NC STATE Engineering

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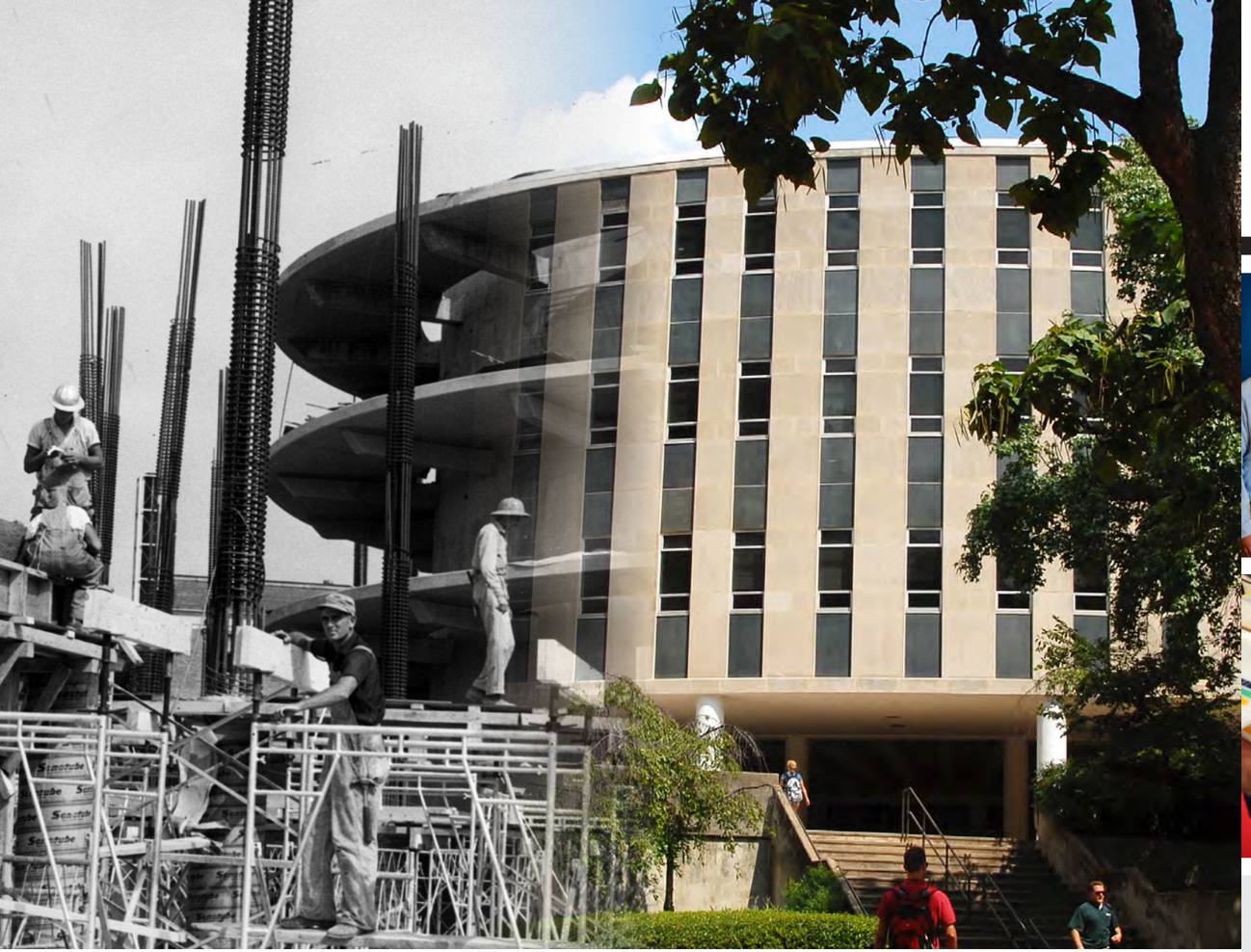

CENTER OF ATTENTION

Since its completion in 1960, Harrelson Hall has been a notorious structure at NC State. You can't miss it — it's the cylindrical building overlooking NC State's Brickyard and the D.H. Hill Library. It features pie slice-shaped rooms and a layout that leaves new students flummoxed. You either love it or loathe it.

Its namesake, Colonel John William Harrelson, was an NC State mechanical engineering alumnus and former NC State chancellor; he was the first alumnus to serve as dean of administration, a title that has since been changed to "chancellor." As a student, Harrelson was senior class president, captain of the student military unit and valedictorian, among other leadership roles.

Later, during his time as an instructor, he took a leave of absence to serve as a colonel during World War I. Harrelson later served as deputy chief of the Army Specialized Training Program in the Fourth Service Command during World War II.

In 2003, the university made the decision to demolish Harrelson Hall after a thorough building analysis revealed that most of the building lacks the potential to undergo renovations that would meet requirements of the Americans with Disabilities Act. Additionally, low floor-to-floor heights and the building's configuration limit interactive and collaborative teaching.

The target date for Harrelson Hall's demolition is summer 2016, according to the Office of the University Architect at NC State. A new — rectangular — building will one day fill the space.

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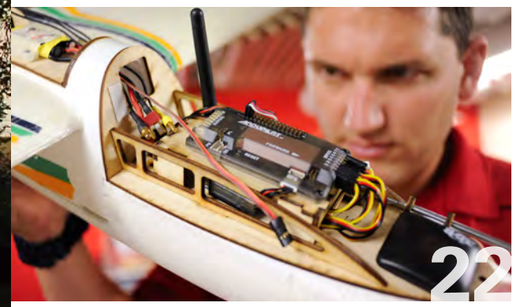

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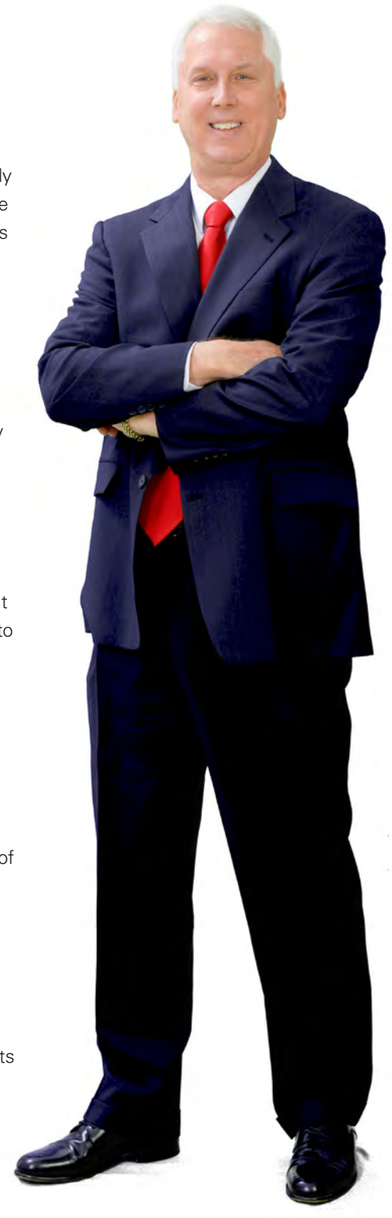
Q&A

QUESTIONS FOR **JOHN GILLIGAN**

Dr. John Gilligan is an NC State nuclear engineering professor, holds a position with the Department of Energy and, in 2013, became the College's first executive associate dean. He talks about the College's research reputation and ability to attract the best students to its graduate programs.



Tell us about your role as executive associate dean.
First, it was an honor and a pleasure to come back to the College, work directly with Dean Louis Martin-Vega, and serve the staff, students and faculty. I coordinate most aspects of the College's operations, including strategic planning and budget. I also have overall responsibility for the research and graduate studies areas.

How strong is research in the College?
Research permeates every aspect of faculty and student life. We have grown tremendously over the years in the dollar volume, complexity and sophistication of research activities. We have also moved up the rankings in research support. Our new, very large research centers set us apart.

How do our two National Science Foundation (NSF) Engineering Research Centers (ERCs) — FREEDM and ASSIST — impact the College?
These centers represent the highest level of achievement as viewed by NSF. We are the only university in the US hosting two ERCs simultaneously, and the centers integrate cutting-edge research along with new academic programs, outreach activities and industry and international partnerships. They also provide special access for students at all levels to interact with researchers.

What goes into landing ERCs and other College-led centers like the Science of Security Lablet and the Consortium for Nonproliferation Enabling Capabilities?
The quest for these prestigious awards is at the top of the list of most major universities. It takes many years of focus, planning and investment to bring faculty and staff to the table to realistically compete. We currently have two more large centers in final negotiations.

Attracting and hiring top graduate students is at the core of the College's mission. How does the College make this happen?
We recently created a position for an assistant dean for graduate programs who will coordinate with departments to improve recruiting activities and secure support for students. We have already seen larger numbers of excellent doctoral- and master's-level students expressing interest in our programs. However, we need to increase the number of US students and diversity.

Where do the College's greatest strengths lie? Where can we improve?
Every department in the College has centers of excellence. The greatest strength of NC State is our graduates who are job-ready, from day one after graduation. They are highly sought after by industry and other organizations because they can deliver right away. The College needs to continually tout our accomplishments and success of faculty and students in order to gain more respect from our peers.

You have several job titles. Any tips on time management and balance?
Make sure your bosses know what you are doing and buy into the total working model. Other than that, enjoy what you are doing!

FROM THE DEAN

Louis A. Martin-Vega

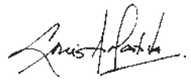
Why is it so important for the College of Engineering at NC State to have a strong research program? When I've been asked this question my explanation has been simple. Research and education go hand in hand to produce the best-educated, job-ready students and strengthen the economy of our state and nation.

Our students are so highly sought after, in part, because of the experience they gain from professors who conduct research and from working in research labs while they are still undergraduates. These students are able to participate in finding solutions to the vexing issues that face our society. In the College of Engineering, we are fortunate to lead some very high profile research centers. Our newest, the Consortium for Nonproliferation Enabling Capabilities, is funded by a five-year $25 million grant from the National Nuclear Security Administration and will investigate ways to keep nuclear material from falling into the wrong hands. Our students benefit from having these national centers on campus. After participating in the research and learning about these new developments in the classroom, they carry that knowledge into the workplace or conduct their own research as graduate students.

This issue of *NC State Engineering* provides examples of how our students and faculty benefit from the robust research environment here in the College. There are updates on the two National Science Foundation Engineering Research Centers — FREEDM and ASSIST — that are led by NC State faculty. We'll show you how research in the Rehabilitation Engineering Initiative housed in our Joint NC State/UNC Department of Biomedical Engineering is improving the lives of people dealing with limb loss. You will also see how our students are starting companies that hold great promise for creating jobs in North Carolina and developing exciting new products and how faculty in our college are working with faculty from the College of Textiles to use gaming technology to solve crimes. None of these projects, and learning experiences, would be possible without the integration of research and education.

We also want to remind you that the college will hold its annual Homecoming Celebration on November 7th at the award-winning James B. Hunt Jr. Library on NC State's Centennial Campus. We hope that you will be able to join us.

Please enjoy this fall issue of *NC State Engineering*. And as always, I hope this magazine is just one of the ways you learn more about your alma mater and the many ways your college impacts the world.



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

Narayan receives O. Max Gardner Award

Dr. Jay Narayan, John C. C. Fan Family Distinguished Chair Professor of Materials Science and Engineering, is the 2014 recipient of the O. Max Gardner Award — the most significant honor given to faculty by the University of North Carolina Board of Governors.

The award is presented each year to a faculty member from one of the system's 17 campuses who is recognized as having "made the greatest contribution to the welfare of the human race."

Narayan has made groundbreaking contributions to the field of materials science, most notably in domain matching epitaxy, a method of combining nanomaterials that reduces defects in the semiconductor materials that affect LED efficiency. This work led in turn to the development of high-efficiency LEDs that will save energy, reduce greenhouse emissions and contribute to our nation's energy independence.

Narayan has published nine books and more than 500 papers in scholarly journals, has earned 40 US patents, and has been invited to present papers at numerous conferences, symposia and seminars. He also has mentored more than 65 PhD students and trained numerous postdoctoral researchers who are employed by leading companies and universities. Since joining NC State's faculty in 1983, Narayan has developed eight graduate courses that are connected with his research, three of which are offered via NC State's Engineering Online to engineers within the microelectronics and photonics industry.

Narayan is the 29th faculty member from NC State to win the O. Max Gardner Award since its inception in 1949. ▪

Cracking the code

The attackers are winning.

Those attackers are hackers who exploit deficiencies in software code that allow them access to your credit card number and even your medical records. What's at stake is more than money. In the case of vital healthcare software, lives could be at risk.

The US National Security Agency (NSA) established lablets at NC State, Carnegie Mellon and the University of Illinois in 2012 in hopes of taking a different approach to preventing cyber-attacks, to change how code is written and take away opportunities from thieves.

This year, those three universities were asked to compete against other schools to keep their lablets. The NSA invited 190 schools to submit proposals, but the agency renewed all three schools, and the University of Maryland was added to the program.

The Science of Security Lablet at NC State is housed in the Institute for Next Generation IT Systems, a joint university/government research organization tasked with working on current information technology challenges.

Dr. Laurie Williams and Dr. Michael Rappa, professors in the Department of Computer Science, were the original co-principal investigators in NC State's lablet. Rappa is also founding director of NC State's Institute for Advanced Analytics, which offers the nation's first Master of Science degree in analytics. In 2014, Dr. Munindar Singh, also a professor in the Department of Computer Science, replaced Rappa as the co-PI with Williams.

Williams points to a number of reasons that hackers have the upper hand right now, chief among them the lure of a big financial windfall.

"For them, the payoff can be really high," Williams said. "They're willing to dedicate a lot of time to get in."

For the developers writing software code, too often the financial incentives are reversed. With a push to get products out the door, not adding code that makes a product secure means time is saved.

Add to that the fact that software engineers are not taught to code securely. The fix often is as simple as replacing one line of code with another, but if no one knows about that secure option then mistakes are repeated. Attackers are familiar with those mistakes.

"There can be vulnerabilities that we all know about, and people just keep coding that way," Williams said. "They just keep developing more and more software with the same vulnerabilities in them."

Williams describes the current approach to security as often a reactive approach. We've been attacked — let's fix that problem. But that turns into a cat-and-mouse game of chasing the attacker.

What if cyber security was looked at with a scientific approach with hypotheses and the research to back them up, plus repeatable research methods that can be used to teach? What if, instead of plugging holes, system designers worked together to make sure there are no holes to begin with?

Maybe then, the attackers will be put on the defensive. That's the aim of the Science of Security Lablet.

At NC State, the lablet exemplifies the kind of interdisciplinary cooperation that is one of the university's strengths. The lablet is based in the Department of Computer Science, but involves faculty from the departments of Electrical and Computer Engineering and Civil, Construction, and Environmental Engineering, along with the College of Education and departments of Psychology and Statistics.

The NSA provides $2 million to $2.5 million in annual funding to each lablet. At NC State, 16 faculty and 18 students are involved. Six collaborating university partners — Purdue, UNC-Chapel Hill, UNC-Charlotte, Alabama, Virginia and Rochester Institute of Technology — are also part of the NC State project.

The NSA asked the lablets to come up with five hard problems to solve. Those problems look not just at security metrics and the architecture of systems but how humans behave when they are interacting with the software that is being studied.

Being selected by the NSA for three more years of funding means the lablet at NC State will continue that work.

"Three years from now, I hope that we have made a lot of progress on those hard problems," Williams said. ▪

Cooling cardiac patients

During cardiac arrest, mere seconds are important. Quickly cooling the patient on the way to a hospital can limit neurological damage.

In December, federal officials issued a final patent on a device called HypoCore that puts patients into "therapeutic hypothermia." The new technology could be in rescue vehicles as soon as 2015.

Dr. Andrew DiMeo, a biomedical engineer and associate professor of the practice in the Joint NC State/UNC Department of Biomedical Engineering, and five of his senior design students developed the device in 2007-08.

Two dozen or more undergraduate and graduate students, professionals in the university's Office of Technology Transfer, and expert entrepreneurs have been involved in taking the cooling technology from initial concept through business development to the marketplace, DiMeo noted.

"Therapeutic hypothermia is when you lower the body temperature to help slow down the cellular metabolism," explained Tony Voiers, CEO and co-founder of Novocor Medical Systems. Voiers and DiMeo founded Novocor last year to license the new technology.

"Users asked for something portable and rechargeable, but what they needed was on-demand cooling — something we determined could be done without any power at all," DiMeo said.

They determined an endothermic chemical reaction similar to ice packs could quickly cool room-temperature saline to less than 3 degrees Celsius.

The device could make a huge difference in the lives of the more than 500,000 heart-attack patients a year.

Novocor is one of 11 companies recently awarded a grant from the Daugherty Fund, an NC State endowment fund established to bridge pure research and product commercialization. ▪

Taking an elephant by the collar

Imagine you are on foot, a sentient dump truck is angry with you, and it can follow you home. It might come crashing through your walls at night, or it might eat all of your food and empty your bank account while doing so.

This is a reality for many villagers in African nations — in the form of rampaging elephants. A wild elephant's multi-ton size and matching appetite has led to conflict between the animals and farmers trying to protect their crops, their equipment, and ultimately their lives.

For one group of NC State engineering students, learning that these creatures shared a fear that many humans hold — a swarm of bees and their sting — got them steps closer to addressing a problem that has existed for centuries in Africa and India.

Over spring break, two senior design teams and leaders from the departments of Electrical and Computer Engineering and Textile Engineering, Chemistry and Science flew to Johannesburg, South Africa. The US Army Research Office in Durham, NC, was working with Adventures with Elephants near Bela Bela in South Africa when they contacted the College of Engineering in hopes of finding a way to limit elephant rampages and damage caused by elephants wandering into populated areas, saving human and elephant lives in the process.

The College responded.

The team developed a self-powered tracking and stimulation collar with some similarity to an invisible fence for dogs — a collar that provides sensory "warnings" to elephants approaching a village or farm. Unlike an invisible fence system, this collar operates with GPS, and a boundary may be "drawn" in any shape around a farm or village.

When the team arrived in Johannesburg, they quickly discovered they were missing one thing: a bolt that would be used to securely fasten the collar around the elephant's neck. After rummaging through a bucket of bolts and screws, the team was able find one that would work, after a few adjustments to the collar.

The team's collar has three stimuli signals; each subsequent signal is more potentially distressing to the elephant. The first signal is the sound of swarming bees. The second signal is a combination of the sound stimulus and a vibration mimicking the sensation of bees swarming around the elephant's neck. The third and final signal is a combination of the sound stimulus and an electric shock meant to simulate a bee sting.

The team tested the collar in an open field by placing apples in the middle of three circles drawn with corn starch. Each circle represented a boundary, and stimuli were manually administered as the elephant crossed the line to enter a new circle.

When the elephant was tested, it paused immediately upon hearing the "buzz" of the first stimulus, and stopped in its tracks upon feeling the vibration stimulus. Once "trained," the elephant was led away from the field. The second time, upon application of the first stimulus, the elephant turned and quickly moved away from the direction of the circle. From the testing, the team concluded that the vibration stimulus was the most effective.

The team hopes that future teams can improve upon the design and eventually make elephant collars that can be sold and placed on roaming elephants to help resolve the problem of unwanted human-elephant conflict. Hopefully their research was a giant step. ▪

Drones over Centennial Campus

An inaugural programming challenge on unmanned aerial computing platforms took place at NC State over the course of six months.

The challenge culminated in a daylong final challenge on April 12, when the finalist teams took turns running their programs on CentMesh drones to see if their code would fly. CentMesh, formally known as Centennial Mesh, is the wireless network that covers NC State's Centennial Campus.

The programming challenge required teams to fly unmanned aerial vehicles, widely known as UAVs or drones, using the CentMesh wireless network.

The challenge proceeded in phases, with participants who qualified in one phase moving on to the next. The first phase included three initial challenges of increasing difficulty, each with a time limit.

Twelve teams registered for the challenge, put together by the departments of Computer Science, Electrical and Computer Engineering, and Mechanical and Aerospace Engineering. Each team was required to clear the initial challenge by March 31, the day the final challenge problem was revealed.

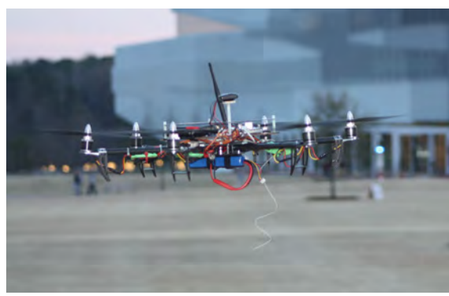
All the code submitted by the finalist teams performed admirably on the final challenge day.

Team YOLO, comprised of Konstantinos Christidis and Yun Wang, and Team Splash Brothers, made up of Hong Xiong, Fengyuan Gong and Miguel Báguena Albaladejo, tied for first place. Each team won a $1,000 prize.

Abhijeet Deshpande and Neha Gholkar, calling themselves Team Garuda, placed third and received a $500 prize.

The day saw only one crash (forced landing), which turned out, upon examination of the logs, to have been the fault of a firmware bug and not the code submitted for the challenge.

The hope is that the challenge will become an annual event that can be expanded to include students from outside NC State and mobile computing aspects other than drones. ▪



Engineers help with hunger relief

The Food Bank of Central and Eastern North Carolina, a nonprofit organization that has provided food for people at risk of hunger in a 34-county service area for more than 30 years, is always very careful that the food distributed is safe to eat.

Food cans go through a rigorous inspection process. All canned food donations are weighed, sorted, inspected and labeled by volunteers.

Those volunteers carefully examine each can, checking for dents, creases or other damage that can break the seal of the can and compromise the quality and safety of the food.

Nearly half of the inspected cans are discarded because of damage they believe could compromise the food inside.

However, the Food Bank believes about 70 percent — or 175,000 pounds — of the discarded donations are actually safe for consumption. That's the equivalent of 147,000 meals.

Seeking an effective way to determine which cans are safe for consumption, the Food Bank reached out to the Department of Mechanical and Aerospace Engineering at NC State.

Dr. Chau Tran's senior design class initiated a competition to create devices for the Food Bank that would determine if the cans are safe for consumption. They divided into six groups, and each began designing a unique system to determine which cans are safe to pass on to clients.

The teams had some restrictions: The machine had to accept different sizes of cans; it needed to plug into a standard power outlet; it had to be portable and easy to operate; and it had to cost $800 or less.

The Sealed Team Six team won the competition. The winning factor: Their machine, which resembles a grill or pig cooker, can test more than 80 cans at a time. Inside, vacuum pressure that is strong enough to draw the content out of a defected can determines which ones have defects. The pressure is regulated and applied to the chamber from the bottom.

Sealed Team Six members Daniel Clements, Marc Holbach, Alex Mauney, Paul Peffly and Kevin Young were all spring 2014 graduates.

This machine can detect punctures as small as a needle and has an automated brush that cleans up the cans so the investigator can distinguish regular rust on the can from the content being drawn out.

All six machines were donated to the Food Bank to help reduce waste and further its mission of feeding the hungry. ▪

The magnetic field meets the football field

Many NC State football fans still insist that Wolfpack running back T.A. McLendon crossed the goalline on second down at the end of the game with UNC-Chapel Hill in 2004.

The record books show that a referee who originally signaled a touchdown was overruled and the ball was placed inside the one-yard-line. On the next play, McLendon got the ball again and fumbled. The Tar Heels recovered and came away with the victory.

It's too bad that technology being developed by researchers at NC State and Carnegie Mellon University, in collaboration with Disney Research, wasn't available in 2004. They are building a system that can track a football in three-dimensional space using low-frequency magnetic fields.

The researchers designed and built a low-frequency transmitter that is integrated into a football and is within the standard deviation of accepted professional football weights, meaning it could be used in a National Football League (NFL) game. Antennae placed around the field would receive signals from the transmitter and track its location.

The technology would be particularly useful when the ball is blocked from officials' view, as in a goal-line rushing attempt when the ball carrier is often buried at the bottom of a pile of players. The technology could also help track the forward progress of the ball or help viewers follow the ball during games with low visibility (think January NFL playoff games in snowy Green Bay or Pittsburgh).

This technology differs from previous attempts because it uses low-frequency radio waves instead of high-frequency radio waves.

High-frequency radio waves are absorbed by players and can be thwarted by the complex physical environment of a football stadium. And because the

technology would be most useful in pile-ups, when the ball is obscured by players, these high-frequency approaches aren't practical. The absorbed radio waves would result in incorrect or incomplete data on where the ball is located.

"But low-frequency magnetic fields don't interact very strongly with the human body, so they are not affected by the players on the field or the stadium environment," said Dr. David Ricketts, associate professor of electrical and computer engineering at NC State and senior author of a paper describing the research. "This is part of what makes our new approach effective."

The researchers had to address another complicating factor.

When low-frequency magnetic fields come into contact with the earth, the playing surface included, the ground essentially absorbs the magnetic field and re-emits it. This secondary field interacts with the original field and confuses the antennas, which can throw off the tracking system's accuracy.

However, researchers realized they could use a technique developed in the 1960s called complex image theory.

"Complex image theory allows us to account for the secondary fields generated by the earth and compensate for them in our model," said Dr. Darmindra Arumugam, lead author of the paper and former PhD student at Carnegie Mellon now at NASA's Jet Propulsion Laboratory.

This could be a game-changer for the way a touchdown or a first down is determined. ▪

MEP celebrates two decades of helping students transition

Roommates and dorm life. Networking and research opportunities. College-level work.

First-year engineering student Bailey Arteta is now considering all these things as he makes the transition from high school to life at NC State.

Arteta decided to take advantage of a summer bridge program for incoming minority engineering students. For six weeks this summer, he was one of nearly 30 students participating in the Summer Transition Program (STP) — a pre-college prep initiative hosted by the Minority Engineering Programs (MEP) at NC State. STP celebrated 20 years this summer.

When Arteta completed the program, he had a college-level math course under his belt along with a refresher chemistry course and exposure to E 115, a computer course required for first-year engineering students. Outside the classroom, he had time to explore the two-campus university that is home to more than 34,000 students and top-notch facilities and faculty.

"My first reason for participating was to get ahead of the game because college is a lot different than high school," Arteta said. "STP is also a great opportunity to meet new friends, experience college life, and do other activities."

One of the perks of the program is that students become familiarized with campus resources — weeks before NC State swells with students. STP participants stay in University Towers, a privately owned residence hall on main campus. Most of their time is spent balancing study- and class-time, networking during industry visits, and attending evening workshops known as "Pack Sessions." The sessions range from best practices for diet and nutrition to guidelines for budgeting money.

Upper-class minority engineering students pay it forward as they help lead the program.

"It was interesting trying to develop each student in their own way and bring out the right traits that we need in our engineering program," said Toluwalope Oyelowo, a junior in biomedical engineering. "It was also good showing them what engineering is like, telling them which classes to take and organizations to join. Overall, it was really inspiring."

Through interactions with Oyelowo and others in the program, STP students quickly learn that there is a strong support system rooting for their success. For leaders on campus, seeing the incoming engineering and computer science students exemplifies their commitment to excellence.

"When a student decides to do STP, it lets us know that they're really committed to tapping into resources so they can do the best that they can," said Angelitha Daniel, director of MEP. "Giving up your summer is big, so being here and utilizing everything that's in place says a lot about a student. STP is the best way to begin getting acclimated to NC State and the resources that are here on campus."

For Arteta, starting strong is important. STP has given him the boost he'll need to hit the ground running. ▪

NC Solar Center changes its name to NC Clean Energy Technology Center

The NC Solar Center wanted a name that reflected its growth in renewable energy sources beyond solar. That new name — the NC Clean Energy Technology Center — encompasses those expanded interests.

The Center has evolved to include technology in wind and biomass; energy efficiency; distributed generation systems like combined heat and power; clean transportation, including electric cars and vehicles powered by natural gas, propane and biofuels; and smart grid and green building.

The Center serves as a resource for innovative clean energy technologies through demonstration, technical assistance, outreach and training. It also works to break down barriers for clean energy technologies and businesses that want to locate and grow in the state.

The Center now includes energy policy and economic development programs. It assists businesses by providing information on state regulatory and tax policies and serves as a connector for other resources. Further, the Center consults with citizens, local governments and organizations to provide clean technology implementation strategies.

The NC Clean Energy Technology Center helps the state's businesses, policymakers and organizations develop clean energy technology and policy initiatives.

North Carolina has distinguished itself as a state committed to clean energy. The state is increasingly recognized, nationally and internationally, for its growth and authority in clean energy technologies. The Center has been at the forefront of this progress for more than 25 years.

Today, North Carolina supports more than 15,000 direct jobs at more than 1,000 companies in the clean energy sector. It is the only state in the Southeast with a Renewable Energy Portfolio Standard.

It is known internationally for having the largest smart grid industry cluster in the US and is ranked fifth in the US for clean energy development and second for solar capacity. ▪

The lone wolf of the Hunt Library

NC State mechanical and aerospace engineering students Michelle Phillips and Kevin Young wanted their University Honors Program capstone projects to be anything but ordinary. They decided to create an animatronic wolf.

Their mentor on the project, Dr. Larry Silverberg, professor and associate head and director of undergraduate programs in the Department of Mechanical and Aerospace Engineering, was skeptical that two undergraduates would be able to create a functional device. He soon discovered Phillips and Young were up for the challenge.

The duo used a 3D scanner from the James B. Hunt Jr. Library to scan a $3 plastic toy bought from Toys"R"Us to create the wolf. They obtained a student license for Geomagic computer-aided design software from 3D Systems in Morrisville and imported their scan into SolidWorks, another design program.

To fund the project, the students used Park Enrichment Grants, offered through the university's Park Scholarships program, and undergraduate research grants to buy the materials and received help from Silverberg and electrical engineering students.

Since April, the four-foot tall, 120-pound creation has been on display in the glass-enclosed Apple Technology Showcase on the second floor of the Hunt Library on Centennial Campus. Their creation, "The Timber-Wolf," earned its name because it is made from sheets of waterjet-cut Baltic birch plywood.

The wolf has a control panel with both show and individual modes, so visitors can see the wolf open its mouth and wiggle its ears.

"We kind of want it to serve as an inspiration to others to be creative in what they create," Young said. "Most engineers just use an upgraded version of their senior design project as their capstone project. We wanted to go above and beyond that."

Phillips and Young met during their freshman year while living on the second floor of the Honors Program dormitory. They spent most of their spare time working on the wolf from last September until the project's completion in April.

Now graduates, both are interested in pursuing careers in mechatronics, a melding of mechanics and electronics. ▪

NC State Solar House gets a second life

The Engineering Place, the College of Engineering's K-12 outreach program, has taken over management of the North Carolina State University Solar House. Originally part of the North Carolina Solar Center, the 1,700-square-foot Solar House has served as a showcase for solar technology since it opened to the public in 1981. It is adjacent to the McKimmon Center on NC State's campus.

In July, the North Carolina Solar Center changed its name to the NC Clean Energy Technology Center to reflect its expansion into many types of clean energy technologies.

"The Center's focus has moved away from the kind of outreach associated with the Solar House," said Dr. Laura Bottomley, director of Women in Engineering at NC State and the Engineering Place. "The Engineering Place has taken over the management of the Solar House, not only to maintain its historical purpose and presence, but to ramp up its usefulness in terms of what it can do for the general public, K-12 teachers and their students and interested NC State researchers."

The Solar House will continue as an education and demonstration center for solar and other renewable energies, but new goals include adding STEM — science, technology, engineering and mathematics — education tools for teachers and their students and research displays beyond what has been traditionally present at the house.

"For example," Bottomley said, "I want to have self-guided field-trip kits. So instead of bringing a class here just to tour, a teacher might be able to view a preparatory video online and then find stored in one of the kitchen cabinets a kit that they could use to do an energy-related experiment while they are here. The kits would be tied to the North Carolina Standard Course of Study in science, math and social studies to maximize the utility for the teachers."

Bottomley also wants to give a platform to NC State researchers by introducing their cutting-edge research to the public through kits or displays at the Solar House.

While Bottomley is seeking funding for her plans, the Solar House is closed for tours. She hopes she will have the funding she needs to reopen the house to the public in the fall.

The house is not standing idle, though. The Engineering Place's summer campers used it for STEM hands-on activities. ▪

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

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

Dog-powered disaster response

Disaster response today is a collaborative effort that includes humans, drones, robots, and dogs.

As part of the Smart Emergency Response System (SERS) project, Dr. Alper Bozkurt and Dr. David Roberts have designed a highly customized dog harness to be used in disaster response. Bozkurt and Roberts are assistant professors in electrical and computer engineering and computer science at NC State, respectively.

SERS was one of 24 research groups to compete in the SmartAmerica Challenge that kicked off in late 2013. The competition highlighted state-of-the-art practical innovations. The SERS team demonstrated their work at the SmartAmerica Expo on June 11 at the Walter E. Washington Convention Center in Washington, DC.

The expo was organized by the White House Office of Science and Technology Policy and Presidential Innovation Fellows to demonstrate how cyber-physical systems, also referred to as the "Internet of things," can increase American competitiveness and provide socio-economic benefits.

The SERS team was one of four teams to be selected to present at the White House the day before the SmartAmerica Expo.

The project's goal is to use cyber-physical systems to share information and coordinate emergency and disaster response and recovery. These systems are designed to work in real time via a variety of wireless network technologies.

The high-tech harness for dogs Bozkurt and Roberts developed includes three technologies: environmental monitoring, dog monitoring and active communication.

Passive technology, including microphones, cameras and gas sensors, retrieves and transmits data from the field in real time.

Active communication technologies on the harness will allow handlers to relay commands to a dog remotely. Bozkurt and Roberts have incorporated audio communication, via speakers, into the vest.

They are also training dogs to respond to "tactile inputs," nudges from the vest similar to a vibrating cellphone.

"We're using exclusively reward-based training techniques," Roberts said.

Their approach is customized.

"We're developing a platform for sensors that is designed to be plug-and-play, allowing emergency responders to further customize the harness," Bozkurt said. "For example, if there's the possibility of a natural gas leak, you could attach a natural gas sensor. Or if there's the possibility of radiation, you could attach a Geiger counter."

Using wireless communication, the sensors can be monitored remotely at a command center or by dog handlers on a handheld device nearby.

The harness also includes new sensors that monitor a dog's behavior and physiology, such as heart rate. These sensors will allow both dog handlers and the emergency response command center to remotely track a dog's wellbeing and to determine if the animal has picked up a scent or found a specific object or area of interest.

The work being done by Bozkurt and Roberts, along with their collaborator Dr. Barbara Sherman of NC State's College of Veterinary Medicine, is supported by a grant from the National Science Foundation.

The SERS team also includes researchers from MathWorks, the University of Washington, MIT, BluHaptics, National Instruments, the University of North Texas, Boeing and Worcester Polytechnic Institute. ▪

The Engineering Place adds new program coordinator

Leyf Starling has joined the Engineering Place team as program coordinator. The Engineering Place is NC State's K-12 education and resource program designed to stimulate enthusiasm in students for math and science through hands-on engineering activities.

As program coordinator, Starling will build on existing outreach programs and develop new ones. She will manage programs that are part of the Engineering on the Road series, such as NC STEM, Marbles Kids Museum, Boys and Girls Club and Girl Scouts. She also will assist with K-12 summer camps and professional development workshops and will teach a section of E 101 — Introduction to Engineering and Problem Solving.

Starling received a Bachelor of Science in mechanical and aerospace engineering from the University of Virginia (UVA) in 2003 and a Master of Arts in teaching with a focus on special education from UNC-Charlotte in 2010.

When she graduated from UVA, Starling began teaching middle school math and very quickly incorporated hands-on engineering activities in her classroom as a way to teach math in a meaningful, real-world way.

She said she soon discovered that children with learning disabilities and attention deficit disorders perform better with hands-on engineering activities. When she returned to school for her master's degree, she supported these observations with research for her dissertation.

"It seemed obvious, but now I had the data to back it up," Starling said. Starling is excited to be part of the Engineering Place team. "I want children to look at the world in a different way, and if they end up going into engineering, that would be awesome." ▪

Defeating pilots' distance bias

According to the Federal Aviation Administration, there were 4,400 instances of planes flying too close, an average of 12 per day, in 2012. Of those, 41 were deemed "high-risk events."

Carl Pankok, a PhD student in the Edward P. Fitts Department of Industrial and Systems Engineering, saw an opportunity to decrease the risk of collision by improving radar technology.

The issue at hand involves the GPS displays, called "cockpit displays of traffic information" (CDTIs), used by private pilots to track other aircraft in their vicinity.

Pilots often focus on the closest aircraft on the display — a habit referred to as "the distance bias" that can pose a significant hazard.

If the pilot of Plane A sees two planes on the CDTI, he's more likely to focus on the closest aircraft (Plane B). But if the more distant plane (Plane C) is moving at a high speed, it could cross his path before Plane B does. Not paying enough attention to Plane C increases risk of a midair collision.

Researchers modified the CDTI so that the plane that would cross a pilot's path first either began blinking or was colored yellow.

"Our goal was to modify a CDTI to help pilots recognize which other planes pose the greatest risk," Pankok said. "And it worked."

Pankok and his research team compared licensed recreational pilots' response times and decision-making accuracy when using the modified and unmodified displays. They saw the pilots' accurate decisions increase from 88 to 96 percent with the new CDTI, decreasing the risk of collision.

"We're hoping that CDTI manufacturers can incorporate these changes and possibly save lives," Pankok said. ▪

DR. CARL ZOROWSKI

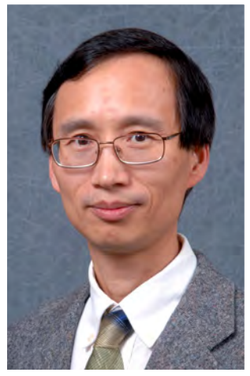
Zorowski presented 2014 Jackson Rigney International Service Award

NC State's Committee on International Programs (CIP) has selected **Dr. Carl Zorowski**, Reynolds Professor Emeritus in the Department of Mechanical and Aerospace Engineering, as the 2014 winner of the Jackson Rigney International Service Award.

The award recognizes distinguished contributions of full-time, active faculty or staff at NC State who have achieved distinction in international service through their lifetime work in terms of scholarly activity in teaching, research and public service. Zorowski received his award at the Global Engagement Exposition on April 10; the award is sponsored by the CIP.

Zorowski's research efforts focus on bringing a real sense to students of the practical side of engineering. A significant part of his research looks at how modern communication technologies can contribute to this goal for students pursuing graduate degrees through distance education. ▪

DR. JOSEPH TRACY



DR. YUNTIAN ZHU

Tracy, Zhu receive Alcoa Foundation Engineering Research Awards

The Alcoa Foundation Engineering Research Awards for 2014 were presented to **Dr. Joseph Tracy**, associate professor of materials science and engineering, and **Dr. Yuntian Zhu**, Distinguished Professor of Materials Science and Engineering, at the spring faculty meeting for the College of Engineering.

Tracy was awarded the Alcoa Foundation Engineering Research Achievement Award, which recognizes young faculty who have accomplished outstanding research achievements during the preceding three years. He has established himself as a leader in the synthesis, characterization, self-assembly and applications of metal and magnetic nanoparticles. The optical properties of gold nanorods make them desirable for use in biomedical applications ranging from imaging technologies to cancer treatment.

Zhu received the Alcoa Foundation Distinguished Engineering Research Award, made to a senior faculty member for research achievements over a period of at least five years at NC State. Zhu, considered one of the foremost researchers in the areas of carbon nanotube composites and nanostructured metals and alloys, has developed a new nanotechnology to enable the fabrication of ultrastrong carbon nanotube composites that is stronger than any current commercial composite materials. ▪

Three assistant professors receive Young Investigator Awards

Three faculty members in the College recently received prestigious Young Investigator (YIP) Awards from the US Air Force Office of Scientific Research (AFOSR) and the US Army Research Office (ARO).

Dr. Linyou Cao, assistant professor in the Department of Materials Science and Engineering, earned an ARO YIP to support his research on the electron-phonon coupling in two-dimensional materials. The results of Cao's research have the potential to lead to next-generation lasers, light emission diodes, and photo detectors that are important for defense needs.

Dr. Michael Kudenov, assistant professor in the Department of Electrical and Computer Engineering, earned an AFOSR YIP that will support his research project "Passive Snapshot Remote Sensing of Object Velocity." Kudenov's current research is focused on developing novel imaging systems, interferometers, detectors, and anisotropic materials related to polarization and spectral sensing for wavelengths spanning ultraviolet through the thermal infrared.

Dr. James LeBeau, assistant professor in the Department of Materials Science and Engineering, earned an AFOSR YIP, which will support his research project "A Transformational Approach to Quantify Chemistry at the Atomic Scale." LeBeau's current project centers on studying alloys deployed in extreme aerospace environments and how elements within these alloys interact, providing a critical step forward in new material development. ▪

DR. LINYOU CAO

DR. MICHAEL KUDENOV

DR. JAMES LEBEAU

Turinsky reappointed to Nuclear Waste Technical Review Board

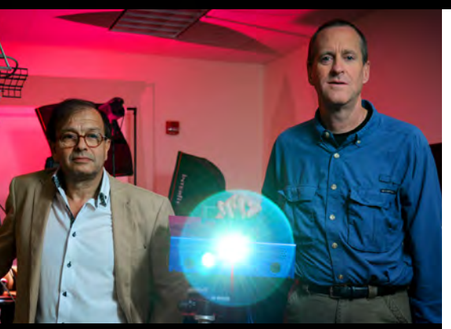
President Barack Obama has reappointed **Dr. Paul Turinsky**, professor of nuclear engineering, to the US Nuclear Waste Technical Review Board.

Turinsky has held a position on the board since 2012 and has taught at NC State since 1980, serving several stints as head of the Department of Nuclear Engineering. His reappointment was announced on June 12.

Turinsky also serves as chief scientist at the US Department of Energy's Consortium for Advanced Simulation of Light Water Reactors, a position he has held since 2010. From 1973 to 1980, he worked in a variety of positions for Westinghouse Electric and was an assistant professor of nuclear science and engineering at Rensselaer Polytechnic Institute from 1970 to 1973. Turinsky earned a BS from the University of Rhode Island, an MSE and PhD from the University of Michigan, and an MBA from the University of Pittsburgh.

The US Nuclear Waste Technical Review Board is an independent agency of the federal government that performs scientific and technical peer review of the Department of Energy's nuclear programs on high level waste and spent nuclear fuel disposition, providing recommendations to Congress and the Secretary of Energy. ▪

DR. PAUL TURINSKY



NC State's nuclear engineers will lead new nonproliferation consortium

Since May 2004, a federal agency tasked with securing vulnerable radioactive material around the world has removed or verified the removal of more than 4,100 kilograms of highly enriched uranium and plutonium.

That's enough material for 165 nuclear weapons, according to the National Nuclear Security Administration's (NNSA) Office of Defense Nuclear Nonproliferation R&D.

This so-called Special Nuclear Material (SNM) is scattered all over the planet. It's dangerous — and plentiful.

Keeping this material out of the wrong hands is an important effort that will now be helped by a new nonproliferation consortium being led by faculty in the Department of Nuclear Engineering at NC State.

The Consortium for Nonproliferation Enabling Capabilities (CNEC) will set the stage for research on the next generation of methods and tools to detect, locate, identify, and characterize SNM while also training future scientists and engineers to take up the nonproliferation effort in the coming decades.

The $25 million award from the NNSA Office of Defense Nuclear Nonproliferation R&D to fund CNEC is the largest research award in the Department of Nuclear Engineering's history.

The consortium's four focus areas are: identify and exploit signatures and observables associated with SNM production, storage and movement; develop simulation analysis and modeling methods to identify and characterize SNM and facilities processing it; apply multi-source data fusion and analytic techniques to detect nuclear proliferation activities; and develop viable replacements for potentially dangerous industrial and medical radiological sources.

CNEC's principal goal is for faculty to train students to be leaders in the nonproliferation field. To that end, a new CNEC fellowship program will be developed to attract nationally ranked graduate students in nuclear science and engineering. NC State will begin offering a new certificate program in the policy and technology of nuclear nonproliferation for engineering, science and nuclear science students. The consortium will provide a broad array of opportunities for NC State students across disciplines, including new courses and course materials, laboratory experiments, and opportunities to work with and be mentored by scientists at national laboratories.

NC State will partner with the University of Michigan, Purdue University, the University of Illinois at Urbana-Champaign, Kansas State University, Georgia Institute of Technology, North Carolina A&T State University, Los Alamos National Laboratory, Oak Ridge National Laboratory and Pacific Northwest National Laboratory.

A multidisciplinary team will be involved in the work at NC State. Nuclear engineering professor and department head Dr. Yousry Azmy will direct the effort. Dr. Robin Gardner and Dr. John Mattingly, faculty in the department, are co-principal investigators on the project, with Gardner serving as the consortium's chief scientist.

"For NC State to be selected to lead this vital national effort is a testament to our great faculty and strong leadership in nuclear engineering," said NC State Chancellor Randy Woodson. "NC State is increasingly recognized as the university of choice for government and industry partners who want to collaborate with world-leading faculty and students to solve some of our nation's biggest challenges."

TAPPING THE POWER OF UNIVERSITIES

The multidisciplinary NC State team behind CNEC includes faculty from the departments of Computer Science, Electrical and Computer Engineering, Statistics, Mathematics and Political Science.

Their expertise will shape the initiative's work on nonproliferation science and technology and create methods to mine data from a wide range of sources.

Using radiation detection equipment has long been the primary way to track the production and movement of SNM.

Along with work on new detection equipment and optimizing the capabilities of existing measurement devices, CNEC researchers will work to further the use of other kinds of data. That could mean satellite images or shipping manifests. It could mean tracking the sale of certain kinds of materials and components used in uranium centrifuges.

The University of Michigan is the lead university on the Consortium for Verification Technology, also announced by NNSA this spring, that will work on nuclear treaty-compliance monitoring. NC State is one of 13 institutions involved in that project with Mattingly serving as principal investigator on NC State's portion of the project.

A NEW DIRECTION

CNEC represents another big step forward for NC State's Department of Nuclear Engineering, home of the world's first non-governmental university-based nuclear reactor.

The department is already the lead university partner in the Consortium for Advanced Simulation of Light Water Reactors, or CASL as it is widely known, an effort to design the next generation of nuclear reactors and improve the ones online today.

One of Azmy's goals when he became department head in 2008 was to grow the department's work on nuclear security to complement its strong work on reactors and other nuclear research areas.

To that end, he hired Mattingly, a veteran of two national laboratories with extensive experience in nuclear security.

> "The work that they will produce will establish NC State as a prime academic site for innovative research and education designed to advance the case for global nuclear security."
>
> **DR. YOUSRY AZMY**

Azmy thinks that having Mattingly and Gardner, who boasts decades of research in radiation detection, helping assemble a team and selecting research areas to focus on was one of the factors that helped NC State's proposal beat out 22 others to land CNEC and play its lead role.

In the near term, leading the consortium will mean new faculty and postdoctoral research positions for the department, along with more graduate students and undergraduate interns. It will also position NC State's nuclear engineering program as a national leader in a research area that couldn't be more timely and important.

"The work that they will produce will establish NC State as a prime academic site for innovative research and education designed to advance the case for global nuclear security," Azmy said. "As our prestige in this area solidifies and grows, our faculty and students will have ample opportunity to contribute generously to our nation's, perhaps even the world's, safe and prosperous future." ▪

SYSTEMS-BASED APPROACH PAYS OFF

In its second year, ASSIST moves closer to a working health monitoring system

The goal of the Nanosystems Engineering Research Center for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST) — creating wearable health monitoring systems that are powered by the human body — is closer to becoming a reality.

The National Science Foundation (NSF) established ASSIST in 2012 with NC State as the lead institution. The goal: to improve global public health by combining nanotechnology and the power of the human body to create devices that measure patients' health and the environment that surrounds them as they go about their lives.

Fresh off its second site visit from NSF officials this spring, ASSIST is making big strides in human energy harvesting and building its first device platform. The network of industry partners that is supporting ASSIST is still growing as companies realize the kind of groundbreaking work the center is doing, Director Dr. Veena Misra, professor of electrical and computer engineering, said.

This year's site visit was held at the University of Virginia, one of three ASSIST partner institutions. Florida International University and Penn State University are also partners, and critical center research is also being done at UNC-Chapel Hill and the University of Michigan. The University of Adelaide in Australia, the Korean Advanced Institute of Science and the Tokyo Institute of Technology are global partners.

Whether the devices that grow from ASSIST research are worn as a patch on the chest or like a wristwatch, they will need to draw power from the human body. The amount of power our bodies produce varies throughout the day, depending on what type of activity we are involved in. The boost converters built into ASSIST devices will be tasked with powering the system, even when the user is snoozing on the couch.

Just as important in the first two years has been work on flexible form factors — finding ways to have the device adhere to the skin with minimal energy loss — and creating the ultra-low-power radios needed to transmit the health and environmental data gathered by the system.

With the ASSIST-developed platform, devices that take a number of health and environmental readings can be built. By the end of this year, ASSIST researchers hope to have a prototype respiratory tracker that takes an electrocardiogram reading from the patient and measures ozone in the air, then uses an algorithm to extrapolate the wearer's respiratory rate.

During this year's site visit, ASSIST leaders emphasized to NSF officials the strength of the center's systems-driven approach. The center's research areas come from the system specifications determined by end users — physicians, environmental scientists and electronic product manufacturers with a need for the systems ASSIST is working on.

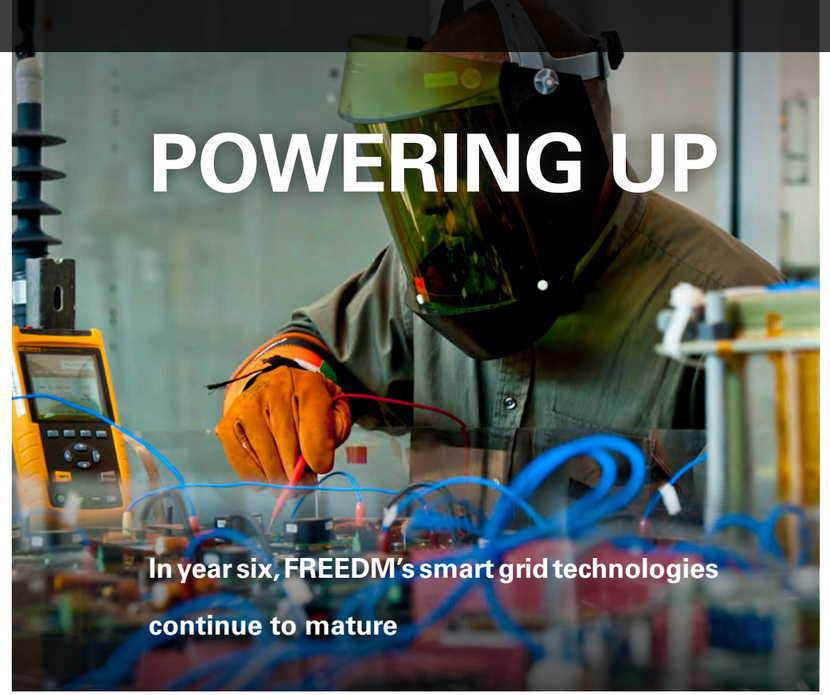
ASSIST's list of industry partners is long and includes hospitals and medical device makers along with energy harvesting and fitness companies.

"At the end of the day," Misra said, "industry is our gauge to how we are doing."

The hope is ASSIST partners take the technology being developed in the center and run with it, leading not just to economic development but also healthier lives.

"The long-term impact of our center's success is going to be measured by industry," she said. "If you can create an impact in industry, create jobs, create new directions for the wearable space, that's really the success." ▪

POWERING UP



In year six, FREEDM's smart grid technologies continue to mature

The Future Renewable Electric Energy Delivery and Management — FREEDM — Systems Center had a lot of new technology to show off to National Science Foundation (NSF) officials during the center's sixth site visit this spring.

FREEDM — an NSF Engineering Research Center led by NC State and tasked with changing the nation's power grid to accommodate renewable energy and enable bi-directional power flow, started in 2008 with an $18.5-million NSF grant. The addition of the ASSIST Center in 2012 made NC State the only university in the country to lead two ERCs at once and one of only two schools (along with Carnegie Mellon University) to ever be awarded the lead role in three.

The center — which includes partner institutions Florida State University, Florida A&M University, Arizona State University and Missouri University of Science and Technology and international partners Swiss Federal Institute of Technology in Zurich and RWTH Aachen University in Aachen, Germany — is based in the Keystone Science Center on NC State's Centennial Campus.

"The review went well from our perspective," said Rogelio Sullivan, managing director of the center. "We successfully demonstrated several of our energy technologies (solid state transformer, fault isolation device, communication and control systems) integrated into our Green Energy Hub laboratory, and they performed well."

Officials from NSF visiting in May saw two hours of technology demonstrations conducted by FREEDM students that included a look at FREEDM's Green Energy Hub, a model of the home of the future powered, in part, by renewables and able to send the extra energy it produces back into the grid.

Guided by NSF feedback from the visit, the FREEDM leadership team is redoubling efforts to recruit more domestic students, female students and students from underrepresented groups to study at the center through a recharged marketing effort and the hiring of a recruiting specialist. The NSF also asked FREEDM to analyze how cost-effective the center's innovations will be in the real world and to seek more outside guidance from the center's Scientific Advisory Board.

The center saw a change in leadership in year six, as director Dr. Alex Huang stepped down earlier this year to devote more time to research. Huang was responsible for envisioning the center, building the team, leading the research, and successfully guiding its growth for the first five years. Dr. Iqbal Husain, ABB Distinguished Professor in the Department of Electrical and Computer Engineering, is the center's new director.

FREEDM continues to graduate a significant number of the power engineers nationwide, according to Sullivan, and these graduates are being quickly snapped up by many of the center's industry partners.

Other successes include three start-up companies that have grown, in part, from licensing of center-developed technology. GridBridge, a developer of technologies designed to improve power management on the grid, is based on Centennial Campus.

Some of the biggest news for FREEDM this year, though, came on another part of NC State's campus. President Barack Obama came to Raleigh in January to announce that the university would lead the Next Generation Power Electronics Manufacturing Innovation Institute (now called PowerAmerica), a $140 million Department of Energy initiative that aims to create jobs while furthering development, deployment and domestic manufacturing of wide bandgap semiconductors.

These new semiconductors can operate at a higher temperature, voltage, and frequency than traditional silicon semiconductors, making it possible to reduce the size, weight, volume and life cycle costs in a wide range of energy, consumer, and industrial applications.

Led by Huang, the faculty and staff from FREEDM had the vision, conceived a comprehensive concept, recruited the industry partners, and wrote the winning proposal that brought the institute to Raleigh, Sullivan said. ▪

the engineering place

SUMMER PROGRAMS

go.ncsu.edu/espinfo

Summer Programs are part of the Engineering Place, the College of Engineering's K-12 outreach program. They were started a number of years ago as a way to introduce a diverse group of K-12 students to the many types of engineering and to show them through real-world challenges how engineers help people improve their lives. Day and residential camps are held in Raleigh and in other partner locations. In summer 2014, a total of 1,533 students attended the camps.

DAY CAMPS

The weeklong K-12 summer day camps are designed to have campers experience engineering through hands-on, creative investigations and design activities.

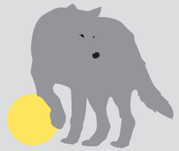
ELEMENTARY SCHOOL

Grade levels
Rising 3rd through 5th

Past activities
Putty Products, Newspaper Chairs, Rocket Design

Locations
Charlotte, Hickory, Raleigh and Rocky Mount

MIDDLE SCHOOL



Grade levels
Rising 6th through 8th

Past activities
Rube Goldberg on the Wall, Squishy Circuits, Egg Nest Drops

Locations
Charlotte, Havelock, Hickory, Raleigh, Rocky Mount and Wilson

HIGH SCHOOL

Grade levels
Rising 9th and 10th

Past activities
Ionic Imprinting of Hydrogels, Water Consumption, Biomimicry Challenge

Locations
Raleigh and Rocky Mount

RESIDENTIAL CAMPS

The discipline-specific residential camps at NC State are for rising 11th and 12th grade students. The camps allow students to explore engineering in depth through workshops and other activities and to experience college life. Engineering departments develop content for the workshops.

JOIN US NEXT YEAR

Open enrollment for day and residential camps is from January 5 through April 1. Visit **go.ncsu.edu/espinfo** for details, including acceptance criteria and fees.

CHALLENGE ACCEPTED

The National Academy of Engineering's 14 Grand Challenges for Engineering in the 21st Century name some of the toughest problems for engineers to solve. The challenges are in the areas of sustainability, health, security and joy of living.

- Integrated into the College's undergraduate curriculum
- Help shape summer camp activities to encourage students to think about their career goals early

DIVERSITY

Summer Programs celebrate diversity — the diversity of engineering disciplines and the diversity of students attending the camps.

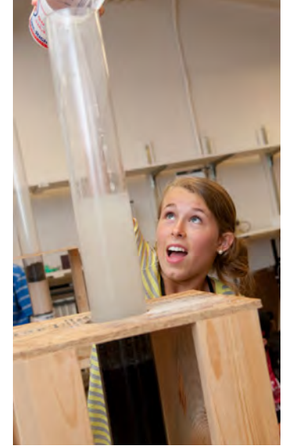
Summer 2014

- A middle school camp incorporating campers with hearing disabilities was held for the first time at the Eastern North Carolina School for the Deaf in Wilson
- Summer Programs have partnered with the Salvation Army to bring homeless children into summer camps through scholarships, including this year's camp in Raleigh

ENGINEERING IN THE CLASSROOM

Engineering activities challenge students to work with others to investigate and solve real-world problems.

- Creative and fun way for students to experience the relevancy of science, math and social studies
- Teachers hired for the summer camps in Raleigh and partner locations learn the benefits of engineering activities and take them back to their classrooms, grade levels and schools



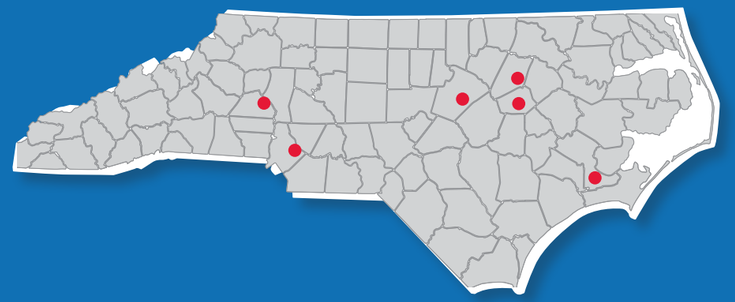
SUPPORT SUMMER PROGRAMS

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

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

PARTNER LOCATIONS

Summer Programs have established several partner locations in North Carolina and plan to increase those partnerships throughout the state. Summer camps are typically held in centers of higher learning to help students envision themselves attending a community college or university.



- **CHARLOTTE:** Queens University
- **HAVELOCK:** Craven Community College
- **HICKORY:** The North Carolina Center for Engineering Technologies, Appalachian State University
- **RALEIGH:** NC State
- **ROCKY MOUNT:** ECU/NC State Gateway Collaborative Center, NC Wesleyan College
- **WILSON:** Eastern North Carolina School for the Deaf

FROM THE GARAGE TO THE VALLEY

NC STATE'S ENTREPRENEURSHIP INITIATIVE PROVIDES IN-HOUSE TRAINING FOR ENTREPRENEURS-TO-BE

Being your own boss. Setting your own hours. Having your name on the front door. Those are the perks that come to mind when most people think of life as an entrepreneur. Natalia von Windheim wants more; she wants the freedom to change the world.

Thanks to her involvement with NC State's Entrepreneurship Initiative (EI) — a university-wide program encouraging entrepreneurial and collaborative efforts across disciplines — the idea doesn't seem too far-fetched.

Among the EI's innovative programs is an annual spring break trip to Silicon Valley — the northern California spot that has been a training ground for budding entrepreneurs while providing a historical blueprint for some of the most successful companies in the world. Since then, the creation of an on-campus entrepreneurial competition known as the Lulu eGames and a try-and-try-again space known as the EI Garage have followed.

BETA-TESTING AN EXPERIENCE

In March, von Windheim became part of the EI spring break tradition as she and 15 other EI students made the cross-country trip to Silicon Valley. The trip is made possible thanks to generous sponsors and friends of the EI.

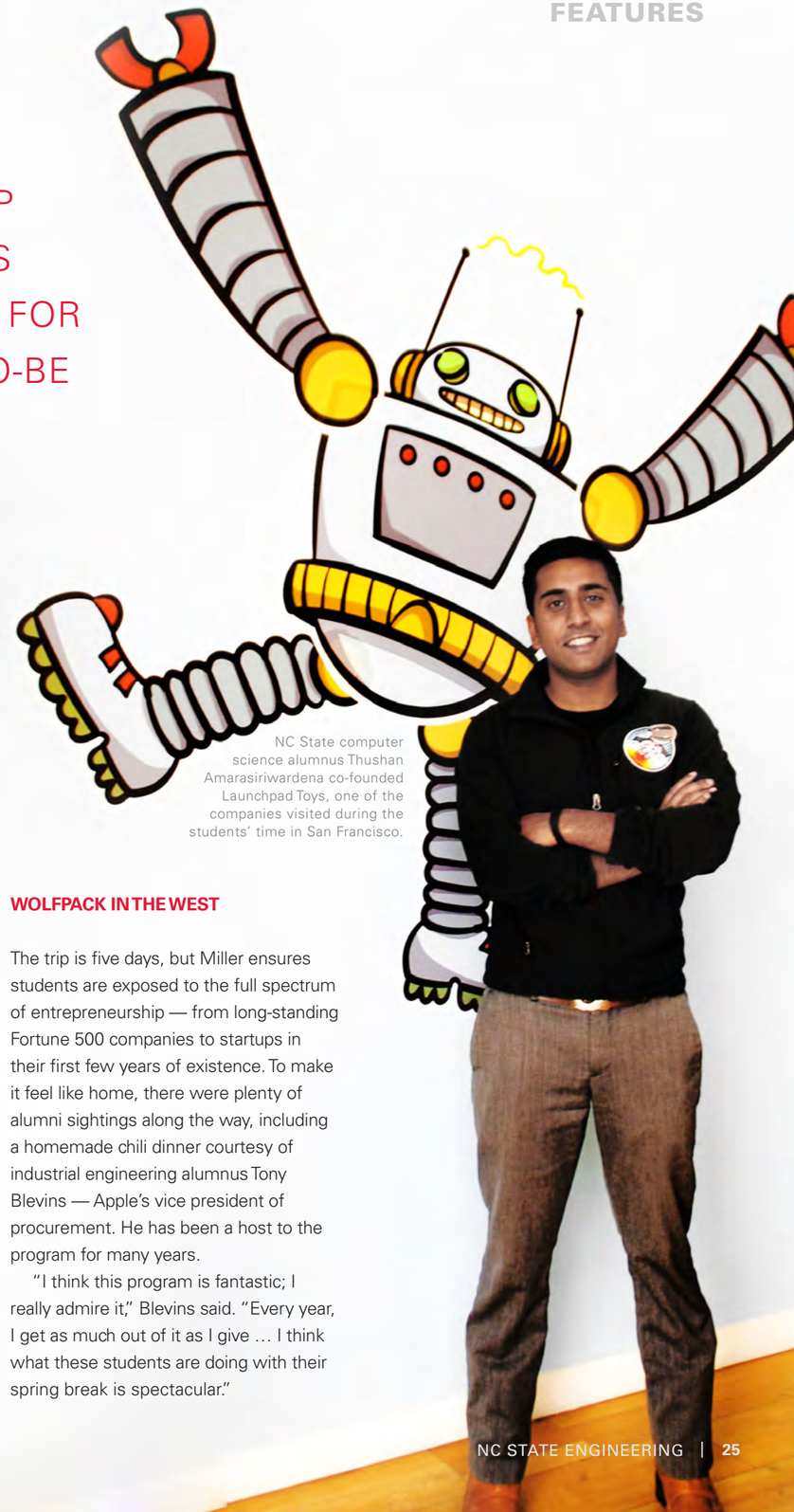
"It was really inspirational to go out there and see all the things happening," said von Windheim, a junior in materials science and engineering. "I think a lot of the things about the environment in Silicon Valley encourage people to be motivated — to make something happen."

Hearing this type of reaction is what keeps Dr. Tom Miller going. He is founder of the Engineering Entrepreneurs Program (EEP) and the EI, and it has been a decade since he first traveled with 12 students and three faculty members to California.

In the mid-1990s, Miller made a connection that would help bring the experience to life when he was invited to keynote at a meeting for department heads in electrical engineering. There, he met fellow keynote speaker Dr. Tom Byers from Stanford University, who invited him to attend what is known today as the Roundtable on Entrepreneurship Education Conference. During a later visit in the early 2000s, he and colleague Dr. Steve Walsh ran into a former student turned entrepreneur named Joe Britt — co-founder of Danger, the company that created the T-Mobile Sidekick. The interaction would inspire him to make his next big move: bringing NC State students out to Silicon Valley.

"After the very first one of these trips, going into it, I thought, 'Well, we'll probably do this one time — this will be the one and only time,'" said Miller, who is also the McPherson Family Distinguished Professor of Engineering Entrepreneurship. "But then, after the trip, we had a number of students coming and saying very sincerely that this was a life-changing experience. I realized we were doing something good."

This year's group — the largest cohort yet — included students representing disciplines from analytics to chemical engineering. Many were members of the EI Garage, a unique space on Centennial Campus that has all the things you'd need to transform a sketch into a pitch-worthy prototype. Others were members of both the Garage and the EI Ambassadors Program, of which von Windheim is president.



NC State computer science alumnus Thushan Amarasiriwardena co-founded Launchpad Toys, one of the companies visited during the students' time in San Francisco.

WOLFPACK IN THE WEST

The trip is five days, but Miller ensures students are exposed to the full spectrum of entrepreneurship — from long-standing Fortune 500 companies to startups in their first few years of existence. To make it feel like home, there were plenty of alumni sightings along the way, including a homemade chili dinner courtesy of industrial engineering alumnus Tony Blevins — Apple's vice president of procurement. He has been a host to the program for many years.

"I think this program is fantastic; I really admire it," Blevins said. "Every year, I get as much out of it as I give … I think what these students are doing with their spring break is spectacular."

"After the trip, we had a number of students coming and saying very sincerely that this was a life-changing experience. I realized we were doing something good."

DR. TOM MILLER

Dinner at Blevins' house was the end to a busy first day that included a walking tour of Stanford led by electrical and computer engineering alumnus Greg Mulholland. Mulholland, who also co-founded the Krispy Kreme Challenge at NC State, made the same trip during his senior year in 2007.

The next few days included travel to San Francisco to tour the city and visit entrepreneurs like NC State computer science alumnus Thushan Amarasiriwardena, who co-founded Launchpad Toys to develop digital toys and tools that empower kids to create, learn and share their ideas through play. The group later received personal tours and had lunch with alumni at Silicon Valley giants like Google and Apple. Sprinkled throughout the trip were stops at iconic spots like the Palo Alto Creamery and the Dutch Goose — the backdrops for many business deals.

Throughout the trip, students posed their best questions, including to a venture capitalist — the person they'll one day work with to receive funding for their next big idea. As they sat in a boardroom where previous entrepreneurs pitched business plans, their confidence allowed them to ask bold, timely and challenging questions.

"You only have one shot, so you've got to be confident," said Chad Etoroma, a senior in mechanical engineering. "The EI has definitely helped with that."

Having NC State computer science alumnus Marshall Brain, director of EEP, on the trip was a tremendous resource. He is founder of HowStuffWorks.com, and students look to him for guidance both in the classroom and as they venture out and interact with potential investors.

"It's interesting to see what they'll do when they get back," Brain said, reflecting on how students respond to their experience during the trip.

Later, when these students walk away with a degree, they'll have a network of alumni to meet if they decide to make the trip back to the West Coast.

"To see these alumni who were in their shoes as students just a few years ago, taking their classes and having this kind of success in the hottest tech community in the world — not only competing, but succeeding in this world — it lets them know their NC State degree will allow them to do anything they want to do," Miller said.

DRIVING THE IDEA — A NEW SPACE FOR THE GARAGE

The Garage is the place to be for EI students. The space was established in 2010 after Red Hat made a gift to NC State and quickly turned into more than a place to build a company or launch the next best thing.

Imagine a place with 3D printers for making a prototype in a few hours, a media room with hi-tech equipment that helps students make a creative video that will be pitched to investors, and a plush sofa to crash on when it's been a long day of brainstorming.

Well, that's the Garage.

The space was previously located in Research Building IV on NC State's Centennial Campus, but it became part of the new Andy and Jane Albright Entrepreneurs Living and Learning Village on Centennial Campus this summer. The Garage is now housed on the first floor of Innovation Hall, which is located in Wolf Ridge Apartments. Now, students can be neighbors and business partners.

Having resources like the Garage, fueled by other staple programs of the EI, attracts the next round of world-changing entrepreneurs to NC State.

"Many of these students — they've got the mindset, they've got the drive, they've got the passion, and they're going to do great things," Miller said. "If they do these great things as NC State alumni, it really makes the university more visible on the national and international scene in a positive way, a very positive way." ▪

OPENING THE GARAGE DOOR

What happens when students finish their products? Some end up at Maker Faire North Carolina. Others work with investors to see how far their idea can go. Here's what happens when students leave the EI Garage.

FRESH BOX

Allison Fairbank, Thomas Saile and Kate Sintavanon (not pictured)

"Think bigger."

That's what Allison Fairbank heard over and over as she and her team narrowed down ideas in her Engineering Entrepreneurs Program course. The push led to Fresh Box, a patent-pending compact countertop kitchen appliance that relies on modified atmosphere packaging, which removes the oxygen from the atmosphere surrounding food. There are three components: a countertop pump station, plastic containers to hold content, and four gas canisters with different gas compositions to meet the specific requirements to best preserve a piece of bread versus a block of cheese, for example.

» LIFE AFTER THE GARAGE

- **Joined the world's largest clean technology accelerator, the Cleantech Open**
- **Selected as part of New York Energy Week's Startup Showcase**

TRACK2QUIT

Tarang Patel, Suraaj Doshi, Anirudh Mulukutla and Ian Rogers

Smoking is the leading preventable cause of death in the nation, according to the Centers for Disease Control and Prevention. To help smokers take control of their habit, 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.

» LIFE AFTER THE GARAGE

- **Took first place at the Charlotte Venture Challenge**
- **Gained support from world-renowned smoking cessation center and its top experts**

KONNECT

Bradford Ingersoll and Tia Simpson

During an emergency, a cell phone isn't always nearby. Konnect is a band that, using Bluetooth-enabled technology, sends a text message that includes a user's GPS coordinates. People on the user's list of emergency contacts will receive the coordinates and can make sure help is on its way.

For now, the prototype's circuit can be found inside a plastic bracelet. The system, which is slightly larger than a watch battery, could one day fit inside a wristwatch or on another piece of jewelry such as a brooch or necklace.

» LIFE AFTER THE GARAGE

- **Appeared at Maker Faire North Carolina, representing NC State's Entrepreneurship Initiative**
- **In August, Tia Simpson began living at the ThinkHouse, a Raleigh-based nine-month living and learning accelerator** ▪

FEATURES

A VIRTUAL WHODUNIT

IC-CRIME PROJECT USES DIGITAL GAMING TECHNOLOGY TO SOLVE CRIMES

Crime scenes are fleeting.

Police and first responders are trained to disturb as little as possible at the scene of a homicide or other violent crime. But no one's perfect, and eventually the scene must be released. Homes must be occupied. Businesses must reopen. Traffic on a busy street must flow once more.

But what if you could preserve that space virtually, so that investigators and the specialists with whom they collaborate could return to the scene of the crime during the investigation?

That is the aim of IC-Crime, a multidisciplinary project led by faculty from NC State's College of Textiles working alongside colleagues from the Department of Computer Science and the College of Design to give real law enforcement a tool that might fit on the popular television drama "CSI."

IC-Crime's development is part of NC State's Digital Games Research Center (DGRC), housed in the Department of Computer Science on Centennial Campus. Work on the design of the IC-Crime software is overseen by Dr. Michael Young, professor of computer science, director of DGRC and a co-principal investigator on the project. Dr. David Hinks, Cone Mills Professor of Textile Chemistry and interim dean of the College of Textiles, is the principal investigator.

"The project has been a fantastic collaborative effort amongst computer scientists, industrial designers, management technology experts and textile chemists, all of whom are interested in contributing their expertise to the field of forensic science, which is ultimately applying science to the law and protecting the innocent as well as effectively convicting or identifying guilty parties," Hinks said.

ON THE (VIRTUAL) SCENE

In a world imagined by IC-Crime, an expert on blood spatter would sit down at her computer and access a secure server online. Investigators faced with a particularly vexing homicide case need her help.

She starts as an avatar walking into a virtual lobby. From that lobby, she chooses from several rooms in which to enter. Each room is a crime scene in another state or even another part of the world that she can see without leaving her desk.

Once inside the scene, she will be able to move around the room and look at things from different angles. Just as in a real crime scene, this room is filled with markers. By clicking on these markers, she is able to pull up additional data points like high-resolution photographs, information on shell casings or lab reports.

The homicide detective who has asked for her help is also in the room, represented by an avatar of his own. They are able to speak with each other within the virtual environment and even trade views of the room.

The work done to create this virtual environment was done by crime scene investigators as the scene was processed. After CSIs dusted for fingerprints and scoured the room for fibers, they also set up a 3D scanner on a tripod that took a digital scan of the room.

The kind of traditional paper trail that is part of an investigation has been scanned and added to the virtual setting, so the avatars can quickly pull them up by clicking on those markers.

And it doesn't stop there: The infinite power of the digital realm allows access to large databases. One example is an unprecedented database of commercially used dyes being assembled in NC State's College of Textiles under Hinks' leadership. Using that database to match dyed materials taken as evidence would allow detectives a useful tool to exclude or focus in on a suspect. The IC-Crime environment would make that tool available to all the collaborators in an investigation.

The software is integrated into the Unity3d computer game engine.

Unity provides a powerful 3D software environment to build upon, Young said, and allows the team to deploy the software remotely across a number of platforms.

Collaborators can log into the Unity environment via a Web browser without having to download any software onto their computer.

CHASING DOWN LEADS

The IC-Crime team at NC State has worked with the NC Program for Forensic Sciences, the North Carolina State Bureau of Investigation, the Wake City-County Bureau of Identification, and the North Carolina Justice Academy, among others.

Detectives from the Fayetteville Police Department invited the NC State research team to use a house in Fayetteville to set up a mock crime scene and scan it. The team staged a similar scene in the main hall of the Park Alumni Center on NC State's Centennial Campus. Young played the unfortunate deceased during

Dr. David Hinks, left, and Dr. Michael Young examine a virtual crime scene.

that simulation, a task that required lying motionless for several hours.

Collaborators from Arizona State University and Indiana University are conducting social science research that examines how the software affects the perceptions and understanding of the crime scene by the investigators who use it.

Tim Buie, an associate professor in industrial design, works with Young to create the visual elements within IC-Crime's interface. Dr. Roger Azevedo, a professor in NC State's Department of Psychology, is using tools including biometric data to study how a typical user interacts with IC-Crime and whether it can be made more user-friendly.

Young says working with artists, sociologists and psychologists is typical when building the kind of games being developed by the DGRC. These so-called "serious games" take core games technologies traditionally used for entertainment and use them to address a broad range of issues, including training, education, security, healthcare or social interaction.

"Games by their nature are multidisciplinary. They define an intimate relationship that sits at the boundary between technology and a player," Young said. "It's very natural that there's an engineering component to the research, but also a strong humanist element."

All that work has led to a system that is ready to go to the next phase, one that will transform it from a research tool to an investigatory one.

The three-year National Science Foundation grant that started the project will end in January. While Young and Hinks are seeking additional funding to continue research, the first version of the IC-Crime software is nearly complete.

Hinks says the NC State team is looking into proposals that include industry and university partnerships, and there has been interest from software companies in the United States and elsewhere.

Law enforcement agencies that want to use IC-Crime will need a digital scanner, a secure server to store the information and the flexibility to scan a crime scene. Scanners are expensive, but Young says that advances are being made — software that works with the Microsoft Kinect can make the motion-sensing device into the kind of digital scanner that is needed, and Google is working on smartphones that have 3D data acquisition capability.

In order for the system to be practical, scanning of crime scenes must be more efficient. It takes about 15 minutes for a digital scanner to take a 360-degree image of a room and because of laser shadows created by obstacles in the room, the room must be scanned more than once from different vantage points. Because of the impact the scanning laser has on the human eye, the room must be vacant.

The hope is that industry will perfect the IC-Crime system and then take it to crime labs that need the help.

"The work isn't done," Hinks said. "In many cases, we've done a lot of the groundwork, the basic work for IC-Crime. But there are many future levels that could be developed and should be developed."

CLOSING THE CASE

Hinks says he received an encouraging insight into IC-Crime's potential uses when discussing the idea with a Fayetteville Police detective who said he could see utilizing the technology during a suspect interrogation.

"So that's your version of the night's events?" a detective might ask a suspect. "Watch this digital simulation of exactly what the crime scene looked like that night. It shows that what you are telling me is impossible. Would you like to change your story now?"

"For me, that was quite illuminating," Hinks said.

Whether IC-Crime technology goes beyond the precinct house and into the courtroom remains to be seen. The benefits seem obvious: While jurors are sometimes taken to a crime scene, the passing of time means what they find is always different than what prosecutors and defense attorneys have described. With IC-Crime, they could see what that scene looked like the night of a murder. But is that what prosecutors, defense attorneys, judges and even investigators want?

Hinks points out that technology, including digital photography, is slow to make its way into the courtroom as defense attorneys find ways to poke holes in the new methods' accuracy and cast doubt in jurors' minds.

"There's tremendous benefit to be able to bring the crime scene to the jury as it was, but it's still a simulation and that will be challenged in the courtroom, no doubt," Hinks said. "My anticipation is that there will be some states that would be very reluctant to go down that road, and then there will be some states that will be quite open."

And investigators and prosecutors worry about what they refer to as "the CSI effect." The whiz-bang technology deployed on popular crime investigation television shows isn't always available for real-life law enforcement agencies, and the lack of the kind of technology jurors are familiar with from sitting on their couch might make it hard for them to convict when sitting in a jury box instead.

Other potential applications go beyond the homicide beat.

Crime scene photographers must learn what to shoot on the scene and how to shoot it. Staging crime scenes can be time-consuming and expensive. A virtual scene could provide a cheaper, easier training ground.

New prosecutors and defense attorneys need to know what to look for at a crime scene. So do investigators. The training potential for IC-Crime could be just as strong as its potential use in investigations.

Hinks even sees possible military applications as a tool to reconstruct a battlefield and determine what happened. Young mentions the US Department of Defense as a potential source for a next round of funding.

As Hinks says, "the platform that we are building has tentacles that can run into different arenas."

It's a project that provides a different perspective on the usefulness and impact of computer games.

"There's a breadth of new capabilities that game technologies enable that go well beyond entertainment," Young said. ▪

PLANS IN *MOTION*

"You just felt if you could develop something to help them, even if it was just one person, it would be huge."

DR. HELEN HUANG

NEW REHABILITATION ENGINEERING DIRECTOR HAS HIGH HOPES FOR THE FUTURE

Dr. He (Helen) Huang became interested in rehabilitation engineering when she saw what a challenge it was for one of her cousins to get around. Her cousin was born paralyzed, and as Huang watched her family member struggle with mobility, she wanted even more to help others dealing with paralysis.

"Knowing how difficult their daily living is and how the technology could help them motivated me to pursue this direction," Huang said. "You just felt if you could develop something to help them, even if it was just one person, it would be huge."

"I was interested in biomedical engineering from the beginning because it is a field where you can use an engineering approach rather than becoming a medical doctor to help people."

Huang joined the Joint NC State/UNC Department of Biomedical Engineering (BME) in July 2013. A year later, she was appointed as the new director of the Rehabilitation Engineering Initiative, founded in 2011.

The initiative combines the engineering knowledge of NC State and the medical strengths of UNC-Chapel Hill to evaluate, design, develop and promote improved care and function for individuals with short- and long-term rehabilitation needs.

The work done at NC State takes place primarily in Engineering Building III on Centennial Campus.

Knowing how important it is to work with the patients, the convenience of having a nearby amputee clinic appealed to Huang. "It was a no-brainer, I was going to come."

Today, Huang's bionic technology work allows an amputee to open, for example, a prosthetic hand based on neural/neuromuscular signals that initiated in the brain. To the patient, it feels as if they are controlling a real hand.

This differs from other methods of prosthesis control in which amputees are able to open a prosthetic hand using shoulder motion.

"Essentially, it is the technology that we're developing to help people with a limb amputation to live better, to have a better quality of life," she says.

She saw an opportunity to bring new technology such as smartphones and robotics into the field.

"It's available, and it really hasn't been translated to helping people with this disability," she said.

Smartphones can assist with the calibration of advanced prosthetics and real-time evaluation of their performance.

"Every time I see a technology works and patients are happy, that's really powerful. I guess that's the satisfaction that your research is really helpful, useful."

Huang received her PhD from Arizona State University, where she designed technology to help people with spinal cord injuries and patients recovering from strokes.

She was a postdoctoral research associate in the Center for Bionic Medicine at the Rehabilitation Institute of Chicago, recognized as the top rehabilitation hospital in the country.

From 2008 to 2012, Huang was an assistant professor at the University of Rhode Island, and was an associate professor there from 2012 to 2013.

With many years of experience as a rehabilitation engineer, Huang knows the field, the people working in it, what should be done and what's missing.

Dr. Richard Wysk, co-interim director of the program and the Dopaco Distinguished Professor in the Edward P. Fitts Department of Industrial and Systems Engineering, described Huang as "the perfect person for this opportunity."

She also knows how to work with clinicians and patients. And, for Huang, working directly with the people who will be impacted the most by her work is essential.

"You definitely need to work with patients to translate your technology to the clinics. They know what they want, so the technology they develop will probably benefit them the most. They will understand what they really, really need."

The proximity of the amputee clinic at the UNC Medical Center — a 30-minute drive from NC State's Centennial Campus — allows Huang and her research team to easily work with clinicians and patients. The Department of Biomedical Engineering provides a free shuttle between the two campuses for faculty and students.

The UNC Health Care system also includes Rex Hospital in Raleigh, where Huang works with Rex prosthetists, physical therapists and occupational therapists.

However, Huang's work will not only affect those living in this area. There are currently two million people living in the United States with limb loss — including an amputee from UNC-Chapel Hill who did a summer internship in the program. Approximately 185,000 amputations occur in this country each year.

"I do believe whatever research we're conducting will impact the whole nation," Huang said. "I am excited about the potential of the initiative because I have seen the great research that's already been done here."

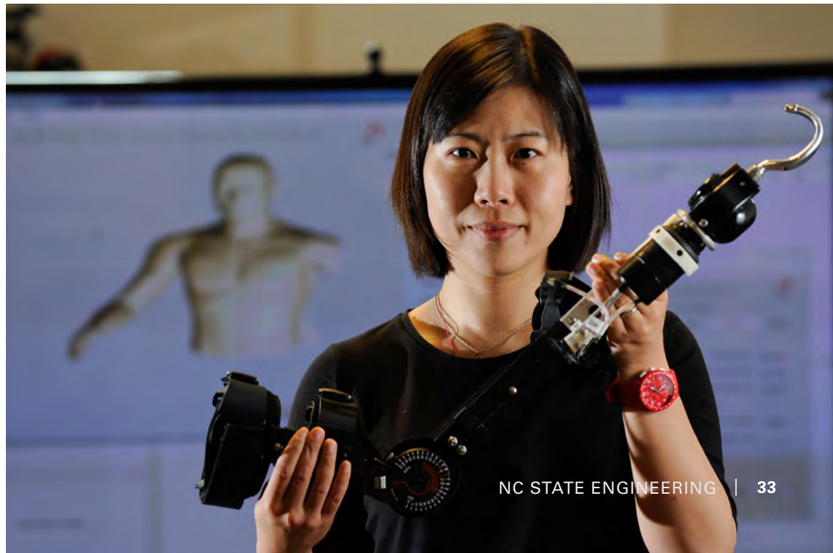
She looks forward to the new challenge of being in an administrative position and sees two major components to her role: to lead and define the direction they want to pursue and to hire people to work together toward that goal.

She recalls the three floors of patients, space devoted to research, and collaboration between researchers, doctors and patients at the Rehabilitation Institute of Chicago.

"That's the perfect environment because you interact with clinicians, physical therapists, occupational therapists, and then you work with the patients directly and you're doing research."

The joint program between NC State's College of Engineering and the UNC School of Medicine allows for the same kind of environment.

"I believe we have the capability to do that here. We have all the components," Huang says. "We need to start from our strengths." ▪



On return to campus, **CEO engages next generation of NC State engineers**

Funding for scholarships and an endowed professorship.

Steve Angel, a 1977 civil engineering alumnus and chairman and chief executive officer of Praxair, Inc., returned to campus on April 11. He addressed a room filled with engineering faculty and students, speaking about his career and the value of an engineering degree. He also offered students advice on finding success after graduation. At the close of the event, new signs were revealed in a lecture hall in Engineering Building I on NC State's Centennial Campus. The space was renamed the Praxair Lecture Hall.

Angel told students that engineers are in high demand and that a third of CEOs of Fortune 500 companies have an engineering degree, more than any other discipline. He said that getting through the rigors of earning an undergraduate degree in civil engineering from NC State gave him the confidence to take on whatever came next.

"An engineering degree provides a platform to launch your career in any direction," Angel said. "My NC State experiences and degree not only gave me the technical knowledge but fueled my intellectual curiosity, focus and discipline that have helped me be successful in business."

> "An engineering degree provides a platform to launch your career in any direction."
>
> **STEVE ANGEL**

The combined gift from Angel and Praxair is designed to support workforce development, diversity initiatives, teaching and research related to areas of engineering and technology of specific interest to Praxair.

"Supporting STEM education globally is critical to our long-term success. Praxair is constantly focused on developing a diverse pipeline of talented STEM professionals to ensure we always have the best talent and remain competitive globally," Angel said.

Angel's personal contribution of $667,000 will be matched by the state of North Carolina's Distinguished Professors Endowment Trust Fund to create the $1 million Angel Family Distinguished Professorship in Mechanical Engineering. The professorship will be awarded to a faculty member in the Department of Mechanical and Aerospace Engineering whose research activities include one of the following areas: heat transfer, turbo machinery, insulation, fuel efficiency, thermal integration, combustion, energy efficient processes, or computational fluid dynamics.

The company, through its Global Giving program, has committed an additional $666,000 to the College to support a mix of endowed and annual scholarships for students in chemical and mechanical engineering. These scholarships are intended to enhance diversity in the College as well as to pursue research and recruiting opportunities to further the College's efforts to train engineers in the fundamentals of sustainability. In addition to this commitment, Praxair funds international engineering and STEM-related programs and skilled trades scholarships targeted at educational institutions across the country.

"We are very grateful for the generosity and commitment of both Praxair and Steve and Lori Angel," said Dr. Louis A. Martin-Vega, dean of the College. "Their significant gifts will allow us to improve our academic stature, attract more people to the field of engineering, and accelerate our research efforts in areas of mutual interest."

A Fortune 250 company, Praxair is the largest industrial gases company in North and South America and one of the largest worldwide. Praxair produces, sells and distributes atmospheric, process and specialty gases, and high-performance surface coatings for a wide variety of industries, including aerospace, chemicals, food and beverage, electronics, energy, healthcare, manufacturing and metals.

Following the unveiling of the new signs, Angel and a team from Praxair got a chance to mix with engineering students and faculty during a lunch reception that was also attended by NC State Chancellor Randy Woodson. ■

PRAXAIR
Making our planet more productive

ON THE RECORD

Praxair CEO Steve Angel talks about the gift to the College of Engineering and what an NC State degree has meant to him.

1. Praxair and NC State have a strong relationship, one that is continuing to grow. Why is that relationship important to your company?

It is our responsibility as an employer of the best and brightest engineers in the world to support top engineering schools that ensure students have the foundation to succeed in an increasingly complex and dynamic global business environment. NC State is one of the best and is a strong source of diverse engineering talent. The school's highly rated engineering program produces students that are intellectually curious, humble, hardworking and hungry for opportunity – just the kind of people we want working with Praxair.

We typically hire about 50 new engineering grads each year straight from universities. About half of them go into one of our rotational programs, and the other half go right into a permanent engineering position. I know from my own experience that an NC State graduate will be a well-prepared, well-rounded and qualified candidate for us.

2. As an alumnus, why do you feel it is important to support NC State and the College of Engineering?

I believe in the school, the professors and the "product" – qualified and capable students. The gift from the Angel Family Foundation supports that commitment. It's also my responsibility to give back to the people and the institution that prepared me so well for my career. I'm fortunate to be in a position to help the university continue to build on its success and provide great educational opportunities for future generations.

3. The gift from Praxair will make it possible for several students to study engineering at NC State. What did an NC State engineering degree do for your career?

My engineering degree provided a solid platform that has served me well throughout my career. Success in engineering gives you the confidence and the critical thinking abilities to take on just about any discipline. My NC State experience fueled my constant thirst for knowledge and opened up a world of opportunities for me. I became more disciplined while I was in college and much more focused on what I wanted to do career-wise. My degree definitely put me on the right path.

4. The contribution from Praxair will support several areas that are important to the College, including the recruitment of women and members of under-represented minority groups to engineering and pointing students to STEM fields. Why are these priorities important for you and for Praxair?

We are facing a serious shortage of STEM graduates – both male and female – in the world today. Economic projections point to a need for approximately 1 million more STEM professionals than even the US will produce at the current rate over the next decade. In fact, fewer than 40 percent of students who enter college intend to major in a STEM field. Obviously, our industry relies on bright and talented STEM graduates, and I believe it's our responsibility to provide the support to help address the issue.

College names **2014 Distinguished Engineering Alumni**


JEFFREY R. GARWOOD


IRWIN R. HOLMES JR.

The College named Jeffrey R. Garwood, founder and managing member of Liberation Capital, and Irwin R. Holmes Jr., a former senior manager of computer development at IBM, as its Distinguished Engineering Alumnus award winners for 2014.

The award honors alumni whose accomplishments further their field and reflect favorably on the university. Dr. Louis A. Martin-Vega, dean of the College, recognized Garwood and Holmes at a banquet on Sept. 25.

Garwood earned his bachelor's degree in chemical engineering from NC State in 1984. Today, he leads Liberation Capital, a global private equity firm specializing in CleanTech solutions like alternative energy, waste water treatment and water reuse. He started his career at DuPont and McKinsey & Co., and was the chief operations officer at Commerx and Youcentric. He later led GE Engineered Styrenics Resins, Garrett Aviation Services and GE Fanuc Automation and is former president and CEO of GE Water & Process Technologies.

Garwood is a member of the NC State W.C. Riddick Society, and a bulk of his giving has gone to create the Garwood Family Scholarship. He previously served on the Board of Directors for the NC State Engineering Foundation (NCSEF) and has been active with the Department of Chemical and Biomolecular Engineering, including giving an address at a departmental commencement ceremony.

Holmes earned his bachelor's degree in electrical engineering from NC State in 1960; he also received a master's degree in electrical engineering from Drexel University. Recognized as the first African-American to earn an undergraduate degree from the university, Holmes stands among a distinguished group of trailblazers who had the courage to integrate institutions of higher learning in the South, as well as NC State and Atlantic Coast Conference athletics; he was co-captain of the men's tennis team.

Holmes worked for several companies, including IBM, where he spent 19 years as senior manager of computer development, earned two patents and was a key member of the task force that led to the development of the IBM PC product line. He supports the NCSEF and Minority Engineering Programs, and the Irwin Holmes and Black Alumni Society Conference Room on Centennial Campus was named in his honor. Also an entrepreneur, he has developed a shopping center and restaurant. ▪

Faculty members **establish legacy** with scholarship endowments

In a decades-long academic career, Dr. Hassan Hassan has never worked with a graduate student from his native Palestine.

The Hassan Family Fellowship Fund Endowment may help change that. The scholarship endowment established by Hassan, a professor in the Department of Mechanical and Aerospace Engineering, provides fellowships for incoming graduate students from the West Bank or Gaza.

Scholarship endowments are a great way for NC State engineering faculty members to support the College's mission and ensure that financial circumstances won't keep gifted engineering and computer science students from attending NC State.

Dr. Carl Koch, Kobe Steel Distinguished Professor in the Department of Materials Science and Engineering, recently established the Carl C. and Evelyn Koch Scholarship in Materials Science and Engineering to provide help for undergraduate students in his department in their junior or senior year.


DR. CARL KOCH


DR. HASSAN HASSAN

Koch, a National Academy of Engineering member, said that he was aware of similar gifts made by Dr. Michael Rigsbee, another professor in his department, and Dr. Korukonda Murty, professor in the Department of Nuclear Engineering. Koch consulted with Dr. Cheryl Cass, teaching assistant professor and director of undergraduate programs in materials science and engineering about the need for scholarships.

"I just decided it would be a useful thing to do," said Koch, who came to NC State in 1983 from Oak Ridge National Laboratory.

After graduating from Arab College, Jerusalem, Palestine, Hassan received a bachelor's degree in mathematics from the University of London. A Fulbright Scholarship brought him to the University of Illinois to earn master's and PhD degrees in aeronautical engineering. He has taught at NC State since 1962.

He said it is difficult for Palestinian students to come to the United States to study and that the Fulbright provided the opportunity he needed. Hassan says he was motivated to establish the endowment by those who have helped him during his career.

"It was only fair that I repay that help that I received," he said. ▪


DR. JOHN FISHER


DR. J. DARRIN HOLT


CHRISTOPHER MURPHY

NC State professors and alumnus build **global enterprise**

Raleigh-based FDH, Inc., a global engineering and construction management company, celebrated its 20th anniversary this year. Its entrepreneurial roots lie in the Department of Civil, Construction, and Environmental Engineering (CCEE) at NC State.

In the early 1990s, then-graduate student Dr. J. Darrin Holt and two professors of civil engineering, Dr. John Fisher and Dr. Robert Douglas, collaborated on a new technology to determine the length of in-place timber piles supporting transportation structures. That technology formed the basis of FDH, Inc., which was founded in 1994. Over the years, the company has honored its roots by giving back to the College and CCEE.

Fisher, now an emeritus professor, is a member of the FDH Board of Directors but has served as chairman of the board and president of the company. Fisher worked with Douglas in those early days to secure funding from the NC Department of Transportation (DOT). Holt, who holds bachelor's, master's and doctoral degrees in civil engineering from NC State, is chairman of the FDH Board of Directors and past president of the company. He worked on the project as Douglas' graduate student.

Holt said, "At the time of the project, there were about 6,000 bridges supported by timber pilings in North Carolina alone, and thousands more across the country."

He explained that, "knowing the length of in-place bridge piling is critical to evaluating both the scour susceptibility and capacity of these vitally important transportation structures. A non-destructive method for determining a pile's length, without digging it up or taking it out of service, proved invaluable to DOTs in the US."

It took two to three years to perfect the non-destructive technology in the laboratory and field, but eventually long hours of hard work resulted in a unique non-destructive testing methodology that used dispersive wave propagation, an area of stress wave mechanics.

"Once Bob Douglas and I published, we received a lot of phone calls wanting to know if we had really solved this problem and how it was done," Holt said.

Recognizing a business opportunity, Fisher, Douglas and Holt started FDH as a non-destructive testing company.

Working out of his college apartment, Holt was the company's only full-time employee, doing the marketing, fieldwork and reporting. Fisher, who had developed the business plan and provided part of the initial startup capital, handled the business end. Douglas, who has since passed away, served as Holt's "springboard" for solving problems.

Twenty years later, the company has six offices in the United States, more than 65,000 projects completed in seven practice areas, three US patents and 285 employees.

"We evolved from a testing company in which we evaluated aging infrastructure to a true engineering and construction management company with the ultimate goal of being a program management company," said Christopher Murphy, now president and CEO of FDH, and the next generation of NC State alumni assuming a leadership role at FDH.

Murphy, who received his master's degree in civil engineering from NC State in 1999, joined FDH in 2000. Since that time, he has been instrumental in utilizing his expertise and background to grow the company into a professionally managed global entity that is highly regarded as the leader in each of its practice areas.

FDH has been supportive of CCEE, for example, funding the department's annual alumni newsletter. The company also maintains ties to the department through participation on boards, research collaborations and recruitment.

The company recruits about 40 percent of its engineers from NC State. Fisher, Holt and Murphy all agree that recruitment is high because of the caliber of the students and the CCEE program and the proximity of FDH headquarters to the university.

"We know the type of education everyone is getting at NC State. It is not just open a book and follow the building codes," Holt said. "It's independent thinking. It's innovation." ▪

JAYLON ALEXANDER

RACHEL NORDBERG

STUART PHILPOTT

ABIGAIL SOBCZYK

HIGHER EDUCATION

As costs go up, Dean's Circle donors continue to support engineering and computer science students.

Graduating with little or no debt seems like a rare opportunity these days. Students must pay for tuition, room and board, and other expenses; they're also trying to focus on financial freedom following life after college.

Members of the Dean's Circle, the College of Engineering's leadership annual giving program, know the challenges faced by the next generation of engineers and computer scientists. To make an impact, they generously contribute $1,000 or more to the Leadership Fund, which goes directly to scholarships and fellowships for engineering and computer science students.

The gifts are the means for a fresh start for bright students like Abigail Sobczyk who wanted to return to school to learn more about the chemical engineering field. Sobczyk had plenty of industry experience, including time as a process control engineer on a North Slope oilfield in Alaska, but foregoing the financial security of an industry job to return to school seemed intimidating. Being named a scholarship recipient made the decision much easier. She is now performing experimental and simulation studies on processes used in semiconductor fabrication.

Dean's Circle donations also allow students to explore and take advantage of research opportunities. Aerospace engineering student Stuart Philpott spent the summer working with a team of fellow students to develop a miniature satellite for space research as a part of NASA's CubeSat Launch Initiative. Rachel Nordberg, who's pursuing a doctorate in biomedical engineering, is examining a cell-signaling pathway known to be involved with bone loss in space. The research may also have earthly implications — doctors could one day have more insight into treating patients with osteoporosis.

One gift makes a difference. One act of generosity makes an NC State engineering degree possible for students working on today's solutions to tomorrow's biggest problems.

When Jaylon Alexander arrived on campus this fall, he became the first person in his family to attend a four-year university. Alexander, a Goodnight Scholar who has loved taking things apart and reassembling them to working order since childhood, intends to pursue a mechanical engineering degree.

"'Thank you' would be the first thing I'd like to say," Alexander said. "It's already stressful enough being an engineering student. Having a scholarship makes it that much easier." ▪

More information:
Visit **www.engr.ncsu.edu/foundation/deanscircle**
or contact Angela Stallings at angela_stallings@ncsu.edu or 919.513.1714.

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The 2013-14 Dean's Circle recognizes individuals and corporations that made unrestricted gifts of $1,000 or more to the College of Engineering and its departments between July 1, 2013, and June 30, 2014. For alumni up to 10 years after graduation, gifts of $250 or more qualify for recognition in the Dean's Circle. Those with company matching gifts are recognized for the combined total of their gift. We apologize for any omissions or errors. If you have a correction, or would like to know how to become a Dean's Circle member, please contact Angela Stallings at angela_stallings@ncsu.edu or 919.513.1714.

Engineering legacy

Engineering operations alumnus establishes scholarship for Forsyth County students

As a boy growing up in Winston-Salem, NC, Van Crotts would spend all day during the summer along Silas Creek, which ran through his family's property, catching critters.

"On the back porch of our house I'd have aquariums full of frogs and snakes and turtles," Crotts said. "In my room, I had three aquariums going where I'd have tropical fish. I was just really into that and enjoyed it."

So it was no surprise when Crotts went to NC State in 1976 to study wildlife biology.

Actually, it was a bit of a surprise. His father, Marcus B. Crotts, is an NC State mechanical engineering alumnus and a co-founder of Crotts & Saunders, a full-service machine tool distributor in Winston-Salem.

Like so many young men, though, Crotts didn't want to follow in his father's footsteps. That is, until he figured out the pay scale for a wildlife biologist.
On a trip home during his first fall break at NC State, father and son had a conversation about what engineers actually do. It sounded pretty cool to the younger Crotts.

"And that Monday morning, I transferred to engineering," Crotts said.

After a successful career that started with that decision to switch majors, Crotts and his family have established a scholarship to help others have the same opportunity.

Armed with a degree in engineering operations in 1980, Crotts headed to Wake Forest University for an MBA. He had other job offers with larger salaries out of graduate school, but Crotts chose to go to work for the family business.

It was an opportunity to work with his father, but also a chance to do work that he found fascinating. Crotts & Saunders, which began as a designer of special tools and fixtures, eventually became a sales company representing businesses that designed and manufactured machine tools.

Look around your house and you'll see all kinds of pieces these tools produce — the rollers on that office chair, the handles on that desk drawer, brackets that hold up your tables and the doorknob you use to go outside. The pistons in a chain saw and the turbine blades in a jet engine are also parts manufactured by machine tools. It's essential work that largely goes unnoticed.

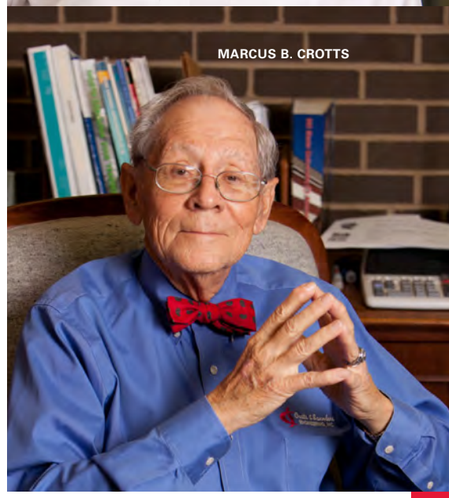
"It's a cool industry because it operates under the radar," Crotts said. "Few people know that we're out there."

Crotts brought a unique skill set to his family's business — the outgoing personality of a salesman and the engineering expertise to help identify clients' needs. He worked as the company's Eastern North Carolina rep, covering territory from Burlington to the coast, and settled in the Triangle.

In fall 1994, Crotts was able to buy co-founder Charles Saunders' share of the company. Crotts and his wife, Sally, returned to Winston-Salem. Crotts spent 12 years running the company, which the family sold last year.

Crotts chaired a committee for the North Carolina Society of Engineers that interviewed scholarship candidates.


VAN CROTTS


MARCUS B. CROTTS

He had done something similar for his Rotary Club.

So he called it a "natural progression" to establish a scholarship himself. The couple says they have been financially blessed and think it's important to support the future of NC State engineering.

The Van Jackson Crotts Scholarship will benefit engineering students from Forsyth County who are in their sophomore year or above.

"We want to give back," Crotts said. "It's important." ▪

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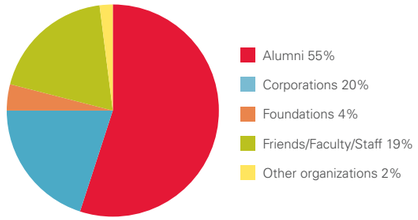
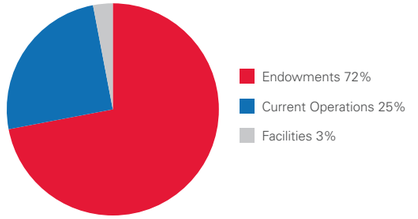
Foundation Year in Review

The NC State Engineering Foundation raised more than $20.2 million in private gifts and new commitments in fiscal year 2013-14 to support educational experiences and groundbreaking research being conducted by students and faculty in the College of Engineering. That is 16 percent more than was raised the previous fiscal year. The accompanying charts illustrate the sources and uses of that private support.

GIFTS AND NEW COMMITMENTS BY GIFT SOURCE, FISCAL YEAR 2013-14



GIFTS AND NEW COMMITMENTS BY GIFT USE, FISCAL YEAR 2013-14



Our priority has remained raising gifts to build the College's endowment. More than $14.6 million of new commitments and gifts booked last year were to endowment. Those gifts are the most important and enduring investments donors can make in the College, and they have a profound impact on our ability to attract and retain people — the students and faculty who define the College. There is a strong correlation between the growth in endowment giving and the growth in giving by alumni. Endowment is one of the most important ways that alumni donors can establish a legacy at their alma mater. The permanence of endowment provides us the opportunity to recognize our endowment donors through namings, preserving legacy for the donor and establishing an important leadership standard for others.

On university campuses, facilities projects — bricks and mortar — are the other means through which philanthropists can leave their mark, and their name, on the school's future. We expect that facilities will make up a much larger share of the designation of new gifts next year. Our incredible home on Centennial Campus inspires and enables our faculty and students to solve big challenges every day, and we look forward to inviting our donors to play a key role in unifying the entire College. On behalf of the students, faculty and staff, the Foundation expresses its sincere thanks to all who continue to give so generously. ▪

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HANDBALL,

AN NC STATE ENGINEERING TRADITION

Within an hour of Dr. Donald Bitzer's arrival at NC State in 1989, he was playing handball with Dr. Thom Hodgson.

"We just beat the crap out of each other," Hodgson remembers of their first game.

The two engineering professors had been playing nearly their whole lives.

"I started playing and couldn't stop," says Bitzer, a Distinguished University Research Professor in the Department of Computer Science and Emmy-award winner for his work on the plasma television screen.

Hodgson, a Distinguished University Professor in the Edward P. Fitts Department of Industrial and Systems Engineering, was introduced to the game in 1962 as a transportation officer in the US Army. At an invasion staging area in Orlando, Florida, he didn't have a lot to do after the Cuban Missile Crisis passed, he recalls. During this time, a friend from another company introduced him to the game.

Bitzer and Hodgson, who are both National Academy of Engineering members, played six days a week (every day except for Saturday) at the Carmichael Gym on campus. Together, they won three NC State intramural doubles championships.

Bitzer first came to NC State on a trial basis. Hodgson, who at the time was head of the Department of Industrial and Systems Engineering, says he knew if he could show Bitzer a good handball game, his colleague would make NC State a permanent home. Bitzer later admitted to Hodgson that this was the case.

"We had a lot of fun," Bitzer says, "It was a good group of people."

Hodgson offered any students who could beat him on the court an A in his class. But no one ever received this A. Thus proving the old adage, "Old age and treachery will always overcome youth and skill," as Bitzer recalls.

"We just became very good friends. Our wives are good friends," says Hodgson. "Bitzer is a really smart guy. It was fun to play with Bitzer because he's such a smart handball player."

Hodgson recalls that Bitzer would somehow manage to dink the ball into the corner of the court during doubles matches and win the point. The other teams wouldn't realize he was doing this on purpose until it was too late.

Bitzer played into his seventies, but had to stop a few years ago because of knee problems. Hodgson continues to play today.

NC STATE Engineering

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Dr. Jay Baliga and Dean Louis Martin-Vega will be among the speakers.

- **Tour the Engineering Building Complex on Centennial Campus**
- **Enroll your children ages 5-18 in Engineering Mini-Camp**

HOMECOMING WEEKEND KICK-OFF

NOVEMBER 7, 2014

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