the interview.

But he was a chemical engineer and had been taught the skill set needed to learn.

Weinberg worked for Cryovac from 1966 to 2001 in research and development, marketing and business development and then R&D again. He retired as global vice president of research, development and extension for the Cryovac Division of the Sealed Air Corporation.

Weinberg, who retired as author of 15 original patents, saw Cryovac's sales grow from $100 million annually to just under $3 billion during his career. He traveled the world as Cryovac operated in more than 20 countries with several R&D facilities.

Great high school chemistry and math teachers sparked his interest in both topics. Chemical engineering was a natural fit and a major that could lead to a challenging career. During his high school years, Alan followed Coach Everett Case's Wolfpack basketball teams on the radio.

"State was an easy choice for me," he said.

His time on campus included joining Sigma Alpha Mu fraternity and playing on the men's tennis team as a freshman.

In retirement, he has enjoyed nature and landscape photography and both taking and teaching classes at the Osher Lifelong Learning Institute at Furman University in Greenville. Weinberg also has served on the Alumni Advisory Board of the Department of Chemical and Biomolecular Engineering and is a member of the Wolfpack Club.

When it came time to make estate plans, he and his wife, Ellen, chose to assist the university and its mission. After all, Weinberg said, the career that was made possible by his NC State education meant a great deal.

ALAN AND ELLEN WEINBERG

"Virtually everything that we enjoy is because of the education," he said. "The process of creative problem solving." ▪

DR. KEITH GUBBINS

Professor creates lecture series in **chemical and biomolecular engineering**

Renowned physicist Dr. Giovanni Ciccotti of the University of Rome spent a week on the NC State campus in April 2013, delivering a series of lectures for the Department of Chemical and Biomolecular Engineering (CBE) entitled "Time-Dependent Nonequilibrium Molecular Dynamics."

Dr. Keith Gubbins, W.H. Clark Distinguished University Professor in the department, was impressed by the visit.

During his visit, Ciccotti was able to give three lectures on campus and spend time meeting with faculty and students.

Often, Gubbins said, a visiting lecturer will fly in on Sunday, lecture on Monday and fly out Monday evening. A tour of the facilities, a couple of meetings and the lecture itself are about all that can be packed into the schedule.

Gubbins thinks that there is a larger impact for students when the visitor can spend more time. He hopes that the Keith E. Gubbins Lecture Series he and his wife, Pauline, have created in CBE will afford some of those opportunities.

Gubbins says it's particularly important to give students in the department a chance to meet and interact with visiting researchers.

"We struggle to do that because of funding and I thought this was something I could do and make an impact," he said.

Gubbins, a member of the National Academy of Engineering, admits to a bias for researchers doing quantitative engineering but would like to see lecturers from different fields.

He hopes to bring visiting lecturers in for a week for multiple lectures and plenty of interaction time. The first Gubbins Lecture is planned for the 2015-16 academic year.

Gubbins would like to see the series start with some distinguished engineers, but could also see physicists and other scientists in different fields of interest to engineers as featured lecturers. A faculty group would present names of potential guests and the entire CBE faculty would vote.

Gubbins received a B.S. in chemistry and a Ph.D. in chemical engineering, both from the University of London, and has been on the CBE faculty for 17 years. He came to NC State from Cornell University, where he had taught and served as the department head in chemical engineering. ▪

Foundation welcomes four new staff members

MICHAEL WALSH

MICHAEL WALSH joined the Foundation in June 2014 as the director of development for the Department of Mechanical and Aerospace Engineering and the Edward P. Fitts Department of Industrial and Systems Engineering. He worked previously for the Lehigh Valley Health Network in Allentown, Pa. as director of major gifts from January 2013 to June 2014. Before that role, he worked at NC State as a director of development for the College of Physical and Mathematical Sciences, now part of the College of Sciences. Walsh received a master's degree in organizational leadership from Mansfield University in Pennsylvania in 2012, a bachelor's degree in geography and environmental studies from Radford University in Virginia in 2003 and an associate's degree in environmental science at Keystone College in Pennsylvania in 2000.

SHAWNDA HILL

SHAWNDA HILL joined the Foundation as a business officer in September 2014 after spending almost 10 years with North Carolina Central University in Durham, NC. Her time at NC Central included work as an accountant, interim associate dean for finance and administration for the law school and six years as the assistant director of business affairs for the law school's development department. It was here she gained knowledge of governmental and departmental budgeting practices, prepared fiscal reports and analyzed financial documents. Hill received a master's degree in public administration from NC Central in December 2007 and a bachelor's degree in accounting from NC State in 2000.

KETURA PARKER

KETURA PARKER joined the Foundation in December 2014 as director of development for the Department of Electrical and Computer Engineering and the Department of Materials Science and Engineering. She will also have a regional assignment to engage alumni and friends who have multiple interests across the College of Engineering. She comes to NC State from the College of Arts and Sciences at UNC-Chapel Hill, where she spent two years as an associate director of development. From 2008-12, she worked as a development officer and as an annual fund manager at the UNC School of the Arts. Parker graduated from UNC-Greensboro with a master's degree in consumer apparel and retail studies in 2013 and received a bachelor's degree from UNC-Chapel Hill in political science in 2003.

CARISSA BURROUGHS

CARISSA BURROUGHS joined the Foundation in February 2015 as the new event and alumni relations coordinator. She will coordinate and plan all of the Foundation's events and work in alumni relations. Burroughs comes to the Foundation from North Carolina Central University in Durham, NC, where she had worked as assistant to the director of development with involvement in gift processing, alumni relations and event coordination. After earning a bachelor's degree in mass communication from NC State in 2000, Burroughs worked for a recruiting advertising firm, as a legal assistant and as a consumer specialist for the North Carolina Department of Justice before starting at NC Central in 2010.

What is the **NC State Engineering Foundation, Inc.**?

The NC State Engineering Foundation was founded in 1944 to help recruit Dean J. Harold Lampe. J. Melville Broughton, then the governor of North Carolina, was the Foundation's first president. For the last 70 years, the Foundation has been the primary fundraising arm for the College of Engineering.

As of 2015, the Foundation manages $78M (an additional $43M is held by the University on behalf of the College) in endowment funds that provided $2,573,640 in support to the College.

There are 246 scholarship endowments and 21 fellowship endowments. Along with the NC State Endowment Fund, the Foundation currently manages 40 endowed professorships within the College.

There are 96 other endowments that benefit a wide variety of activities in the College, including the Minority Engineering Programs, Women in Engineering, faculty research, student chapters, entrepreneurship and student experiences.

There are 891 funds supported by donors annually that fund a variety of programs and initiatives.

When making a donation to the Foundation, please remember the tax identification number is 56-6000756 and the official name of the organization is the NC State Engineering Foundation, Inc.

For information on giving to the College of Engineering, please contact a member of the Foundation's staff listed in yellow below: ▪

BRIAN CAMPBELL
Assistant Dean for Development and College Relations
Executive Director of the NC State Engineering Foundation
Major gift contact for the College of Engineering, the Department of Nuclear Engineering and Engineering Operations
919.515.7458

MARTIN BAUCOM
Executive Director of Major Gifts and Campaign Planning
Major gift contact for the departments of Biomedical Engineering and Chemical and Biomolecular Engineering, and for the Engineering Entrepreneurs Program
martin_baucom@ncsu.edu | 919.513.3950

LORA BREMER
Associate Executive Director of Development and Alumni Engagement
Major gift contact for the Department of Civil, Construction, and Environmental Engineering
lora_bremer@ncsu.edu | 919.513.0983 | 919.513.3202

CARISSA S. BURROUGHS
Events & Alumni Relations Coordinator
csburrou@ncsu.edu | 919.515.9975

SHAWNDA HILL
Business Officer
smhill6@ncsu.edu | 919.513.7557

BEN HUGHES
Special Development Advisor

MARGARET McENDARFER
Business Service Coordinator
margaret_mcendarfer@ncsu.edu | 919.513.1778

KETURA PARKER
Director of Development
Major gift contact for the departments of Electrical and Computer Engineering and Materials Science and Engineering
knparker@ncsu.edu | 919.513.1338

ANGELA STALLINGS
Assistant Director of Development and Alumni Engagement
Contact for the Dean's Circle and Annual Giving
anstalli@ncsu.edu | 919.513.1714

KEN TATE
Director of Development and External Relations for the Department of Computer Science
tate@csc.ncsu.edu | 919.513.4292

MICHAEL WALSH
Director of Development
Major gift contact for the Edward P. Fitts Department of Industrial and Systems Engineering and the Department of Mechanical and Aerospace Engineering
mpwalsh2@ncsu.edu | 919.515.7237

NC STATE ENGINEERING FOUNDATION, INC.

BOARD OF DIRECTORS 2015–16
Robin E. Manning, President, EE '78
Ashley S. Barnes, IE '95
Ashok S. Bhatnagar, NE '79
Bob Brooks, EO '69
Calvin H. Carter, Jr., MSE '77, '80, '83
W. "H" Clark, Jr., IE '56
Christopher M. Crump CSC '78
S. Frank Culberson, CHE '60
William H. Dean, EE '88
Ralph G. Edwards, Jr., IE '61
John Freeman, MSE '57
Suzanne S. Gordon, CSC '75, MA '75, ST '80
Carlos D. Gutierrez, CHE '60
Len Habas, EE '66
James A. Hackney III, ME '61, IE '62
Jacob T. Hooks, MSE '78
Susan A. Horn
Ross W. Lampe Jr. IE '77
Lee T. Mazzocchi, CE '90
Thomas R. McPherson Jr., EE '76, '77
Mark A. Norcross, FMM '76
Thomas D. Pearson, FMM '65
V. Nelson Peeler Jr., EE '88
Alvin Sumter, IE '87
Carl S. Stutts Jr., CHE '68
Pamela Townsend, CE '84, '87
Gregory N. Washington, ME '89, '91, '94
Charles T. Wilson Jr. CE '65
Scot Wingo, CPE '92
Robert R. Womack, ME '59
James L. Yocum, ME '84
Deborah B. Young, CE '77

THE CHANCELLOR AS AN ACTION FIGURE

EVEN AS A 3D-PRINT FIGURE, Chancellor Randy Woodson keeps a vigilant watch over the goings on at NC State.

For his senior design class in electrical and computer engineering, William Galliher and his team were given an opportunity to design a full-body 3D scanner as a demonstration piece for the James B. Hunt Jr. Library on Centennial Campus. They got a chance to scan Woodson during the chancellor's tour of the Department of Electrical and Computer Engineering and created action-figure size versions of the chancellor in red and white.

The subject of a scan is asked to stand on a rotating platform as a camera takes a 3D full-body image. Using a 3D printer — which lays down successive thin layers of materials like metal, plastic and wax to create objects that traditionally could only be made by cutting — the scan can be used to create a model of the subject.

The technology isn't limited to just university or business use.

"The sensor and the software is surprisingly cheap and something that most people can just pick up and start doing, which is really neat," Galliher said.

Galliher's teammates on the project were Austin Carpenter, Jonathan Gregory and Dennis Penn. All four graduated in spring 2014.

The scanner was originally housed in Hunt Library and Galliher is now mentoring a second-generation team seeking to utilize the previous 3D scanner for their project and upgrade it from the existing hardware.

"They're using some of the technologies that we used and improving on some of the areas that we didn't quite get right the first time around and that's primarily in the mechanics of spinning the person around and moving the sensors," says Galliher. "They're making a far more robust solution that can last for a lot longer in the intended environment in the library."

Galliher is pursuing a master's degree in computer engineering and is serving as a research assistant under Dr. Eric Rotenberg.

The 3D scanning and printing technology can be used to create everything from complicated parts for automobiles to simple household products like funnels. Putting a person in a body scanner offers another way to bring that capability to life.

"When someone sees a scan of themselves on the screen and then can go and print out a figurine of that, it's really powerful in terms of communicating that technology," Galliher said. ▪

NC STATE Engineering

NC State University
College of Engineering
Campus Box 7901
Raleigh, NC 27695-7901

@ncstateengr

facebook.com/ncstateengineering

twitter.com/ncstateengr

NC State Engineering Alumni

www.engr.ncsu.edu

JOIN THE DEAN'S CIRCLE

Joining the **DEAN'S CIRCLE**, the College of Engineering's signature annual giving fund, means making an annual gift to the College of $1,000 or more. Gifts help fund scholarships and fellowships and support the College's departments and programs.

"It wasn't just my engineering education at NC State, it was my experience at NC State that paved the way for me to have a successful career. Fairly early on, it was important for me to find a way to support the university. Donating to the Dean's Circle is a really great way to ensure your money is used productively to further NC State in general and, particularly, the College of Engineering."

– JAKE HOOKS

Retired president of Eaton Corporation Automotive North America, NC State materials engineering graduate and Dean's Circle member

www.engr.ncsu.edu/foundation/deanscircle