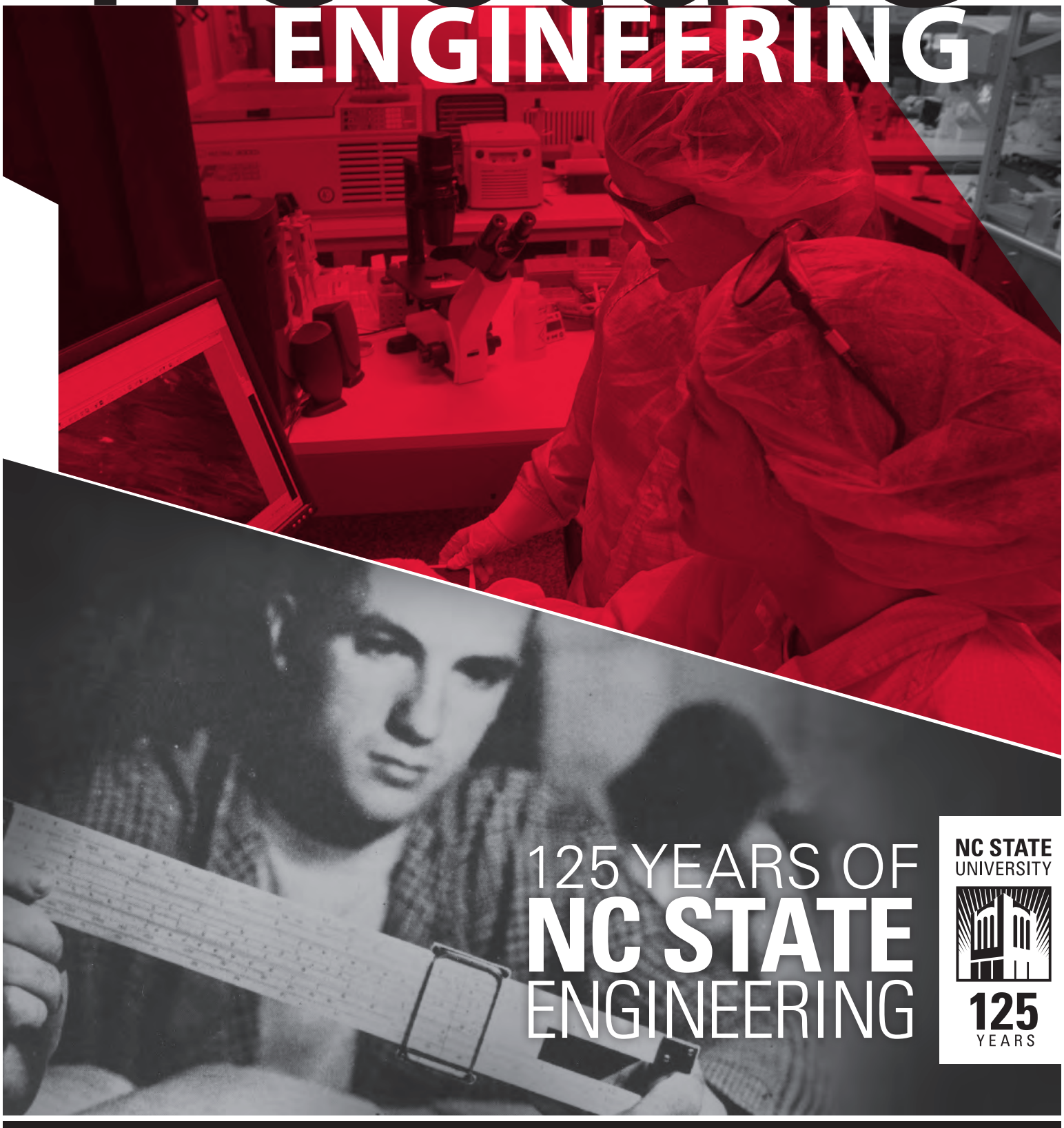
SPRING/SUMMER **2012**

nc state ENGINEERING



125 YEARS OF NC STATE ENGINEERING

NC STATE UNIVERSITY

125 YEARS

THE PATRON SAINT OF ENGINEERS?

Most people know Saint Patrick as the patron saint of Ireland. His big day is March 17.

Less well-known is that, for a time at least, engineers considered him the tongue-in-cheek patron saint of their profession.

This connection involves a worm drive, a gear arrangement in which a worm — a gear in the form of a screw — meshes with a rotating circular gear. Engineers have employed such drives in everything from automobiles to ship rudders to guitars.

There's no evidence that Saint Patrick used a worm drive during his missionary work in Ireland in the 5th century. But that didn't stop NC State engineering students from honoring him with a 200-foot snake replica that was paraded through downtown Raleigh as part of the 1930 Engineers Fair.

The story connecting engineers with Saint Patrick goes something like this:

Patrick is famous for driving the snakes out of Ireland. Snakes look like large worms. Therefore, Patrick completed the first "worm drive."

And since engineers use worm drives, Patrick is the patron saint of engineers.

Makes sense, right?

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nc state ENGINEERING SPRING/SUMMER **2012**

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ON THE COVER: In the days before computers, NC State engineers used slide rules (below) to make calculations. Now our engineers work to create bone tissue from adult stem cells (above). See page 20 for 125 years of NC State engineering highlights, from 1887 to today.

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Did you know?

Did you know that NC State has the largest biomanufacturing training facility in the world? The 82,500-gross-square-foot Golden LEAF Biomanufacturing Training and Education Center on Centennial Campus saw nearly 1,000 students and industry members take its courses in 2010-11. Its goal: Expand the state's already robust biomanufacturing industry.

FROM THE DEAN

Louis A. Martin-Vega

I am happy to report that the College of Engineering has much to celebrate during this 125th anniversary of NC State University.

Our research expenditures continue to be strong and are predicted to equal or surpass last year's record total. Two of our faculty members were honored with Presidential awards: Dr. Jay Baliga received the National Medal of Technology and Innovation, the nation's highest honor for technological achievement, and Dr. Michael Escuti was awarded a Presidential Early Career Award for Scientists and Engineers, the top honor for young scientists and engineers. These lofty honors show once again that within our faculty are some of most talented engineers and computer scientists in the world.

Our students have also received significant honors. Most recently, NC State's team of engineering and design students won the national Walt Disney Imagineering ImagiNations Design Competition for their work on a theme park proposal set on the moon in the year 3011. The first place award for this extraordinarily creative project marks the third time in four years that our students have placed in the top three in this competition.

This issue of our alumni magazine may be among my favorites because it features an article on some of our finest undergraduate researchers. The piece hits on a topic that is central to the vision of this college — the integration of research and education. Fusing the two is key to producing graduates who are able to think critically about the challenges facing our society. You will undoubtedly be as impressed as I am by these students.

Our achievements are even more remarkable in that they come during a year marked by what have been arguably our most severe state funding cuts in decades. While the budget reduction was painful, we made strategic decisions to protect our students, faculty and degree programs.

In spite of the budget cuts, the work of our faculty, staff and students keeps boosting North Carolina's economy. The start-ups that result from our research and our Engineering Entrepreneurs Program continue to create jobs. Our graduating students continue to find positions with excellent starting salaries. And our programs have never been in greater demand. Moving forward, it is imperative that we continue to invest in engineering in North Carolina. Our state's prosperity demands it.

I hope you enjoy this edition of your magazine. I invite you to contact us to learn more about your college and the many opportunities to support our efforts.

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

Engineering new White House connections

The list of connections between NC State engineering and the White House is long – and it's getting longer.

Last fall, Dr. B. Jayant Baliga received the National Medal of Technology and Innovation, the nation's highest honor for technological achievement. He is the third member of the NC State engineering family to receive the award, joining faculty member Dr. Jerome Cuomo and alumnus Dr. Calvin H. Carter Jr.

And Dr. Michael Escuti was the College's third recipient of the Presidential Early Career Award for Scientists and Engineers, another top honor. Baliga and Escuti, faculty members in the Department of Electrical and Computer Engineering, accepted their awards at the White House.

Earlier in 2011, NC State engineers' ground-breaking smart grid work helped prompt the White House to choose the university to host a roundtable discussion on the smart grid and energy with members of President Barack Obama's Council on Jobs and Competitiveness. The visit included a tour of the FREEDM Systems Center, a National Science Foundation Engineering Research Center dedicated to smart grid technology and distributed energy.

President Obama was later briefed on the council's findings during an afternoon event at Cree, the Durham-based LED lighting company co-founded by NC State engineering alumni. He also spoke at Reynolds Coliseum during a separate event in September. ▪

Q & A

Questions for JAY BALIGA

Dr. B. Jayant Baliga traveled to the White House last fall to receive the country's highest technology honor, the National Medal of Technology and Innovation. Baliga, Distinguished University Professor of Electrical and Computer Engineering at NC State, talks about growing up in India, inventing the landmark energy-saving Insulated Gate Bipolar Transistor (IGBT) device, and meeting President Obama.

What was your childhood like?

I was born and grew up in India. My father was an electronics engineer and became the first chief engineer for the national radio network after India's independence. When I was nine, he brought home a TV to test whether a video transmitter the network had placed at a big exhibition event had the range to reach our house. That test represented the country's first television broadcast, and it took place in our living room.

What got you hooked on electrical engineering?

My father's work inspired me to become an electrical engineer. Then, during my third year at the Indian Institute of Technology, I discovered Richard Feynman's "Lectures on Physics" and became interested in semiconductor devices. I decided to do my graduate work on semiconductor transistors and processes.

How did you develop the IGBT?

In 1980, my group at GE was challenged to create a compact, highly efficient heat pump using semiconductor technology. I had already been working on power transistors, and within a month I prepared a patent disclosure for what would become the IGBT. Due to its widespread potential impact, I was asked in 1981 to present my idea to CEO Jack Welch, who enthusiastically supported its commercialization. By 1983, the IGBT was being used all over the company.

What has made the IGBT so important?

The IGBT enabled controlling large amounts of power with inexpensive control circuits while increasing power efficiency 40 to 70 percent. Now it's used in everything from refrigerators to bullet trains. It's saved the world's consumers $15.8 trillion in energy and gasoline costs and has reduced carbon dioxide emissions by 78 trillion pounds over the last 20 years.

Describe your work with NSF FREEDM Systems Center.

FREEDM is working to get more renewable energy on the power grid. My group is developing the power devices inside FREEDM's solid-state transformer, a remarkable innovation that will enable consumers to connect devices that generate and store energy with their homes and offices.

What's it like to receive a medal at the White House?

It was a grand affair in the East Room with bright lights and cameras clicking away. It was difficult to maintain my composure as I thought about the long road leading to that moment. I said something to the President when I shook his hand, and he gave a gracious reply. But you'll have to wait for my memoir to learn what we exchanged!

A new knee for Cyrano

A big tabby named Cyrano received international attention in January for being the first-ever feline recipient of an osseointegrated knee implant. It happened at NC State.

Cyrano had previously been successfully treated for bone cancer, but the disease and treatment weakened the bone in his affected back leg and his knee deteriorated as a result. The implant production and subsequent knee replacement surgery happened because of a collaboration between industrial and systems engineer Dr. Ola Harrysson and orthopedic surgeon Dr. Denis Marcellin-Little.

ABC News, the Associated Press, and the London *Daily Mail,* among many other media outlets, ran the story. ▪

Creativity personified

Look no further than NC State for one of the South's most creative teachers. Dr. Michael Steer is just that, according to *Oxford American* magazine.

Steer, Lampe Professor of Electrical and Computer Engineering, "used his expertise in electrical engineering to develop a method of detecting the cell-phone triggers used to detonate roadside bombs," the magazine said. The work has saved hundreds of soldiers' lives in Iraq and Afghanistan.

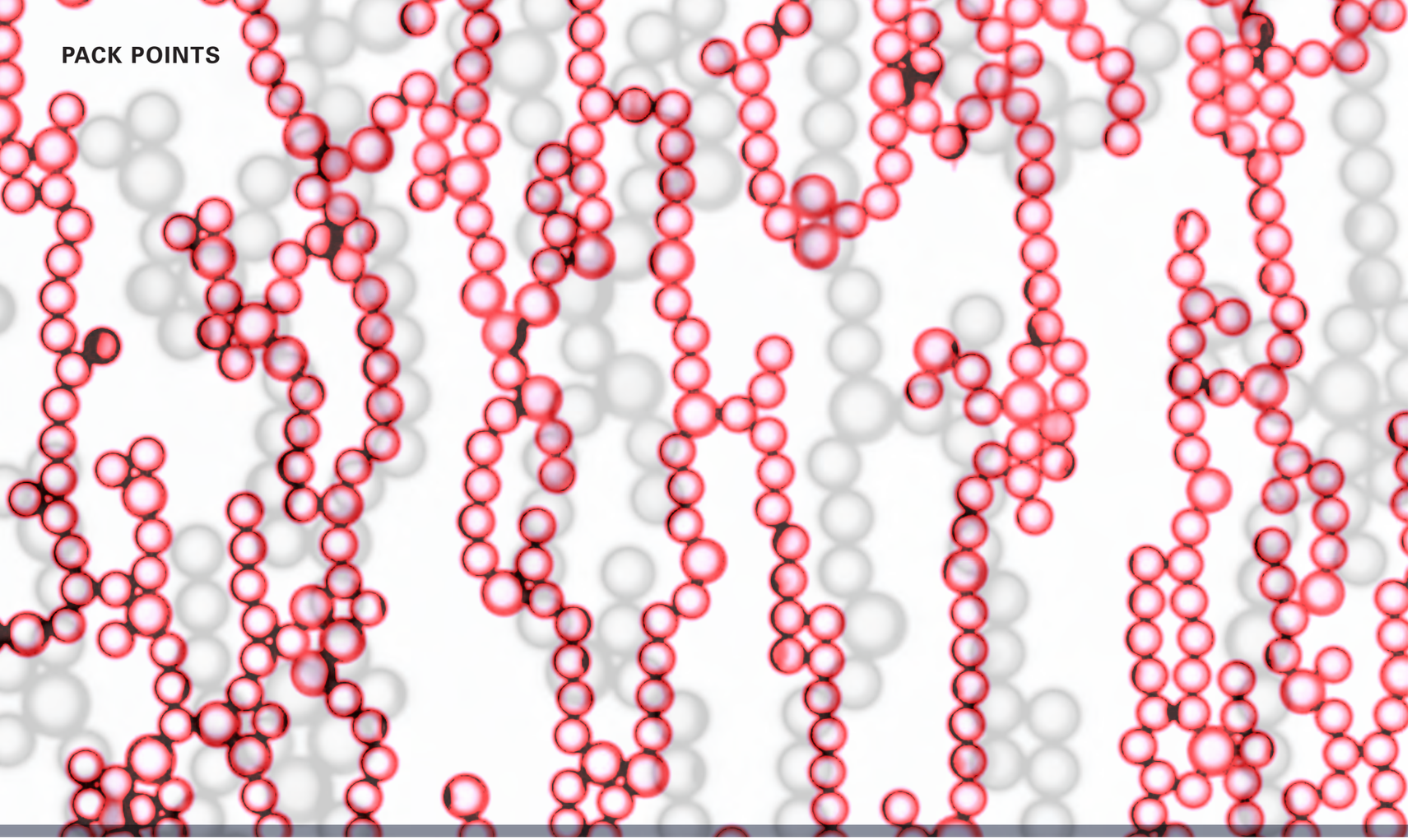
Steer's efforts also earned him the US Army Commander's Award for Public Service in 2010. ▪

Tar Heel of the Week

In March, the *News & Observer* recognized Dr. Laura Bottomley as its "Tar Heel of the Week." The Sunday feature highlights North Carolinians who have made a significant impact within the state.

Bottomley "has made a specialty of breaking down barriers in her 15 years leading outreach efforts for the College of Engineering," the story said. "She works with children as young as elementary school, trains their teachers, and has helped form state and national education policy. Her work has earned her many honors, including a trip to the White House to receive a mentoring award."

That last sentence? A reference to Bottomley's 2009 Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring. ▪



Hard research on soft matter

NC State engineers are playing a leading role in a new multi-university center that focuses on soft matter research, a branch of materials science with almost limitless practical applications, from organic solar cells to tissue implants to new classes of drugs.

Recognizing that some of the leading scientists and engineers involved in soft matter research are located in the Research Triangle area, the National Science Foundation provided a six-year, $13.6 million grant to establish the center in 2011.

NC State is expected to receive about $4 million of the center funding. The initiative is a collaboration between researchers at NC State, Duke University, the University of North Carolina at Chapel Hill and North Carolina Central University.

In general terms, soft matter describes such states of matter as foams, gels, polymers or emulsions. They are typically created by combining smaller particles — such as DNA, proteins and nanoparticles — to form larger structures with novel properties. The researchers involved in this project will not only investigate how and why these particles assemble in certain ways but also how this assembly can be manipulated to achieve soft matter with defined and often unique characteristics.

The new initiative is known as the Triangle Materials Research Science and Engineering Center (MRSEC). The center joins a prestigious network of university centers across the country, each of which has a specific focus on a cutting-edge area of materials science.

The center's research team includes six NC State professors. Dr. Carol Hall, Camille Dreyfus Distinguished University Professor of Chemical and Biomolecular Engineering at NC State, serves as co-principal investigator for the center. Dr. Orlin Velev, INVISTA Professor of Chemical and Biomolecular Engineering, leads one of its two thrust areas.

"This center is the remarkable result of a convergence of ideas from some of the world's leading soft matter experts at universities right here in the Triangle," Hall said. "Working together, this diverse group will develop new materials that help solve some of humanity's most challenging problems while jump-starting the careers of the next generation of soft matter researchers and entrepreneurs." ▪

$148.4 million = One year of research

"I've been on the faculty here for more than 30 years," Keltie said, "and I've never seen a period of such **sustained investment and expansion in the College**."

Dr. Dick Keltie is seeing a lot of green. The associate dean for research and graduate programs says College faculty are garnering unprecedented support from federal funding agencies for research projects.

The numbers speak for themselves. College research expenditures have grown a staggering 42 percent over the past five years. That includes a 15 percent jump from fiscal years 2010 to 2011, when College researchers spent $148.4 million.

Engineering now leads all NC State colleges in research expenditures from contracts and grants, the first time that's happened in at least a decade.

"Last year, we had this huge influx of new research awards, $85 million, which was by far the biggest year ever," Keltie said. "And this year we're seeing the outflow of that in terms of research expenditures."

NC State is one of two flagship research institutions in North Carolina, so conducting research that solves problems and transforms lives is part of its core mission. Research funding is also a key component of national rankings that help influence where faculty and graduate students choose to work and study.

Though many institutions saw research funding increase as a result of the 2009 federal stimulus, there are signs that NC State engineers and computer scientists are outracing their competitors. The College has more faculty competing for research dollars — more than 90 new faculty have been hired over the past five years — and graduate student enrollment has grown significantly and is expected to grow further.

These talented researchers have become more aggressive and adaptive in pursuing funding for large research projects from multiple funding agencies, Keltie said.

The biggest of the bunch was the National Science Foundation Engineering Research Center grant for the FREEDM Systems Center. Other large grants include funding for the Consortium for Advanced Simulation of Light Water Reactors, a US Department of Energy nuclear energy project, and a Multidisciplinary University Research Initiative grant, known as a MURI, from the US Office of Naval Research to use sound waves to help US soldiers identify roadside bombs and other hazards.

The College research office facilitates the proposal process for researchers. And with $300-400 million in research proposals passing through the office on the way to funding agencies each year, the research staff keeps very busy.

"I've been on the faculty here for more than 30 years," Keltie said, "and I've never seen a period of such sustained investment and expansion in the College." ▪

Once a model student, now leading Libya

Dr. John Grainger, professor emeritus of electrical engineering, was listening to the radio in October when he heard the news: One of his former graduate students at NC State was the new interim prime minister of Libya.

Grainger has fond memories of Abdurrahim El-Keib, who earned a doctorate in electrical engineering from NC State in 1984 before going on to teach at the University of Alabama. He said El-Keib (at right below) came to NC State with several other students from the Middle East after completing a master's degree at the University of Southern California.

Grainger said El-Keib was soft-spoken, refined and reverent, as well as a strong student.

"He was a very mature person," Grainger recalled. "He carried himself very well."

Grainger said that El-Keib, whom he knows as "Rahim," was a devout Muslim who was troubled about not being able to return to his home country because of the ruling regime. Grainger said El-Keib would meet family members in Morocco rather than risk returning to Libya, where he had earlier done his undergraduate studies at the University of Tripoli.

"He clearly felt a great loss at not being able to go home," Grainger said. "He was quite cautious about being in Libya and being caught by the regime."

In his doctoral thesis, a copy of which sits on a bookshelf in Grainger's office on Centennial Campus, El-Keib thanked his family for their support.

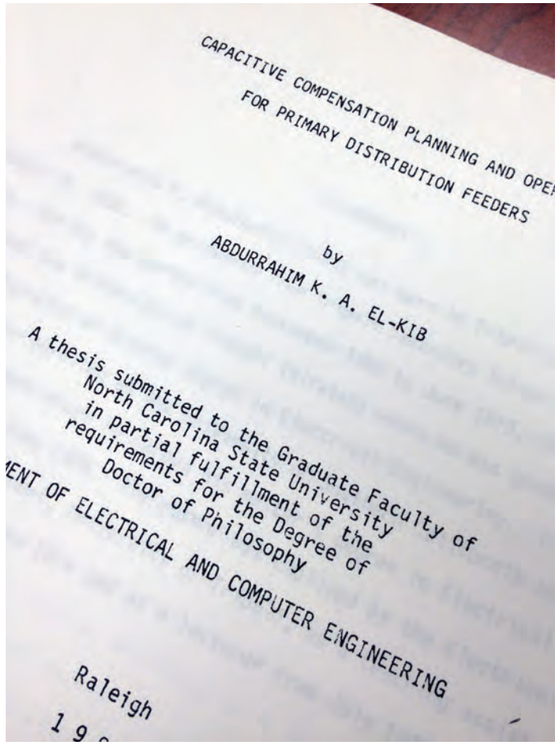
"To them I dedicate this work," he wrote. He also thanked Grainger for his "encouragement, patience and enthusiasm."

Grainger periodically ran into his former student at conferences after El-Keib became a professor at the University of Alabama. El-Keib would greet Grainger with warm and robust laughter.

"He has a strong sense of humor," Grainger said.

Grainger said he never discussed the situation in Libya with El-Keib, who was named the country's interim prime minister following Libya's liberation on Oct. 23, three days after the death of Muammar Qaddafi. But Grainger was encouraged that the Libyan leadership chose El-Keib as prime minister during the country's difficult transition.

"If a guy like him, as an outsider from politics or military things, if he was chosen for that job, then that's a wonderful, wonderful tribute to the Libyans who are now in charge," Grainger said. ▪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FOR PRIMARY DISTRIBUTION FEEDERS

by

ABDURRAHIM K. A. EL-KIB

A thesis submitted to the Graduate Faculty of
North Carolina State University
in partial fulfillment of the
requirements for the Degree of
Doctor of Philosophy

ENT OF ELECTRICAL AND COMPUTER ENGINEERING

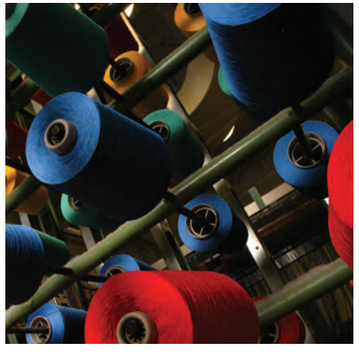
Raleigh

19

Made (and connected) in North Carolina

A new network helps NC manufacturers boost the bottom line.

The Manufacturing Makes It Real Network is a new initiative sponsored by the Industrial Extension Service (IES), an arm of the College of Engineering. It promotes manufacturing in North Carolina and offers its member companies powerful marketing and networking opportunities and the chance to enhance operational excellence through access to NC State and IES professionals.



The network grew out of the 2010 Manufacturing Makes It Real bus tour, which made 11 stops across the state during the last week of September to recognize manufacturers, their products and their employees. Since then, the network has added more than 20 companies, including Flextronics, an international provider of electronics manufacturing services that hosted the network's first public event last year.

"We were thrilled to have so many fellow manufacturers come to the site and have the opportunity to see what Flextronics does here in North Carolina," said David Gilmore, general manager of Flextronics' Morrisville facility. "The opportunity to spend time with this group wouldn't be possible without the network, and we are thrilled to be a part of it and look forward to upcoming events."

Manufacturers across the state employ more than 510,000 people, making manufacturing the largest employment sector in North Carolina and accounting for about 15 percent of its workforce. Manufacturers produce nearly 20 percent of the state's gross domestic product.

Network events will continue in 2012 as IES spreads the word statewide about the importance of manufacturing to the state's economy. Since 2006, IES programs have provided more than $1 billion in economic value to the state's manufacturers and created or retained more than 5,000 jobs. ▪

Clearing a superconductor hurdle

NC State researchers have developed a new computational approach to improve the utility of superconductive materials for specific design applications — and have used the approach to solve a key research obstacle for the next-generation superconductor material yttrium barium copper oxide (YBCO).

A superconductor is a material that can carry electricity without any loss, meaning none of the energy is dissipated as heat, for example. Superconductive materials are currently used in medical MRI technology and are expected to play a prominent role in emerging power technologies, such as energy storage or high-efficiency wind turbines.

One problem facing engineers who want to design technologies that use superconductive materials is that they are required to design products based on the properties of existing materials. But NC State engineers are proposing an approach using computer models that would allow product designers to interact directly with the industry that creates superconductive materials — such as wires — to create superconductors that more precisely match the needs of the finished product.

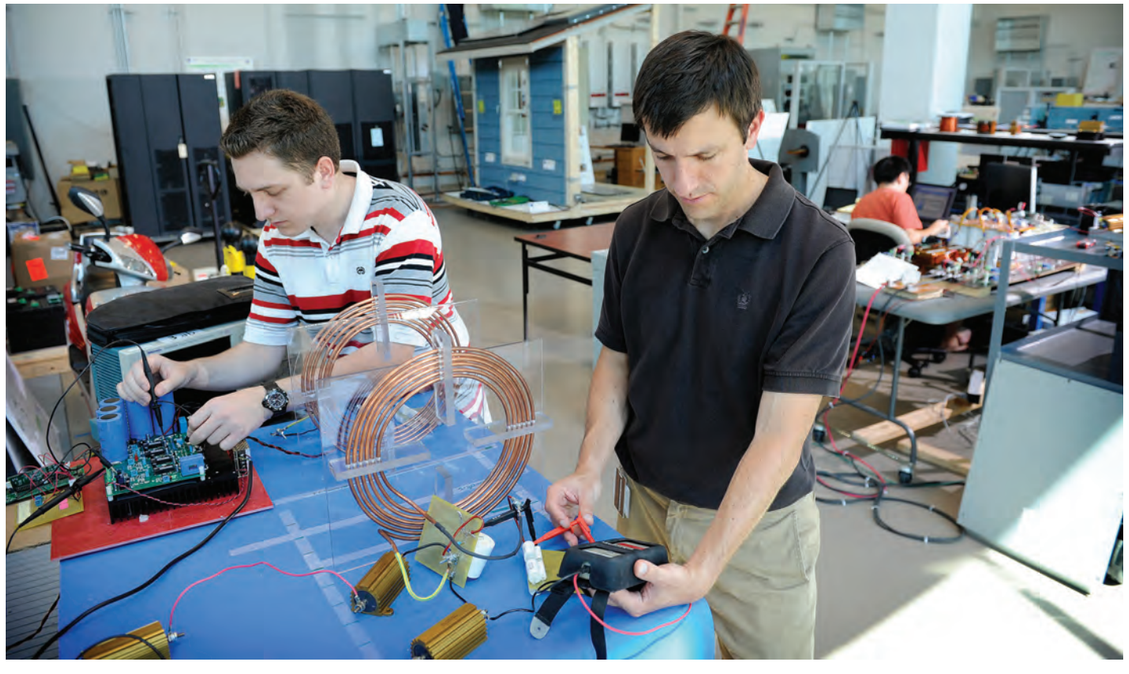
"This approach moves us closer to the ideal of having materials engineering become part of the product design process," said Dr. Justin Schwartz, lead author of a paper on the process and Kobe Steel Distinguished Professor and head of NC State's Department of Materials Science and Engineering.

One of the obstacles to widespread use of next-generation YBCO super conductors is how to handle "quench," a phenomenon that occurs when a superconductor suddenly loses its superconductivity. Superconductors are used to store large amounts of electricity in a magnetic field — but a quench unleashes all of that stored energy. If the energy isn't managed properly, it will destroy the system — which can be extremely expensive.

Researchers demonstrated their new modeling approach by exploring seven different variables to determine how best to design YBCO conductors in order to optimize performance and minimize quench risk. The insights gained will likely accelerate the potential use of YBCO in areas ranging from new power applications to particle accelerators, Schwartz said.

The process is of particular interest given the White House's recently launched Materials Genome Initiative, which was created to expedite the process that translates new discoveries in materials science into commercial products, he added.

The paper was co-authored by Dr. Wan Kan Chan, a research associate at NC State. The research was funded by the Air Force Research Laboratory. ▪



Two “firsts” for budding graduate students

Two new NC State programs are giving full-time students and working professionals the chance to earn master’s degrees in white-hot engineering fields.

The programs are in different areas — electric power systems engineering and biomanufacturing — but they share a distinction. Both are the first programs of their kinds in the nation.

Starting this past summer, students began taking courses toward a professional science master’s degree in electric power systems engineering. The unique program was established thanks to a $3.4 million US Department of Energy grant to NC State’s Department of Electrical and Computer Engineering. And it was bolstered by a recent gift from Siemens that will establish a term professorship and two graduate fellowships for students enrolled in the program.

Professional skills, interdisciplinary learning and industry exposure are the key features behind the program, which exposes students to real-world issues related to smart grid, solar and wind generation, and energy storage technologies. The NSF FREEDM Systems Center, an international smart grid center headquartered at NC State, provides lab space to students working on the capstone power systems project undertaken during the second semester of the one-calendar-year program.

> The programs in electric power systems engineering and biomanufacturing share a distinction. They are the **first programs of their kinds in the nation.**

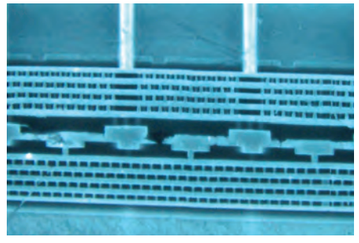
NC State is also offering the nation’s first industry-scale professional science master’s degree in biopharmaceutical biomanufacturing.

The new master of biomanufacturing (BIOM) program allows students to study upstream or downstream biomanufacturing processes while also taking MBA coursework. The first class of students entered the program in Fall 2010.

During the program, students take classes including biocatalysis, global regulatory affairs, protein characterization techniques, influenza vaccine manufacturing, monoclonal antibody manufacturing and biomanufacturing research, as well as professional development coursework. After students complete the BIOM program, they can enroll in NC State’s bioscience management MBA program and complete that degree in one additional year.

The BIOM program is offered through the Golden LEAF Biomanufacturing Training and Education Center (BTEC) on NC State’s Centennial Campus. BTEC is the only facility of its kind in the US and provides educational and training opportunities for undergraduates, graduate students and skilled professionals in the biomanufacturing industry. ▪

Building a better computer brain



NC State engineers are developing a three-dimensional (3D) central processing unit (CPU) — the brains of the computer — with the goal of boosting energy efficiency by 15 to 25 percent. The work is being done under a $1.5 million grant from the Intel Corporation.

The computer industry has a great deal of interest in 3D integrated circuits, which are vertically integrated chips that are connected by vertical electronic connections that pass through silicon wafers. These 3D circuits represent an advance over conventional computer chips, which operate in only two dimensions.

“Under this grant, we are building a 3D CPU chip stack and will be solving some of the problems currently facing the development of 3D CPUs,” said Dr. Paul Franzon, professor of electrical and computer engineering at NC State and lead researcher on the project.

One problem the researchers plan to address is how to reconcile chips that are designed and manufactured in different places to different specifications so that they can work together in three dimensions. They will also address questions concerning heat dissipation, since the 3D nature of the design would otherwise lead to much higher temperatures within the machine.

“Our goal is to achieve at least a 15 percent improvement in performance per unit of power, through architectural and circuit advances,” Franzon said.

The researchers plan to have a complete prototype developed in 2014 and will also be addressing “test and yield” challenges — such as how manufacturers can test individual CPU components to ensure they are functional. These challenges are key to facilitating the manufacture of 3D CPUs.

In addition to Franzon, the research team includes Drs. Eric Rotenberg and Rhett Davis, professor and associate professor, respectively, of electrical and computer engineering at NC State; and Dr. Krishnendu Chakrabarty of Duke University. ▪

Hi-dye: Invention boosts light energy harvest

An NC State invention has significant potential to improve the efficiency of solar cells and other technologies that derive energy from light.

Dr. Ahmed El-Shafei’s research group invented a new “sensitizer,” or dye, that harvests more ambient and solar light than any dyes currently on the market for use in dye-sensitized solar cells (DSSCs).

“A third-party solar energy company compared our new dye, NCSU-10, against the state-of-the-art dye on the market. Our dye had 14 percent more power density,” said El-Shafei, an assistant professor in the textile engineering, chemistry and science department. “In other words, NCSU-10 allows us to harvest more energy from the same amount of light.”

The new dye should significantly boost the efficiency of DSSCs, which have a host of applications. Indoors, these DSSCs can be used in technology to power cellular phones, laptop computers and MP3 players using ambient light. Outdoors, they could be used in conventional solar arrays or in improved energy-driven applications for building-integrated photovoltaic products including, but not limited to, windows, facades and skylights.

Compared to the state-of-the-art dye on the market, NCSU-10 can absorb more photons at lower dye concentrations and can therefore be used to create more effective solar cells on windows and facades while still allowing the windows to be highly transparent.

DSSCs are made of inexpensive and environmentally benign materials including a dye, an electrolyte and titanium dioxide (TiO_2) — the white component used in toothpaste. They outperform conventional silicon photovoltaics by 20 to 40 percent under diffuse light, on cloudy and/or rainy days, and in indoor ambient light, which make DSSCs a unique class of photovoltaics.

A patent is pending on the new dye, and the university is in communication with potential industry partners about licensing the use of NCSU-10, as well as funding additional research in this area. ▪

Manufacturers get a boost from students

The US Department of Energy (DOE) is awarding NC State $1.4 million over five years to continue training students to become the nation's next industrial energy efficiency engineering experts.

The award is part of a $30 million DOE training initiative with university-based Industrial Assessment Center (IAC) programs. The grant is one of 24 being awarded to universities across the country.

NC State's IAC program operates within the Department of Mechanical and Aerospace Engineering and serves manufacturers in North Carolina, Virginia and South Carolina. The program was established with DOE funds in 1992 to conduct energy assessments for small- and medium-sized manufacturers.

Since then, students in the program have conducted more than 400 energy assessments at manufacturing facilities in the region, helping companies save energy, reduce waste and improve productivity.

Under the new grant, each IAC will be expected to train at least 10 to 15 students per year, conduct approximately 20 energy assessments annually and perform extensive reporting, tracking, implementation, and management-improvement activities.

The NC State program is led by Dr. Herbert Eckerlin, the center's director and a professor of mechanical and aerospace engineering. Dr. Stephen Terry, extension assistant professor of mechanical and aerospace engineering, is the center's assistant director. ▪

Learning computer science? Game on

NC State researchers are launching a project to develop a video game that will help improve computer science knowledge in middle-school students — and contribute to a better educated workforce in the future. The game, which is being developed under a $1 million grant from the National Science Foundation, could be used nationally if it proves successful.

"Looking ahead, the United States is facing a significant shortage of people who will be able to fill jobs in science, technology, engineering and mathematics fields. That shortage is particularly acute for computer science," said Dr. James Lester, a professor of computer science at NC State and primary investigator of the project. "Forecasts consistently predict that we will have far more computer science jobs than there will be trained personnel to fill them."

One reason for this problem is a lack of students entering college with a basic knowledge of computer science. The shortage is particularly marked among girls, who tend to steer away from math and computer science in middle school, studies show.

"Our goal is to create a video game that will help middle-school students understand basic computer science concepts and related skills," Lester said. "We want to encourage students to pursue computer science in high school and beyond, and we want to give them the foundation they'll need to do so successfully."

While the project is not specifically focused on boys or girls, the researchers plan to incorporate game elements that have been shown to appeal to female students, including public health and environmental challenges.

The researchers will also be working with middle-school teachers and administrators in North Carolina to develop and test the game — and to assess the effectiveness of the program in the classroom.

"We need to make sure this produces real results," Lester said. "And if it does, we would like to roll the program out nationally."

Co-principal investigators on the project include Dr. Kristy Boyer, an assistant professor of computer science; computer research scientist Dr. Bradford Mott; and Dr. Eric Wiebe, an associate professor of science, technology, engineering and mathematics education. ▪

A new solution to an age-old problem

Conventional sewage treatment is not available in many parts of the world, and disposing of human waste can be both difficult and hazardous in developing nations. So a team of researchers from NC State, with support from Grand Challenges Explorations, an initiative of the Bill & Melinda Gates Foundation, is pursuing a new approach to an ancient problem.

In crowded cities, it can be difficult or impossible for waste disposal trucks to empty septic systems or cesspools — the large trucks just can't fit through the narrow alleyways in many neighborhoods.

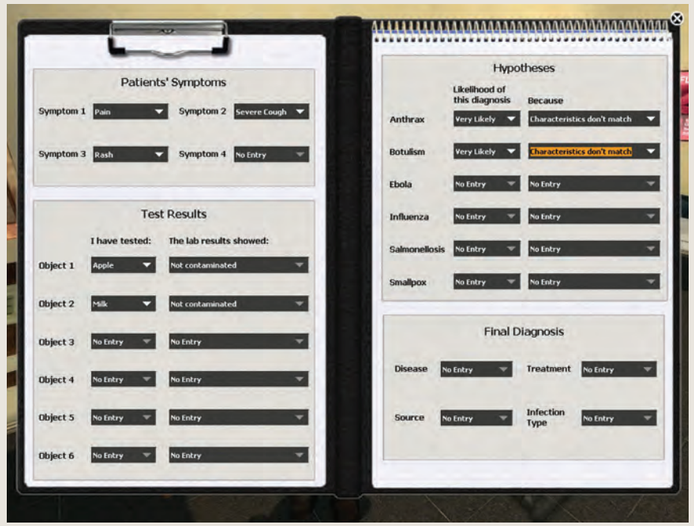
To address this problem, Tate Rogers, an environmental engineering graduate student, and his advisor, Dr. Robert Borden, are developing a hand-held tool that can be used to empty these latrines. The tool utilizes a gasoline-powered earth auger (think of an industrial-sized corkscrew) as the pumping mechanism, which would divert the waste either through a hose to a nearby truck or into smaller, transportable containers.

The turning motion of the corkscrew-shaped auger lifts and carries up the waste. The tool is similar to an Archimedes screw traditionally used to bring low-lying water to irrigation ditches above it.

"This seemed like a cost-effective solution to the waste-disposal problem," Rogers said. "And it could be effectively implemented, with little training, in developing countries. Safety was also a key concern when we began working on this. We want to minimize contact with the waste to reduce the risk of contracting disease."

Rogers developed the original idea and the Gates Foundation proposal as part of an undergraduate senior design class taught by Borden, a professor of civil, construction, and environmental engineering at NC State. The research team is using the Gates Foundation grant, received in November, to develop a prototype of the waste-disposal tool that should be ready by the end of 2012. Field testing in the Philippines could begin in spring 2013.

"If it's successful, we want to make the technology and the training available globally," Rogers said. "Solving a real-world problem — that's what engineering is all about." ▪



Engineering living tissue and organs

When it comes to manufacturing tissues and organs to cure disease and save lives, regenerative medicine is just like any other industry in which automation, quality and efficiency are keys to success.

That's why NC State's Edward P. Fitts Department of Industrial and Systems Engineering recently teamed up with Wake Forest Baptist Medical Center's Institute for Regenerative Medicine to apply the latest advances in industrial engineering to the new field of regenerative medicine. The partnership is one of the first in the world to link an engineering program with a regenerative medicine research group to systemically examine manufacturing and automation issues.

Regenerative medicine, which has been called the "next evolution of medical treatments" by the US Department of Health and Human Services, is the science of creating living, functional tissue to repair or completely replace damaged tissue or organs in patients. Patients are already benefiting from such lab-engineered tissues as skin, cartilage, bladders, blood vessels, urine tubes and tracheas.

"The revolution under way in regenerative medicine needs to be supplemented by advanced manufacturing systems that help make its life-changing results available to everyone," said Dr. Richard Wysk, Dopaco Distinguished Professor in the Edward P. Fitts Department of Industrial and Systems Engineering at NC State and a lead faculty member on the project. "This partnership brings together two world-class organizations that want to see regenerative medicine become a key part of our health care system."

The partners seek not only to increase the number and quality of organs produced, but also open the door for the manufacturing of more difficult-to-produce organs such as kidneys and livers. The goal is to become a recognized leader in research and development of industrial and systems engineering solutions for the growing field of regenerative medical products.

Three students from NC State are already working under the agreement at Wake Forest, located in Winston-Salem, NC. They are focusing on the manufacturing aspects of a cell treatment for incontinence, engineering cartilage on a human ear implant and developing a system to stretch and grow skin in the lab for burn victims.

The other lead faculty member on the project is Dr. James J. Yoo, professor and chief scientific officer at the Wake Forest Institute for Regenerative Medicine. ▪

Escuti receives Presidential Early Career Award

Dr. Michael Escuti, associate professor of electrical and computer engineering, received the Presidential Early Career Award for Scientists and Engineers last fall. The award is the US government's top honor for early-career researchers in science and technology.

Escuti was honored for his pioneering development of liquid crystal "polarization gratings," which consist of a thin layer of liquid crystal material on a glass plate. The White House also recognized him for educating students through collaborations with international academic teams and industries, as well as for outreach work in underserved communities. ▪

Gu, Yingling receive NSF CAREER Awards

Two College of Engineering faculty were recently honored with National Science Foundation (NSF) CAREER Awards, some of the highest honors given by NSF to young faculty in science and engineering.

One award went to Dr. Xiaohui (Helen) Gu, assistant professor of computer science, whose CAREER project aims to find solutions to performance glitches in large-scale virtualized hosting infrastructures.

The other award went to Dr. Yaroslava G. Yingling, assistant professor of materials science and engineering. Among her project's goals is to develop a better understanding of the structure and properties of DNA-functionalized surfaces. ▪

Westmoreland named AIChE president for 2013

Dr. Phillip R. Westmoreland, professor of chemical and biomolecular engineering and executive director of the Institute for Computational Science and Engineering (ICSE) at NC State, has been elected president of the American Institute of Chemical Engineers (AIChE) for the 2013 term.

Westmoreland will serve as the organization's president-elect in 2012 and as past president in 2014. AIChE, founded in 1908, provides leadership in advancing the chemical engineering profession. ▪

Narayan named R.J. Reynolds Award winner

Dr. Jagdish (Jay) Narayan, the John C.C. Fan Family Distinguished Chair Professor in Materials Science and Engineering, was named the 27th recipient of the R.J. Reynolds Tobacco Company Award for Excellence in Teaching, Research and Extension.

Narayan is an internationally recognized authority in his field. His research has proven pivotal to the understanding of basic phenomena in metals, ceramics and electronic materials and processing. ▪

Martin-Vega honored by Great Minds in STEM, ASEE

Dr. Louis A. Martin-Vega, dean of the College of Engineering, was inducted into the HENAAC Hall of Fame by Great Minds in STEM, a non-profit organization that promotes science, technology, engineering and mathematics careers among Hispanics and other underrepresented communities.

Martin-Vega is also serving as the American Society for Engineering Education (ASEE) Global Colloquium co-chair at the 2012 World Engineering Education Forum in Buenos Aires, Argentina. ▪

STARTING EARLY

publishing often

Some of the College's top undergraduates show research isn't just for faculty members and graduate students.

There was a time when it was rare to see undergraduates immersed in real research.

No more. Today, many undergraduate students in the College of Engineering are developing new technologies that will change the way we live. And even though they work among experienced faculty and graduate students, these young researchers aren't afraid to take leadership roles. Lots of undergraduates have published papers in important journals and won prestigious research awards.

The work also gives these students a key advantage for the future: Graduate schools and employers like to see research on an undergraduate's resume.

Here's a look at six undergraduates who have made real contributions to NC State's research community.

Tojan Rahhal

Senior
Biomedical Engineering
Raleigh, NC

Some of the mice were dying. Tojan Rahhal wanted to know why.

The result could lead to a new way to treat a painful tooth disorder that affects tens of thousands of people worldwide.

The mystery of the dying mice began in an NC State veterinary lab, where Rahhal was conducting research on a grant from the National Institutes of Health as part of the university's Initiative for Maximizing Student Diversity program. She noticed that some of the lab's mice were dying, so she began analyzing their genetic makeup and monitored them all day for six months.

She discovered that some of the mice had genes that made their teeth fragile and prone to abnormal growth. She trimmed their teeth so they could eat, which helped them live longer.

Rahhal knew that a protein called SP3 regulates tooth development genes in the mice. She also knew that SP3 and another protein, called SUMO, must be linked together genetically or else tooth development problems might arise. For those sick mice, the link of SUMO and SP3 had been broken.

Rahhal thinks these genes are also responsible for a tooth disorder in humans called amelogenesis imperfecta in which teeth are covered with thin, abnormally formed and colored enamel. People with this disorder are sensitive to temperature changes and at a higher risk for cavities.

"I hope to find a cure for this disease through further study," Rahhal said.

Next up for Rahhal: Pursuing a PhD in biomedical engineering, or an MD in medical school.

Dean Pixton

Senior
Industrial and Systems Engineering
Raleigh, NC

If Dean Pixton gets his way, the days of waiting around in the doctor's office could be over.

Pixton studies scheduling patterns for outpatient health care centers, including those that use chemotherapy to treat cancer patients. Doctors and nurses often struggle with the daily appointment schedule in these offices, as some patients don't show up for their appointments and other visits take longer than expected. That makes it hard to devise a schedule that gives patients plenty of time with caregivers but doesn't keep anyone waiting too long.

To solve this problem, Pixton has been developing new algorithms that use historical patient data from the chemotherapy treatment center at the NC Cancer Hospital in Chapel Hill. The center simulations created by these algorithms help him identify scheduling problems and find the best combination of doctors, staff, rooms and equipment to keep appointments running smoothly and on time.

The work is funded by a Research Experiences for Undergraduates grant from the National Science Foundation.

"Dean has a lot of 'what if' questions," said Bjorn Berg, a research assistant who mentors Pixton. "He has contributed much to our creative process by considering many different perspectives of a problem and intuitively finding the right paths to take."

Pixton wants to continue his work, so graduate school is probably his next stop.

"I enjoy the research because it is in health care," he said, "and working on this project makes me feel like I'm making a difference."

Shu Zhu

Senior
Chemical and Biomolecular Engineering
Qingdao, China

Imagine wearing a snowboarding jacket that plays MP3 music files with the help of controls stitched into the sleeve.

It's no joke. Sometime soon, your closets could be equipped with these "electronic textiles."

Shu Zhu is among a group of researchers trying to make new fibers that are flexible, stretchable and electrically conductive. Potential applications could include wearable electronics, health monitoring devices and sports equipment.

To develop this new technology, Zhu and her group injected fluid metal into hollow fibers made of commercial elastic polymers. The fibers resemble the head phone wires used in an iPod, yet can be stretched up to eight times their original length without losing the ability to conduct electricity. The fibers are very thin, so they can be incorporated in clothing without changing how the clothes feel.

The project was an award winner at the 2011 annual meeting of the American Institute of Chemical Engineers. A published paper is forthcoming with Zhu as the lead author.

"Shu has taken the lead role on this project and has come up with very creative solutions to the problems we are trying to solve," said Zhu's advisor, Dr. Michael Dickey.

Zhu plans to continue this type of work as a graduate student.

"I enjoy school life and always want to learn more," she said. "This field is very interdisciplinary, so I can conduct research on everything from fashion design to electronics to biomedical engineering."

John Obare

Senior
Materials Science and Engineering
Raleigh, NC

John Obare wants to save companies energy — and money.

Obare is studying how an electric field affects the sintering of zirconia-based ceramics, a process that creates solid objects from powders. Doing something like this typically requires a great amount of energy because the normal way to consolidate the powder is to add a lot of heat.

Along with another undergraduate student, William Griffin, and their advisor, Dr. Hans Conrad, Obare began working on finding a way to consolidate these powdered particles without using as much heat, a phenomenon that would be of great interest to makers of engines, oxygen sensors and fuel cell membranes, as well as other manufacturers that use ceramics and want to cut down on costs.

Obare analyzed the sizes of the microstructure features, called grains, in the materials he was studying. He found that applying an electric field during the sintering process made the grains smaller and lowered the interfacial energy between the grains. This effectively means that the particles densify faster, saving energy or heat. His next step is figuring out why all this happens.

The researchers presented their findings in a paper that has been submitted to the well-regarded *Journal of Materials Science*. The paper is currently in review.

After graduating, Obare wants to enter the work force to gain experience in the field, perhaps with an automotive or aerospace company.

"It's a growing field," Obare said. "Lots of companies need materials scientists and engineers."

Then, it's on to graduate school.

Jennifer Felder

Senior
Electrical Engineering
Raleigh, NC

Jennifer Felder's work has attracted attention from big power companies like Duke Energy.

That's because she helped develop a software tool called Watchdog that creates detailed maps, videos and other visuals that let utilities monitor their power systems more closely. Such a tool could be invaluable to utilities that depend on consistently getting power from their plants to homes and businesses.

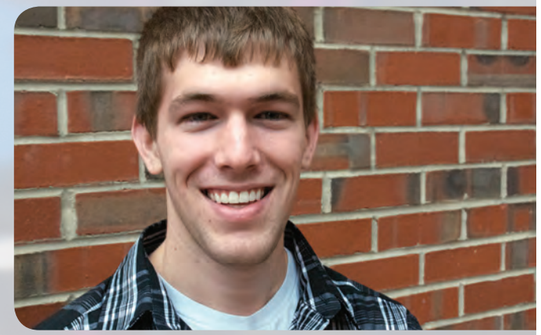
She does her work at the FREEDM Systems Center, a National Science Foundation Engineering Research Center headquartered at NC State that's developing technology for an "Energy Internet." FREEDM's annual meeting is among the various venues where Felder has presented her work.

"The motivation behind this project is to prevent power outages in many areas," she said. "It's a promising area of research."

Felder is extending Watchdog to real-time predictions and visualizations of power system data. As designed, the software would let utility operators know if a big blackout is just a few hours away, allowing them to take measures to prevent it. That might have been useful to utilities in 2003, when a huge blackout cut power for 50 million people in the northeastern US.

After she graduates, she wants to pursue a PhD focusing on renewable electric energy. The director of the Watchdog project, Dr. Aranya Chakrabortty, thinks she'll be successful.

"Jenny stands out among other undergraduates due to her sincerity and vision for the research career ahead of her," Chakrabortty said.



Matthew Authement

Senior
Environmental Engineering
St. Petersburg, Florida

Matthew Authement is the son of two veterinarians. Growing up, he watched his parents diagnose and treat hundreds of animals; it was almost as if he learned biology by osmosis.

"I always found it interesting browsing through their office and watching them work," he said.

Now Authement is applying that bio-heavy childhood to new ways to treat water. He's working with other NC State environmental engineers to gauge the potential of a new drinking water treatment technology called a UV light-emitting diode (UV LED) reactor. The reactor, developed at NC State, would disinfect water passing through UV light to kill bacteria and other microorganisms that could make humans sick.

UV light has long been used to treat wastewater and is gaining use in drinking water. However, the new reactor's LED component means it has the potential to use less energy. In addition, the new reactor does not contain the mercury found in traditional reactors that often poses environmental problems when disposed.

Dr. Joel Ducoste, Authement's advisor and the developer of the new treatment tool, introduced Authement to the project. When he realized his student could handle much more complicated tasks than what he had assigned, he gave him a tougher job: Modeling the hydraulic characteristics and disinfection performance of the new system.

"Again, he rose to the challenge and performed this additional task very well," Ducoste said.

Authement's career plans have him treading closer to his parents' footsteps. Medical school is probably his next stop. ▪

125 YEARS OF NC STATE ENGINEERING

Engineering and NC State have been synonymous since 1887, when the university and the first engineering departments were established. Since then, the College of Engineering has developed into one of the best and largest public engineering schools in the country. As NC State celebrates its 125th anniversary, its engineering graduates can look back on a record of exceptional accomplishment.

1862
» President Abraham Lincoln signs Morrill Act, paving way for the creation of land-grant colleges focusing on agriculture and mechanical arts

1887

MARCH 7
» The North Carolina College of Agriculture and Mechanic Arts established; includes engineering departments

1889
» The first student enrolls; studies engineering

1893
» First graduation. Fourteen of the 19 students receive engineering degrees

1900

1923
» School of Engineering formed; Wallace Carl Riddick Jr. named first dean

1944
» North Carolina Engineering Foundation, Inc., established

1945
» J. Harold Lampe begins 17-year tenure as dean

1953
» Nation's first university-based nuclear reactor opens on NC State's campus

1978
» Alumnus Larry K. Monteith named dean; helps shape Centennial Campus

1987
» Engineering alumni co-found Cree, the LED lighting company

1988
» Precision Engineering Center becomes Centennial Campus's first occupant
» NC State awarded NSF Engineering Research Center for Advanced Electronic Materials Processing

1993
» North Carolina Solar Center established

1996
» Constructed Facilities Laboratory established
» Nino A. Masnari named dean; grows facilities, enrollment and endowment
» College offers state's first online, real-time distance-education class
» NC State engineer helps develop artificial retina microchip

1997
» Opening of Engineering Graduate Research Center

1998
» Students establish NC State Engineering Career Fair

2000

2003
» Joint NC State/UNC Department of Biomedical Engineering established

2004
» Research from NC State engineers leads to development of breakthrough processes for creating self-assembled nanostructures

2005
» Engineering Building I dedicated
» Collaboration with the College of Veterinary Medicine produces world's first successful osseointegrated prosthetic limb for a cat

2006
» NC State engineer helps invent filter that removes human form of Mad Cow Disease from blood
» Louis A. Martin-Vega named dean; boosts College rankings and research funding

» Edward P. Fitts Department of Industrial and Systems Engineering becomes NC State's first named academic department
» Engineering Building II dedicated

2007
» Golden LEAF Biomanufacturing Training and Education Center opens
» NC State's PULSTAR nuclear reactor produces world's most intense low-energy positron (antimatter electron) beam

2008
» NC State awarded FREEDM Systems Center, an NSF Engineering Research Center

2009
» Industrial Extension Service reaches goal of creating $1 billion in economic value to NC manufacturers from 2006 to 2010
» Centennial Campus celebrates 25 years

2010
» Engineering Building III dedicated
» NC State takes leading role in federal nuclear energy hub
» NC State co-hosts NAE Grand Challenges Summit

2011
» FREEDM's smart transformers named among world's 10 most important emerging technologies by MIT Technology Review

2012
» College and University celebrate 125th anniversary

REINVENTING REHAB

NC State engineers join with their UNC medical school counterparts to help people recover from injuries and disease.

Bruce Wiggin adjusts the spring-loaded ankle device he co-developed to help patients recovering from stroke walk more easily.

Biomedical engineering graduate student Bruce Wiggin wants to help patients recovering from stroke walk the way they used to — before the sudden loss of neurological function slowed them down.

To do that, he uses a perceptive set of eyes — advanced motion-capture technology that records patients' movements as they walk on a hi-tech treadmill. The resulting data helps Wiggin custom-design devices that can be strapped to patients' lower legs, making walking easier and less tiring.

Thanks to the partnership between NC State's College of Engineering and UNC-Chapel Hill's School of Medicine, researchers like Wiggin are making bold advances in the emerging field of rehabilitation engineering, which applies engineering techniques to solve everyday problems faced by people with disabilities.

The partnership is particularly important in a rapidly aging state where large retiree and injured veteran populations create new challenges for the health care system. People who are 65 and older make up nearly 13 percent of North Carolina's population, and that number is expected to reach 18 percent by 2030. Nearly 800,000 residents are war veterans.

The state's stroke rate is already among the highest in the country.

"We're combining so many fields in one, and it's aimed at helping people and benefiting the community," Wiggin said.

[Allies in health care]

The health-care alliance between NC State engineers and UNC medical providers formally began in 2003 with the establishment of the Joint NC State-UNC Department of Biomedical Engineering. Department leaders prioritized the development of a top program in rehabilitation engineering; a big step forward was the formation of its Rehabilitation Engineering Center in 2011.

The center, the first of its kind in the state, connects problem-solving rehabilitation engineers with patients, doctors and physical therapists who can benefit from their work.

"The facilities are world-class," said Dr. Nancy Allbritton, Paul Debreczeny Distinguished Professor at UNC and head of the joint department. "And having physical therapists in Engineering Building III at NC State shows how the two universities are working together."

The center is new, but students in the department have been developing patient rehabilitation tools and devices for years. One group's senior design project, for example, set out to help people with limited mobility by developing a mechanical walker that can help patients use the stairs at home. Other projects help doctors and nurses at WakeMed hospitals do their work more efficiently.

"It's one thing when an engineer imagines what a problem might be like, versus personally seeing and feeling the pain in the environment where the problem exists," said Dr. Andrew DiMeo, the assistant professor of biomedical engineering who leads the senior design course. "Talking with clinicians and patients allows students to empathize with them and understand the real problem."

[Keeping North Carolina moving]

Americans are living longer. The average life expectancy was 78.3 years in 2011, up from 70.8 in 1970.

With age, moving around gets tougher. Arthritis and muscle weakness slow people down, and severe strokes can permanently shut down one side of the body. Treating these conditions will require more attention from the nation's health care system in the coming decades.

"The number of baby boomers who are retiring and requiring services increases every year," said Dr. Richard Wysk, the Dopaco Distinguished Professor in the Edward P. Fitts Department of Industrial and Systems Engineering at NC State and the center's interim co-director. "If we can provide tools and get them back on their feet and make them productive, ambulatory people again, I think it impacts both their lives and their medical budgets."

Strokes, for example, are the leading cause of death and disability in North Carolina; the risk of having one more than doubles each decade after the age of 55. Post-stroke effects range from difficulty with balance and coordination to partial paralysis.

But thanks to the advanced motion-capture technology in the rehab center's gait lab, researchers can get an in-depth look at the way humans move and gain a better understanding of the problems faced by a patient who has trouble walking.

While a patient walks on a treadmill, the lab's eight high-speed video cameras record the movements of ankles, knees and other

Supporting the cause

A nationwide search is underway for the new director of the Rehabilitation Engineering Center. That person will hold the Lampe Distinguished Professorship endowed by NC State industrial engineering alumnus Dr. Ross W. Lampe Jr. and his wife, Ming-Mei. It is the first endowed professorship for the Joint NC State-UNC Department of Biomedical Engineering.

by the numbers
Rehabilitating NC

North Carolina is considered the "buckle" on the "stroke belt" — a stretch of states in the southeastern US and the Mississippi Valley with high stroke mortality rates. As the state's senior population grows, the work of rehabilitation engineers becomes even more important.

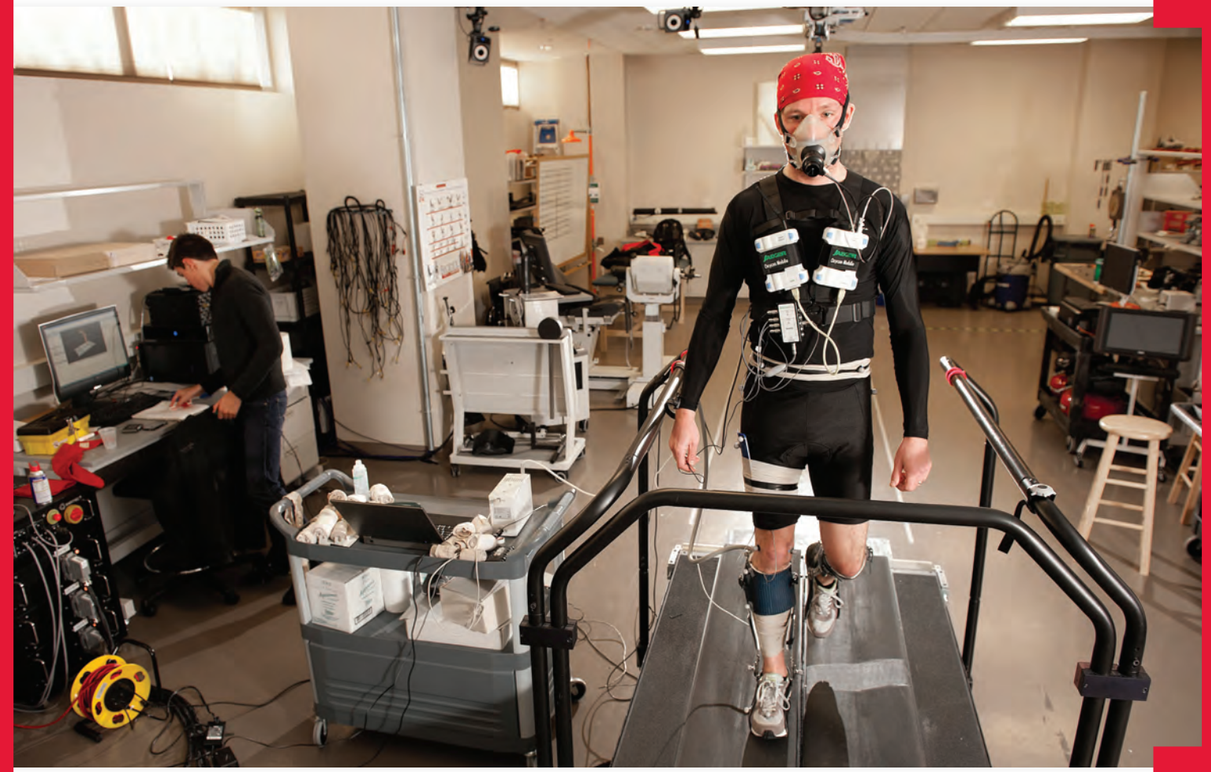
[10]
North Carolina's rank among the 50 states for senior citizen population

[43.4]
Percentage of the state's seniors with a disability

[33]
Percentage of Americans with arthritis that causes work limitations

[1]
Raleigh-Cary area's national rank, from 2000 to 2010, as the metro area with the fastest growing senior population

[67]
Percentage increase of Raleigh residents who were 45 and older during the century's first decade



Dr. Gregory Sawicki (right) walks on the gait lab's hi-tech treadmill. Sawicki and Bruce Wiggin (left) will use the data to better understand how humans move.

body parts. Researchers use these high-speed videos to compare the images with those of healthy, mobile people.

A research team led by Dr. Gregory Sawicki uses this locomotion biomechanics data to develop devices that can be strapped to lower limbs that encourage lower leg muscles to work the way they were designed.

"Our goal is to try to make the devices more biological, so we use inspiration from human locomotion," said Sawicki, assistant professor in the department who oversees the gait lab and directs the Human Physiology of Wearable Robotics (PoWeR) Laboratory.

Sawicki is also working closely with Dr. Michael Lewek, an assistant professor in the Division of Physical Therapy at UNC. Lewek is using virtual reality technology to help patients recovering from stroke relearn how to walk. He provides Sawicki's team with physical therapy know-how and access to patients.

One problem the engineering researchers address is how to reduce the amount of energy patients use to compensate for weakness in their lower limbs, particularly the ankles. The patients are forced to rely more on their hips and thighs to walk, an unnatural motion that requires 50 or 60 percent more energy than normal walking. Exhaustion comes quickly.

Enter Wiggin, who is working with Sawicki and Dr. Steven Collins at Carnegie Mellon University to develop a spring-loaded ankle device that encourages normal ankle motion. The device is passive and doesn't need power or batteries. Instead, it imitates the rubber-band action of the Achilles tendon, which loads and unloads as it stores and releases energy.

"A device will integrate better if it's designed around our body's movements," Wiggin said.

[Building strong bones]

Researchers are also working to improve the lives of people who've lost limbs, and they're focusing on the revolutionary procedure known as osseointegration that fuses a prosthetic limb with the bone. The process may someday be life-changing for the growing number of soldiers who return home as amputees.

Dr. Ola Harrysson, associate professor of industrial and systems engineering, has done groundbreaking work with these types of implants. In 2005 he teamed up with Dr. Denis Marcellin-Little at NC State's College of Veterinary Medicine on the first procedure to attach an osseointegrated prosthetic implant to a cat's bone.

The procedure provided the animal with a new hind leg and foot. The team has refined the process and the prosthetics on both dogs and cats since that first surgery.

Next up are procedures on humans, for which the recovery times are much longer — close to 18 months. Harrysson thinks he can reduce that recovery time to six months, but there are obstacles.

If a patient walks on the prosthetic limb too early, one wrong move can cause permanent damage and prevent the bone from fusing with the implant as designed. But putting weight on the prosthetic limb is imperative to promote bone growth.

Harrysson's solution: vibrations. By vibrating the bone, the cells responsible for bone growth, called osteoblasts, become excited. Harrysson wants to stimulate the bone before surgery and add more vibrations to continue bone growth after surgery, cutting down on recovery time.

"This couldn't be done unless we had multidisciplinary research," Harrysson said. "We collaborate with orthopedic surgeons, and as we continue our work, we're also going to have to collaborate with physical therapists."

[A center for the people]

Thanks to support from both NC State and UNC, biomedical engineering students, including seniors creating new medical devices in the program's capstone class, are working together in top-notch facilities with physical therapists, occupational therapists, engineers and patients.

The work would not be possible without the completion of Engineering Building III on Centennial Campus, which was funded through legislative appropriations. The new building opened its doors in 2010 and is an example of how important infrastructure is to innovation and education.

Rehab center leaders envision spin-off companies, in-house clinical trials and the arrival of more world-class faculty who will drive the center forward. A nationwide search is underway for a permanent center director.

"We're going to be unique because, here in the Triangle, we have resources that would require multiple states to put together," said Dr. Richard Segal, professor and director of the Division of Physical Therapy at UNC and the center's interim co-director. "We have three top-flight universities. If we have an idea, we can make it happen and do it locally." ▪

Modeling the future of **NUCLEAR ENERGY**

NC State researchers use advanced computer simulations to create safer, more cost-effective nuclear power plants.

Dr. Paul Turinsky (right) is CASL's chief scientist.

Dr. Paul Turinsky does not like CRUD.

It's the nasty buildup of corrosive products on fuel rods inside nuclear reactors that, if left unmanaged, can lead to nuclear authorities "derating" plants. That means the plants aren't allowed to produce as much energy as before for safety reasons.

As chief scientist of the Consortium for Advanced Simulation of Light Water Reactors (CASL), Turinsky wants to make sure that future reactors can work safely and more efficiently. CASL, a unique collaboration between universities, laboratories and industry, develops advanced computer models that will help engineers design the next generation of nuclear reactors and improve the performance of current ones. The team is working on making nuclear power more economical, reducing the amount of nuclear waste and assuring safety.

NC State, which built and operated the first university-based nuclear reactor in the world in 1953, plays a key leadership role in the $122 million Department of Energy (DOE)-funded effort that began in 2010. NC State researchers working with CASL have academic and industry experience in fields ranging from computational science to nuclear engineering.

"There's a lot of talent on this campus," said Turinsky, a nuclear engineering professor. "I want to get as much breadth of expertise involved as I can because nuclear engineers don't know everything that needs to be done."

There are 104 nuclear power plants operating in the United States that supply 20 percent of the nation's electricity. After a decades-long shift away from nuclear power in this country, a few new plants will finally come online by 2020.

CASL's work will help shape the industry in the coming decades. Its research will provide nuclear engineers with the most up-to-date information needed to build and operate safe and cost-effective reactors. This includes finding ways to stay one step ahead of what's known as CRUD, formally known as Chalk River Unidentified Deposits (a reference to the Canadian nuclear plant where the buildup was first observed).

"Think of boiling a pan of water after the liquid has evaporated, leaving a film of solids coating the pan," Turinsky said. "We're dealing with that buildup constantly."

Finding ways to limit CRUD safely and inexpensively is one of CASL's toughest technical modeling challenges.

Led by Oak Ridge National Laboratory, DOE's largest science and energy laboratory, CASL consists of 10 core partners and more than a dozen contributing partners. The wide range of partners and facilities has its perks. Oak Ridge and Los Alamos National Laboratory, for example, have some of the fastest computers in the world for doing computer simulations and modeling.

CASL's work focuses on current Generation II reactors and Generation III+ pressurized water reactors, which differ from the ones at Japan's Fukushima Daiichi plant that were damaged in the earthquake and tsunami last year.

For those reactors, plant operators relied on back-up generators to safely shut the reactor down. The new Generation III+ reactors don't use back-up generators, which are no longer required, and can safely function for longer periods of time if there's a complete loss of electrical power. Also, like all nuclear plants, they have automatic systems that shut the plant down safely in the event of an emergency.

To design the next round of nuclear reactors and enhance the performance of current ones, engineers are gearing up to work with a collection of CASL-produced advanced modeling and simulation tools known as the Virtual Environment for Reactor Applications (VERA).

"We're building a monster code that simulates nearly all the phenomena involved," Turinsky said.

VERA will allow engineers to test nuclear reactor designs using computer simulation, avoiding the safety issues and costs associated with performing real-world experiments. CASL researchers will have the tools to simulate coolant flow, fuel performance and other scenarios that are hard to observe in operating reactors.

To use VERA, however, the nuclear engineering students of tomorrow will need general knowledge of everything from mechanical engineering to materials science to reactor physics.

Dr. John Gilligan, CASL's education program coordinator, helps recruit top students into the program to get the exclusive training on the VERA system.

"The kind of expertise they get here can be applied anywhere in the world," said Gilligan, a professor of nuclear engineering.

One of CASL's students, Sterling Satterfield, is working with Turinsky to gain a better understanding of reactor simulation. He's using a concept called Adaptive Model Refinement that allows researchers to apply simple modeling techniques in some situations and more complicated ones in others. Knowing when to use each model and how to combine the results allows researchers to spend less time running simulations, saving time and money.

He learned that from Turinsky.

"I got the opportunity to work with Dr. Turinsky — the best of the best," Satterfield said. "That's one of the main reasons I came to NC State." ▪

ABOUT CASL

Established in 2010
More than 230 participating researchers across the country

Core Partners

- Oak Ridge National Laboratory *(lead partner)*
- Idaho National Laboratory
- Los Alamos National Laboratory
- Sandia National Laboratories
- North Carolina State University *(lead university)*
- Massachusetts Institute of Technology
- University of Michigan
- Electric Power Research Institute
- Tennessee Valley Authority
- Westinghouse Electric Company

STAYING TUNED

It's been more than a year since an earthquake and tsunami crippled the Fukushima Daiichi nuclear power plant in Japan, but the effects continue to be felt worldwide.

This spring, NC State nuclear engineers plan to hold a symposium to update the public on what's been happening since the tragedy. They'll talk about cleanup efforts, health effects, and lessons learned for future nuclear reactor construction. More details will be available soon at www.ne.ncsu.edu.

The symposium is a follow-up to a similar event held last March, when several NC State experts discussed damage to the nuclear plant and challenges faced by officials trying to contain radioactive material.

BRIDGE **to the** FUTURE

NC State engineers have developed new ways to repair, monitor and replace aging bridges and other large structures.

Students at NC State's Constructed Facilities Laboratory calibrate instruments before testing large structures.

When the American Society of Civil Engineers graded the nation's infrastructure health in 2009, the United States was nowhere near the honor roll.

It earned a "D."

More recently, the North Carolina Department of Transportation (NCDOT) labeled nearly four in 10 North Carolina bridges "deficient." Findings like these indicate that our nation's "backbone" — bridges, roads and other infrastructure — could use some TLC.

NC State engineers believe the hi-tech tools and materials they have developed will help solve the problem. They're using a technique called structural health monitoring to find better ways to inspect, repair and forecast the long-term health for bridges, parking decks and other large structures.

Some examples: sensor technology that finds a tiny bridge crack; space-age composite materials that repair structures previously considered irreparable; and data-gathering that helps transportation engineers develop customized bridge maintenance and repair schedules. The work should lead to structures that last longer and save taxpayers big bucks.

All this work happens at a unique testing facility on NC State's Centennial Campus called the Constructed Facilities Laboratory (CFL). It is one of the few large-scale structure-testing facilities in the country with the ability to perform tests in accordance with the International Organization for Standardization (ISO), the world's largest developer and publisher of international industrial and commercial standards. Researchers in the lab are so well regarded that they were called upon to help investigate the devastating I-35 bridge collapse in Minneapolis that killed 13 people in 2007.

"I wouldn't scare the public by saying that there's going to be a bridge collapse every day," said Dr. Sami Rizkalla, Distinguished Professor of Civil Engineering and Construction and director of the CFL. "But it's like if you have high blood pressure — you're not healthy, and if you don't do something, your life expectancy may be shorter."

Staying one crack ahead

NCDOT maintains nearly 13,000 bridges across the state, and it labels more than 5,000 of them as "structurally deficient" or "functionally obsolete." That doesn't mean motorists can't drive on them, but it does mean they could use some work.

If a bridge is "structurally deficient," that means it falls below current design standards because of its original design or deterioration. "Functionally obsolete" bridges are usually narrow and may have weight limits for vehicles.

Restrictions like these mean fire trucks and ambulances might be forced to take alternate routes, causing delays that can lead to lives lost. And if tractor-trailer drivers are forced to detour around a bridge into heavy traffic, they lose time. This can be a financial loss for both the supplier and the consumer.

NCDOT allocates $65 million for bridge maintenance annually and inspects the structures at least every two years. But Dr. Fuh-Gwo Yuan, Samuel P. Langley Professor in the Department of Mechanical and Aerospace Engineering at NC State, thinks there may be a more efficient way to monitor bridge health.

Yuan has developed a hi-tech way to watch bridges age from his computer screen, 24 hours a day. His tools are wireless sensors and a new signal processing technique (see sidebar).

The wireless sensors, which have become increasingly important in structural health monitoring, can show engineers how much "stress" a structure is experiencing and exactly where it's happening.

But sometimes sensors break. And in events like earthquakes, when engineers are relying on the technology for important information about a structure's health, if the sensor doesn't work, there's no information.

Now, thanks to Dr. Kara Peters, professor of aerospace engineering, there's a sensor that can heal on its own.

Peters and her students have created a sensor that contains an infrared (IR) light wave that detects changes as the sensor stretches and compresses along with the material it's monitoring. The change in length tells engineers how much strain the material is undergoing.

The sensor consists of two glass optical fibers running through a reservoir filled with ultraviolet (UV)-curable resin. The ends of the glass fibers are separated by a small gap. Focused beams of IR and UV light run through one of the fibers, and when the tightly focused UV beam hits the resin, the resin hardens. The result is a thin polymer filament that connects the glass fibers, creating a closed circuit for the IR light.

The rest of the resin in the reservoir remains in liquid form, surrounding the filament. If the polymer filament breaks under stress, more liquid resin rushes into the gap, hits the UV beam and hardens — repairing the sensor automatically.

"The idea with self-healing is that you don't have to say, 'Oh, I know sensor 10 broke, let me fix it,'" Peters said. "It's part of the process. When a sensor breaks, it automatically heals itself."

Breaking down to build better

Researchers at the CFL have been testing big structures since 1996. The 20,000-square-foot research complex has state-of-the-art spaces like the Large Structural Systems Laboratory, which has powerful equipment that allows researchers to watch how the concrete in a parking deck reacts to an earthquake. Pushing super-strong materials to their breaking point – and beyond – is part of the lab's mission.

The lab also has a walk-in environmental chamber, which gives engineers a chance to see how well a bridge support handles strong winds or brutally cold temperatures. Environmental effects that may take years to happen in the real world can be created at the CFL in a few weeks.

Today the CFL is one of the few university labs in the country accredited to standards set forth by the International Code Council, which publishes building safety and fire prevention codes that have been used by companies and agencies across the nation. The accreditation means that all the lab's testing results can be applied to real structures. This distinction has also attracted international attention — the Korea Institute of Construction Technology and Nippon Steel, the giant Japanese steel producer, are among the lab's clients.

Breaking down the CFL

- Established in 1996
- Joint investment by the National Science Foundation and the State of North Carolina
- One of the nation's busiest facilities for structural engineering testing and developing innovative construction materials and systems

Notable projects

- Reinforcements used in the foundations of the Freedom Tower in New York
- Wooden "glulam" beams in the new terminal at the Raleigh-Durham International Airport

Faculty at the CFL use the facility to explore new materials found in today's buildings and bridges and those that will be used in the future. They include advanced composite materials like high-performance concrete and fiber-reinforced polymers. These kinds of materials are stronger, lighter and more efficient than traditional materials, such as steel and concrete.

In 2001, Dr. Mervyn Kowalsky, professor of structural engineering, and Dr. Paul Zia, Distinguished University Professor Emeritus of Civil Engineering, were part of a team that constructed North Carolina's first high-performance concrete bridge. The bridge, located over the Neuse River in northern Wake County, used fewer support beams, cost less to build and should perform better over the long term than its predecessors.

Hi-tech materials can also save money by allowing engineers to repair bridges, rather than replace them.

"The goal is to return structures back to their original performance and increase their service life," said Dr. Rudi Seracino, associate director of the CFL and associate professor in the Department of Civil, Construction, and Environmental Engineering.

While the CFL often tests materials found in soaring bridge columns, NC State engineers' work extends underground, as well.

Dr. Mohammad Pour-Ghaz, an assistant professor in the Department of Civil, Construction, and Environmental Engineering, is working with electrically conductive concrete and grout to help engineers detect cracks quickly and easily in underground pipelines.

The special nature of the materials allows engineers to easily monitor the conductivity. If there's a change, they can pinpoint the exact location of the damage and have a very good idea of the severity of the damage.

"It's like having a wire and passing electricity through it," Pour-Ghaz said. "If someone cuts the wire, there won't be any electricity passing through it. Therefore, we know something happened."

Finding the right health plan

NC State engineers are developing new materials and techniques to keep the nation's infrastructure around much longer.

They've taken their research to the coastal town of Jacksonville, NC, where faculty and graduate students are developing monitoring techniques to better protect bridges against the dangerous scour that occurs when fast-moving water removes sediment around bridge abutments or piers. NC State engineers also want to see if their work can extend beyond our atmosphere; they're exploring ways to monitor structures in outer space.

"The CFL is unique," Rizkalla said. "I feel it can have an impact on the United States and the world in terms of the fact that we can do things that very few people can do." ▪

A first for NC

Most people see an old bridge. Dr. Fuh-Gwo Yuan sees a guinea pig.

Yuan, who has developed a wireless sensor system that monitors a bridge as it ages, needed a test bridge for his work. He recently set his sights on a truss bridge in southeastern North Carolina (above).

From his conversations with NCDOT, it will be the first time a North Carolina bridge has been monitored from afar with wireless sensors.

His technology uses those sensors along with damage-detection signal processors to detect cracks and other areas of weakness on a bridge. Advanced algorithms will tell engineers what the damage means for the bridge's long-term health. The system will be self-powered with tiny wind energy collectors and solar panels.

Armed with this constant stream of data, transportation officials will be able to make more accurate predictions on when bridge repairs are needed. The equipment isn't entirely precise — it doesn't have a prophetic ability to nail down the exact date a bridge will collapse, for example — but it will provide a general estimate on when a bridge should be replaced.

Introduced at NC State
Entrepreneurs for life

Barbara and Carlos Gutierrez (above and far right, opposite page) met at NC State in the late 1950s. Among the many companies they've founded is URRC, which partnered with Coca-Cola on the largest bottle recycling plant of its kind in the world (center, opposite page).

The business-building bond between Carlos and Barbara Gutierrez started in Raleigh.

NC State gave Carlos Gutierrez technical skills. It hatched many friendships. It helped develop a keen business acumen that has been invaluable to his 50-year engineering career.

But his biggest debt to the school can never be repaid: NC State is where he met his wife.

The resulting relationship between Carlos and Barbara Gutierrez has produced not just a family and a lifetime of good memories, but a slew of successful businesses in a variety of industries. The couple's most recent entrepreneurial venture resulted in a mammoth deal with Coca-Cola that produced the largest bottle recycling plant of its kind in the world and helped divert millions of pounds of plastic from landfills.

"Not only is Barbara a great partner," said Gutierrez, the founder, president and CEO of United Resource Recovery Corp., or URRC, "she has a flair for entrepreneurship herself."

The couple met in the late 1950s when they were both students at NC State. Gutierrez, who hailed from Mexico City but had attended high school in Virginia, was a speedy left wing on the NC State varsity soccer team. He remembers seeing a design student from Cherryville, NC, named Barbara Hoyle at one of his games.

Around that time, Gutierrez's roommate introduced the two. (Fun fact: The roommate, Nicolás Ardito Barletta, later went on to become president of Panama.) They were still students when they married in 1959.

After graduating with a bachelor's degree in chemical engineering a year later, Gutierrez worked in New Jersey for a few years before moving back south to Spartanburg, SC, to do specialty chemical manufacturing for Milliken Chemical. By 1966, he was director of development and seemed headed for a promising career with the company.

"She said, 'if you go out and do this, I'll help you,'" he remembered. **"And that's all I needed."**

But he wanted more. Emboldened by what he'd learned at Milliken, Gutierrez began talking with Barbara about starting their own business.

"She said, 'If you go out and do this, I'll help you,'" he remembered. "And that's all I needed."

In 1974, they started Unisphere Chemicals, a company that developed and manufactured chemical compounds for the textiles and cosmetics industries. The first few years were lean — the couple had to get by without salary for a time while they focused on building the business.

But Unisphere did well, so much so that the couple began to seek out other entrepreneurial ventures. In 1984, Barbara led the launch and served as president of G&H Industries, a business that ended up managing multiple plants for DuPont, the giant chemical company.

Two years later, they sold Unisphere so Gutierrez could concentrate on commercializing a new technology. He had developed a new way to recycle plastic made with an increasingly popular manufacturing material called polyethylene terephthalate, known as PET.

In 1992, the couple founded URRC, which focused on refining silver but also recovering PET from X-ray films discarded by hospitals and doctors' offices. Gutierrez was landing patents for his new PET process, and the new company used the technology to begin recycling plastic bottles into tiny, super-clean plastic chips that would be used to make new bottles.

The process was licensed to other companies and led to the construction of numerous so-called "bottle-to-bottle" recycling facilities on three continents. A big break came in 2008, when URRC formed a joint venture with the Coca-Cola Company to build the world's largest bottle-to-bottle polymer recycling plant in Spartanburg. Coke agreed to invest about $50 million in the venture.

Today, the plant produces 100 million pounds of crystallized PET chips from used plastic bottles every year. Those chips have been used to make more than six billion new bottles for Coke, Diet Coke and other drinks.

Through the years, NC State has benefited from the couple's success. Gutierrez serves on the NC State Engineering Foundation Board of Directors and spoke at the 2009 commencement ceremony for the Department of Chemical and Biomolecular Engineering. The Gutierrez's generous financial contributions have resulted in membership to the university's Charles William Dabney Lifetime Giving Society.

In 2010, the couple established the Carlos D. and Barbara Hoyle Gutierrez Endowed Scholarship. The idea for the scholarship, Gutierrez said, came from Barbara, who had noticed many talented young people skipping college because they couldn't afford it.

"No matter who they are, if they have the ability, we want to make sure we have the funding," Gutierrez said.

When Gutierrez was honored last year for his accomplishments and his service to the College with recognition as a Distinguished Engineering Alumnus, he said in his acceptance remarks that Barbara had helped him "get through the hard times and extended the good times."

In October, they will celebrate their 53rd wedding anniversary.

"Nothing," he told the audience, "would have been possible without her." ▪

‘The welcome mat is out’

Engaging with more alumni and friends is a priority for new NC State Engineering Foundation Executive Director Brian Campbell.

Brian Campbell expected to find a mixed bag when he joined the College of Engineering last year. There would be strengths and weaknesses. Some programs and departments would be better than others.

But after meeting with administrators, faculty and students, he came away with a singular impression: Any NC State engineering department would fit right in at MIT, Stanford or any other elite engineering school.

“If you lift the roof up and look down into this house,” Campbell said, “you’re going to see some of the smartest people in the world working on some of the most important issues in new and innovative ways.”

The main difference between NC State and the schools ranked above it, Campbell believes, is its support apparatus. The College can improve the way it presents itself to alumni, friends and corporate partners, he said, and turn many of those admirers into financial supporters who can grow the College’s $76 million endowment into something much larger.

“We’re going to make people feel like the door’s open, the welcome mat is out and we need their help,” he said.

Campbell, who joined the Foundation as executive director in October after the retirement of longtime director Ben Hughes, brings a variety of experiences to his new role.

He grew up in a working-class family in southeastern Virginia. After high school, he joined the US Air Force as a security instructor and remained in the service for six years.

He soon became interested in politics, and ties he’d forged with Virginia leaders helped him rise to the chairman’s seat on the state’s Social Services board. From that post, he helped lead Virginia’s welfare reform efforts in the late 1990s and early 2000s.

Around that same time, he went back to school, earning a bachelor’s degree in business administration from Averett University and, later, a master of education degree in higher education policy from the University of Virginia. He took a job coordinating reunions at Virginia and eventually worked his way up to the top fundraising post at the university’s Medical School Foundation.

He went on to hold leadership development positions at Iowa State University, the Nevada System of Higher Education, and, most recently, the Commonwealth Medical College in Scranton, Pa., the first independent, allopathic medical college created in the US in three decades.

“Brian brings a wonderful combination of talent, enthusiasm and experience to the outstanding staff of the Engineering Foundation,” said Dr. Louis A. Martin-Vega, dean of the College of Engineering. “He understands the importance of building support for our research and education programs, and he’s already working on new ways to grow the endowment and reach out to more alumni and friends.”

“If you lift the roof up and look down into this house,” Campbell said, “you’re going to see some of the **smartest people in the world** working on some of the most important issues in new and innovative ways.”

At NC State, Campbell has two primary goals: Boost engagement and create a development plan for the future.

On engagement, he believes that NC State needs to interact with its supporters more frequently and promote giving in more sophisticated ways. A first step, he said, is to bring College alumni back to campus each year for a big event. One such event is planned for Nov. 2 in conjunction with the university’s Homecoming and 125th anniversary.

He’s also working with Foundation staff and board members to build a specific fundraising plan that “plays off our strengths, which will provide more opportunities for funding.”

Campbell knows that the College’s students and faculty, as well as Martin-Vega, Hughes and Foundation board members, have built a place that’s easy to market to supporters.

“Really, all I am is a real estate agent,” Campbell said. “And the seller that I’m representing is this phenomenal college.” ▪

Brian Campbell can be reached at 919.515.9956 or brian_campbell@ncsu.edu.

Gwen Bell retires

For 20 years, Gwen Bell has been the backbone of the NC State Engineering Foundation.

She oversees budgets. She plans events. She handles gift receipts. And she answers questions — from pretty much everyone.

Now, she’s retiring. Her last day is May 1.

“It’s really nice to have a job that you enjoy doing,” she said. “It changes every day, and I’ve met so many new and interesting people.”

Bell grew up in Camden, SC, and attended nearby Coker College. She later moved with her husband, Frank, to North Carolina — first to Charlotte and then to Raleigh in 1982 where she eventually took a job with NC State’s Department of Mechanical and Aerospace Engineering. In 1992, following the recommendation of a co-worker, she joined the tiny Engineering Foundation as an accounting clerk.

Ben Hughes, the former Foundation director who retired last year, kept upgrading her position and giving her more responsibilities. She’ll leave as manager for business and operations for an organization with 10 full-time employees and an endowment of $76 million.

“She knows everything,” said Brian Campbell, the Foundation’s executive director. “I was joking with her the other day that we should confine her here and not let her leave!”

In retirement, Bell plans to spend more time with her two children and five grandchildren, the latter of whom range in age from 17 months to 17 years old. She will miss the organization she helped build but is looking forward to retirement.

“When you enjoy doing something,” she said, “you give it all you’ve got.”

Leading by *EXAMPLE*

The Board of Directors of the NC State Engineering Foundation galvanizes support for the College.

How can we make the College of Engineering better?

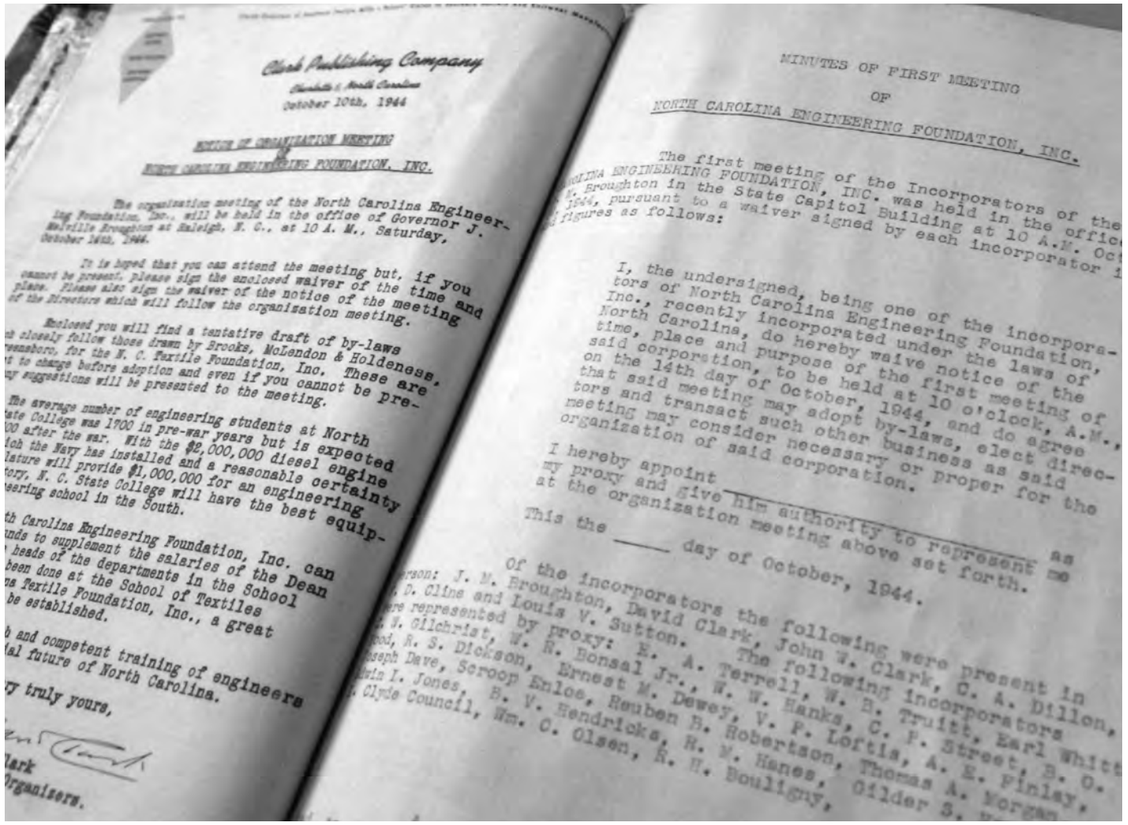
That question guides the Board of Directors of the NC State Engineering Foundation, a group of alumni and friends working to make the College the top public engineering school in the nation.

Their efforts are paying off. Over the past five years, the College has risen in national rankings, boosted research expenditures more than 40 percent, and met a College priority by growing graduate student enrollment to record levels.

The 30 or so board members, all volunteers, contribute an awful lot of time, money and talent to the cause.

"Above all, we are there to promote the quality of NC State engineering," said board member Robin Manning, an electrical engineering alumnus. "We want to boost the value of an NC State engineering education."

The board members' work includes two daylong meetings held each spring and fall. The group gathers with Dr. Louis A. Martin-Vega and other College leaders to align the board's work with the Dean's vision for the College.



Clark Publishing Company
Charlotte : North Carolina
October 20th, 1944

MINUTES OF FIRST MEETING
OF
NORTH CAROLINA ENGINEERING FOUNDATION, INC.

The organization meeting of the North Carolina Engineering Foundation, Inc., will be held in the office of Governor J. Melville Broughton at Raleigh, N. C., at 10 A. M., Saturday, October 28th, 1944.

It is hoped that you can attend the meeting but, if you cannot be present, please sign the enclosed waiver of the time and place. Please also sign the waiver of the notice of the meeting of the Directors which will follow the organization meeting.

Enclosed you will find a tentative draft of by-laws which closely follow those drawn by Brooks, McLendon & Holdeness, Greensboro, for the N. C. Textile Foundation, Inc. These are subject to change before adoption and even if you cannot be present any suggestions will be presented to the meeting.

The average number of engineering students at North State College was 1900 in pre-war years but is expected to be 2500 after the war. With the $2,000,000 diesel engine which the Navy has installed and a reasonable certainty that the legislature will provide $1,000,000 for an engineering building, N. C. State College will have the best equipped engineering school in the South.

The North Carolina Engineering Foundation, Inc. can raise funds to supplement the salaries of the Dean and heads of the departments in the School of Textiles as has been done at the School of Textiles at the N. C. State Textile Foundation, Inc., a great School will be established.

For a sound and competent training of engineers for the industrial future of North Carolina.

Very truly yours,

Clark
Organizers.

The first meeting of the Incorporators of the NORTH CAROLINA ENGINEERING FOUNDATION, INC. was held in the office of Governor J. Melville Broughton in the State Capitol Building at 10 A.M. October 28th, 1944, pursuant to a waiver signed by each incorporator as follows:

I, the undersigned, being one of the incorporators of North Carolina Engineering Foundation, Inc., recently incorporated under the laws of North Carolina, do hereby waive notice of the time, place and purpose of the first meeting of said corporation, to be held at 10 o'clock, A.M., on the 14th day of October, 1944, and do agree that said meeting may adopt by-laws, elect directors and transact such other business as said meeting may consider necessary or proper for the organization of said corporation.

I hereby appoint _____ as my proxy and give him authority to represent me at the organization meeting above set forth.

This the ____ day of October, 1944.

Of the incorporators the following were present in person: J. M. Broughton, David Clark, John W. Clark, C. A. Dillon, R. D. Cline and Louis V. Sutton. The following incorporators were represented by proxy: E. A. Terrell, W. B. Truitt, Earl Whitt, J. W. Gilchrist, W. R. Bonsal Jr., W. W. Hanks, C. P. Street, B. O. Wood, R. S. Dickson, Ernest M. Dewey, V. P. Loftis, A. E. Finlay, Joseph Dave, Scroop Enloe, Reuben B. Robertson, Thomas A. Morgan, Edwin I. Jones, B. V. Hendricks, R. W. Hanes, Gilder S. [illegible], W. Clyde Council, Wm. C. Olsen, R. W. Boulighy,

Early board meeting records for the NC State Engineering Foundation, which was formed in 1944.

The rest of the year, board members are hosting alumni events, attending recruiting events for high school students and talking up the College wherever they go.

"These men and women will go anywhere at anytime and do what's necessary on behalf of this College," said Brian Campbell, the Foundation's executive director. "And that's incredible."

They're also key donors. Foundation board members or the companies they represent have contributed 13 of the 17 distinguished professorships established in the College since 2006.

"We try to make sure the entire board is engaged financially," said industrial engineering alumnus Larry Bowman, chair of the board's development committee. "And they help us develop relationships with the key constituents around the country."

That committee is one of six groups that develop specific strategies toward the board's different objectives:

- **Advocacy —** This group makes sure the College's interests are supported at NC State and beyond the campus boundaries. Its top priority is to complete the College's move to Centennial Campus.
- **College Relations —** Raising awareness of the Foundation and its support for the College is this group's responsibility. It helps coordinate events and explores new ways to connect with students, faculty and young alumni.
- **Development —** This committee helps solicit and close major endowment gifts from fellow board members and other top prospects. The group also helps out with annual giving initiatives and event sponsorships.
- **Audit —** An independent CPA audits the Foundation's finances each year. This committee reviews that work.
- **Finance —** Overseeing the Foundation's budget, in conjunction with the Board Treasurer and staff, is this committee's top priority.
- **Nominations, Orientation and Recognition —** Recruiting a diverse group of new members to the board is this committee's responsibility. It also gets new members oriented to the board and involved with College activities.

For alumni who aren't board members, there are still plenty of ways to get involved with the Foundation's work.

"First and foremost they can contribute. Their dollars can be the difference between attracting a top-notch student and not," Manning said. "But we also need their experience. Students are always looking for role models, and they want to follow in the footsteps of those people." ▪

THE NC STATE ENGINEERING FOUNDATION: THE BEGINNING

The Foundation was formed in 1944 when **Gov. J. Melville Broughton** brought together 49 engineers, contractors and industrialists to promote and raise money for what was then called the School of Engineering. Broughton was the first president of the Foundation board.

The group's earliest success was recruitment of J. Harold Lampe of Johns Hopkins University to NC State. Lampe, who joined the College as dean in 1945, oversaw major curricula growth and the construction of many new facilities, including the nation's first nuclear reactor on a university campus.

Lampe's recruitment illustrates a larger point about the Foundation's importance. By raising money to support professorships and scholarships for faculty and students, the Foundation helps NC State recruit and retain the best people.

PRESIDENTS OF THE NC STATE ENGINEERING FOUNDATION, INC.

1944 – 1948	J. Melville Broughton
1949 – 1954	C. A. Dillon
1955 – 1956	George P. Geoghegan Jr.
1957 – 1958	E. A. Clement
1959 – 1961	R. Walker Martin
1962 – 1963	Orton A. Boren
1964 – 1965	Nello L. Teer Jr.
1966 – 1967	G. Maurice Hill
1968 – 1969	B. B. Parker
1970 – 1971	Fred E. Reiber
1972 – 1973	Oliver R. Rowe Sr.
1973 – 1974	G. Thomas Holmes Jr.
1975 – 1976	J. A. Jones
1976 – 1977	George E. Norman Jr.
1978 – 1979	Henry A. Foscue
1980 – 1981	Johnie H. Jones
1982 – 1984	Ralph M. McAlister
1985 – 1988	Charles E. Branscomb
1989 – 1990	C. E. Vick Jr.
1991 – 1992	Homer L. Riley
1993 – 1994	Norman G. Samet
1995 – 1996	Larry D. Nixon
1997 – 1998	Glenn E. Futrell
1998 – 2000	James M. Davis
2000 – 2002	Craig M. Wardlaw
2002 – 2004	Robert G. Wright
2004 – 2006	John T. McCarter, Jr.
2006 – 2008	E. O. Ferrell III
2008 – 2010	S. Edward White
2010 –	S. Frank Culberson

donor stories

LULU, RED HAT FOUNDER DONATES $250,000 TO EGAMES

Bob Young

Bob Young, the Raleigh entrepreneur who founded the online self-publisher Lulu and co-founded Red Hat, is making a $250,000 gift over five years to the eGames student business startup competition at NC State.

In recognition of Young's gift, the annual competition will be called "The Lulu eGames" for the next five years. Students competing in The Lulu eGames vie individually or in teams for medals and prizes totaling up to $30,000. The 2012 competition is underway with the final round scheduled for April 30.

Launched in 2009 by NC State's Entrepreneurship Initiative, a university-wide commitment to nurture entrepreneurial thinking and activities, eGames competitions have featured hi-tech motorcycle boosters, temperature-sensing bathtub mats, antibacterial children's apparel and many other student-created products. In addition to designing and engineering their entries, students learn the marketing, business planning, financing, and other skills entrepreneurs need to be successful.

Young is the founder and CEO of Lulu, an online self-publishing company with headquarters on Hillsborough Street near NC State's North Campus. The company lets users self-publish, print and sell print-on-demand books, eBooks, photo books and calendars. He previously co-founded Red Hat, the open source software company headquartered on NC State's Centennial Campus. ▪

SIEMENS ESTABLISHES POWER ENGINEERING PARTNERSHIP WITH NC STATE

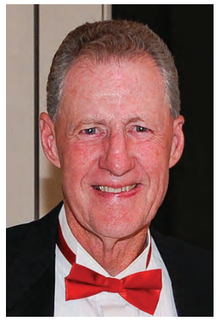
SIEMENS

Siemens, a global supplier of products, services and solutions for the generation, transmission and distribution of energy, has established a partnership with NC State to bolster the university's power engineering research and education efforts.

The partnership includes a monetary gift that will establish the Siemens Term Professorship in Power Engineering and two graduate student fellowships in NC State's Department of Electrical and Computer Engineering.

Siemens has also committed to a full industrial partnership with the FREEDM Systems Center, a National Science Foundation Engineering Research Center headquartered at NC State that is dedicated to smart grid technology and distributed energy. ▪

CULBERSON HONORED WITH 2011 MENSCER CUP


Frank Culberson

S. Frank Culberson, a 1960 chemical engineering alumnus, received the 2011 Menscer Cup in October in recognition of his contributions to NC State through philanthropy and fundraising leadership.

The annual award is named for Darrell V. Menscer, a 1960 electrical engineering alumnus, and his wife, Carolyn, who established an endowment to fund it.

Culberson and his wife, Doris, have been generous contributors to NC State and recently pledged $1 million to endow two professorships in the Department of Chemical and Biomolecular Engineering. The couple previously established the S. Frank and Doris Culberson Academic Enhancement Fund in Chemical Engineering.

Frank Culberson is chairman and a director of Rimkus Consulting Group, a 400-person forensic consulting and engineering firm. He currently serves as president of the NC State Engineering Foundation Board of Directors and was named a Distinguished Engineering Alumnus in 2002. ▪

SCHOLARSHIP ESTABLISHED TO HONOR FORMER FOUNDATION DIRECTOR


Ben Hughes

Friends and colleagues of Ben Hughes, former executive director of development and college relations at the NC State Engineering Foundation, have established a scholarship endowment honoring him for 18 years of service with the Foundation.

The gift creates the Ben H. Hughes Scholarship in Engineering and will be used to provide scholarships for undergraduate students pursuing a degree in the College. Students enrolled in the Benjamin Franklin Scholarship Program, a dual-degree program that pairs coursework in engineering with humanities and social sciences, will receive first preference for the award.

Hughes, who retired in September, presided over the most successful fundraising period in the College's history. During his tenure, he helped grow the College's overall endowment from about $10 million to $76.3 million. Among the many highlights was the $10 million gift from alumnus and former Foundation board member Edward P. Fitts in 2005 to endow the Edward P. Fitts Department of Industrial and Systems Engineering. ▪

ALUMNUS ENDOWS MSE SCHOLARSHIP

An engineering alumnus and his wife have established a scholarship endowment in the Department of Materials Science and Engineering at NC State.

The scholarship established by John J. and Kitty B. DuPlessis includes a new $25,000 gift being made over five years that will eventually be supplemented by a planned estate gift of about $80,000. The scholarship fund is currently valued at more than $50,000, $35,000 of which was previously donated by the couple and transferred over to the new endowment.

John DuPlessis, a well-known expert in metallurgy of permanent magnets and metals recycling, received BS degrees in metallurgical engineering and nuclear engineering in 1958 and an MS in metallurgical engineering in 1961, all from NC State. He is a consultant and member of the Board of Directors for Applied Magnet Technology, an international engineering company.

DuPlessis has been a key supporter of the materials science and engineering department, spearheading the department's first scholarship campaign and helping lead succeeding fundraising efforts. He was named a Distinguished Engineering Alumnus in 1995. ▪

College celebrates distinguished alumni

Marshall D. Brain

William H. Dean

Robert R. Womack

The College of Engineering named Marshall D. Brain, founder of HowStuffWorks.com; William H. Dean, president and CEO of M.C. Dean, Inc.; and Robert R. Womack, former chairman and CEO of Zurn Industries, LLC, as its Distinguished Engineering Alumnus award winners for 2011.

The awards were presented by Dr. Louis A. Martin-Vega, dean of the College of Engineering, at a banquet held Jan. 26 at the Park Alumni Center on Centennial Campus. The award honors alumni whose accomplishments further their field and reflect favorably on the university.

Brain graduated from NC State in 1989 with a master's degree in computer science. Nine years later, he founded HowStuffWorks.com, an award-winning website that offers easy-to-understand explanations of how the world around us actually works. Discovery Communications purchased the site for $250 million in 2007. Brain and his wife, Leigh, have contributed financially to NC State and have maintained close ties to the university. Marshall Brain was the emcee for the 2010 summit on the National Academy of Engineering Grand Challenges in Raleigh and has spoken at events such as NC State's Entrepreneurs' Lecture Series.

Dean received his bachelor's degree in electrical engineering from NC State in 1988. Since 1997 he has been president and CEO of M.C. Dean, Inc., which, under his leadership, has increased its total annual revenues thirtyfold and grown from a company of 100 employees in 1997 to 3,300 employees today. M.C. Dean is an active recruiter of NC State engineering graduates, a consistent participant in the NC State Engineering Career Fair and an industry member of the NSF FREEDM Systems Center. William Dean is also a member of the Engineering Dean's Circle and the NC State Engineering Foundation Board of Directors.

Womack earned his bachelor's degree in mechanical engineering with an aeronautical option from NC State in 1959. He later went on to serve as chairman, chief executive officer or president of four New York Stock Exchange companies, including Zurn Industries. During his tenure at those companies, Womack led business turnaround, restructuring and development activities and was involved in more than 50 acquisitions, mergers and divestments. Womack and his wife, Judith, have been generous supporters of the university's Chancellor's Circle as well as the Engineering Dean's Circle. They recently established the Robert R. and Judith H. Womack Scholarship in the College. ▪

BY THE NUMBERS

A look at some of the figures that shape the College of Engineering

51

NSF CAREER Awards for college researchers since 2000, a strong indicator of young faculty's talent and productivity. Dr. Michael Dickey received the award for work on a moldable metal that could revolutionize antenna design.

1

Raleigh's rank in Businessweek's 2011 listing of America's best cities.

53,143

Total living alumni.

3

National Medals of Technology and Innovation won by College faculty and alumni. The award is the nation's highest honor for technological achievement.

5,060

Students and other job seekers attending the Fall 2011 NC State Engineering Career Fair, a record for the event.

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

SAVE THE DATE

Friday, November 2, 2012

Join College of Engineering alumni and friends on Homecoming Weekend as we celebrate NC State's 125th Anniversary

DETAILS AT WWW.ENGR.NCSU.EDU/ALUMNI/HOMECOMING

NC STATE UNIVERSITY
College of Engineering
125 YEARS