SPRING/SUMMER **2013**

nc state ENGINEERING

THE LIBRARY OF THE FUTURE — RIGHT NOW

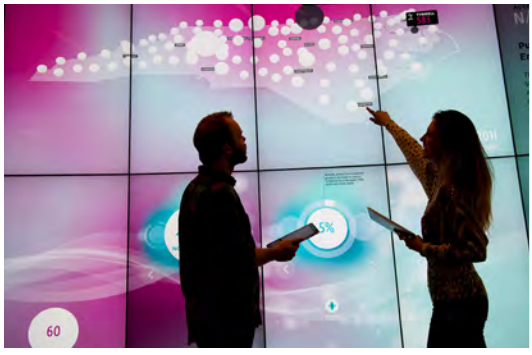
The new James B. Hunt Jr. Library is redefining the engineering study experience

GIFTS THAT LAST LIFETIMES

FROM THE LAB TO THE MARKETPLACE

NC STATE UNIVERSITY

COLLEGE OF ENGINEERING



ENGINEERS' DAY — 30 YEARS AGO

Engineers' Day was a big deal for fun-loving NC State engineering students in the 1980s. A sign placed on campus during that time described the event as "a field day for all engineers in which each engineering dept. will compete in a variety of events for a trophy."

The events? There were human pyramid contests in which competitors piled atop each other, sometimes reaching five student-stories high. There were bumbling three-legged races and hopping potato sack sprints. And there was the pie-eating event, in which students ate cream pies, according to the 1980 *Agromeck* yearbook, in a less-than-genteel manner.

A big draw was the tug-of-war, demonstrated by these soon-to-be-arm-weary students in this 1983 Engineers' Day photo.

contents

nc state ENGINEERING SPRING/SUMMER **2013**

FEATURES

16 THE LIBRARY OF THE FUTURE — RIGHT NOW
The new James B. Hunt Jr. Library is redefining the engineering study experience.

20 GIFTS THAT LAST LIFETIMES
Endowment gifts benefit students and faculty for decades.

22 DESIGN SPONGES
New students soak up the field's lessons at Freshman Engineering Design Day.

26 A WORLD TOGETHER
Engineering faculty bring together top minds at conferences around the globe.

28 READY FOR BUSINESS
The Chancellor's Innovation Fund helps College researchers take ideas to the marketplace.

DEPARTMENTS

03 FROM THE DEAN
The College celebrates a new library and another NAE member.

06 PACK POINTS
News, notes and research highlights.

32 FOUNDATIONS
A son honors his father, introducing the new Foundation Board president, and alumni news and features.

INSIDE BACK COVER BY THE NUMBERS
A look at some of the figures that shape the College of Engineering.

ON THE COVER: The new James B. Hunt Jr. Library, which opened in January on Centennial Campus, just might be the world's most advanced library. It's just a short walk from the new engineering buildings on Centennial.

DEAN **Dr. Louis A. Martin-Vega**

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Did you know?

The NC State Memorial Belltower is bathed in red light for holidays that honor our veterans and after important athletics victories, but did you know the same occurs to celebrate academic accomplishments? In 2012, the Belltower was lit to honor several NC State engineers, including faculty member Dr. B. Jayant Baliga, winner of the North Carolina Award for Science, and undergraduate student Heidi Klumpe, who won a prestigious Barry M. Goldwater Scholarship.

FROM THE DEAN

Louis A. Martin-Vega

For the College of Engineering at NC State University, 2013 began with excitement over the opening of the James B. Hunt Jr. Library, which is located near the Engineering Building complex on our Centennial Campus. Hunt is truly a library of the future – a place where robots retrieve selections at the click of a mouse and walls are interactive touch screens where students design large-format video games. It is also the only academic library in the nation powered by a supercomputer. Hunt holds the university's engineering collections and is rapidly becoming the heart of Centennial Campus where students and faculty gather and study.

The College is also celebrating the recent announcement that our own Dr. Carl Koch, the Kobe Steel Distinguished Professor of Materials Science and Engineering, has been selected for membership in the National Academy of Engineering. He becomes the 11th current faculty member to join the academy. We also congratulate our three newest recipients of National Science Foundation Career Awards, Drs. William Enck, Fanxing Li and Emerson Murphy-Hill. The College now boasts 36 recipients of these prestigious NSF young faculty awards over the past 10 years.

In the following pages you will learn how our creative first-year students tackle challenging design projects and explore the many ways our Chancellor's Innovation Fund helps faculty bring their life-changing work to the marketplace. This issue also contains a variety of exciting and unique research accomplishments, including energy-storing nanoflowers, improved hurricane predictors and even computer-controlled cockroaches.

We have dedicated the centerfold of this magazine to a topic of great importance to our future: our endowment. With recent legislative budget reductions and potential cuts in federal research programs, the College needs contributions from our alumni and friends more than ever. We are grateful to all our donors for their ongoing support, and we hope others will join their generous giving efforts.

I hope this issue of *NC State Engineering* inspires you. I hope it teaches you a few new things about this great college. And, as always, I hope it continues our dialogue with you as we look forward to our shared future.

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

Koch elected to National Academy of Engineering

The NC State faculty now boasts 11 National Academy of Engineering (NAE) members.

The most recently elected member is Dr. Carl Koch, Kobe Steel Distinguished Professor in the Department of Materials Science and Engineering, whose induction was announced in February. He was one of 69 new members and 11 foreign associates joining NAE, a private, independent nonprofit organization that provides engineering leadership in service to the nation.

Academy membership honors those who have made outstanding contributions to engineering research, practice or education, including significant contributions to literature in the field. Election is considered one of the loftiest professional distinctions in the field of engineering.

Koch, whose engineering career spans more than 50 years, is well-known for his achievements in research on amorphous and nanostructured materials. In 1983, he became the first researcher to create an amorphous metallic structure — which differs from a normal metal because of its disordered atomic makeup — from two separate elements through a process known as mechanical alloying.

His recent research has turned to creating nanocrystalline materials that have special mechanical and magnetic properties.

Koch was a research group leader with the Metals and Ceramics Division of Oak Ridge National Laboratory before joining the NC State faculty in 1983. ▪

Q & A

Questions for LISA MARSHALL

Lisa Marshall shepherds students in the Department of Nuclear Engineering through their NC State careers. The director of outreach, who also teaches and advises students, talks about recruiting, dispelling misconceptions and advancing the nuclear renaissance.

Your job is unique because of the many ways you help students. Describe it.
I see the entire student life cycle. I recruit them at the high school level. I teach an introductory engineering course and serve as an academic advisor. I help with professional development workshops and use my industry connections to get undergraduate and graduate students in front of hiring managers. Only a few nuclear engineering departments have this position, which is surprising.

Does working in a top nuclear engineering program make your job easier?
It does. We're a growing, top 10 program with an on-campus research reactor, and that's very attractive to prospective students. The recruiting process is often more hype than substance, but we've got plenty of substance to share here. My phone number is on all our outreach publications, and I encourage students to call me to discuss our program, including how it stacks up against others. I find we do pretty well.

What misconceptions do high school students have about the field?
When I speak to students, I start by asking, "What comes to mind when you think of nuclear engineering?" Some mention bombs and Chernobyl and Fukushima. Others talk about mutant animals from Hollywood movies. Some just say the field seems really hard. So these are their starting points, and it's helpful to get those out of the way before I talk about energy production and other great things nuclear engineers do.

How do you dispel these misconceptions?
I use layman's terms to describe the field, which helps students and their parents understand how it really works. Then I talk about career opportunities. Many of our undergraduates end up at utility companies or manufacturers. A few go on to medical school. Power production organizations hire the largest number of our graduate students, and the petroleum industry hires a few others. Our PhDs typically head to national labs.

Talk about your efforts to support women and minorities in the field.
I encourage them to pursue leadership positions in student groups, have them lead from the front. I also connect them with alumni and some of the field's top women and underrepresented minorities. It is very important to make these connections to build the next generation of female and underrepresented nuclear engineers.

Is the nuclear renaissance alive and well?
It is at NC State. Our department has more than 200 undergraduates and more than 100 graduate students, numbers that have more than doubled over the past decade. I've had this job since 2001, and I think the team outreach effort of faculty, staff and students has really helped grow this program.

Solving a big sanitation problem

Civil engineering student Tate Rogers continues to draw attention for his gasoline-powered earth auger invention that could help sanitation workers empty latrines in crowded developing cities. *Scientific American* was the latest to report on his work, which earned Rogers a grant from the Bill and Melinda Gates Foundation.

Rogers estimates the cost per-latrine-emptied to be less than $5, compared with $30-$80 for current technologies.

WiFi that's 700 percent better

PC World, Engadget and WRAL covered NC State's remarkable WiFox, a new software program that can be incorporated into existing WiFi networks and expedites data traffic in large-audience environments — improving data throughput by up to 700 percent.

The program, developed by NC State computer science students and faculty, acts like a traffic cop, keeping the data traffic moving smoothly in both directions.

The research team tested the program on a real WiFi system in their lab, which can handle up to 45 users. They found that the more users on the system, the more the new program improved data throughput performance. Improvements ranged from 400 percent with approximately 25 users to 700 percent when there were around 45 users.

This translates to the WiFi system being able to respond to user requests an average of four times faster than a WiFi network that does not use WiFox.

A smart bandage that saves lives

Popular Mechanics featured a bandage fabric treatment developed by NC State textile engineering students that could slow down blood loss from wounds and potentially save soldiers' lives.

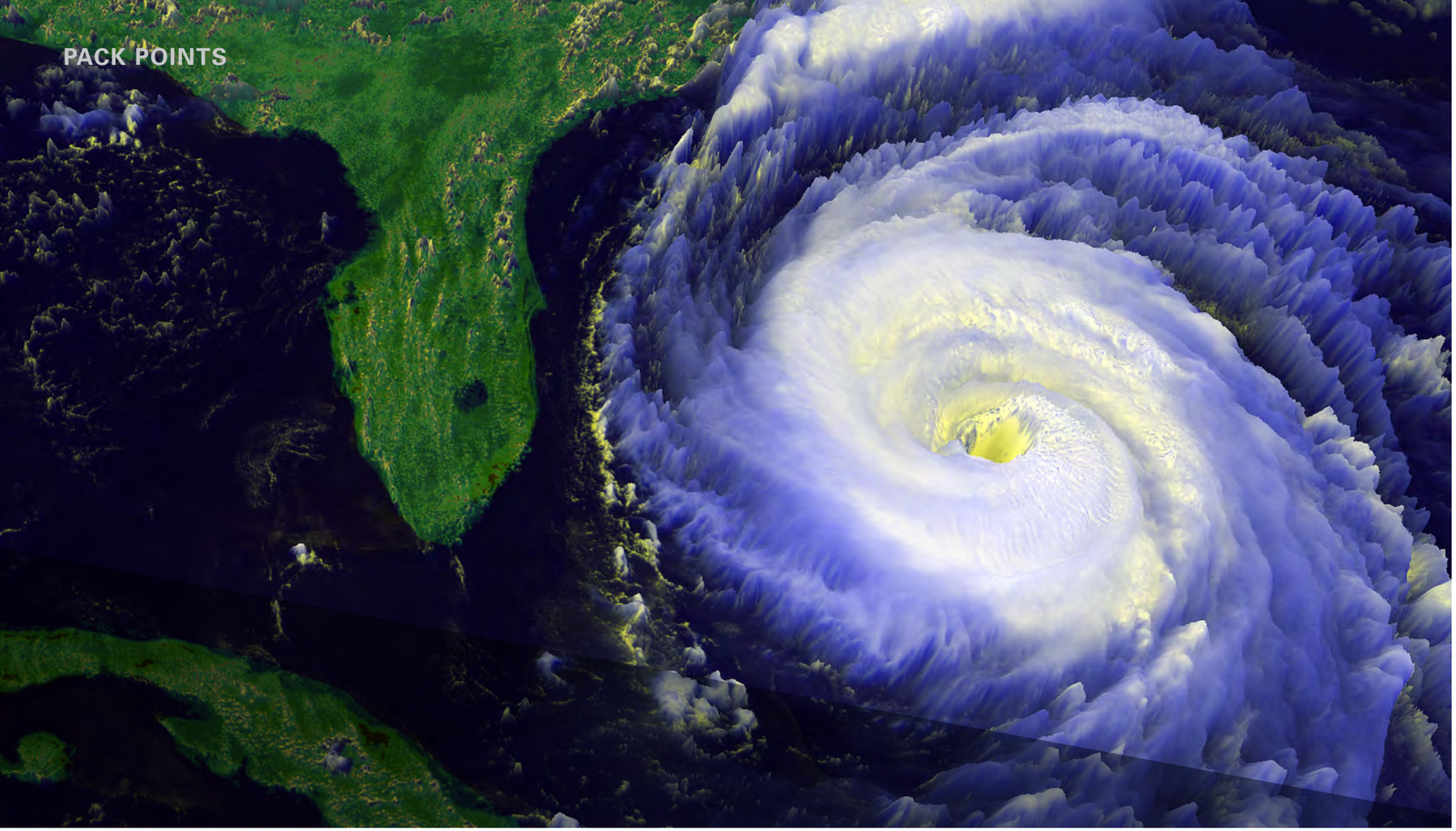
The treatment uses a chemical called tetraethyl orthosilicate that has properties similar to bloodflow-slowing fiberglass (at left in photo), but without the damaging side effects that can occur when glass gets into the body. Fabrics and fibers treated with the chemical (including the cotton at right in photo) reduced the time it took for blood plasma to begin clotting by 25-30 percent.

A top 10 from Physics World

Research that produced the world's first message sent using tiny neutrino particles — a project led in part by Drs. Daniel Stancil and Brian Hughes in the Department of Electrical and Computer Engineering — was named among *Physics World* magazine's top 10 breakthroughs for 2012.

Earlier in the year, the researchers successfully sent a beam of neutrinos through 240 meters of earth with a message in binary code that read, "neutrino." The test, conducted at the Fermi National Accelerator Lab (FermiLab) outside of Chicago, marked the first time information had been transmitted with the particles, which can pass through almost anything because they have no electrical charge and very little mass.

Given the huge amount of technological muscle needed to send and receive one word, neutrinos won't be carrying messages for millions of people anytime soon. But the work opens up possibilities for future advances, including sending messages through the center of the earth and inter-stellar communications.



A better way to predict hurricanes

NC State researchers have developed a new method for forecasting seasonal hurricane activity that is 15 percent more accurate than previous techniques.

Conventional models for predicting hurricane activity rely on classical statistical methods using historical data. Hurricane predictions are challenging, in part, because there are hundreds of thousands of weather variables in play that need to be entered for different places and different times. The trick is in determining which variables at which times in which places are most significant.

This challenge is exacerbated by the fact that we only have approximately 60 years of historical data to plug into the models. But now researchers have developed a "network motif-based model" that evaluates historical data for all of the variables in all of the places at all of the times in order to identify those combinations of factors that best predict seasonal hurricane activity.

The groups of important factors identified by the model are then plugged into a program to create an ensemble of statistical models that present the next season's hurricane activity on a probability scale. For example, it might say there is an 80 percent probability of high activity, a 15 percent probability of normal activity and a 5 percent probability of low activity.

By plugging in partial historical data and comparing the new method's results to subsequent historical events, the researchers found the new method has an 80 percent accuracy rate of predicting the level of hurricane activity. This compares to a 65 percent accuracy rate for traditional methods.

Additional predictive data gleaned from the work could ultimately improve our ability to predict the track of hurricanes, their severity, and the effects of global climate change on future hurricane activity.

A paper on the work was co-authored by Dr. Nagiza Samatova, an associate professor of computer science; Dr. Fredrick Semazzi, a professor of marine, earth and atmospheric sciences; several former NC State students; and researchers at Northwestern University and Zhejiang University in China. The research was supported by the National Science Foundation and the US Department of Energy. ▪

'Nanoflowers' blossom for energy storage

NC State engineers have created flower-like structures with an enormous surface area out of germanium sulfide (GeS), a semiconductor material.

The GeS flower holds promise for next-generation energy storage devices and solar cells because it provides a large surface area in a small amount of space.

"This could significantly increase the capacity of lithium-ion batteries, for instance, since the thinner structure with larger surface area can hold more lithium ions," said Dr. Linyou Cao, an assistant professor of materials science and engineering who co-authored a paper on the research. "By the same token, this GeS flower structure could lead to increased capacity for supercapacitors, which are also used for energy storage."

To create the flower structures, researchers first heat GeS powder in a furnace until it begins to vaporize. The vapor is then blown into a cooler region of the furnace, where the GeS settles out of the air into a layered sheet that is only 20 to 30 nanometers thick and up to 100 micrometers long. As additional layers are added, the sheets branch out from one another, creating a floral pattern similar to a marigold or carnation.

GeS is similar to materials such as graphite, which settle into neat layers or sheets. However, GeS's atomic structure makes it very good at absorbing solar energy and converting it into usable power. This makes it attractive for use in solar cells, particularly since it is relatively inexpensive and non-toxic.

The paper was co-authored by Cao; Dr. Chun Li, a former NC State postdoctoral researcher who is now a professor at the University of Electronic Science and Technology of China; and several former NC State students. The work was supported by the US Army Research Office. ▪

Controlling cockroaches

NC State engineers have developed a technique that uses an electronic interface to remotely control, or steer, cockroaches.

"Our aim was to determine whether we could create a wireless biological interface with cockroaches, which are robust and able to infiltrate small spaces," said Dr. Alper Bozkurt, an assistant professor of electrical engineering. "Ultimately, we think this will allow us to create a mobile web of smart sensors that uses cockroaches to collect and transmit information, such as finding survivors in a building that's been destroyed by an earthquake.

"We decided to use biobotic cockroaches in place of robots," Bozkurt continued, "as designing robots at that scale is very challenging and cockroaches are experts at performing in such a hostile environment."

But you can't just put sensors on a cockroach. Researchers needed to find a cost-effective and electrically safe way to control the roaches, to ensure the roaches operate within defined parameters — such as a disaster site — and to steer the roaches to specific areas of interest.

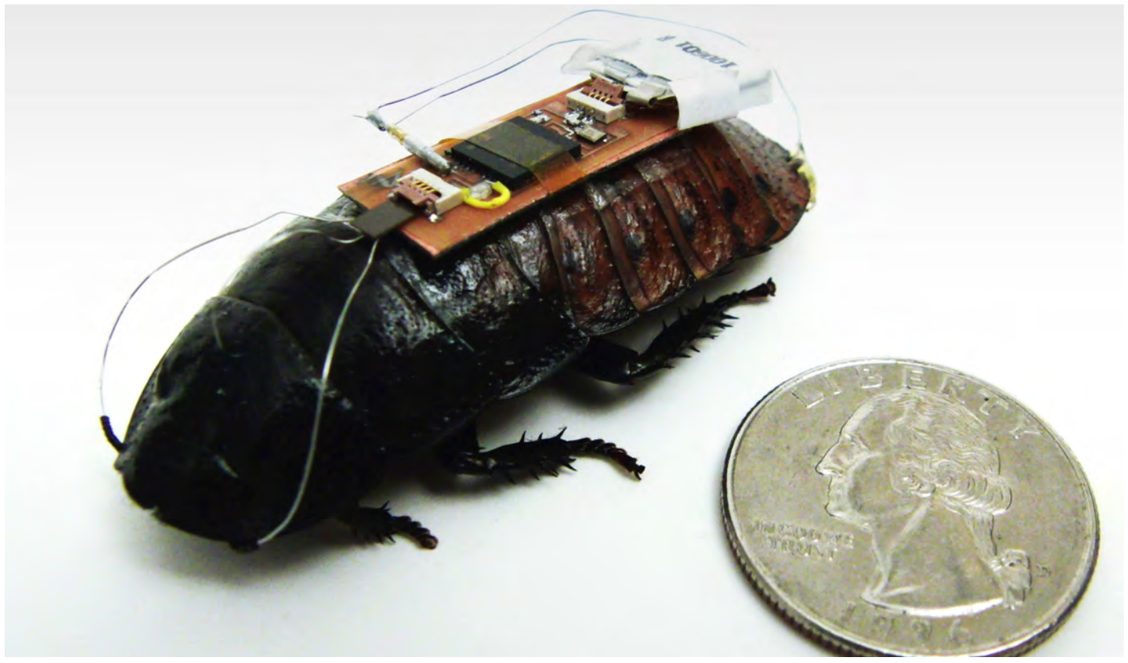
The new technique developed by Bozkurt's team works by embedding a low-cost, lightweight, commercially-available chip with a wireless receiver and transmitter onto each roach (they used Madagascar hissing cockroaches). Weighing 0.7 grams, the cockroach backpack also contains a microcontroller that monitors the interface between the implanted electrodes and the tissue to avoid potential neural damage. The microcontroller is wired to the roach's antennae and cerci, the sensory organs on the roach's abdomen.

The cerci are normally used to detect movement in the air that could indicate a predator is approaching — causing the roach to scurry away. But the researchers use the wires attached to the cerci to spur the roach into motion. The roach thinks something is sneaking up behind it and moves forward.

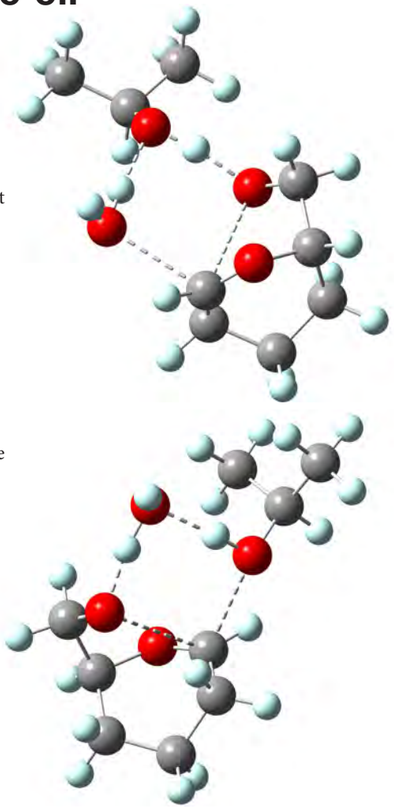
The wires attached to the antennae serve as electronic reins, injecting small charges into the roach's neural tissue. The charges trick the roach into thinking that the antennae are in contact with a physical barrier, which effectively steers them in the opposite direction.

Video of one of the group's roach-steering experiments can be seen at tinyurl.com/9t5tbqc.

A paper on the research was authored by Tahmid Latif, a PhD student in electrical engineering, and co-authored by Bozkurt. The National Science Foundation recently awarded Bozkurt and other NC State researchers $1 million to develop the idea into a sensor network for search-and-rescue and other operations. ▪



New insights into converting wood to bio-oil



New research from NC State provides molecular-level insights into how cellulose — the most common organic compound on Earth and the main structural component of plant cell walls — breaks down in wood to create "bio-oils" that can be refined into any number of useful products, including liquid transportation fuels to power a car or an airplane.

Using a supercomputer that can perform functions thousands of times faster than a standard desktop computer, NC State chemical and biomolecular engineering professor Dr. Phillip Westmoreland and doctoral student Vikram Seshadri calculated what is occurring at the molecular level when wood is rapidly heated to high temperatures in the absence of oxygen, a decomposition process known as pyrolysis.

The results could help spur more effective and efficient ways of converting farmed and waste wood into useful bio-oils.

Much of the energy that can be extracted from wood exists in the cellulose found in cell walls. Cellulose is a stiff, rodlike substance consisting of chains of a specific type of a simple sugar called glucose.

A paper on the research describes a mechanism for how glucose decomposes when heated. The mechanism is somewhat surprising, Westmoreland said, because it reveals how water molecules and even the glucose itself can trigger this decomposition.

"The calculations in the paper show that although the decomposition products and rates differ in glucose and cellulose, the various elementary steps appear to be the same but altered in their relative importance to each other," Westmoreland said.

Knowing the specifics of the decomposition process will allow researchers to make predictions about the ease of extracting energy from different types of wood from various soil types.

The researchers are now conducting experiments to verify their calculations.

The research was funded by the US Department of Energy. The computations were performed on Pittsburgh Supercomputing Center computers. ▪

Advanced manufacturing works in NC

Manufacturing is a big deal in the Old North State. North Carolina is the fourth largest manufacturing state in the country, and it ranks first among southeastern states in terms of manufacturing employment.

So it's no surprise that advanced manufacturing — using cutting-edge technology to improve products and processes — was a big part of NC State's 2013 Emerging Issues Forum held in downtown Raleigh in February. "@Manufacturing Works" featured speakers from industry, state and federal government, and academia focusing on manufacturing trends and the future of the sector.

The College of Engineering has a number of faculty involved in advanced manufacturing, including many in the Edward P. Fitts Department of Industrial and Systems Engineering. And the College's Industrial Extension Service (IES) helps the state's factories find more efficient ways to make their products.

College leaders also play key roles in the Institute for Emerging Issues (IEI), the NC State-based organization that runs the forum and has its headquarters at the new Hunt Library on Centennial Campus.

Dr. Louis Martin-Vega, dean of the College, and Dr. Ruben Carbonell, Frank Hawkins Kenan Distinguished Professor of Chemical Engineering and director of the Golden LEAF Biomanufacturing Training and Education Center and the Kenan Institute for Engineering, Technology and Science, serve on the IEI National Advisory Board. Terri Helmlinger Ratcliff, executive director of IES and interim vice provost for outreach and engagement, sits on the group's Economy Issue Council. ▪

A better way to install solar energy systems

A new grant to NC State and several partners could make installing rooftop solar energy systems much less expensive and time consuming.

Researchers will use the five-year, $9 million grant from the US Department of Energy (DOE) to design solar energy systems and installation and connection procedures that require little or no customization by homeowners and installers. The systems would set up quickly and connect to the power grid easily, while still meeting building and electrical codes.

"The high cost and hassle associated with installing home solar energy systems is a major barrier to their widespread adoption," said Dr. Alex Huang, Distinguished Professor of Electrical and Computer Engineering, director of the FREEDM Systems Center at NC State and the lead researcher on the grant. "By developing standardized and easy-to-use technologies, we can significantly reduce the cost of these systems for homeowners, who would be able to install the systems themselves."

Today, much of what homeowners spend on solar energy systems goes toward supplier overhead, inspections, permitting, installation and other so-called "soft" costs. DOE estimates these costs at $2.50 per watt, a significant amount of money for systems that typically generate several thousand watts of power.

But by creating systems that "plug and play" — universal designs akin to USB interfaces in computers — the researchers believe they can drive these costs under $1 per watt. That means a homeowner installing a 5,000-watt solar energy system could save more than $7,500 in soft costs.

Researchers will use the grant to develop standardized panel mounting systems, communication technologies, electrical wiring designs, automated permitting systems and other cost-cutting technologies. The group will work with codes and standards organizations, electric utilities, building and electrical inspectors and consumers to tackle the real-world challenges faced by solar energy system installers and the local authorities that set installation rules.

Leading the project will be the FREEDM Systems Center, a National Science Foundation Engineering Research Center headquartered at NC State that is developing smart grid technologies. The NC Solar Center at NC State, which develops and demonstrates clean energy technology, is also a key player. Others involved include the National Rural Electric Cooperative Association, the University of Toledo, Isofoton, ABB and Quanta Technology. ▪

Engineering an expanded Panama Canal

Three leaders behind the remarkable Panama Canal expansion project discussed their roles in one of the 21st century's most challenging engineering ventures at an NC State lecture event attended by hundreds of engineers in September.

The presentations by Alberto Alemán Zubieta, former CEO of the Panama Canal Authority; Michael Newbery, locks design manager with MWH Global; and Joseph Cazares, deputy program manager and locks construction manager with CH2M Hill, offered a rare, behind-the-scenes look at the $5.25 billion Panama Canal expansion project.

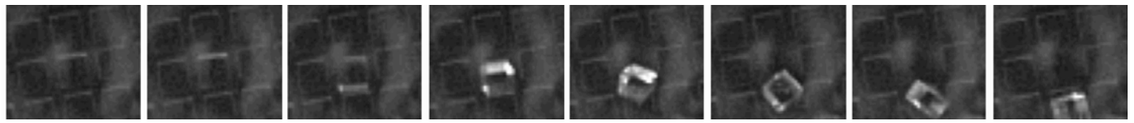
The expansion adds a new set of locks at the Atlantic and Pacific oceans that will double the canal's capacity, allowing more and larger ships to use the 100-year-old waterway. The expanded canal should be fully operational in 2015.

The 800 people who attended were a record for the Paul Zia Distinguished Lecture Series in Civil Engineering and Construction, an annual event featuring prominent engineers in the field. Many of those who packed the conference room at the Raleigh Marriott City Center were NC State engineering alumni.

The series was established in 2002 to honor the accomplishments of Dr. Paul Zia, Distinguished University Professor Emeritus of Civil Engineering at NC State. Zia is a leading figure in the fields of concrete and structural engineering and served as head of the Department of Civil, Construction, and Environmental Engineering at NC State for nine years. He is a member of the National Academy of Engineering.

The lecture series is presented by the Department of Civil, Construction, and Environmental Engineering; the Constructed Facilities Laboratory; and the NC State Engineering Foundation. ▪

Easier cell sorting = speedier research



NC State engineers have helped develop a new technique that uses sound waves to rapidly separate selected collections of cells for use in biomedical research.

The results should make it faster and easier for researchers to sort live cells for everything from disease study to drug development. Almost all cells survive the new process, a big improvement over existing sorting techniques.

Biomedical research often focuses on how specific cell types respond to various chemicals or environmental factors. These cells are often grown in a liquid medium and on top of a collection of "micropallets," which are essentially small plastic platforms that sit on the substrate at the bottom of the container. Researchers then select the cells they want and detach the relevant micropallets, which can be removed for additional experimentation or analysis.

Current techniques for removing these micropallets rely on lasers or physical manipulation to separate the pallets from the substrate. But physical manipulation is a slow process, while the energy produced by lasers to release larger micropallets can inadvertently kill many of the cells.

In the new technique, focused, relatively high-frequency sound waves are translated into a wave of pressure within the substrate itself. When that wave of force hits a targeted micropallet, the pallet is lifted off the substrate and can be removed, together with its attached cells, for further study.

Using this technique, micropallets can be selectively released in less than a millisecond. This is not as fast as laser-based techniques, but much faster than physical manipulation. However, with the ultrasound technique, more than 90 percent of live cells survive the process, which is significantly better than existing techniques with viability rates of less than 50 percent.

The lead author of a recent paper on the work is Sijia Guo, a PhD student in mechanical engineering. Co-authors are Dr. Xiaoning Jiang, an associate professor of mechanical and aerospace engineering and adjunct professor of biomedical engineering at NC State; Dr. Nancy Allbritton, professor and head of the Joint NC State-UNC Department of Biomedical Engineering and Distinguished Professor of Chemistry at UNC-CH; and Dr. Yuli Wang, a research associate at UNC-CH. The research was supported by a grant from the National Institutes of Health. ▪

A partnership with Eastman

The opening of the Eastman Innovation Center in early 2013 marked a novel approach to interdisciplinary research on NC State's Centennial Campus.

After a national search for a university partner, Eastman Chemical Company signed a multiyear agreement with NC State to conduct joint, cutting-edge research in several disciplines. At least six colleges at NC State are participating, with materials science and engineering; chemical and biomolecular engineering; textile engineering, chemistry and science; and forest biomaterials among the departments involved in the work.

Eastman will provide $10 million in grants to NC State researchers over six years in support of the Eastman Chemical Center of Excellence and its new laboratory. In late 2012, a joint NC State-Eastman research steering team chose the first 11 projects for funding from among 50 proposals submitted by NC State faculty.

"This agreement demonstrates NC State's commitment to working with corporate partners on transformative research projects to solve the grand challenges of society," said Chancellor Randy Woodson. "It also provides NC State researchers — and their graduate and undergraduate students — with a number of exciting new opportunities to pursue their specific interests."

The university sought to ease the collaborative process, said Dr. Terri Lomax, NC State vice chancellor for research, innovation and economic development.

"From the very beginning, we want to demonstrate that collaborating with NC State is unlike working with any other university," she said.

Bob Clemens, Eastman's vice president of corporate technology, said the pre-established costs and intellectual property agreements will encourage new projects and easy interactions between Eastman and NC State.

The agreement also allows visiting Eastman scientists to work in NC State labs and allows NC State researchers to do the same at Eastman sites. NC State students are also expected to participate in the research projects. ▪

Solving the bot problem in online games

Casual online games such as FarmVille have thousands of enthusiastic followers, but the use of automated "bots" to give some players an advantage is short-changing the companies behind the games. Now researchers from NC State have developed a new technique to help companies identify these bots and take action against them.

The games, which are free, allow players to accumulate points, virtual objects and other "rewards" that are needed to progress through each game. Obtaining rewards is time-consuming, and designers capitalize on this by allowing players to buy the rewards necessary to advance in their games. These rewards tend to be inexpensive but can add up to significant revenue for game companies.

An emerging problem is the use of bots, automated accounts that pose as players to amass rewards without buying them. Human players can then log into the rewards-laden bot accounts and play the game at a high level without having spent the time or money normally associated with collecting those rewards. And since human eyes are not on the game when the bots are active, no one is seeing – or clicking on – the on-screen advertisements that help pay for the game. This reduces the game's attractiveness to advertisers.

Now, NC State researchers have developed a technique for detecting these bot accounts without alerting the account holders. This will allow game designers to confidently differentiate bot accounts from human accounts and then cancel the bot accounts.

The new technique works by monitoring game play and tracking the subtle but repeatable mouse movements and clicking patterns that are unique to each player. Bots can be identified using only this information because they do not have the same range of variability in how they interact with objects on the screen.

Next steps: Deploy the technique in actual online games — the researchers are already negotiating with gaming companies — and improve the technique so it can detect more bots, more quickly.

The lead author of a paper on the research is Titus Barik, a PhD student in computer science. The paper was co-authored by Dr. David Roberts, an assistant professor of computer science; Brent Harrison, another computer science PhD student; and Dr. Xuxian Jiang, an associate professor of computer science. The research was supported, in part, by the US Army Research Office. ▪

Similar organisms, different stress reactions

Life in extreme environments such as hot acids and heavy metals can apparently make very similar organisms deal with stress in very different ways, according to new research from NC State.

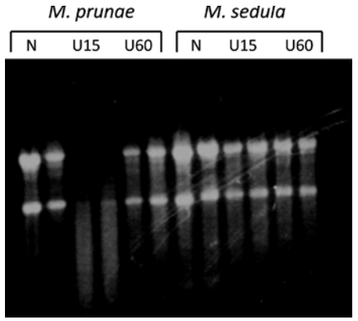
One single-celled organism from a hot spring near Mount Vesuvius in Italy fights uranium toxicity directly — by eating the heavy metal and acquiring energy from it. Another single-celled organism that lives on a "smoldering heap" near an abandoned uranium mine in Germany overcomes uranium toxicity indirectly — essentially shutting down its cellular processes to induce a type of cellular coma.

Interestingly, these very different responses to environmental stress come from two organisms that are 99.99 percent genetically identical. NC State researchers showed that these extreme organisms — tiny life forms called Archaea that have no nucleus — can teach us a lot about how living things use different mechanisms to adapt to their surroundings.

The researchers, led by Dr. Robert Kelly, Alcoa Professor of Chemical and Biomolecular Engineering at NC State, exposed two very close relatives of thermo-acidophilic Archaea — which live in highly acidic environments with temperatures of more than 70 degrees Celsius, or about 160 degrees Fahrenheit — to pure uranium.

One, Metallosphaera sedula, metabolized the uranium as a way to support its energy needs. This finding was the first report of an organism directly using uranium as an energy source, which could lead to a new way of mining uranium using microorganisms to release metals from ores, a process called bioleaching, Kelly said.

But its genetic twin, Metallosphaera prunae, reacted very differently. When faced with pure uranium, it went into a dormant state, shutting down critical cellular processes that enable it to grow. When the toxic threat was removed, M. prunae rebooted its cellular processes and returned to its normal state.



Kelly hypothesized that M. prunae is an offshoot of M. sedula, with just a small number of mutations, or changes, to its genome that allow it to react differently when faced with heavy-metal toxicity. The findings could have implications for understanding how antibiotic resistance develops and operates in pathogens.

The research was funded by the Defense Threat Reduction Agency in the US Department of Defense and by the National Institutes of Health. ▪

Hosting hundreds of science writers

SCIENCEWRITERS2012
RESEARCH TRIANGLE, NC
October 26-30, 2012

More than 500 writers from around the world came to Raleigh in October for the nation's premier science writing and journalism conference. College faculty and staff played key roles in the event.

The Research Triangle — including universities, agencies and research centers — hosted the ScienceWriters 2012 conference Oct. 26-30. The event brought together the annual conferences of the National Association of Science Writers and the Council for the Advancement of Science Writing.

In addition to serving as a co-sponsor, NC State, along with the Colleges of Engineering and Physical and Mathematical Sciences, hosted tours and a "Lunch with a Scientist" event on Centennial Campus in which small groups of conference-goers shared meals with researchers from NC State, UNC-Chapel Hill, Duke University, RTI International and other partners.

Earlier in the event, two NC State engineering faculty presented their work before hundreds of science journalists. Dr. Elizabeth Loboa discussed using fat-derived stem cells to build bone and tissue, and Dr. Joseph DeSimone talked about his work in entrepreneurship and nanotherapeutics.

The College's Engineering Communications office designed the conference's logo and various marketing materials, including name tags, swag bags, signs, T-shirts and lab coats worn by event volunteers. The group also played an important role in the pre-conference organizing and helped staff the event.

The event was the most popular ScienceWriters conference in years; 518 people attended. On a 10-point scale of overall satisfaction, 90 percent of respondents to a post-conference survey rated the event an eight, nine or 10. ▪

Frey named chair of EPA clean air committee

Dr. H. Christopher Frey, Distinguished University Professor of Civil, Construction, and Environmental Engineering, was appointed by the US Environmental Protection Agency administrator to chair the independently chartered Clean Air Scientific Advisory Committee (CASAC) for two years.

The seven-member CASAC advises the administrator on the scientific and technical bases for EPA's National Ambient Air Quality Standards. Frey, whose research interests include measuring real-world vehicle emissions and evaluating power plant energy use and emissions, has been a CASAC member for four years. ▪

President appoints Turinsky to national nuclear waste board

Dr. Paul Turinsky, professor of nuclear engineering, has been appointed by President Barack Obama to the 11-member Nuclear Waste Technical Review Board, a science-based advisor and overseer of the Department of Energy's program for managing and disposing of radioactive waste and spent nuclear fuel.

Members are chosen based on distinguished service and eminence in a science or engineering field. Turinsky, a leading nuclear energy researcher, also serves as chief scientist for the Department of Energy's Consortium for Advanced Simulation of Light Water Reactors. ▪

Baliga receives state's highest civilian honor

Dr. B. Jayant Baliga, Distinguished University Professor of Electrical and Computer Engineering and founding director of the Power Semiconductor Research Center, received the 2012 North Carolina Award for Science, the state's highest civilian honor. He was one of six North Carolinians honored for contributions to science, fine arts, literature and public service.

Baliga invented, developed and commercialized the Insulated Gate Bipolar Transistor (IGBT), a landmark energy-saving semiconductor switch. The IGBT is used in everything from refrigerators to bullet trains and made the compact portable cardiac defibrillator possible. ▪

Zhu named AAAS Fellow

Dr. Yuntian T. Zhu, Distinguished Professor of Materials Science and Engineering, has been named a Fellow of the American Association for the Advancement of Science (AAAS) for his pioneering work in nanotechnology development and nanomaterials science.

Zhu and his research team have made significant contributions to the areas of nanostructured materials and carbon nanotubes, with applications in everything from bicycles to airplanes. ▪

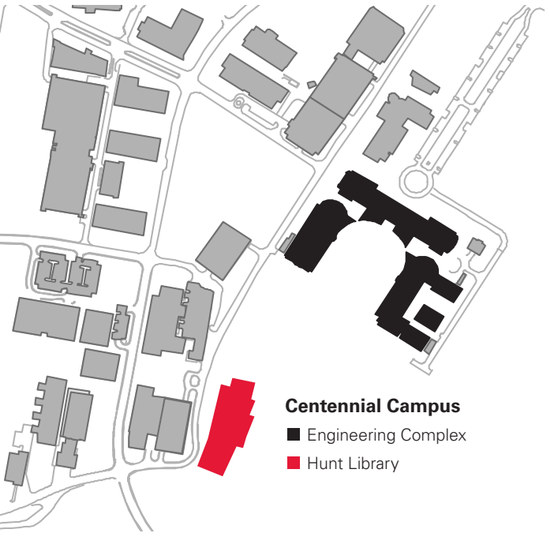
Sitar receives 2012 R.J. Reynolds Award

Dr. Zlatko Sitar, Kobe Steel Distinguished Professor of Materials Science and Engineering and director of the Materials Research Center, was named the 28th recipient of the R.J. Reynolds Tobacco Company Award for Excellence in Teaching, Research and Extension.

The award recognizes superior achievements in both science and education and includes a $25,000 prize distributed over five years. It is the top faculty honor awarded by the College. Sitar is an international leader in crystal and thin film growth and characterization and device development in wide bandgap semiconductors. ▪

THE LIBRARY OF THE FUTURE RIGHT NOW

The new James B. Hunt Jr. Library provides engineering students with some of the world's most sophisticated education and research technology.



The Hunt Library sits along the grassy Centennial Campus Oval just steps from the new engineering buildings (see map on opposite page).

Allison Dubrouillet's new study space just might be the world's most advanced library.

The sophomore in electrical engineering is already carving out her favorite nooks at the new James B. Hunt Jr. Library, which opened in January on NC State's Centennial Campus. The 220,000-square-foot structure has received global attention for its state-of-the-art technologies and futuristic feel, attributes that should boost the College's profile and its efforts to recruit and retain top faculty and students.

The library contains NC State's engineering collections and is just a short walk from the new engineering buildings on Centennial. The building boasts nearly 100 study-group rooms and technology spaces featuring everything from 3D printers to giant high-definition video displays.

"Not only is the library close to all my engineering classes," Dubrouillet said, "but because of the location, all the other engineers are around to work and collaborate with on projects."

The library's namesake, former North Carolina Gov. James B. Hunt Jr., holds two degrees from NC State and is one of the university's staunchest supporters.

"The Hunt Library says that something important is happening at this university," Hunt said. "It also says that NC State is one of the leading universities in the nation and in the world in providing the best opportunities for students to learn."

There are nearly 2 million books in the Hunt Library — but you won't find too many lining the shelves. More than 95 percent are managed by the bookBot, a robotic, automated book delivery system that retrieves titles from a giant storehouse within the building.

After a student selects a book from the library's online catalog, one of four book-gathering machines travels the bookBot's climate-controlled aisles looking for the title. Students can watch the robots work through an observation window on the library's first floor.

In five minutes or less, a bin emerges at a pickup area with the book inside.

"We're an engineering school, evidenced by the fact that we have a 'robotic librarian,'" said Stephen West, a junior in aerospace engineering. "How does it get cooler than that?"

The book-fetching system is just one of many advanced technologies at the new library. During the library design process, planners spoke with engineering students and faculty to see how they worked and what types of spaces they needed. The conversations helped inform how designers crafted the library's study, research and work areas, which include a high-tech, glass-enclosed "Fishbowl" room created to give students and faculty from different fields a place to meet and trade ideas.

There are high-definition display walls for video-game developers, laser cutters that can shape and engrave wood, acrylic and

other materials, and 3D printers that can quickly produce plastic prototypes of everything from medical devices to aircraft parts.

Powering it all is a supercomputer that supports the library's technical infrastructure. Hunt is the only academic library in the US with this technology.

Outside the building, Hunt has lots of environmentally friendly features. They include a rain garden that collects storm water runoff, 12 rooftop solar panels that power the library's hot water system, and an innovative air conditioning system that uses chilled water instead of air to keep the temperature comfortable. The solar "fins" lining the library's exterior are specially sized to keep out the heat while letting in natural light.

For NC State engineers, the library functions as a community center on the growing campus, now home to more than 60 percent of College faculty and students. The library has a café and, like the D.H. Hill Library on Main Campus, is open 24 hours most weekdays.

"The Hunt Library will definitely encourage me to come to Centennial more often — probably every day," said Markhel Jessup, a junior in computer engineering. "It's a great environment; big but quiet."

The origins of a library

When Susan Nutter left the Massachusetts Institute of Technology in 1987 to come to NC State, Centennial Campus was among the most compelling draws. The idea of building a library on the blossoming campus, now home to more than 60 corporations, nonprofits and government agencies, was even more captivating to the new campus libraries director.

"I knew that a library would be the intellectual and social nexus, and that, without it, Centennial would feel more like a research park and not have the campus feel," said Nutter, also a vice provost at NC State.

Library space at NC State was limited back then. It became even scarcer as D.H. Hill and other campus libraries added more technology and group-oriented spaces. The changes were a hit with students and attracted more of them to the libraries, but the additional demand and growing student population meant seats were tough to find. Eventually, NC State's libraries could accommodate less than 5 percent of the student population — a quarter of the percentage needed to meet seating requirements for libraries in the University of North Carolina system.

During Nutter's first years at the university, she began a personal campaign to bring a library to Centennial, gathering support from key administrators and planners.

Once university leaders bought into the idea, Hunt planners began visiting libraries across the world to gather ideas for a space that would remain ahead of its time decades from now. Initial state funding for the library was secured in 2007 — private donors also supported the effort — and construction began in 2009.

Now there are an additional 1,750 library seats available on NC State's campus, nearly doubling the university's previous capacity.

Games on the giant wall

The Hunt Library offers plenty of opportunities for students in NC State's popular game design program, which is consistently recognized by the *Princeton Review* as one of the best in the nation. Many students end up working at one of 40 gaming companies located in the Triangle, the hub of the growing East Coast video game industry.

The library's Game Lab, which features a 21-foot-wide, high-definition video wall, gives students access to the latest in large-scale, touch-screen visualization technology. Students can connect up to six game consoles at a time or run several different games side-by-side.

Dr. Michael Young, professor of computer science and executive director of the proposed Digital Games Research Center at NC State, sees the wall as a sample canvas upon which students can design games that need to run on screens with large and unique dimensions.

Young co-teaches a course that teams computer science students with their counterparts in the College of Design. Demand for programmers and designers with large-screen skills is growing as giant televisions, computer screens and public video displays become more commonplace in homes and businesses. That, coupled with industry and governments using more game theory and simulations in their training and research programs, means students see a growing field with lots of job opportunities.

"This work will pose a lot of technical and design obstacles for our students," Young said. "It's a terrific example of the multidisciplinary work happening in the real world."

The library features light-filled study areas (opposite page) and some of the world's most advanced education technology, including this multimedia exhibit in the Emerging Issues Commons.

A library for the people

The Hunt Library holds more than books — it's also home to some of North Carolina's most prominent policy research organizations.

One of those entities is the Kenan Institute for Engineering, Technology and Science, which funds groups and individuals that want to use those fields to improve the economy and public welfare. Another is the Institute for Emerging Issues (IEI), which was founded by Gov. Hunt in 2002.

IEI's first home was inside the Kenan Institute, which helped the fledgling "think and do tank" grow during its early years. Now, IEI works with communities across North Carolina to devise solutions to the state's most pressing challenges in health care, the economy, the environment and education.

"People from all over the world will be visiting the Hunt Library," said Dr. Ruben Carbonell, the Frank Hawkins Kenan Distinguished Professor of Chemical and Biomolecular Engineering who leads the Kenan Institute. "And all that traffic brings an excellent opportunity to meet new people and learn more about what they're doing and how we can build programs around those activities."

IEI's presence in the Hunt Library includes the Emerging Issues Commons, one of the most attention-grabbing spots in the building. Set up as an interactive multimedia exhibit, the space encourages visitors to learn more about the innovative ways in which North Carolina is preparing for the future.

"My dream for this library is that the people of North Carolina will have at their fingertips the kind of information they need to collaborate with the citizens in the state's 100 counties," Hunt said. "I want them to develop ways to build the economy, improve education, and provide greater opportunities for the people." ▪

By the Numbers

The Hunt Library is futuristic in many ways, from its book storage system to its green construction.

18,000 Approximate number of book-holding bins in the bookBot retrieval system

11 Large-scale interactive multi-touch video displays. One is more than 21 feet wide.

38 Percent reduction in water use through using efficient plumbing fixtures

GIFTS THAT LAST *lifetimes*

An endowment gift touches many lives.

Through endowed scholarships, dozens of engineering students spanning several decades can benefit from the generosity of just one donor. And even more students can learn from the holder of an endowed professorship, awarded to some of the world's keenest engineering minds.

Gifts to the endowment aren't just one-time expressions of a donor's generosity. They are investments in many generations of NC State engineers.

Stability
Endowments make the College less dependent on sometimes unpredictable state funding. After a donor makes an endowment gift, the principal is deposited in an investment account, and only the endowment's annual income is used for the donor's chosen purpose.

Flexibility
Endowments provide extra funds that can be used for purchasing new equipment, conference travel and exploring innovative teaching and research initiatives.

Reputation
Endowment gifts boost NC State's alumni giving rate — one of the factors used in closely watched university rankings.

A transformational gift

In 2005, Edward P. Fitts, Industrial Engineering, '61, made a generous endowment gift toward what would become the first named academic department at NC State — the Edward P. Fitts Department of Industrial and Systems Engineering. Here's how one gift changed a department.

2 *faculty fellowships*

5 *professorships*

7 *graduate fellowships*

TOP 10 RESULTS

15th *undergrad ranking 2007*

10th *undergrad ranking 2013*

13th *graduate ranking 2008*

8th *graduate ranking 2013*

Generosity that endures

Frank Culberson, Chemical Engineering, '60, and his wife, Doris, endowed the S. Frank and Doris Culberson Academic Enhancement Fund in 2001.

36 students

Dr. Elizabeth Nance, Chemical Engineering, '06 Culberson Scholar

"When I found out that I was a scholarship recipient, the weight of the world was lifted off my shoulders. I could finally do the job that I enjoyed doing — teaching and research — and not worry about juggling jobs to pay for school."

Nance, who recently earned her PhD in chemical and biomolecular engineering, is beginning her post-doc work on finding more efficient drug-delivery systems for neuromuscular disorders like cerebral palsy.

The best professors

Leave one chaired professorship at another university. Move to another state and begin a new life. That's exactly what Dr. Edward Jaselskis did after being offered an endowed professorship at NC State.

"Having the distinguished professorship offer tipped the scale for me; the professorship sweetened this opportunity and helped in making the big decision to move my family."

Recipient
Dr. Edward Jaselskis
Jimmy D. Clark Distinguished Professor in Construction Engineering and Management

Donor
Jimmy D. Clark
Civil Engineering, '74

Jaselskis (above left) used the professorship funds from Clark (above right) to travel to universities in India, China and other countries to convince faculty to get involved in a new distance-learning course focused on global construction practices. His efforts paid off, and now his students can watch some of the world's top construction engineers deliver presentations on their techniques from around the globe.

The best students

Scholarships are critical tools for recruiting top students who could not otherwise afford an NC State engineering education.

"I really wanted to attend NC State, but I didn't know how I was going to pay for tuition. If I didn't receive financial support like the Gray Scholarship, I wouldn't be at the university today."

Recipient
Akeem Cox
Senior
Computer Engineering

"My wife and I hope that our giving helps students stay in school and continue their education. It is our pleasure to give, and we hope we are making a difference."

Donors
William (Electrical Engineering, '59) and Tipton Gray

DESIGN *sponges*

First-year engineering students soak up the field's trial-and-error lessons at Freshman Engineering Design Day.

The bubble-blowing machine created by Morgan Danyi and her team worked just fine except for one minor problem: It didn't blow any bubbles.

Some parts spun too fast. The unstable platform wobbled. The bubble solution carried by spinning wands spilled before reaching the bubble-blowing fan. No solution, no bubbles.

Something had to be done. In two weeks, Danyi and her team planned to enter the machine into NC State's 13th Annual Freshman Engineering Design Day.

"Being an engineer is all about trial and error," Danyi, a freshman in chemical engineering, said after some last-minute tweaks made the machine competition-ready. "You identify the problem, brainstorm a way to resolve it and then create the finished product."

Freshman Engineering Design Day brings together more than 1,300 students on more than 400 teams who have completed design projects assigned in the College's introductory engineering course. Students huddle in groups for several weeks before the event, assembling hovercrafts, stitching together fabric buckets, molding concrete canoes, engineering nuclear reactor probes and tinkering with chain-reaction-driven Rube Goldberg machines.

All that work culminates in a day-long competition held in two packed rooms of students, faculty, judges and parents at NC State's McKimmon Center on the Tuesday before Thanksgiving. Medals are awarded to the winners.

Kathan Bender tinkers with a bamboo water fountain created by his team for Freshman Engineering Design Day.

Morgan Danyi (in yellow) and her Design Day team overcame technical hurdles to create a working bubble-blowing machine. Below, students ready their projectile launcher for the competition.

"Design Day is the defining first-semester experience for engineering students," said Brian Koehler, the director of international engagement for the College who helps run the event. "It's a great opportunity for our first-year engineers to tackle difficult engineering problems they'll be facing during the next four years and ultimately in their professional careers."

Each project comes with its own set of constraints. Students must not exceed a $40 spending limit, which encourages creativity and innovation by forcing them to reuse, borrow and find creative resources in places other than store shelves.

That spirit of frugality and reusability was on display at this year's event, where students used toy cars, old plastic containers, aluminum foil, scrap wood, oil funnels, rubber bands, Pez dispensers, Tupperware containers and duct tape to build their entries.

Personalization is encouraged. A plastic watering can and holiday lights topped a flower-rimmed fountain. Arcade pinballs pummeled miniature Duke and UNC mascots. 18-inch concrete canoes — they can hold 10 pounds of marbles if built properly — were proudly painted NC State red.

For Danyi, the event turned out to be more than just a first-semester highlight. It gave her the chance to be a team leader and employ problem-solving skills when things didn't go as planned.

After the bubble-blowing failure, the team regrouped and devised a new design. A battery-powered motor in an overturned toy truck spun a wheel that had been cut from the bottom of a five-gallon plastic bucket. Because the wheel was larger and heavier than the CD covers they had originally used, the spinning wands that cradled the bubble solution became much more rigid, allowing the machine to spit out bubbles by the dozens.

The relieved team had its entry.

"The experiences at Design Day are a very accurate taste of what engineers will have to deal with in the real world," Danyi said.

Kathan Bender, a freshman majoring in civil engineering and environmental engineering, said the event improved his team's time management skills and taught team members the value of advance planning.

The group entered the water fountain competition, in which students must create a device that propels water upward against gravity. Bender and his team decided to meet early in the semester to begin work.

The group built its waterfall from bamboo stalks. The stalks were tied together with twine and then set into a bamboo box filled with water and small stones. The water, propelled by an electric pump, was able to flow through a plastic tube encased in the central bamboo stalk, emerging out of the top and flowing back down into the box.

"After choosing the water fountain as our project, we had to decide on a theme and what parts of the project we wanted to assign to each person," Bender said. "Then we started planning the layout, gathering materials and putting it all together. It helped me learn the necessity of getting everything drawn out in advance before you start working."

Although Bender's team didn't receive a medal, he believes the group's bamboo water fountain was a crowd-pleaser that "gained the popular vote" of visitors to their table. Danyi's team didn't medal either, but that didn't take away from the event's positive experiences.

"Figuring out how to put our strengths together and working through problems are going to be very valuable experiences for the future," Danyi said. "Teamwork and effective communication are highly important for any group of people working together on a project."

The skills learned through Design Day help prepare Danyi, Bender and hundreds of other students for the more challenging projects to come in their academic and professional careers.

"Design Day helps our first-year engineers continue developing their interdisciplinary teamwork, problem-solving and communication skills while creating something that works," Koehler said. "With these skills, students can become leaders who solve challenging problems." ▪

Freshman Engineering Design Day

By the Numbers

2000
First year of the event

1,373
Students entered in 2012 event

40
Dollars each design team can spend on its project

30
Feet from which student-created projectile launchers must hit their targets

10
Pounds of marbles held by a well-built, 18-inch concrete canoe

2012 projects

Nuclear reactor probe
Educational computer game
Rube Goldberg machine
Bubble-blowing machine
Precision launcher
Line-following robot
Water fountain
Arcade game
Concrete canoe
Hovercraft
Fabric bucket

A WORLD TOGETHER

NC State engineers bring together some of their fields' top minds at conferences around the globe.

Dr. Afsaneh Rabiei hasn't missed a Metfoam conference in nearly a decade.

In 2005, she used the gathering of international experts in porous metals and metallic foams to introduce her ultra lightweight composite metal foam — an invention that could improve everything from biomedical devices to armor.

But at this year's conference, to be held in Raleigh, Rabiei will be more than an attendee. As the general chair of Metfoam's organizing committee, it's her job to pull off one of the largest events in her field.

"This is the first time this conference will be held in the US, and much is riding on my shoulders," said Rabiei, an associate professor of mechanical and aerospace engineering. "I'm responsible for everything from creating the website and printed materials to securing sponsors and speakers to planning pre- and post-conference tours. And that's not all of it. It's a big responsibility."

Rabiei joins the long list of faculty and administrators in the College who serve in leadership roles for top international conferences. They are committee chairs, logistics coordinators and keynote speakers for events as far away as Australia and as local as Raleigh.

Dr. Phillip Westmoreland, professor of chemical and biomolecular engineering, believes these conference leaders help spur important advances in their fields. Westmoreland is president of the world's top chemical engineering organization, the American Institute of Chemical Engineers (AIChE), which has more than 40,000 members in more than 90 countries.

"In leading international conferences, there's an opportunity to shape the profession, shape the discipline and also shape the world," said Westmoreland, who also directs the Institute for Computational Science and Engineering at NC State.

Westmoreland has been involved with AIChE for nearly 40 years and credits conference involvement, in part, with helping him earn his leadership role with the organization and keeping up with the research in his field.

At an AIChE meeting in 1992, for example, Westmoreland met a group of industrial chemical engineers who were interested in using molecular modeling, in which researchers use molecular-structure models to compute physical, chemical and biological properties such as boiling points, reaction rates or drug performance.

Westmoreland was already doing research in this area and organized a special session for key industry speakers to share their success stories, bringing more attention to what's now considered a valuable tool for chemical engineering science and technology. That first session also led to new international conferences and a new division within AIChE, the Computational Molecular Sciences and Engineering Forum, which he led.

And when "NC State" graces the pages of conference programs, websites and publications, it advertises the university's influence and expertise in those fields. The publicity also draws attention to the Triangle's many opportunities for engineers, which include a booming technology sector and top research universities. Publicizing these assets helps bring more top faculty and students to NC State.

For conference attendees, the benefits of meeting a world-renowned expert or finding a person with a unique approach to a research problem make the time away from the lab worthwhile. Conferences are a great opportunity to make connections that trickle down to other faculty and students.

"Studying academic journals is only part of the research process," said Dr. Murthy Guddati, co-chair of the 12th US National Congress on Computational Mechanics, which will be held in Raleigh this July. "When you actually interact with the people who generate the ideas, you get more insight and that can actually lead to collaborations."

Guddati, a professor in the Department of Civil, Construction, and Environmental Engineering, said leading the flagship forum for computational scientists and engineers will also help highlight the interdisciplinary research activity happening across the NC State campus. More than 1,200 attendees from six continents are expected to participate.

And like Rabiei and other conference leaders, he is also aware of the exposure that takes place, potentially opening doors for future work.

"Any opportunity you have to go to a conference is the best way to let people know about your work," Rabiei said. "If people don't know what you're doing, your research and knowledge are just sitting in a room with no use." ▪

International leadership

College faculty are leading a global effort to place more emphasis on sustainable development and social inclusion in engineering education.

Dr. Louis A. Martin-Vega, dean of the College of Engineering, served as co-chair of the American Society for Engineering Education Global Colloquium at the 2012 World Engineering Education Forum held last October in Buenos Aires, Argentina. There, leaders from the largest and most important international engineering education organizations worked to identify policies and strategies that use engineering education to bring about more sustainable development and social inclusion.

Martin-Vega was joined by other College leaders who presented at the Forum: Dr. Laura Bottomley, director of the Engineering Place outreach program; Dr. Robert Fornaro and Margaret Heil, former director and interim director, respectively, of the Senior Design Center in the Department of Computer Science; Dr. Linda Krute, director of the Engineering Online distance education program; Dr. Tom Miller, a keynote speaker at the event who is McPherson Family Distinguished Professor of Engineering Entrepreneurship and executive director of the NC State Entrepreneurship Initiative; and Elizabeth Parry, coordinator of STEM Partnership Development at the Engineering Place. Robert Matheson, principal of the Wake NC State STEM Early College High School located on NC State's Centennial Campus, also presented.

The NC State attendees spoke on their experiences in enhancing recruitment and retention of students in engineering, including everything from boosting diversity through new outreach efforts to the role of entrepreneurship in engineering education.

READY FOR BUSINESS

The Chancellor's Innovation Fund helps NC State engineers and computer scientists bring their ideas to the marketplace.

Since its inception in 2010, the annual list of Chancellor's Innovation Fund (CIF) award winners has been packed with NC State engineers and computer scientists. This past year was no exception, as five of the seven awards went to College researchers working on everything from body armor to shape-shifting antennas.

The fund, established by NC State Chancellor Randy Woodson, provides money and support to help researchers bring their inventions to the marketplace. Each recipient gets access to the university's Office of Technology Transfer, which works with researchers to strengthen each project's appeal to the business community.

The fund's goal: Boost the commercial value of intellectual property produced at NC State. In so doing, the university is moving its best ideas from the lab to the real world, solving important societal problems along the way.

Support from the Chancellor's Innovation Fund allows Dr. Afsaneh Rabiei to test armor made from her composite metal foam against bullets and blasts.

Lighter, stronger armor for soldiers

This foam isn't soft and fluffy. It's designed for military vehicles and body armors.

And the material, a composite metal foam created by Dr. Afsaneh Rabiei, is lighter, stronger and less cumbersome to wear than what the military uses now.

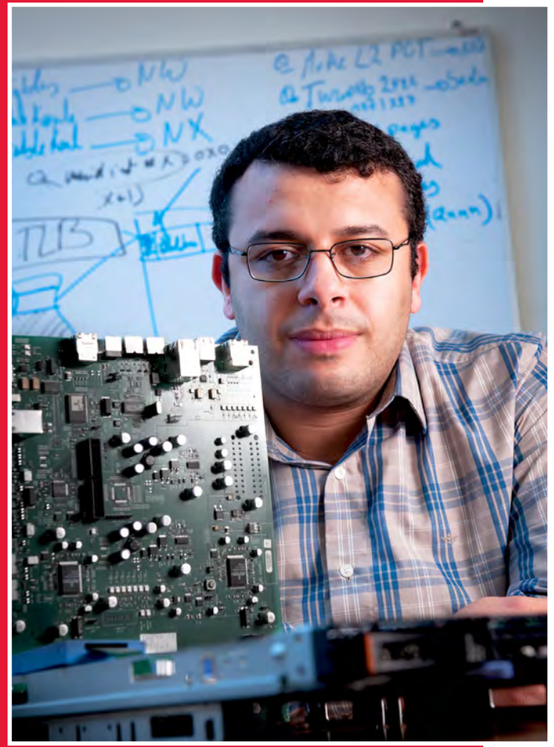
"The current generation of hard body armor can resist penetration of the projectile, but the victim will often have life-threatening internal injuries," said Rabiei, an associate professor of mechanical and aerospace engineering. "And soft body armors still transfer significant energy to the wearer."

Rabiei's foam improves upon these armors by absorbing impact energy from projectiles and blasts, which decreases the risk of injuries and vehicle damage from bullets or explosions.

The material has non-military applications, too. It could be used to create safer car bumpers, stronger buildings and better replacement body parts. And because it's so light, it has potential energy-conservation and alternative-energy applications.

Support from the CIF allows Rabiei's research group to test the armors against bullets and blasts.

"The results will be used to further establish a database," she said. "That information can help take this new material to its next step of commercialization and manufacturing."



Protecting the cloud

At the heart of cloud computing is the hypervisor, software that allows multiple users to run programs concurrently on a host computer. But if a malicious program gains access to the hypervisor, the data held by all those users could be changed or stolen.

Drs. Ahmed Azab (left) and Peng Ning have devised a solution. They've developed a new security mechanism called HyperSentry that is isolated and protected from the hypervisor but retains enough privileges to search the hypervisor code and data for viruses and other malware. The researchers hope their tool can be adopted on large servers, PCs and mobile phones to help keep these devices secure.

Through the CIF funding, Azab, a senior research associate in the Department of Computer Science, and Ning, a professor of computer science, are teaming with a company called Innovalyst that is helping to commercialize HyperSentry. Innovalyst has linked the researchers to key personnel in software and hardware companies who could be future customers.

In addition, the university's Office of Technology Transfer helped the researchers connect with venture capitalists and investors who have evaluated HyperSentry's commercialization potential. These connections kept the researchers updated on what the industry actually needs.

"The CIF is not just about the money," Azab said. "It is also about the support that the inventors get to commercialize products."

Shape-shifting antennas

Dr. Michael Dickey's research team is developing shape-shifting antennas for use in electronic devices such as smartphones, tablets and laptop computers.

The technology behind these adaptable antennas would give electronics more reliable access to cellular networks and, because the antennas are made of soft materials that are difficult to break, could also fit into emerging technologies such as stretchable or wearable electronics. The antennas also show great promise in military equipment because they can be folded and unfolded during grueling deployments.

Support from the CIF has allowed Dickey's team to improve the technology behind the antennas before taking it to market. And by focusing on practical questions raised by the electronic device industry, the team is working to create a product that is exactly what industry wants.

"This funding is different [from other support] because it focuses more on advancing science to make the concepts more appealing as a technology for commercialization," said Dickey, an assistant professor of chemical and biomolecular engineering. "The focus on industrial interests is unique compared to most traditional funding opportunities, yet the research can still focus on fundamental science, which is appealing."

Robotics that put a spring in your step

Dr. Greg Sawicki wants to give injured people the ability to walk easily again.

Sawicki and other members of NC State's Human PoWeR (Physiology of Wearable Robotics) Lab have developed a "smart" walking aid requiring no motors or external power. Through a tension spring and a "smart clutch," the lightweight, wearable boot mimics the interplay between the calf muscle and the Achilles tendon to propel wearers forward. No batteries or motors required.

"Our initial focus is on people who are recovering from stroke," said Sawicki, an assistant professor of biomedical engineering. "Many of them suffer from ankle weakness on one side of the body that leads to asymmetric and exhausting walking patterns."

But while the device is aimed at helping people rehabilitate from injuries, it could also be used by aging baby boomers, soldiers, elite athletes and hiking enthusiasts — basically anyone who could use a boost in power and efficiency.

And its design, inspired by the structure and function of the human ankle, is lighter, less bulky, and more cost-effective than competing devices.

The CIF funding will support further testing and development.

"The CIF award helps us continue to improve the design by making it even lighter and more comfortable," Sawicki said. "Then we can test it in clinical populations who suffer from ankle muscle weakness."

Faster downloads for smartphones

Tired of waiting around for your smartphone to play that video? NC State computer scientists have good news: Faster downloads are coming soon.

Dr. Injong Rhee, a professor of computer science, has helped develop a new algorithm that cuts down data retrieval time for the software programs that power smartphones and tablets.

These mobile devices use "transmission control protocol (TCP) stacks," programs that send and receive packets of data between the device and the network. With help from Dr. Kyunghan Lee, a former senior research associate at NC State who is now an assistant professor at the Ulsan National Institute of Science and Technology in South Korea, Rhee demonstrated that the new algorithm makes the stacks more efficient.

That makes the user experience a whole lot better.

The researchers plan to use the CIF money to quantify that improved efficiency on various network providers using several smartphone and tablet brands. They're also creating a business strategy for US markets. Eventually they want to expand to Asia.

"This technology will help make the smartphone and tablet experience much more enjoyable for users," Rhee said. "And the CIF funding will help convince network providers that it really works." ▪

New NC State Engineering Foundation board president Tom McPherson (right) wants to continue the progress made by his predecessor, Frank Culberson (left).

LEAPS & BOUNDS

Thanks to the NC State Engineering Foundation, more people are giving back to the College. The new Foundation board president wants to continue the trend.

Build the endowment. Boost alumni participation. Finish the move to Centennial Campus.

The goals of the NC State Engineering Foundation Board of Directors remain the same. Only the leadership is changing.

In October, Tom McPherson, who holds two electrical engineering degrees from NC State, took over as Foundation board president. He replaces Frank Culberson, a chemical engineering graduate who oversaw significant increases in alumni giving and participation.

The Foundation, chartered in 1944 to secure private financial contributions to improve the College, appoints a new president every two years. The president leads an active board of more than 30 members who support faculty, students and staff by raising funds and advocating for the College's interests.

"Under Frank's outstanding leadership, we're seeing more people give back to this College in a variety of ways," McPherson said. "My goal is to keep those numbers moving in the same direction."

Among McPherson's objectives is continuing to build the College's endowment, which still lags behind the endowments of many competitors in terms of the number of scholarships and professorships the College can offer to top students and faculty. McPherson and the rest of the board want to see the College become the best public engineering school in the country, "and the way we're going to get there is to have the best students and the best faculty," he said.

Culberson, who remains on the board, can point to a variety of accomplishments during his two years as president. In 2011-12, gifts to the College increased 13 percent over the previous year. Membership in the Dean's Circle leadership giving society, awarded to donors who make at least $1,000 in gifts annually, increased 38 percent during that time.

"We're out there shaking the bushes," Culberson said. "It's just a matter of persistence and telling our story at many levels."

The board also recently authorized an economic impact study that found that College alumni are important job creators. Among the highlights: 35 percent of alumni have engaged in some form of entrepreneurial activity. And nationwide, at least 68,000 people worked at alumni-founded-or-owned businesses in 2010.

"That is a very bold statement about what our engineering graduates are up to," Culberson said. "We're contributing, and we're making a difference."

McPherson and Culberson are no strangers to building businesses. McPherson led the founding and building of several successful high-tech companies, including Network Equipment Technologies, Rapid City Communications and Cognio, Inc. Culberson is chairman and a director of Houston-based Rimkus Consulting Group, which under his leadership has grown into a 400-person forensic consulting and engineering firm. Both men have been named Distinguished Engineering Alumni by the College.

Both have also been generous donors. Gifts from Culberson and his wife, Doris, include a recent $1 million pledge to endow two professorships in the Department of Chemical and Biomolecular Engineering. McPherson's support includes endowing the McPherson Family Distinguished Professorship in Engineering Entrepreneurship.

Looking ahead, McPherson wants to help finish the Foundation's strategic planning process — an effort led by fellow board member and electrical engineering alumnus Rob Manning, who will take over as president when McPherson's term ends — and align that plan with the goals of the university. And he wants the board to help find new sources of funding to finish the College's move to Centennial Campus. About two-thirds of the College has relocated to three new engineering buildings on the campus; two remain unbuilt.

"We committed to it several years ago, and we need to finish the job," he said. "We are not getting as much support from the state as we used to, so we need to figure out creative ways to make that happen." ■

An engineering Homecoming

Alumni celebrated 125 years of engineering at NC State on Nov. 2, enjoying department reunions, quizzing faculty on new research and touring new buildings on Centennial Campus during the College's inaugural Homecoming event.

The event coincided with the university Homecoming festivities, which included the Hillsborough Street parade and a football game, while giving engineering alumni a chance to reconnect with their College. The NC State Engineering Foundation, which organized the College event, hopes to hold a second celebration within the next year.

The day began with mini-events hosted by each of the engineering departments and the College's Minority Engineering Programs. Each group planned a variety of activities, including open houses and lunch.

Later, in a session dubbed "Classrooms Without Quizzes," several top faculty members told alumni about their latest research. The faculty — Drs. Greg Buckner, Chris Frey, Henry Lamb, Elizabeth Loboa, Michael Steer, Laurie Williams and Richard Wysk — hailed from a variety of engineering departments.

While alumni talked with faculty, many of their children and grandchildren went to an Engineering Mini-Camp. There, would-be engineers designed LED flashlights with materials from a recycling bin and created air-powered "stomp rockets."

Following a tour at the end of the afternoon, alumni mingled and enjoyed barbecue and a bluegrass band on the second floor of Engineering Building II.

"The changes that have been made in a half-century are astounding, really," said Raeford Eure, a 1959 civil engineering alumnus who attended the event. "The way the school is growing — all of this is pretty amazing."

HOOKS DREAMS

An engineering alumnus endows a scholarship in memory of his father, who captained the 1924 NC State freshman basketball team.

J.T. Hooks Sr. wasn't a big guy. 5-foot-6. Maybe 5-foot-7.

But he was a heck of a basketball player. And his love for NC State left an indelible impression on his son.

Hooks, who was captain of NC State's 1924 freshman basketball team, couldn't afford to stay in school, so he left the university after one year. But there was never any doubt that his son, Jake Hooks, would go to NC State. His father's affection for the university, and both his parents' resolute insistence on the importance of a college education, foretold his future among the Wolfpack.

The younger Hooks made the most of his NC State materials engineering degree, rising to become a senior executive at Eaton Corp., a Fortune 500 industrial machinery company.

In honor of his father, Hooks recently endowed the Jacob T. Hooks Sr. Scholarship, which will help talented materials science and engineering students pay for their educations. First preference for the awards will go to students from the area around Fremont, a small town east of Raleigh where both father and son grew up.

"I know how much I struggled to pay for school, and my dad could only afford to go for one year," Hooks said. "Maybe this can help some deserving students go to State."

Before making the gift, Hooks learned a few things about his father's NC State career. The elder Hooks arrived on campus with an impressive basketball pedigree, having scored more than 50 points in one high school game at a time when entire teams struggled to break 30. No athletic scholarships were awarded back then, so even as team captain he had to pay his own way.

The team had a good year, beating Wake Forest and Trinity (which became Duke) once each. More importantly, they beat UNC twice.

"Several likely looking men from this team will be out for the berths on the varsity next year," the 1924 *Agromeck* yearbook predicted. It's easy to imagine J.T. Hooks among them.

The younger Hooks wasn't the basketball player his father was, but he is a talented engineer and executive. After graduating from NC State in 1978, he began his career as a product engineer but eventually was promoted into management. At Eaton, he took on roles of increasing responsibility, eventually becoming president of the company's Automotive North America business. He retired this spring after a 35-year career.

Hooks, a member of the NC State Engineering Foundation Board of Directors, hopes his gift will encourage other technical-minded students to pursue leadership opportunities.

Hooks still remembers his 1978 graduation day. His father was infirm and couldn't attend the commencement ceremony, so afterwards Hooks drove to Fremont to show off the new diploma.

His father looked over the document and glanced up at his son, beaming with pride.

He passed away a few months later.

"We always said," Hooks remembered, "that he felt like his job was done at that point." ▪

J.T. Hooks Sr. (in front with basketball) captained NC State's freshman basketball team in 1924. His son, Jake Hooks (right), recently endowed a scholarship in his father's honor.

Washington's WAY

The new dean of engineering at UC-Irvine forged tight bonds with the people who helped him earn three NC State engineering degrees.

NC State helped Dr. Gregory Washington become a star, but what he remembers most are the people.

Faculty and administrators encouraged him. Fellow students remain some of his best friends.

"We not only worked together, we played together. We ate together. We had a basketball team out of our lab," Washington said of his classmates. "All those guys were at my wedding, and I was at theirs. Some of my fondest memories are of that tight-knit group."

Those experiences helped shape Washington, who earned three mechanical engineering degrees at NC State and went on to become a celebrated smart materials researcher. In 2011, he took over as dean of the Henry Samueli School of Engineering at the University of California at Irvine, a top 40 engineering school.

"You had to push the envelope at NC State," he said. "And that gave me the intestinal fortitude to go elsewhere and be successful."

Washington grew up in Harlem, NY, but spent most of his teenage years in Raleigh. His career began to take off as an undergraduate and master's student when he got the chance to work at NC State's giant Mars Mission Research Center. His work helped earn him national recognition in 1990 when *Ebony* magazine named him one of the country's top 10 African American students (also on the list was a Harvard Law School student named Barack Obama).

Four years later, after some innovative research on ultra-light, structurally active antenna systems, he became the first African American to earn a PhD from NC State in mechanical and aerospace engineering.

Along the way, he forged tight bonds with the people around him. Dr. Larry Monteith, who was dean of engineering and then the university's chancellor, encouraged him to pursue his PhD. Faculty — including the late Dr. Larry Clark, a math professor and associate provost who was a catalyst for African American advancement on campus — were mentors as well as instructors. Fellow students supported him in the lab and on the basketball court, where the group was runner-up to the university's intramural champion.

"His research is extremely innovative, and he's one of those people who just lights up a room," said Dr. Larry Silverberg, Washington's PhD advisor. "It's no surprise that he's risen through the ranks to where he is now."

Washington joined the faculty at Ohio State University in 1995. There, he became well-known for research in "smart materials" that can respond to external stimuli in various ways, such as producing electricity when encountering temperature changes or undergoing deformations. He was particularly interested in using these materials in hybrid vehicles, research that gave him the chance to work on the first Toyota Prius on US soil.

He was just completing a stint as interim dean of engineering at Ohio State when the dean's position opened at UC-Irvine. He jumped at the chance to lead a young but growing school that's strong in biomedical research, environmental technology and other emerging areas. It doesn't hurt, he noted, that the southern California campus is six miles from the beach.

Now, Washington is formally reconnecting with NC State. He has joined the NC State Engineering Foundation Board of Directors, serving the institution that helped him do so much.

"There's a Yoruba proverb that says, 'What you give you get, ten times over,'" Washington said. "My service to NC State is just a small return on its investment in me." ▪

GIVING PLANS

Engineering alumni make giving back to the College part of their long-term financial planning.

Funding a brighter future.

That's what motivates donors to make a planned gift, one of the easiest ways to support the College of Engineering at NC State. Planned gifts ensure that future generations of talented engineering students and faculty have the resources they need to thrive at the university.

The NC State Engineering Foundation offers a wide range of planned giving options for prospective donors, including charitable gift annuities, remainder trusts and bequests. Below are a few of the recent bequests, gifts made to the College as part of a will or trust.

William (Bill) H. and Barbara J. Ailor Enhancement Fund for Mechanical and Aerospace Engineering

It was a simple decision for Dr. Bill Ailor III and his wife, Barbara: A portion of their estate would go to NC State, a university that produced many good memories and a tremendous education.

Bill Ailor remembers the day he met Barbara, a fellow NC State graduate student who needed help carrying boxes to her apartment at the start of the semester. He credits NC State with giving him the flexibility to find the major, aerospace engineering, that was the best fit for his interests. He received bachelor's and master's degrees in the field in 1967 and 1969, respectively.

Today Ailor is an expert in space debris and reentry breakup and principal engineer for the Center for Orbital and Reentry Debris Studies at the Aerospace Corporation in California. He hopes the couple's gift, which can be used to buy new equipment and support students and faculty, encourages others to help the department that introduced him to his field.

His advice to alumni: "Make sure that the university that has been so important to you benefits from your work and success."

Dr. J. Michael and Donna W. Rigsbee Distinguished Professorship in Materials Science and Engineering

The Department of Materials Science and Engineering was very different in 1965 when Dr. Michael Rigsbee began classes at NC State. Among the biggest differences: a different name — Department of Mineral Industries — and no Centennial Campus.

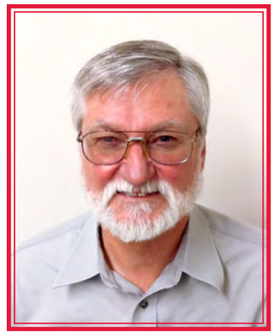
Today the department is growing quickly, both in faculty and student population and in research scope and expenditures. Now Rigsbee, a professor of materials science and engineering, and his wife, Donna, have made a gift that will help the department reward and retain quality faculty.

"Our goal was to provide funds that can help professors achieve national and international recognition for their teaching, research and professional service," said Rigsbee, who received his bachelor's, master's and doctoral degrees from NC State and served as department head for 11 years.

The result: An endowed professorship that will one day be used to bring a top faculty member in the field to NC State, or convince one of the department's star researchers to stick around for a long time.

"We want this gift to benefit the department for years in the future," he said.

Kenneth E. Watkins Enhancement Fund for Engineering



Nuclear engineering alumnus Kenneth Watkins has been away from NC State since he graduated in 1971, but he remains a big supporter of the university.

That's because his NC State education helped him build a 30-year career in the nuclear engineering consulting field. Today, he is vice president of TransWare Enterprises Inc., a consulting group to the nuclear and computer industries. The company's software is used by clients around the world.

Watkins is actively involved in the NC State Alumni Association's Bay Area network in California, which has helped him stay up to speed with what's been happening at the university. His bequest gives future College leaders the flexibility to improve areas that need the most help, which could include helping talented students pay for their educations, student travel support or equipment purchases.

"When you're outside of North Carolina, you find that NC State has a great reputation," Watkins said. "You have a certain amount of pride having graduated from such a prestigious university, and it's another reason to pay it forward." ▪

Finding the best fit

The NC State Engineering Foundation can help supporters find a planned giving option that works best for their long-term financial goals.

Bequest

A donor includes a gift to the Foundation as part of a will or trust. Bequests are eligible for an estate tax deduction.

Charitable gift annuity

A donor makes a gift, and the Foundation provides a fixed income for the donor or a loved one annually for life.

Charitable remainder trust

There are two types of charitable remainder trusts: the unitrust and the annuity trust. The former creates constant life income for the donor or a loved one, but the amount varies based on the annual value of the trust. The latter provides a fixed income for life.

For more information, visit **www.engr.ncsu.edu/foundation/ways-to-give** or contact Martin Baucom at **mabaucom@ncsu.edu** or **919.515.7458**.

donor stories

HONORING A LEGEND OF NUCLEAR ENGINEERING

The Dr. Raymond L. Murray bust

The Department of Nuclear Engineering has unveiled a bust of the late Dr. Raymond L. Murray, a pioneer of the atomic age and a leading figure in establishing NC State's nuclear engineering program.

The bust, located in the north lobby of Burlington Nuclear Laboratories, was unveiled at a reception and ceremony on Nov. 19. Murray, professor emeritus of nuclear engineering, passed away in 2011 at the age of 91.

Speakers at the event included four engineering alumni — Drs. Norman Banks, G. Lansing Blackshaw, Thomas Hirons and Wilson "Bill" Leggett — who donated funds for the bust and had previously banded together to raise money for an endowment that honored Murray. Dr. Wesley Doggett, a professor emeritus of physics and a student-turned-colleague of Murray, also spoke.

Murray joined NC State in 1950 and contributed to the design and construction of the nation's first university-based nuclear reactor, an important research and teaching tool that was activated on the NC State campus in 1953. He served as head of the newly formed Department of Nuclear Engineering from 1963 to 1974. Under his direction, a new building was constructed, and the PULSTAR reactor, which remains in use today, was acquired and activated.

His career also included seminal contributions to the Manhattan Project and the Three Mile Island recovery. ▪

SCHOLARSHIP TO BENEFIT RANDOLPH COUNTY STUDENTS

Allen Jefferson Fuller

Students from Randolph County, NC, are eligible for a new endowed scholarship that was recently established in the College.

The endowment gift from Frances Stalvey Fuller honors her late husband, Allen Jefferson Fuller, who graduated with honors from NC State in 1960 with a bachelor's degree in electrical engineering. He passed away in 2009.

The Allen Jefferson and Frances Stalvey Fuller Endowment will provide scholarships for undergraduate engineering students from Randolph County, where both Fullers grew up and attended high school.

Allen Fuller served in the US Army Signal Corps and was a veteran of the Korean War. He worked for General Electric in Virginia for 25 years before moving to Illinois and joining Bally Manufacturing in Chicago, where he was vice president of engineering. He later joined Life Fitness in nearby Franklin Park, Illinois, from which he retired in 2002 as the company's executive vice president of manufacturing and engineering. ▪

New Foundation staff

The NC State Engineering Foundation welcomes several new staff members.

Tasha Martin

Margaret McEndarfer

Erika Knox

Tasha Martin is the director of development for the Departments of Electrical and Computer Engineering and Mechanical and Aerospace Engineering. She came to NC State in 2012 from the University of Florida, where she served as director of development for the Department of Industrial and Systems Engineering. In that role, she was responsible for major gift fundraising efforts and program development for the department. She received a bachelor's degree in health care administration from the University of Central Florida in 1998.

Katalina MacCabe joined the Foundation in 2012 as director of finance and operations. She previously worked in the Aerospace Division of MIT's Lincoln Laboratory, working closely with the Department of Defense on US Air Force initiatives. Her unique engineering experience includes being a heavy-equipment operating engineer and serving as operations manager for an infrared space surveillance telescope. MacCabe holds bachelor's and master's degrees from Boston College and completed additional graduate coursework at MIT.

Margaret McEndarfer is the Foundation's administrative and business specialist. Before joining the Foundation in 2011, she worked as an office manager for APPLES Service-Learning, a student-run service-learning organization at the University of North Carolina at Chapel Hill. She received bachelor's degrees in English and women's studies from UNC-Chapel Hill in 2010.

Erika Knox joined the Foundation as its administrative support associate in 2012. She previously worked as a reception and reservations agent at the Umstead Hotel and Spa in Cary, NC, and held hotel and food service internships in upstate New York. She graduated from NC State in 2010 with a bachelor's degree in parks, recreation and tourism management. ▪

GIVE RIGHT

Ensure your gift reaches the students and programs you want to support. Make your check payable to "NC State Engineering Foundation, Inc." and send it to this address:

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Raleigh, NC 27695

Or give online at www.engr.ncsu.edu/foundation.

College honors distinguished alumni

Stephen F. Angel

Jimmy D. Clark

John A. Edmond

The College named Stephen F. Angel, chairman, president and chief executive officer at Praxair, Inc.; Jimmy D. Clark, owner and president of Guy M. Turner, Inc.; and Dr. John A. Edmond, director of advanced optoelectronics at Cree, Inc., as its Distinguished Engineering Alumnus award winners for 2012.

The awards were presented by Dr. Louis A. Martin-Vega, dean of the College, at a banquet held Jan. 24 at the Park Alumni Center on NC State's Centennial Campus. The award honors alumni whose accomplishments further their field and reflect favorably on the university.

Angel earned his bachelor's degree in civil engineering from NC State in 1977. Since 2007, he has led Praxair, Inc., a Fortune 250 producer and distributor of atmospheric, process and specialty gases and high-performance surface coatings. The company is the largest to be led by a College alumnus. Angel has generously supported the College, endowing with his wife, Lori, the Robert F. and Romaine S. Angel Scholarship in memory of his parents. The scholarship generates income for students equivalent to full tuition and fees. He also provides annual support through the Dean's Circle and has led strategic engagement efforts between Praxair and the College.

Clark earned his bachelor's degree in civil engineering from NC State in 1974. The registered professional engineer leads Guy M. Turner, Inc., a rigging, millwright, heavy transportation and crane services company headquartered in Greensboro, NC. A generous supporter of NC State, Clark established the Jimmy D. Clark Distinguished Professorship in the Department of Civil, Construction, and Environmental Engineering in 2007. He and his wife, Vickie, also support the College's Leadership Fund and Dean's Circle. Clark serves on the university's Board of Trustees, the Engineering Foundation Board of Directors and the Alumni Association Board of Directors.

Edmond earned his PhD in materials science and engineering from NC State in 1987. While a student, he teamed with a group of other graduate students and young faculty on some promising silicon carbide research, and upon graduation they co-founded what became Cree, Inc., one of the world's top LED manufacturers. Edmond and his wife, Rita, recently pledged $150,000 to endow the Dr. John A. Edmond Graduate Fellowship in the Department of Materials Science and Engineering. He has also been the driving force behind more than $1 million in unrestricted research support that Cree has provided to NC State's Analytical Instrumentation Facility. ▪

BY THE NUMBERS

A LOOK AT SOME OF THE FIGURES THAT SHAPE THE COLLEGE OF ENGINEERING

22

NC State students awarded scholarships by the Astronaut Scholarship Foundation, more than almost any other university. Most of those students studied engineering, including Ryan Going, a scholarship holder from 2007 to 2009.

1862

Year President Abraham Lincoln signed the Morrill Act, paving the way for land-grant colleges focusing on agriculture and mechanic arts. NC State was founded in 1887.

86

Percentage of NC State students who passed the October 2012 Fundamentals of Engineering (FE) Exam, well above the national average of 70 percent.

6

College faculty who have won the O. Max Gardner Award, the top faculty honor awarded by the 17-campus University of North Carolina system.

39

North Carolina manufacturers enrolled in the NC State Industrial Extension Service's Manufacturing Makes it Real Network, which offers opportunities for marketing, networking and improving efficiency.

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