



NC STATE UNIVERSITY

# results.

Fall 2013 • Research, Innovation & Economic Development

SMART GRIDS  
& CLEANTECH:  
ENERGY  
CONVERSIONS



ALSO IN THIS ISSUE:

- FOOD SAFETY + BETTER PACKAGING = JOBS
- MEET A CENTENNIAL PARTNER
- PRODUCTS ON THE HORIZON



## Reaping What We Have Sown

**ABOVE:** Chancellor Randy Woodson and SAS founder Jim Goodnight were among participants in the Transforming Economies symposium at NC State earlier this year.

**R**esearch is an exciting endeavor in itself, but through hard work and partnership, at NC State we often experience the thrill of applying our discoveries in the real world. There are so many great examples of NC State's research impacts, it was difficult to decide which stories to feature in this issue.

We are leading global efforts to modernize the national power grid and bring clean energy sources into the mix, sparking economic growth here in North Carolina. A startup based on technology developed at NC State has introduced packaged food products with improved nutrition and taste to the marketplace — creating good jobs in the process. A Centennial Campus partner is seizing the opportunity to launch new products with help from our research community. We are excited to share these results and other breakthrough solutions that improve North Carolina's economy, environment, and the well-being of its people.

And what a fruitful fall season is ahead.

The 2013 Raleigh Innovation Summit is an example of how NC State is driving development of the entrepreneurship ecosystem in the region and state. The university and city again are hosting the summit, along with partners from academia, industry, government, and community organizations.

Since the first summit in 2012, innovation has been at the forefront of discussions and actions.

- Direct flights now run between Raleigh-Durham International Airport and San Francisco, encouraging synergies with — and attracting venture capital from — Silicon Valley.
- Entrepreneurs have more spaces to nurture startups, including HQ Raleigh and its ThinkHouse, American Underground @Raleigh, and NC State's Incubator 2.0.
- Triangulate is a new online tool to connect entrepreneurs with resources and one another. The site, triangulatenc.com, reflects the enormous activity all across the region.

- NC State's innovation symposium, Transforming Economies, drew national academic and industry experts who cited our cutting-edge partnerships as a model for their own growth.

Discussions at this year's Raleigh Innovation Summit will focus on what is needed for the region to be recognized as a "top five" center for innovation and entrepreneurship. Who knows what big idea today will be a reality in 2014?

Innovate Raleigh continues as the umbrella organization for many public/private/academic activities. Along with NC State and the City of Raleigh, partners are Raleigh Economic Development, Wake County Economic Development, the Downtown Raleigh Alliance, Wake Technical Community College, the Wake County Public School System and the Council for Entrepreneurial Development.

Here at NC State, we have brought various offices and programs to the building now known as the Poulton Innovation Center, named for Bruce Poulton, whose tenure as chancellor included Centennial Campus' early days. The center's second floor is home to the Springboard Innovation Hub, which includes the Concierge, Centennial Campus Partnership Office, Industry Alliances, Office of Technology Transfer, Research Development Office, Venture Development, and the Small Business Technology and Development Center.

Audacious may have been the description of early Centennial Campus visions shared by Poulton and others. Their dreams of public/private partnerships have come true. Now we are shaping new visions for a future focused on innovation.

I am often at Springboard, working with university, industry, and community partners. Stop by to share your big idea. In the meantime, join the conversation on Twitter at #InnovateRal and with @NCStateResearch.

TERRI L. LOMAX  
Vice Chancellor

*Research, Innovation and Economic Development*

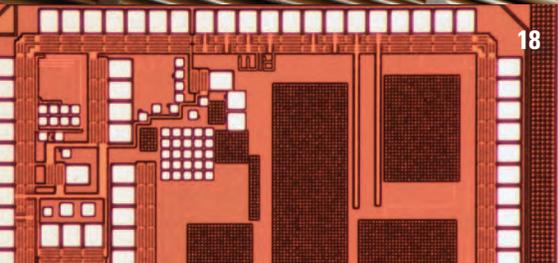
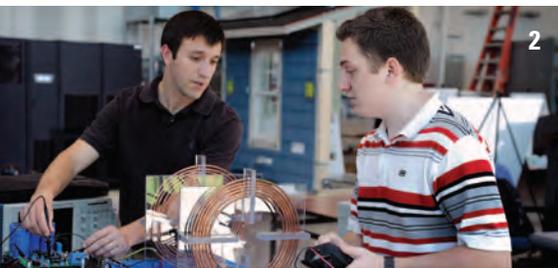
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# Table of Contents



results.

XIII, Number 2, Fall 2013



2..... High-Powered Punch  
*A global effort to modernize the power grid also is sparking a cleantech bonanza in North Carolina.*

10..... The Wright Way  
*A startup built on NC State innovation brings new direction to the packaged food industry — and new life to a small town.*

15..... Opportunity Knocks  
*Pentair Aquatic Eco-Systems builds upon varied campus connections.*

18..... Sharing Solutions  
*NC State's 2013 Chancellor's Innovation Fund helps research results move to market.*

20..... Progress toward Products  
*Past CIF projects are generating startup companies and commercial licensing of products.*

21..... Kudos  
*Carl Koch elected to National Academy of Engineering, while other faculty, staff and students also earn local, national and international honors.*

24..... Quick Takes  
*Check out NC State research that is making the news.*

27..... Annual Report  
*NC State shares key accomplishments in research, innovation and economic development in FY2013.*

29..... Creative State  
*Animation, landscape design and Earth observations' data visualizations are just some of the creative sparks for students and faculty.*

Back..... Show Me the Data  
*Maps that identify dialect trends have drawn millions of online views. Do you say soda or pop?*

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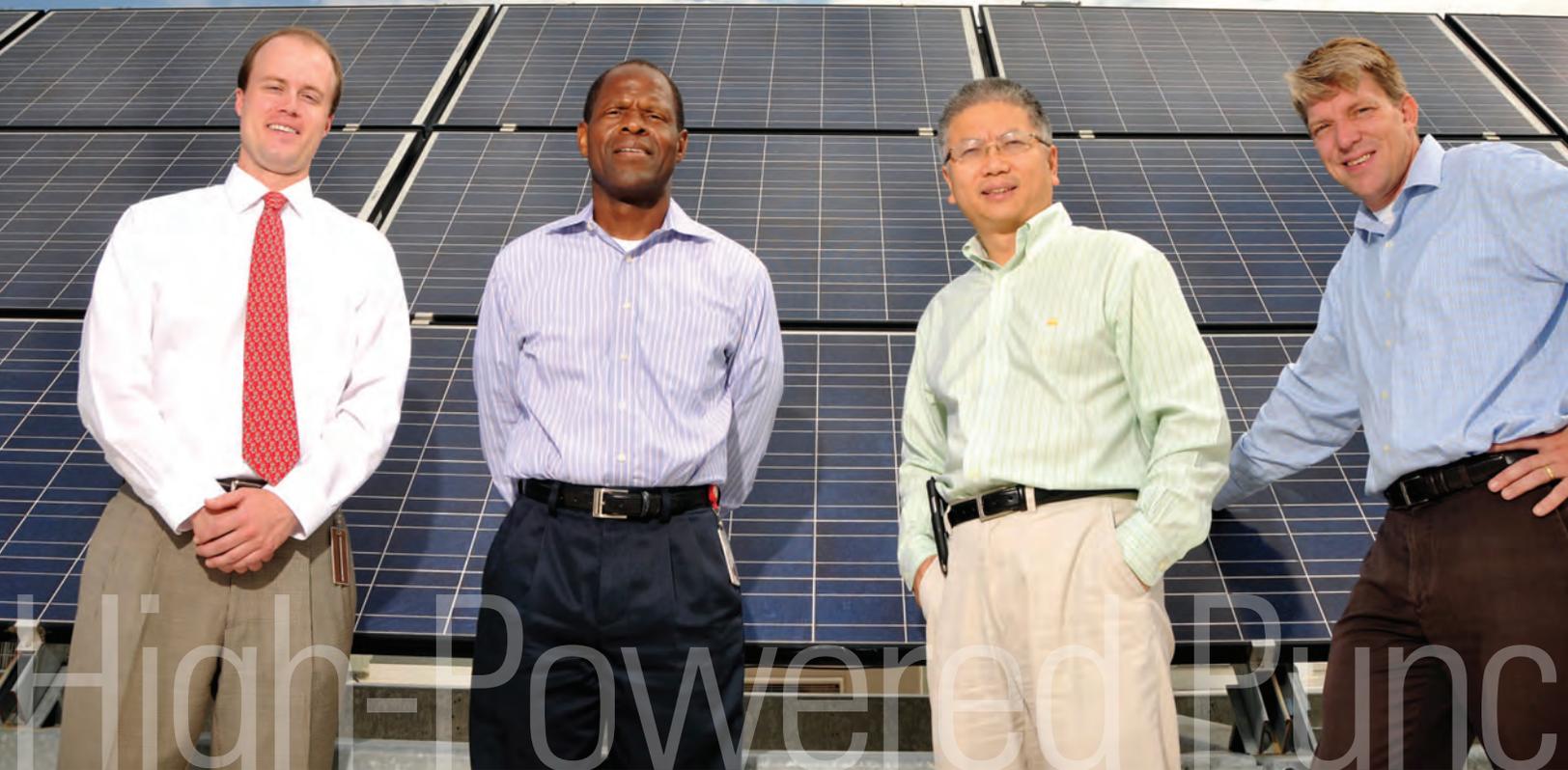
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Front cover: *Alex Huang leads the FREEDM center that has attracted global partners to change the way we think about, generate and deliver power.*

# NC State fuels clean energy bonanza High-Powered Punch

By David Hunt



**ABOVE:** The FREEDM Center draws upon vast expertise at NC State, including, from left: Seth Crossno, industry liaison; Rogelio Sullivan, managing director; Alex Huang, center director; and Ewan Pritchard, associate director.

“We’re trying to create a new electric grid infrastructure that we call the energy Internet. We’re looking at the whole distribution system. That’s a huge engineering system. It’s very, very complex.”

— ALEX HUANG

A severe summer storm roared across North Carolina’s Triangle region in June, knocking out power to more than 28,000 homes and businesses, and reminding residents of the high-tech area just how dependent they are on a steady supply of electrical current. It’s not just the loss of air conditioning that makes people sweat during a blackout. From computers and communication devices to entertainment consoles and even a new generation of cars, the essential tools of modern life run on power generated by utility companies.

“It’s a very old system,” says NC State professor Alex Huang, an expert in electrical and computer engineering. “In the future, it’s going to change.”

Huang is spearheading a global collaboration of leaders in research, industry and economic development to envision and then create the energy system of the future. With \$20 million in funding from the National Science Foundation and

\$30 million in industry support, the effort has sparked the growth of dozens of clean energy businesses in the Triangle, making the region the epicenter of smart grid development.

Among the center’s 50 industry partners are global leaders, including Duke Energy, Itron and Samsung, as well as newer enterprises, such as Triangle Technology Ventures and Sarda Technologies.

“We’re trying to create a new electric grid infrastructure that we call the energy Internet,” Huang says. “We’re looking at the whole distribution system. That’s a huge engineering system. It’s very, very complex.”

According to the U.S. Department of Energy, the smart grid will be more efficient, capable of meeting increased consumer demand without adding infrastructure; and be more intelligent, sensing system overloads and rerouting power to prevent or minimize a potential outage. It will

accept energy from virtually any fuel source, and offer improved security and resiliency in case of a natural disaster or threat. It also will allow real-time communication between the consumer and utility, ushering in a new era of consumer choice.

The Center for Future Renewable Electric Energy Delivery and Management Systems, better known as FREEDM, is working to make these ideas reality. From headquarters on NC State's Centennial Campus, the NSF Engineering Research Center directs varied activities, from the creation of new devices that will allow energy to flow in more than one direction to the development of the software architecture that will give the smart system its brainpower.

"It's not a fundamental technology barrier we face," Huang says. "It's more a matter of systems engineering, along with business and policy challenges."

That's not to discount the importance of the new discoveries emerging from the FREEDM center. Research and development are key components of the center's work, especially in areas like energy storage, grid control and communication.

The facility boasts a 1-megawatt demonstration hub and real-time digital simulation lab, as well as labs specializing in computer science, power electronics, energy storage and motor drive technology. Under the FREEDM umbrella, researchers and students are tackling more than a dozen research projects in partnership with colleagues at Arizona State University, Florida State University, Florida A&M University and Missouri University of Science and Technology. That's just this year. In five years, the center has

launched dozens of projects in fields ranging from systems theory to intelligent energy management.

The result is one innovation after another. Researchers have developed a technique that allows a common electronic component to handle voltages almost seven times higher; created an ultra-fast fault detection, isolation and restoration system; and invented a new solid-state transformer to replace the 100-year-old electromagnetic transformer. The new transformer gained international acclaim in 2011 when it was named one of the world's 10 most important emerging technologies by *MIT Technology Review*.

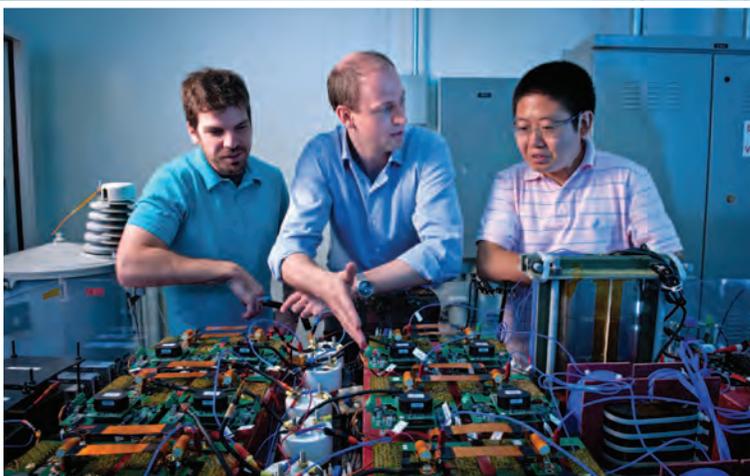
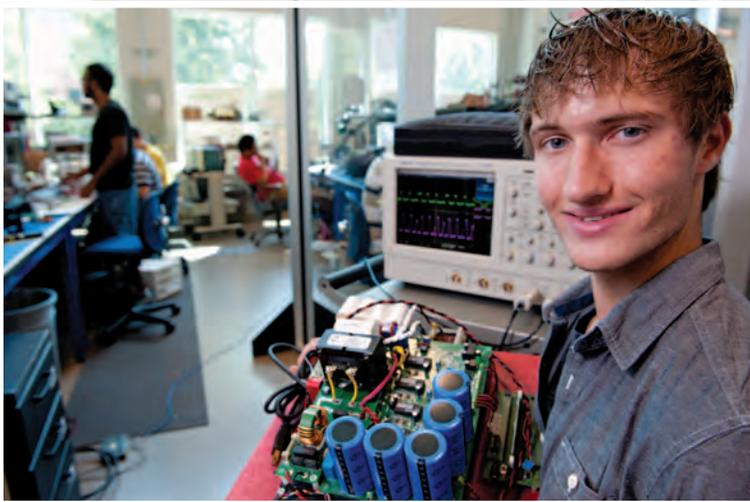
The center is working to commercialize these and a score of other new technologies, systems and devices.

"We're operating a grid that was primarily designed in the early 1900s and hasn't changed much, while consumers have changed dramatically. We're adopting all these new devices, such as electric vehicles, rooftop solar, even compact florescent light bulbs. These all cause problems on the grid."

— CHAD ECKHARDT

*TOP: Senior Travis Tippens has worked at the FREEDM center to earn a certificate in renewable electric energy systems.*

*BOTTOM: GridBridge CEO Chad Eckhardt, center, examines prototypes with Chandler Bennett and Sherwin Yang.*



*continued on page 4*



**ABOVE:** As an NSF ERC, the FREEDM center has a key mission to provide education and training for students.

## POWER TO THE PEOPLE

Think of the energy grid as an open faucet. It carries power in just one direction, and it's always on. The paradigm has worked for more than a century because power consumers and power generators occupy opposite ends of the grid.

At the utility company's end, energy is primarily generated by burning fossil fuels. At the consumer's end, at what power companies called the edge of the grid, a meter

records the amount of energy consumed. In today's energy marketplace, there are many buyers but most of the time one seller in a locale.

The system is strong, but not particularly flexible. Huang has a better system in mind.

A new infrastructure would support the individual customer participating in new roles in the electrical energy market.

Huang essentially wants to change the paradigm, creating an energy marketplace that supports many buyers and many sellers. Where will all that new energy come from? Homes, offices and small businesses, he says, in the form of alternative energy sources like solar panels and wind farms. Renewables account for a tiny share of the market now — about 5 percent in North Carolina — but have the potential to capture 50 percent or more.

To make that happen, the electrical grid will have to incorporate many of the new technologies under development at the FREEDM center.

"We'll have to create a totally new business concept of the grid," Huang says. "The grid will no longer have a single entity dominating the generation of power and the regulation of voltage and frequency."

Like the Internet, the smart grid will rely on a decentralized system connecting thousands of individual users in a robust network. The system will collect and process thousands or even millions of bits of data, and intelligently manage the flow of power across the network, ideally doing most of its work at the edge of the grid, close to the customer. This kind of system — called distributed generation — is potentially more efficient and environmentally sustainable than the existing system.

## BRIDGING THE DIVIDE

A block away from the FREEDM center, at the offices of a startup company called GridBridge, Chad Eckhardt is working to put some of the university's innovations into the hands of utility companies. He has a receptive audience.

"The utilities have to do a great deal of heavy lifting on a daily basis to be able to provide power in the way that they do," he says. "And now, to try to modernize the grid is a monumental task."

Eckhardt, the company's president, is a passionate entrepreneur who's worked in the energy industry for more than a decade. He says the coming changes are long overdue and will help optimize the flow of electricity based on consumer demand.

"We're operating a grid that was primarily designed in the early 1900s and hasn't changed much, while consumers have changed dramatically," he says. "We're adopting all these new devices, such as electric vehicles, rooftop solar, even compact fluorescent light bulbs. These all cause problems on the grid."

Utility companies see that they need to modernize, he adds, but they find the technical challenges daunting. That's an opportunity for companies like GridBridge.

"We're working with them to provide the devices, and the advanced intelligence and control they need, to be able to modernize the grid."

One of the new technologies GridBridge is promoting is a way to integrate renewables and energy storage devices, including electric vehicles, into the grid.

"We're on the front of a very large wave.

Utilities want to help solve all these

problems, but they need the

equipment to do it. They need

an advanced set of technologies."

— CHAD ECKHARDT



# The Smart Grid Cluster

## in Wake County and the Research Triangle Region



ABOVE: Wake County and the Triangle region are home to more than 96 smart grid companies, including many of the industry's heavy hitters. Map developed by Wake County Economic Development, a member of the Research Triangle Regional Partnership. See Results online for a link to an interactive map.

"You can introduce these devices," he says. "But how do you optimize the flow of electricity once they're connected? It's not that easy because there are so many variables. You need some brains in the system to control these devices and the resulting power flow."

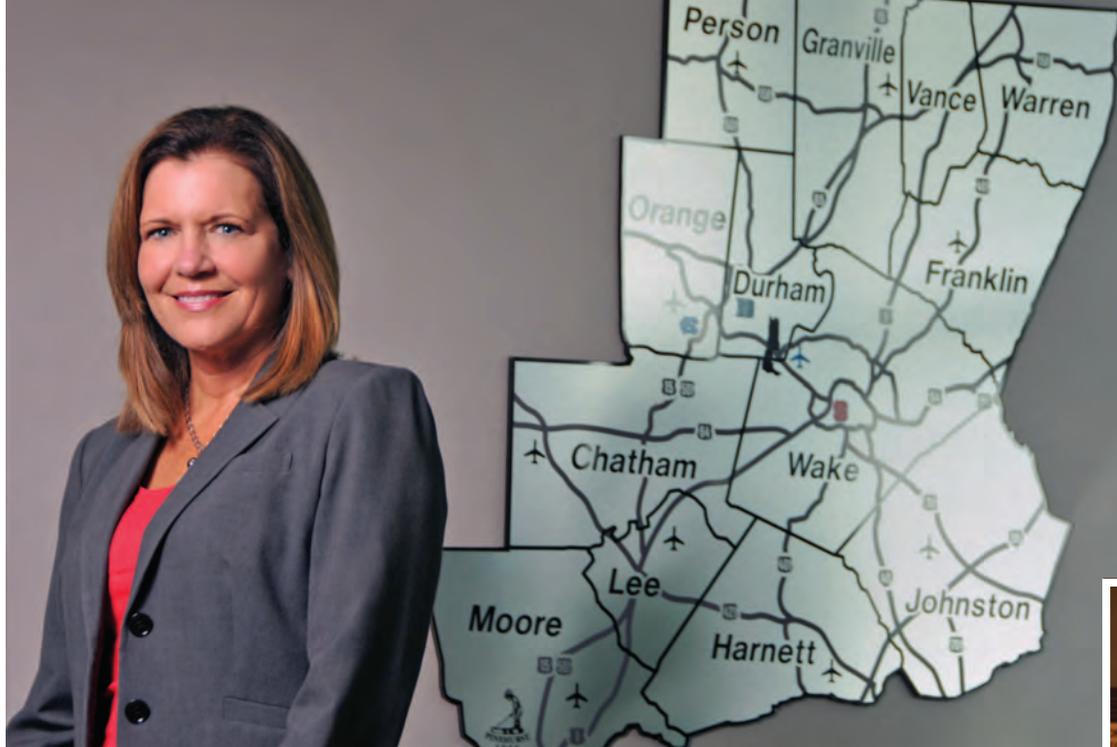
Utility companies need to maintain a steady flow of power to customers, but the system isn't set up to handle the highly variable power generated by renewable energy sources like wind turbines and solar panels. On a sunny day, a solar array provides a lot of power, for example, but the power drops as soon as night falls. In order to provide steady power for the grid, the array needs an

energy storage device, like a bank of batteries, along with innovative controls to tell the batteries when to charge and discharge and essentially to direct traffic on the system.

With the adoption of renewable energy production rising exponentially, the industry needs to find practical solutions fast.

"We're on the front of a very large wave," Eckhardt says. "Utilities want to help solve all these problems, but they need the equipment to do it. They need an advanced set of technologies."

continued on page 6



**LEFT:** Lee Anne Nance says North Carolina's public universities and colleges are helping to fuel the growth of the cleantech sector.

**RIGHT:** NC State's Wade Fulghum works to commercialize university research discoveries through strategic business partnerships. Some of the region's top companies started at NC State.

**"This is a disruptive and transformational time in infrastructure delivery throughout the world and our region is leading the way. We're right in the middle of the action and that's good for the economy, the people who work here and the people who live here."**

— LEE ANNE NANCE

Utilities face financial as well as technical challenges. They need to modernize while preserving their enormous investment in a business model based on the existing infrastructure.

"Modernize doesn't necessarily mean rip everything out," Eckhardt says. "It means making the infrastructure operate better and more efficiently."

To do that, GridBridge brings together researchers and industry clients to identify and solve the immediate, specific problems facing utilities.

"They have these great ideas, but how do we begin to form them into tangible products?" he says. "That's very difficult in a new frontier. We're in a white-space area where we have to mold the research to fit today's application environment. We have to do guided research in a way that thinks about cost and manufacturability."

## CLEANTECH CLUSTER

GridBridge isn't the only company in the region eyeing the opportunities for energy innovation.

A recent study identified 169 firms within the 13-county Triangle region, including 16 Fortune 500 companies, working to develop sustainable solutions to the world's energy needs. The sector, called cleantech by the industry, spans every county in the region.

Lee Anne Nance, executive director of the Research Triangle Regional Partnership, spearheads a collaborative network called the Research Triangle Cleantech Cluster that promotes the region's competitive edge in the global marketplace

by building on local strengths and nurturing new areas of innovation. Its members include some of the industry's biggest players, including Duke Energy, Siemens Energy, ABB Inc. and Schneider Electric, as well as major high-tech companies such as SAS, Cisco, Power Analytics, Sensus, Power Secure, RTI International and Field2Base.

Combined, they pack a powerful punch, employing thousands of high-skill workers and driving innovation in energy management, water, transportation, data analytics, information technology, renewable energy, electronics and engineering.

"This is a disruptive and transformational time in infrastructure delivery throughout the world and our region is leading the way," Nance says. "We're right in the middle of the action and that's good for the economy, the people who work here and the people who live here."

Although the cleantech sector in North Carolina is young, it has experienced explosive growth in the past few years, emerging as a global leader in the field. The group was invited to join the International Cleantech Network, making it one of just two U.S. members of the exclusive partnership, based in Denmark.

The FREEDM center may be the region's biggest success story, but it's hardly the only one. For example, research teams at NC State, UNC Chapel Hill, North Carolina Central, RTI International and Duke are working together on a \$17.5-million project funded by the U.S. Department of Energy to synthesize new molecular catalysts and light absorbers and integrate them into nanoscale architectures for improved generation of fuels and electricity from sunlight.

"This region is well positioned for the future because of our community colleges and universities," Nance says. "We bring in more than \$2 billion in research funding every year through our research universities and organizations."

Wade Fulghum, who helped launch the Research Triangle Cleantech Cluster, leads venture development efforts within NC State's Office of Technology Transfer. He sees firsthand how the region's commitment to higher education pays off in the marketplace.

"These companies have all experienced having talented employees poached by other firms," Fulghum says. "We've made an effort over the past couple of years to plant our flag in the ground and let people in the industry know that this is the place to come to get an education and get jobs."

An Army infantry veteran with an MBA and experience in energy conservation and renewable energy, Fulghum chairs the cluster's entrepreneurship working group. He's



"These companies have all experienced having talented employees poached by other firms. We've made an effort over the past couple of years to plant our flag in the ground and let people in the industry know that this is the place to come to get an education and get jobs."

— WADE FULGHUM

"There are many opportunities for collaboration between members of the Research Triangle Cleantech Cluster and NC State, including sponsored research and project partnerships," he says.

Sponsored research gives companies the opportunity to work with university experts to identify industry pain points and solve specific technical problems. And it frequently results in the creation of valuable intellectual property, such as products or patents, that can be leveraged by companies for a competitive advantage. NC State alone holds more than 800 U.S. patents and is responsible for commercializing more than 400 new products.

The area's universities also support another goal of the cluster: improving workforce development. Simply put, there aren't enough skilled workers to go around.

working to connect the region's cleantech startup companies with strategic partners from the cluster.

Of the 39 new companies that have opened their doors in the region over the past decade, many are based on NC State research, including Tethis, which develops and markets super-absorbent biodegradable foams and powders in various water-treatment industries; Harrison Analytic Technologies, which is seeking to commercialize a novel battery management technology aimed at the electric vehicle market; and PlatiNix, which has developed a replacement catalyst for platinum in the production of hydrogen gas.

Fulghum hopes the Research Triangle Cleantech Cluster can help the state sort out some of the complex policy issues facing the industry as new technologies — and new businesses — come into the market.

*continued on page 8*

“This can be a delicate issue in areas with highly regulated electricity markets,” he says. “The question for North Carolina and for the region is what the policy environment will look like for companies that want to engage in the next generation of the grid.”

Reliability is the issue that keeps utility executives up at night. In fact, interest in microgrids among energy professionals rose significantly after a major blackout in the Northeast in 2003. In a white paper published in 2011, the global energy company Siemens said it envisions a

**LEFT:** *LEFT: ABB project manager Will Galton, left, and general manager Brad Luyster at the Microgrid Regional Execution Center on Centennial Campus. Their technology could be key to grid modernization.*

**RIGHT:** *Alex Huang, left, Engineering Dean Louis Martin-Vega, gesturing, and Chancellor Randy Woodson, right, lead a 2011 tour of the FREEDM center for U.S. Sen. Kay Hagan and members of the President’s Council on Jobs and Competitiveness, including Jeff Immelt, chairman & CEO of General Electric.*



## SMALL GRID, BIG BUSINESS

“Anything that produces power could potentially be a microgrid. That adds a new level of reliability. If the power goes off from the main grid, the microgrid has its own generation on site.”  
— BRAD LUYSTER

Policy questions get at least as much attention as technical issues in the Centennial Campus offices of energy giant ABB, which belongs to both the FREEDM center consortium and the Research Triangle Cleantech Cluster. The company runs the Smart Grid Center for Excellence and recently launched a new enterprise called the Microgrid Regional Execution Center.

A microgrid essentially mimics the operations of the larger grid but, as the name suggests, provides power on a smaller scale, serving a town, military base or university, for example. Microgrids can operate independently of the main grid or run parallel to it.

“Anything that produces power could potentially be a microgrid,” says Brad Luyster, vice president and general manager of the centers. “That adds a new level of reliability. If the power goes off from the main grid, the microgrid has its own generation on site.”

time when microgrids will be connected seamlessly to the nation’s grid, providing “a solution that enhances reliability, efficiency, security, quality and sustainability for energy consumers and producers alike.”

Like Siemens, ABB sees microgrids as the key to grid modernization. The company, one of the first on Centennial Campus, is aggressively pursuing a strategy to gain technical and competitive advantages. Its centers at NC State collaborate with the FREEDM center, local utilities, and other local metering and communications companies to develop and test innovative solutions. Its microgrid technology is notable for one reason: it works.

ABB’s microgrid is designed to seamlessly integrate renewables, with their fluctuating energy profiles, and output reliable power. If the main grid goes down, its microgrid system isolates itself from the larger grid and continues to provide power to its customers. When the larger grid comes back online, the connection is reestablished.



The smart technologies built into the ABB system may open the door to connecting a higher percentage of renewables to the grid. And that's not just wishful thinking. The technology has already been commercialized and has a solid track record of performance, mostly outside the United States.

"We've been doing this for 25 years," Luyster says. "We have over 80 microgrids deployed, mostly in remote areas, in places like Antarctica, the Azores, and down under in Australia."

Making room on the U.S. grid for solid-state transformers, smart meters, microgrids and other emerging technologies is no easy task. And the major utility companies aren't the only ones having to adapt. From the biggest players to the smallest, the industry will be forced in the coming years to navigate an uncharted stream of risks and rewards as consumers embrace these new technologies and the marketplace evolves in response.

At the FREEDM center, the industry's key players have a seat at the table and a chance to shape the future, wherever it leads.

## FAST FORWARD

The industry is at a crossroads, says Steve Kalland, a green energy professional with a master's degree in public policy analysis. As the longtime director of NC State's Solar Center, he's seen the changes coming for over a decade.

"If you asked somebody 10 years ago to define cleantech, you would have gotten a lot of mystified looks," he says. "If you asked them five years ago, you would have gotten 20 different answers. Today, the consensus is better defined."

As the sector matures, its innovations are being embraced by larger companies with deeper pockets and more influence in the market, Kalland adds.

"It used to be us versus them, solar versus the utilities," he says. "Now we're working together to take these technologies and integrate them into the system."

If there are clear winners in these uncertain times, it's undoubtedly the students gaining real-world experience through the research, education, training and internship opportunities created by the FREEDM center and its many industry partners.

The center, which recently added a professional master's degree program in smart grid management, is educating the generation of engineers, scientists and business leaders who will map the world's clean energy future, turning research discoveries into practical realities. In an industry facing an aging workforce, the influx of job-ready, high-skill workers can't come too soon.

"Our students are very, very highly employable," says Huang. "Our students are all gone, as soon as they get their degrees. I haven't heard of anybody who doesn't have a job."

Considering how much work lies ahead, that may be the FREEDM center's most important achievement.

"Our students are very, very highly employable. Our students are all gone, as soon as they get their degrees. I haven't heard of anybody who doesn't have a job."

— ALEX HUANG

*Check Results online for links to the FREEDM Center, and businesses and programs cited in this story. Go to: [research.ncsu.edu](http://research.ncsu.edu) and select Results.*



**LEFT:** Food science researcher Josip Simunovic set out to solve a puzzle. The result is a revolution in food processing and packaging.

**RIGHT:** North Carolina Gov. Pat McCrory, standing, applauds the creation of 500 new jobs at Wright Foods. N.C. Commerce Secretary Sharon Decker is seated next to Wright CEO Michael Drozd, far right, who is partnering with NC State food scientists Ken Swartzel and Josip Simunovic in the venture.

## Job growth and food safety **THE WRIGHT WAY**

By David Hunt

**“We’re in the bull’s-eye. If North Carolina wants a model, we’re it. We’re the model for economic prosperity in North Carolina.”**

— MICHAEL DROZD

The bustle inside the Wright Foods plant in Troy, N.C. contrasts sharply with the quiet atmosphere of its rural surroundings. The small town, settled by Scottish immigrants on the edge of the Uwharrie Forest before the Civil War, seems a more likely mecca for fishing than food processing. But the company’s year-old factory off N.C. Highway 24 is at the center of a scientific revolution that’s changing the packaged food industry.

It’s bringing the region, long plagued by high unemployment, along for the ride. “We’re in the bull’s-eye,” says CEO Michael Drozd. “If North Carolina wants a model, we’re it. We’re the model for economic prosperity in North Carolina.”

It’s not hard to win converts, including North Carolina Gov. Pat McCrory, who toured the plant in July to see if

the company had found matching funds for a \$1.5 million economic development grant from the state. Wright Foods didn’t disappoint, announcing a \$53 million expansion that is projected to triple the size of the plant, adding 120,000 square feet and more than 500 new jobs.

The company’s growth is particularly welcome news for Ashley Cagle, director of the Economic Development Corporation in Montgomery County, where Troy is the county seat. The region has long prided itself on the diversity of its open spaces — from farms to golf courses — and its wealth of natural resources. But the loss of textile and furniture manufacturing jobs in recent years has cast a long shadow.

“We are one of a handful of counties that have seen a decline in the population of young people every year,” Cagle says.

“Like a lot of rural areas, we have trouble retaining residents under 30 because of a lack of opportunity.”

The new job opportunities coming to Wright Foods may help stabilize the demographic shift, she says.

“The jobs they’re offering are on the forefront of technology,” Cagle says. “They’re new and evolving. I think those jobs will enrich the workforce.”

## GAME CHANGER

Innovation is the watchword at Wright Foods, founded last year by Drozd and NC State food scientists Ken Swartzel and Josip Simunovic, who have received university honors for innovation. The company was born out of a decade of research at the Center for Advanced Processing and Packaging Studies, sponsored by the National Science Foundation.

The success of the venture also stems from a fortunate convergence of consumer demand and industry need. By luck or design, the company seems to have come up with the right product at the right place and the right time.

“If we had launched this five years earlier, we wouldn’t have had nearly the success,” Drozd says. “The timing is perfect.”

“Why would anybody want to do anything like that?” Drozd thought to himself.

Answering that question would eventually lead to dozens of inventions, 10 patents and a wildly successful startup company, all focused on finding better ways to package and deliver processed foods.

“We’re a game changer,” Drozd says. “We keep the technology moving forward. We’re always looking for ways to innovate.”

Innovation is hardly a new concept in the food processing industry. Since the early 20th century, consumers have relied less on homegrown products and more on grocery shelves stocked with an ever-increasing variety of packaged products to feed their families. Big food brands have led the way in embracing new materials, phasing out glass containers in favor of plastic, for example.

Now researchers at NC State are focused on delivering a knockout blow to one of the last old-fashioned food packages still sitting on store shelves: the metal can. In its place, look for new packages that are lighter, safer and greener, and can hold an amazing variety of shelf-stable foods without preservatives or refrigeration for years.



Photo courtesy Office of the Governor, State of North Carolina

## ASEPTIC SOLUTION

Anyone who’s ever opened a jar of preserves has enjoyed the benefits of shelf-stable food. For generations, people have followed a simple formula: fill a jar with an acidic food like tomatoes or strawberries, and then boil the jar in a pan of water until a seal forms under the lid. The action creates a vacuum in an acidic environment that discourages the growth of bacteria. Canning doesn’t deliver a product with the same flavor or texture as fresh fruit, but it extends the shelf life of many foods well beyond the growing season.

A better system, first tested in the 1920s and then initially commercialized in the 1940s, involves sterilizing both a food product and its container separately, and then combining them in a sterile environment. Aseptic processing, as it is known, is sort of like canning on steroids, delivering a wider variety of shelf-stable foods more reliably, efficiently and safely than home canning. The technology also has a long history in Europe, where aseptically canned milk was first marketed in 1953.

“The jobs they’re offering are on the forefront of technology, They’re new and evolving. I think those jobs will enrich the workforce.”

— ASHLEY CAGLE

The partnership started with a question. In the late 1990s Drozd, then working at an equipment manufacturer in Research Triangle Park, fielded a telephone call from Simunovic at nearby NC State.

“Can you guys heat food that’s being pumped through a pipe?” the researcher asked.

*continued on page 12*



**ABOVE:** *The Wright Foods plant in rural Montgomery County has launched a \$53-million expansion after less than two years in business. That’s good news for employees like Marco Torres.*

“Chemists, microbiologists and engineers all work together to solve problems. And it’s a very applied science. You see the direct connection between basic science and how it applies in the real world.”

— AN TROUNG

Efforts to perfect the aseptic process have kept food scientists busy since then.

The Schaub Food Science Building at NC State is home to the two food scientists behind Wright Foods. Here, in a ground-floor lab, they’ve built an elaborate testing system to help turn ideas into reality. It’s a time-tested relationship for Swartzel, a pioneer in the field, and his colleague and former Ph.D. student, Simunovic, now an associate professor. The relationship intensified in 2006 when the researchers teamed up with Drozd to found Aseptia Inc., the parent company of Wright Foods.

Together, the professors and their students have created a wealth of new processes, prototypes and products. And they’re not nearly done.

“I didn’t really set out to build a business venture,” Simunovic says. “In my mind, I set out to solve a puzzle.”

That puzzle, it turns out, involves many gallons of minestrone soup.

## GO WITH THE FLOW

Simunovic, who began his academic career in his native Croatia four decades ago, is an expert in a technology called advanced aseptic processing, the applied science of sterilizing food before it’s packaged to ensure that you kill harmful bacteria. That’s a relatively simple process for liquids like milk or broth, which are uniform in texture. For example, milk can be sterilized rapidly, through a process known as ultra-high-temperature treatment, by pumping it through heated pipes until it reaches 138 degrees Celsius for three seconds.

In fact, pumping products through a system of heated pipes — called continuous flow thermal processing — is a common way to sterilize liquids like soups, sauces, fruit juices and other beverages. The trouble starts when you try to sterilize something like minestrone soup, beef stew or salsa.

“Minestrone has over 10 different solid components, flowing with different velocities and heating at various rates,” Simunovic says. “How do you quantify the amount of heat that each of them has received and how will you deliver the process that will make each and every piece properly sterilized? It’s a very challenging puzzle for a scientist.”

And it’s a puzzle with public health implications. If you improperly or partially sterilize a highly acidic food like strawberry preserves, you most likely risk little more than an upset stomach, assuming you have a healthy immune system. Low acidic foods, on the other hand, can harbor some truly serious pathogens, including *Clostridium botulinum*, nature’s most heat-resistant pathogenic bacterial spore and the cause of botulism, a rare but sometimes fatal paralytic illness.

Perhaps the easiest way to approach the problem would be to simply overheat the soup until all those bits of green bean, carrot, celery and pasta were reliably sterilized. That’s a nonstarter for the industry. Heat not only degrades the nutritional value of food, it impacts sensory characteristics like appearance, color, flavor and texture. All are important considerations for consumers.

The NC State team began to unravel the puzzle looking for ways to speed up the heating process, to make it virtually instantaneous and uniform at the same time. This process, called advanced thermal sterilization, seeks to maximize both quality and food safety.

Through years of experiments, pumping untold gallons of simulated and real minestrone soup through the lab’s testing equipment, Simunovic and his students have developed a system tailored to the needs of the industry, combining advanced thermal processing with continuous flow monitoring in a completely aseptic environment. Pair it with environmentally friendly cartons, cups and pouches, and the innovative system sets a new standard for food processing and packaging. Ingredients go in one end of the elaborate airtight system, and a box of soup or a squeezable fruit pouch — ready for store shelves — comes out the other.

Early on, just figuring out a way to measure the effectiveness of the system seemed an insurmountable problem. To avoid overheating the minestrone soup, the researcher needed a device that would alert him as soon as each ingredient —

every individual piece of pasta, carrot and celery — was bacteria free.

One of his collaborators, Koray Palazoglu, now a professor of food engineering at Mersin University in Turkey, frustrated at Simunovic's initial ideas, came up with an elegant solution on his own. He soldered two tiny magnets together, with their like poles facing one another, and embedded them inside a plastic cube about the size of a piece of carrot. Then he placed the plastic carrot into a batch of minestrone soup and ran it through the lab's continuous flow testing system, a long series of tubes mounted on the west wall of the lab.

Magnetic sensors on the outside of the tubes tracked the progress of the simulated carrot and its tiny magnets on their journey through the system. When the solder melted, the magnets jumped free of each other, causing a spike in the magnetic signal picked up by the sensors.

Because the alloy he used for the solder melts at a temperature just above the temperature required to kill *Clostridium botulinum*, Palazoglu was able to gauge the position of the carrot at the time it was effectively sterilized.

After his success with the simulated carrot, he and other researchers eventually did the same for every other ingredient in the soup, crafting small plastic peas, onions, beans, peppers, potatoes, celery and pasta for testing. Eventually, the data helped Simunovic define the minimum time required to safely process an entire batch of soup.

"We have hundreds of prototypes of these little simulated food particles now that we can create on a 3-D printer," Simunovic says. "We have very strict principles regarding how to fabricate them, and they're simulated very conservatively. They're better protected than a real carrot. So if we can deliver sterility to that particle, then we know that all the carrots in the process will be done properly."

## THE TASTE OF SUCCESS

At Wright Foods, where workers load bushels of apples onto a conveyor belt that never sleeps, you can taste success — literally. Drozd picks up a pouch of baby food and twists off the top. The fruit is all natural, high in vitamin C and retains more than 90 percent of its natural flavor. It's a big hit with consumers.

"There's an interesting dynamic in the marketplace," he says. "For the first time in history, people are acutely aware of nutrition and what they put in their bodies."



He describes a recent trip to the grocery store, where he watched a couple read every ingredient on every package before placing it in their cart. In an age of health-conscious consumers, packaged foods that deliver both flavor and nutritional value have a competitive advantage.

Those same attitudes will likely lead to the disappearance of metal cans from grocery shelves as consumers avoid them to reduce their exposure to bisphenol A, a synthetic compound that acts as an endocrine disruptor. The chemical is found in some plastic products and in the epoxy resin used to line the inside of many metal cans.

Moving hundreds of products from cans to cartons will be a challenge for the industry, but one that opens a window of opportunity for Wright Foods — if it can expand fast enough.

"So far we've been under the radar," Drozd says. "When we started the company we were a consulting firm more than anything else. In the past 18 months we changed the dynamic with our customers and have begun to do product development and product packaging. We don't market ourselves but we already have more inquiries than we can deal with."

Drozd, who has a master's in engineering from Cambridge, a Ph.D. in engineering from Duke and a master's in engineering economic systems from Stanford, is well aware of both the economic and technological impact his company could have on the industry. Aseptic packaging not only offers an alternative to the ubiquitous metal can, it can be used to extend the shelf life of fruits and vegetables, as well as many products that now require refrigeration.

*ABOVE: Wright Foods is moving from consulting to product development and product packaging. Employee Anita Shek is a 2012 graduate of NC State's food science program.*

*"I didn't really set out to build a business venture. In my mind, I set out to solve a puzzle."*

*— JOSIP SIMUNOVIC*

*continued on page 14*



**TOP:** Shelf-stable foods are packaged under completely aseptic conditions at Wright Foods, preserving their natural flavor and texture.

**BOTTOM:** Michael Drozd also has a Raleigh office for Aseptia, the parent company for Wright Foods.

**“We’re a game changer. We keep the technology moving forward. We’re always looking for ways to innovate.”**

— MICHAEL DROZD

“We can produce and package foods that other companies can’t,” he says. “That opens a lot of doors.”

## PEOPLE SKILLS

Doors also are opening on the research side, where Simunovic is negotiating a collaborative research agreement with the U.S. Army Soldier Systems Center in Natick, Mass. There, he hopes to test further refinements in aseptic technology, including a process for rapidly cooling food that has been sterilized before packaging. Once perfected, that

innovation — coupling rapid heating with rapid cooling — could virtually eliminate the differences in flavor and texture between fresh and processed foods.

“They’re in the best position to evaluate food quality,” Simunovic says of the Army center. “They have a world-class team of sensory scientists and trained tasters, and they have chambers for shelf-life testing and simulation climates. I took a tour. On one side of the street they had a tent with a Sahara climate, and on the other side of the street was another big tent with an arctic climate. It’s pretty amazing.”

For all his expertise, the researcher is constantly looking to collaborate, reaching out to colleagues across campus as well as industry professionals like Drozd.

He also values teams with a variety of cultural and international backgrounds.

“At one point we had collaborators from five different continents working on a project that resulted in another North Carolina food processing facility, the first of its kind in the world,” he says.

Over the past decade, collaborators have included researchers Pablo Marcelo Coronel from Ecuador, now working with Aseptia; Prabhat Kumar of India, now at Frito Lay; Cristina Sabliov of Romania, now at Louisiana State University and Yvette Pascua Cubides, an American completing her Ph.D. at NC State.

“Cross pollination in this industry is key,” he says. “Bringing in experts from different fields can change the game.”

The same holds true for students. Simunovic keeps an eye out for inventive undergraduates and graduate students he can recruit into his lab. Regardless of their background, be it biology or mechanical engineering, students can get an invitation if they impress the professor.

“I’m very selective and critical,” he says. “What I like to see is a spark. I like people who can orchestrate things and coordinate other people and activities.”

At NC State, where entrepreneurship and collaboration play a role in much of the curriculum, it’s not difficult to find students who fit the bill. Graduate student An Truong, who dropped plans for medical school to study food science with Simunovic, is excited about the opportunities to put his research into action.

“It’s such a multidisciplinary field,” he says. “Chemists, microbiologists and engineers all work together to solve problems. And it’s a very applied science. You see the direct connection between basic science and how it applies in the real world.”

Nowhere is that more evident than in Troy, where Drozd is interviewing job candidates to join his growing staff. When he breaks for lunch at a nearby sandwich shop, the manager tells him the new plant has done wonders for the town, lifting spirits in tough economic times.

“That comment felt better than any other accolade,” Drozd says. “We’re having a real impact on the community and on North Carolina. That’s because we’ve combined state-of-the-art technology with the state’s strengths in people and natural resources.”

It’s a model — and a message — he hopes will resonate far beyond the food processing industry and his small town on the edge of the forest.

“Stop focusing on ephemeral service-based industries,” he advises state leaders. “Manufacturing is what will make North Carolina great again. That’s sustainable growth.”



**LEFT:** Brian Boothe of Pentair Aquatic Eco-Systems finds Centennial Campus the perfect location to develop and test new products and systems.

## Opportunity Knocks

*Centennial Proximity Spurs Partnerships*

By Gene Pinder

**B**rian Boothe wouldn't mind if someone called him an opportunist. In fact, he relishes the moniker.

Engineering manager with Pentair Aquatic Eco-Systems, a division of Pentair Aquatic Systems, Boothe is based at a research lab on NC State's Centennial Campus. In the past eight years, the personable NC State alum has tapped into a treasure trove of collaborative research opportunities, venturing into directions he never anticipated.

Take aquaculture, for example.

"Somewhat out of the blue, one of our executives asked me to find out if there was any research being done in aquaculture at NC State," Boothe recalls. "We came to the Centennial Campus Partnership Office and within three hours found out that there are fish farms nearby. Since that time, we've developed a very significant relationship with the aquaculture researchers — and have even hired a couple of folks from the university to be part of our executive team."

That expansion is part of Pentair Aquatic Eco-Systems' recent growth in commercial aquaculture and aquaponics, aquatic life support systems, laboratory animal housing,

and lake and pond management. Revenues are moving to approximately \$60 million in 2013. "The target is publicly stated at \$100 million by 2015," Boothe adds.

The larger Pentair global operations include products and services focusing on water and fluid filtration, thermal management, and equipment protection.

In Boothe's partnerships with NC State, proximity is key. State-of-the-art laboratories and equipment are within a short walk. Equally close contact with researchers and students has proven to be enormously beneficial. In fact, Pentair first developed a relationship with NC State through a single student project and now takes advantage of varied opportunities.

Boothe had a question, so he asked a neighbor. "Brian came to us initially with an idea for mapping out pools, with the idea that we could use the mapping to run an autonomous robot to clean pools automatically versus a lot of the manual systems they have today," says Bart Green, retired director of the Troxler Design Center in the electrical and computer engineering department.

"We came to the Centennial Campus Partnership Office and within three hours found out that there are fish farms nearby. Since that time, we've developed a very significant relationship with the aquaculture researchers — and have even hired a couple of folks from the university to be part of our executive team."

— BRIAN BOOTHE

*continued on page 16*



**LEFT:** Tom Losordo, retired NC State professor now working for Pentair, shows NC State's Marine Aquaculture Research Center, or MARC, to Zacharia Yasudes from the company's office in Dubai.

"The students get a lot out of our relationships with our corporate and institutional partners. They, of course, get paid for their work and get some great experience, but they can also put their work on their resume and they make contact with people that hire."

— JOHN BASS

"From there, we started getting into power efficiencies. How can we make the pumps run at the right speeds, at the right times of day that are the most cost-efficient for the pool owner as well as less impact on the power grid?"

Pentair now has a wide network of university expertise, such as with Poole College of Management's Center for Innovative Management Studies, known as CIMS. "We wanted to make sure the relationship we had with the university went beyond just the technical," Boothe explains.

"As a result, we reached out to CIMS to expose our product management staff to the research and best practices behind innovation management. We wanted them to basically look at their product lines as their own entrepreneur endeavor. And by having the relationship with the College of Management, they have the tools that can help them expand on that."

The company also enjoys a strong a relationship with the College of Textiles and, in particular, the Nonwovens Cooperative Research Center, where it is a research partner. From using equipment to help with product validation in water filtration to attending conferences showcasing the latest advances in applied research, Pentair seeks a competitive advantage in the marketplace by being on the cutting edge of research.

"The benefit to us is that we don't have to have the validation equipment in-house," Boothe notes. "We don't have to have the expertise in-house that might run that type of equipment. We can just use the relationships we have and the equipment the university has on Centennial to help us further our efforts in product validation. It's really a win-win for us and the university."

## DIVING INTO INFORMATION TECHNOLOGY

Boothe easily taps into other resources located on Centennial, including a "hidden treasure" just across the street from the Pentair lab. Located on the first floor of the Venture III building, the Institute for Next Generation IT, known as ITng, provides cutting-edge research in information technology and consulting services to Centennial partners and other companies.

By working with ITng, Pentair realized it could explore new computer-assisted ways to monitor electricity use and optimize power consumption.

"Swimming pool pumps consume a lot of electricity," says John Bass, ITng director. "Brian came out with some hardware to monitor temperature, amount of chlorine and other factors. Then, the company came out with a unit that collects this data and then sends it back to the Internet." Thus, a swimming pool operator can tell exactly how much electricity is consumed.

"The problem was — how do you scale that effort to tens of thousands of customers? Working with Brian, we came out with a way to collect all that data, pull it periodically and then create time-series data sets for each measure," Bass adds.

The partnership that Pentair developed with the ITng researchers not only gave the company tangible results that can benefit its operations, but it also provided ITng students with real-world experience. Undergraduate and graduate students spend a semester at the institute.



**MIDDLE:** Boothe and Genevieve Garland discuss the filters that have been improved through Pentair's work with NC State's Nonwovens Institute.

**RIGHT & INSET:** Pentair tests products on Centennial Campus and at MARC in Carteret County.

"The students get a lot out of our relationships with our corporate and institutional partners," Bass notes. "They, of course, get paid for their work and get some great experience, but they can also put their work on their resume and they make contact with people that hire."

Many echo those sentiments. Green's students enjoy working with mentors on challenging projects. "The whole process of dealing with things outside their discipline is often very motivating to them and gives them a fresh perspective," he says.

Boothe estimates that Pentair has interacted with about 50 electrical and computer engineering students since the company started collaborating with the College of Engineering in 2008. Some of the relationships continue beyond the senior year design projects.

Scott Hilbert, an electrical and computer engineering major who graduated in 2009, began working with Pentair when his senior project team was asked to help design a wireless water-flow regulator for pool cleaning systems.

"The work gave us a lot of experience building an actual device, as opposed to developing components in the lab," Hilbert explains. "I also got experience collaborating with others on a project, which was really helpful. I was very lucky."

He has continued working with Pentair on projects as founder of Scott Hilbert Software.

"We look at the relationship we have with the students, and with these projects, as an opportunity to essentially give them professional exposure that will allow them to have a more comprehensive resume when they leave the university," Boothe says. "We benefit by having the opportunity to identify talent for the future by being exposed to very bright students."

Companies also benefit from building and maintaining a relationship with the university. Green notes that when working with the College of Engineering, corporate partners start to understand younger engineers better, where their mindsets are, and what they can bring to the table when hired.

In this period of tight competition for engineering talent, those insights can often give a company an edge. Whether it's tapping into smart fiber research in the College of Textiles or finding new ways to manage and control the explosion of data residing in cloud computing, Pentair, through Brian Boothe's efforts, maximized its presence on Centennial Campus in ways neither he nor the company originally imagined.

Not a bad track record for an opportunist.



**"We benefit by having the opportunity to identify talent for the future by being exposed to very bright students."**

— BRIAN BOOTHE

**ONLINE EXTRA:** Pentair Partnerships Video: <http://research.ncsu.edu/videos/pentair/>

## CHANCELLOR'S INNOVATION FUND

NC State research improving lives

# Sharing Solutions

# NC

State continues its commitment to moving research results to the

marketplace with six projects funded by the 2013 Chancellor's Innovation Fund,

or CIF. "The range of topics reflects the diversity of real world issues that our

research teams tackle," says Kelly Sexton, Office of Technology Transfer director.



• **TOP:** Sensors in a wireless headband can monitor bloodflow and oxygen levels.

• **BOTTOM LEFT:** Matthew Breen's research may help identify likely treatment outcomes for canine cancer.

• **BOTTOM RIGHT:** New treatments for canine allergies could provide relief without side effects of steroids.

## MONITORING YOUR SLEEP

Getting a good night's sleep is important. NC State engineer **Alper Bozkurt** has developed new technology to help researchers detect and understand sleep disorders by monitoring blood flow in the brain.

The SleepiBand, developed in Bozkurt's iBionicS lab, is a wireless headband that contains sensors to monitor bloodflow and the oxygen level in the blood using near-infrared light. The headband units also include a power supply and radio to send the monitoring data to a

laptop or a smartphone. Bozkurt is collaborating with researchers in Duke Medical Center's Sleep Disorders Laboratory and will be using his CIF award to initiate clinical testing of the SleepiBand.

## PREDICTING CANINE CANCER OUTCOMES

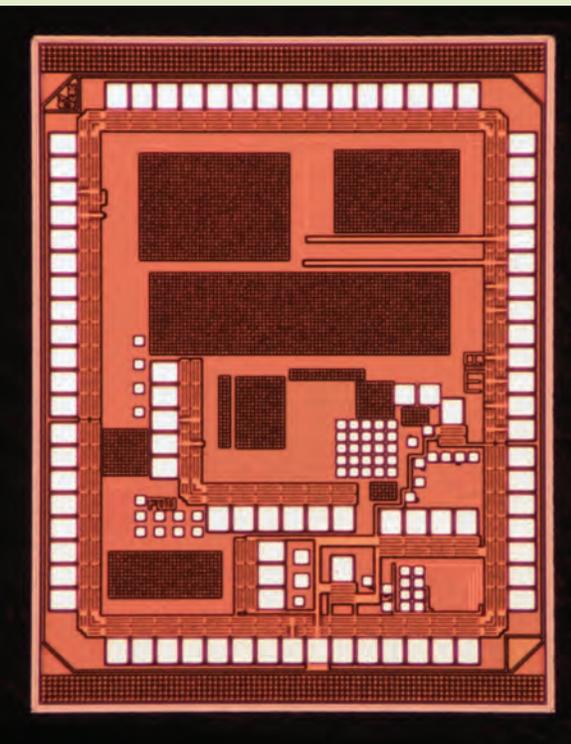
Canine lymphoma is one of the most common cancers in dogs — with an estimated 300,000 cases reported each year. Without treatment, this cancer is usually fatal within three months of diagnosis. Chemotherapy is usually effective, with most dogs entering remission and around 50 percent living

for at least nine months. However, the high cost of treatment and the lack of a reliable prognostic test for individual cases means that most dogs don't get treated. Genomics professor **Matthew Breen** has developed a genetic test that is faster and more cost-effective than those currently in use. The test can predict how long a dog with lymphoma will respond to chemotherapy, allowing dog owners to make informed decisions about what is best for their pets.

"CIF funding will allow us to validate the new test on a series of patient samples and prepare it to be offered broadly to veterinarians," Breen says.



• **TOP:** Surgery is a goal of many students seeking graduate school in health professions. • **BOTTOM LEFT:** A new chip design would allow RFID readers to be farther than 10 meters from the chip. • **BOTTOM RIGHT:** NC State researchers are harnessing the potential of plasma technology. Plasma is the fourth state of matter.



## TREATING CANINE ALLERGIES

Humans aren't the only ones who suffer from allergies to dust mites and pollens. Dogs get them too. The most common treatment for canine allergies — corticosteroids — can have side effects such as increased thirst, appetite, weight gain and predisposition to infections. But immunologist **Bruce Hammerberg** and dermatologist **Thierry Olivry** are working on a new therapy for canine allergy sufferers that will give relief without steroids' side effects.

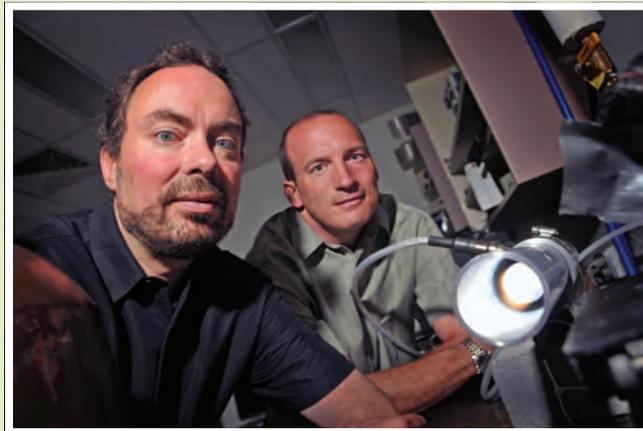
The therapy is based on mouse antibodies that bind to and neutralize

the antibodies that activate allergic cells. A similar therapy for human allergic asthma has been on the market for years. The researchers will use their CIF funding to create a canine

## IMPROVING RFID SYSTEMS

version of this antibody that they anticipate will give dogs long-term allergy relief, without the side effects. Radio-frequency identification (RFID) systems use centralized readers to collect data from small tags, which can be attached to a wide variety of electronic sensors. But the use of RFID tags has been limited by the fact that they need to be within 5 to 10 meters of a reader to work. Until now.

A research team led by engineering professor **Paul Franzon** — and including NC State students Peter



Gadfort, Josh Ledford and Shep Pitts — has developed circuit technology that will allow the creation of RFID tags that can operate at greater distances from RFID readers. And, because the technology requires less silicon, they will be less expensive to produce than existing RFID tags. "We'll be using the funding to validate the performance of our circuit technology and to develop technical plans for incorporating the technology into RFID tags," Franzon says.

## HARNESSING PLASMA POTENTIAL

Engineers are trying to harness "lightning in a bottle" — also known as plasma technology — to treat water without using chemicals. Potential uses range from removing contaminants in drinking water to fertilizing crops in the developing world with plasma-treated water.

Plasma, the fourth state of matter, is created when a gas is energized and

its electrons break free. The sun contains hot plasma. Engineering professors **Steven Shannon** and **Detlef Knappe** are working to bring non-thermal plasma technology to the market. Look in their lab right now and you'll see a golf-ball sized orb of glowing air. They're hoping plasma technology has the potential to go the distance, as they improve energy efficiency

through innovation in reactor design enabled by CIF.

## TRACKING GRAD SCHOOL INFO

Keeping track of all the information required to apply to graduate school — the test scores and academic records, CVs, recommendations and especially the deadlines — can drive any applicant around the bend. But **Anita Flick** has a web-based solution that not only helps students track their applications and acceptances but also helps advisors check student progress toward academic goals.

Director of NC State's health professions advising center, Flick calls her solution, FolioFiler, the "helicopter parent without the parent." FolioFiler is flexible enough to be used for applications to any type of professional school or even for job applications.

Past CIF project updates on Page 20

# CHANGE

## Progress Toward Products

**F**rom a smart exoskeleton to safer data transfer, promising technology is moving toward market, thanks to the first two years of the NC State Chancellor's Innovation Fund. Startups are moving forward, as are commercial licenses with existing companies. The initial 11 CIF projects have leveraged \$2.8 million in new funding. NC State's Office of Technology Transfer, known as OTT, offers a quick update:



- **Elizabeth Lobo**'s discoveries not only may improve wound care but also may advance tissue engineering and regenerative medicine. Her hollow, porous nanofibers can be filled with varied compounds. A "smart-release system" sends out the compounds continuously, in a single burst or a through combination of timings. Other potential markets include air filtration, lab diagnostics and blood filtration. Two companies are working with NC State to develop commercial uses for Lobo's technology. The N.C. Biotechnology Center is interested in the product development.
- Victims of stroke, spinal cord injuries, and other traumatic brain injuries often struggle with muscle strength/control. To help them, **Greg Sawicki**'s team created a smart exoskeleton walking aid. Unlike heavy units encompassing the entire body, Sawicki's lightweight boot aids those with trouble walking, or even enhances the performance of soldiers or athletes. With CIF funding, Sawicki improved the device, adding a battery-powered clutch and posture-correcting ankle orthotic for stroke patients. NC State is talking with a company interested in developing new products incorporating the technology. Sawicki expects additional funding from the National Institutes of Health.
- Annually, about 40,000 cases of acute salmonella infections are reported in the United States — and 400 people die. The Centers for Disease Control notes the numbers do not include milder cases that go unreported. **Hosni Hassan** and **Matt Koci** offer a promising technology that could be the foundation for a poultry vaccination to greatly reduce salmonella transmission. They also are working toward a vaccine for humans to prevent the disease. The researchers, who collaborated with NC State's Hi-TEC program to develop a business plan, received a \$2.5 million grant from the U.S. Department of Agriculture.
- TIMA/HyperSentry — a system of hardware and firmware components developed by **Peng Ning** and **Ahmed Azab** — greatly improves security of computer clouds and mobile systems. Customers can verify the integrity of software systems that manage cloud and mobile hardware platforms. CellSentry was launched to commercialize the TIMA/HyperSentry technology. The team is working with a major player in the mobile phone market to improve the security of mobile devices.
- As smart phones and tablets become more popular, the performance of transmission control protocol, or TCP, over cellular networks is critical. **Injhong Rhee** and **Kyunghan Lee** have developed a new, dynamic mobile TCP standard to replace the current static standard. By reducing network congestion up to 50 percent, it provides rapid uploads and downloads that consumers demand. The mobile TCP standard has been quantified, with two carriers testing the new method.



• **TOP:** *Hosni Hassan and Matt Koci not only work on salmonella research in their lab, they also draw upon business expertise in the Hi-TECH program.* • **BOTTOM LEFT:** *Elizabeth Lobo's research may advance tissue engineering and tissue regeneration.*

- Demand continues to grow for low-cost textiles with extended UV protection — part of the \$2 billion market for outdoor fabrics.

Just ask **Greg Parsons**, whose laboratory deposits UV-absorbent finishes to materials without adding noticeable stiffness or weight. The coatings may be applied to raw textiles or to finished products, allowing them to retain texture and color.

- **Adam Meade**'s rapid response personality test ensures employers obtain accurate personality data by not allowing applicants time to manipulate the system by entering what they predict the employer wants, or by being dishonest. Meade is creating a web version of his software named PerSight™. This would allow him to correlate results of his testing and performance of newly hired employees. Scientific Organizational Solutions is a startup formed to commercialize the technology.
- **Michael Dickey**'s research group has a new invention that manipulates the shape of liquid metals using electrical stimuli. The ability to define the shape of materials is what usually gives materials function. The team provides a unique way to create shape-reconfigurable structures with interesting electrical, optical, and thermal properties. The team has an agreement with an industry partner to further develop the technology.
- **Afsaneh Rabiei** expects her composite metal foam to be applied across many platforms in aerospace, military, naval, automotive, and biomedical industries. The novel material is simultaneously lighter and stronger than those now used in body and vehicle armors. It also absorbs impact energy from projectiles or blasts, thus decreasing risk of injury or vehicular damage from high-velocity bullets or explosions. In testing under federal ballistics standards, sheets based on the metal foam earned high marks.
- Noroviruses annually cause about 5.5 million cases of gastroenteritis, according to the CDC. **Lee Ann Jaykus** is developing new methods to test for noroviruses in water, food, and individual patients — with a goal of more efficient disease identification, treatment, and prevention. Noroviruses spread quickly through families and even cruise ships, accounting for more than half of all cases of food-borne illnesses.
- **Coby Schal**'s laboratory designed an 'artificial human' liquid bait system to attract and kill bed bugs. The bait system is designed to mimic certain human aspects that attract bed bugs. A prototype allows multiple bed bugs to feed on the bait.

*Learn more about the NC State Chancellor's Innovation Fund. Go online to [research.ncsu.edu/ott](http://research.ncsu.edu/ott) and select For Entrepreneurs.*

# KUDOS

## KUDOS

### PLATINIX QUICKLY EARNING HONORS

PlatiNix — a new NC State startup that provides a replacement for platinum in the synthesis of hydrogen gas — is one of three members of the Cherokee-McDonough Challenge Class of 2013.

PlatiNix has a license with the university for worldwide exclusive rights to a novel material created in the laboratory of Linyou Cao in the Department of Materials Science and Engineering. Expensive and in short supply, platinum is currently the most widely used catalyst for this process.

With assistance from the Office of Technology Transfer's Venture Development arm, PlatiNix competed in the U.S. Department of Energy's ACC Clean Energy Challenge, hosted by NC State in coordination with Duke, UNC Chapel Hill and Wake Forest in April. PlatiNix quickly went on to apply to both the Cleantech Open and the Cherokee-McDonough Challenge.

Brian Iezzi, co-inventor of the core technology and an NC State sophomore, explained the technology at the Research Triangle Cleantech Cluster's May meeting. There, Iezzi met potential partners and investors.

"Brian presented his technology to our regular gathering of industry leaders who were uniformly impressed not only with the technology but also the maturity and passion Brian exhibited for what he and the team were doing," notes Ed White, chairman of the cluster's board of directors and past president of the NC State Engineering Foundation Board of Directors.

"We want to see more students like Brian take risks with their ideas, both because of the innovations they will introduce to the marketplace and because we think that many of tomorrow's solutions will originate from the Research Triangle Region."

PlatiNix was recognized at the regional level in the 2013 Cleantech Open national accelerator program. PlatiNix was chosen from an elite group of cleantech entrepreneurs that applied from across the Southeast United States.

In July, PlatiNix was selected a winner of the 2013 Cherokee-McDonough Challenge that recognizes high-impact environmental startups. The company, which will be featured in a September showcase, also receives \$20,000 in seed funding, free office space for three months, complimentary back office support from Cherokee Investment Services (including help with incorporation, accounting and IRS compliance), hands-on mentoring from an advisory committee of experienced entrepreneurs and investors, and an opportunity to present to other investors and the public.

The challenge's announcement cites the PlatiNix catalyst, which can be produced at a fraction of the cost of platinum, as setting the stage for hydrogen to become a cost-effective fuel source, and notes "a hydrogen-based energy economy means affordable, abundant clean energy."

NC State continues to work



• ABOVE: Carl Koch has been elected to the National Academy of Engineering for his groundbreaking research. He has also received university honors for teaching and mentoring.

closely with PlatiNix toward commercializing the licensed technology. This includes an introduction to the Blackstone Entrepreneurs Network's leader, Bob Creeden. "The Blackstone Entrepreneurs Network is a key partner in OTT's effort to ensure that our startups are connected to seasoned and successful entrepreneurs in order to maximize their chances of success," explains Kelly Sexton, OTT director.

### KOCH ELECTED TO NATIONAL ACADEMY OF ENGINEERING

When Carl Koch heard he'd received a box from Washington, D.C., he expected a set of documents to review for a federal agency. He found something else altogether: a letter announcing his election to the National Academy of Engineering.

"It's the most prestigious honor that any engineer or any person in engineering could receive," says Koch, Kobe Steel distinguished professor of materials science and engineering at NC State. "It's very humbling."

With 50 years in engineering, he is known for research on amorphous and nanostructured materials. In

1983, he was the first 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.

Recent research has turned to creating nanocrystalline materials that have special mechanical and magnetic properties. In 2008, his team produced an iron composed of tiny crystals that is far stronger than traditional iron. The new substance has a wide variety of potential applications, such as engine components exposed to high stress and temperatures.

"Dr. Koch's numerous honors during his impressive career are a testament to his dedication to education and the field of engineering," Chancellor Randy Woodson notes.

Koch is a fellow of numerous professional societies, including the Minerals, Metals and Materials Society. At NC State he has earned the Alexander Quarles Holladay Medal for Excellence; the NC State Alumni Association Outstanding Research Award; and the R.J. Reynolds Award for Excellence in Teaching, Research and Extension.

*continued on page 22*

# KUDOS KUDOS



## NC STATE: STEM LEADER

A national ranking confirms that NC State is a leader in educating students in the STEM disciplines — science, technology, engineering and math.

The recent *U.S. News & World Report* list, establishes NC State as the No. 1 land-grant and No. 7 overall among public, national colleges and universities granting the largest percentage of bachelor's degrees in STEM fields. The U.S. Department of Commerce estimates that STEM occupations will grow 1.7 times faster than non-STEM occupations in the coming decade.

To make the list, institutions had to rank in the top half of national colleges and universities and grant at least a third of their undergraduate degrees in the STEM disciplines during the 2011-12 academic year. Only 39 universities made this new list of leading STEM institutions.

The list ranks NC State 17th overall and seventh among public universities. In 2011-12, NC State awarded nearly 2,600 bachelor's degrees in STEM fields, almost half the university's total.

With strengths across a wide range of disciplines, including the humanities, social sciences and design, NC State offers a robust student experience. As a result, NC State graduates overall are among the most sought after by corporate recruiters, according to the *Wall Street Journal*.

## LIBRARY JOURNAL CITES YORK

Maurice York, director of information technology at NCSU Libraries, is one of the field's "movers and shakers." *Library Journal*

recognized York for visionary work on the new James B. Hunt Jr. Library and on the Tech Sandbox at the D.H. Hill Library

The journal cited York's work with the Hunt Library's BookBot, which earned wide media attention, along with the new facility's computing, imaging and "digital media backbone" technology.

York and his 22-member team also earned recognition for the Technology Sandbox, 1,700 square feet designated for testing experimental and leading-edge technology with gaming and engineering students. The collaboration allowed the team to determine how the library could support the students' learning and innovation.

York joined NC State in 2007 and was included in the Spring 2013 Results cover story on the Hunt Library.

## HUNTINGTON HONORED

The American Society of Animal Science recently honored NC State researcher Gerald Huntington with its Fellow Award for his contributions to the industry. Huntington is professor emeritus in the Department of Animal Science.

Since joining the faculty in 1997, Huntington has been known for his work with cattle. His research, conducted in collaboration with



• **TOP:** NC State has earned high marks as a leader in STEM education for science, technology, engineering and math. • **BOTTOM:** At NC State, STEM students have opportunities to join researchers working on critical topics. • **OPPOSITE PAGE:** Marvin Malecha, dean of the College of Design, coordinated design of the chancellor's residence, including the kitchen that earned Room of the Year national honors.

professor Matt Poore and USDA agronomist Joe Burns, has led to improvements in animal productivity through better nutrition.

Huntington previously was a research scientist at the USDA and an independent consultant. The American Society of Animal Science is a professional organization that serves more than 5,000 animal scientists and producers around the world.

## ROOM OF THE YEAR

The NC State chancellor's residence must serve many functions, from official events to family meals. Its kitchen earned the 2012 Room of the Year honors in American Living Awards program of the National Association of Home Builders.

"The house has, at its roots, a North Carolina vernacular," says architect Marvin Malecha, who led design efforts.

Dean of NC State's College of Design, Malecha says the award honors the collaborative vision that guided the design. He shepherded the project to completion during daily visits to the construction site, often interacting with N.C. craftsmen.

Reflecting the university's commitment to sustainability, the entire house incorporates the latest energy-efficient technologies. "Good architecture always begins with those principles," Malecha says.

## NATIONAL PANEL TAPS GOULD, KELLEY

Fred Gould and Stephen Kelley are now serving on the Board on Agriculture and Natural Resources, a major program unit of the National Research Council. The board is responsible for organizing and overseeing studies on agriculture, forestry, fisheries, wildlife, and the use of land, water and other natural resources.



William Neal Reynolds professor of entomology, Gould received the state's 2012 O. Max Gardner Award. A member of the National Academy of Sciences, he directs a National Science Foundation-funded graduate training program in genetic engineering and society.

Kelley leads the forest biomaterials department in the College of Natural Resources. Previously, he worked on biomass conversion technologies in the U.S. Department of Energy's National Renewable Energy Laboratory.

Gould and Kelley join the board as Julia Kornegay, NC State professor of Horticultural Science, leaves it.

## KUZNETSOV RECEIVES HUMBOLDT AWARD

Andrey V. Kuznetsov recently earned the international Humboldt Award for multidisciplinary research that may identify critical factors in Alzheimer's and Parkinson's diseases. Given by the Alexander Von Humboldt Foundation in Germany, the honor recognizes researchers whose discoveries, insights, or theories have made significant impacts on their scientific disciplines.

Kuznetsov, a professor of mechanical and aerospace engineering, leads teams in which molecular biology meets mathematics and physics of microscale dimensions. The results advance the understanding of what goes wrong in the

intracellular transport machinery in neurodegenerative diseases. He also developed models of transport of prions, or infectious agents that cause mad cow disease.

He expanded research on transport in various thermofluid and biological systems at the Institute of Thermofluid Dynamics in the Hamburg University of Technology, collaborating with Heinz Herwig.

## SCIENCE TEACHERS SELECT PENICK

The National Science Teachers Association recently presented its Robert H. Carleton Award, to John E. Penick for his national leadership in science education. Retired from the College of Education in 2009, he continues emeritus status at NC State.

His career started as a biology and chemistry teacher at an inner-city high school in Miami. At NC State, he headed the Department of Science, Technology, Engineering and Mathematics Education.

He has also worked in 35 countries on a wide range of projects, including teaching university faculty in Indonesia, evaluating teacher workshops in Portugal, designing a science education center in Venezuela and translating science curriculum from Portuguese to English. He also has been a leader in the International Council of Associations for Science Education.

## CITY LAUDS CAMPUS SUSTAINABILITY

NC State received Raleigh's 2013 Environmental Stewardship Award, presented annually for leadership in sustainable development.

"This award is a great honor for NC State and the many people on campus working to make the university leaner, smarter and stronger through sustainable projects and programs," notes Tracy Dixon, university sustainability director.

NC State captured numerous awards at the city's Earth Day ceremony, including:

- James B. Hunt Jr. Library, Green Design (Nonresidential) Award
- University Dining, Pioneering Efforts Award
- Artists' Backyard, Natural Resource Conservation Award
- Sullivan Shops, Natural Resource Conservation Award
- Students Wei Wang and Robert Smith, Donna Jackson Trailblazer Award for environmental public service announcement

*The Princeton Review* also included NC State in its 2013 Guide to 322 Green Colleges. This is the second year NC State has been selected as one of the nation's most environmentally responsible schools. Go online to learn more about NC State's efforts: <http://sustainability.ncsu.edu/>



## BROWN-GRAHAM EARNS WHITE HOUSE HONORS

Anita Brown-Graham, director of NC State's Institute for Emerging Issues State is among the "Champions of Change" honored in July by the White House. She was cited for efforts to increase civic participation in North Carolina.

Brown-Graham has led development of the Emerging Issues Commons. Its combination of a physical location at the new Hunt Library and a virtual online portal transforms the way citizens can access information and connect with each other.

"I am extremely proud of the way the Emerging Issues Commons is already engaging North Carolina's citizens," notes Brown-Graham, who also is a William C. Friday Fellow, American Marshall Fellow and Eisenhower Fellow.

The overall institute works to improve North Carolina's competitiveness and addresses issues such as job creation, the environment and health care. The annual Emerging Issues Forum attracts businesses and civic leaders from around the state and nation.

# QUICK TAKES

## 3-D PRINTER MAKES LIQUID METAL WIRES

**F**lexible LED displays are now in your future thanks to technology developed at NC State. A team of researchers demonstrated a remarkable process for creating liquid metal wires on a 3-D printer in July. These wires could be used to create any number of stretchable electronics, including ultra-flexible monitors.

How do you create a wire out of liquid metal? Easy, says Michael Dickey, a chemical and biomolecular engineer. "We've found that a liquid metal alloy of gallium and indium reacts to the oxygen in the air at room temperature to form a 'skin' that allows the liquid metal structures to retain their shapes."

Collin Ladd, a 2013 graduate, was key to this project, Dickey adds. "He helped develop the concept, and literally created some of this technology out of spare parts he found himself."

Electrical and computer engineering professor John Muth and Ph.D. student Ju-Hee So also worked on the process, published online in *Advanced Materials*.

## HELPING STUDENTS GAIN ENVIRONMENTAL LITERACY

**E**nvironmental education programs that take middle-schoolers outdoors help minority students close a gap in environmental literacy, according to research from NC State.

Published in *PLOS ONE* the study showed that time outdoors seemed to affect African-American and Hispanic students more than Caucasian students, improving minority students' ecological knowledge and cognitive

skills. Researchers tested the environmental literacy of sixth- and eighth-grade students in 18 N.C. schools. Half of the schools studied had registered an environmental education program with the state.

Using a published environmental curriculum, such as Project Learning Tree, Project WET or Project WILD, helped build students' cognitive skills, researchers found. Learning in an outdoor environment improved students' ecological knowledge, environmental attitudes and behavior.

"This is one of the first studies on a broad scale to focus on environmental literacy, which is more than mastering facts," says co-author Nils Peterson of NC State's College of Natural Resources.

Sixth graders showed greater gains in environmental literacy than eighth graders, suggesting that early middle school is the best window for environmental literacy efforts, notes graduate student Kathryn Stevenson. North Carolina Sea Grant funded the study.

## GAME TECH TO STEER ROACHES

**R**oaches could soon be saving lives. NC State researchers are using video game technology to remotely control cockroaches. Ultimately, the technology could allow the insects to explore collapsed buildings.

Incorporating Microsoft's motion-sensing Kinect system into an electronic interface developed at NC State, the team tracks how large roaches respond to the remote

control. The insects might even be fitted with mikes and sensors to detect survivors trapped in debris. "We want to build on this program, incorporating mapping and radio frequency techniques that will allow us to use a small group of cockroaches to explore and map disaster sites," says Alper Bozkurt, an electrical and computer engineer with funding from the National Science Foundation.

The interface controlling the roach is wired to the antennae and and cerci, or rear spine. The wires attached to the cerci spur the roach into motion and those attached to the antennae send small charges that trick the roach into thinking that it is approaching

a barrier steering them in another direction.

## MULTITUDE OF MATES BENEFIT HONEY BEES

**W**hen it comes to honey bees, having more mates is better. A new study from NC State, the University of Maryland and the U.S. Department of Agriculture shows that genetic diversity is key to honey bee survival.

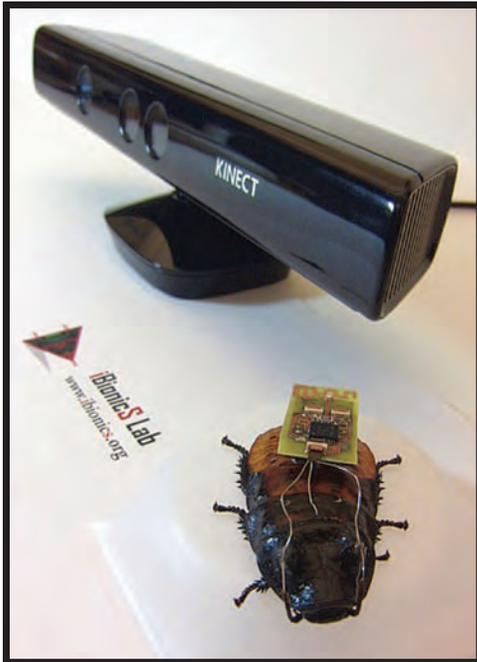
Researchers found that colonies where the queen had mated at least seven times were 2.86 times more likely to survive the 10-month working season. Specifically, 48 percent of colonies with queens who had mated at least seven



# Quick Takes



**CLOCKWISE FROM TOP LEFT:** • Liquid metal technology from NC State could make future LED displays flexible. • Students learn more when their science lessons take them outside, NC State researchers say. • Technology from the Kinect gaming system could help steer cockroaches through damaged buildings. • Honey bee colonies have better survival rates if the queen bee takes a multitude of mates.



## OLDER IS WISER

There's a perception in some tech circles that older programmers can't keep pace with rapidly changing technology. Actually, the opposite is true. NC State researchers report that knowledge and skills of programmers actually improve over time.

"We found that, in some cases, veteran programmers even have a slight edge," says computer scientist Emerson Murphy-Hill. His team compiled data on more than 80,000 programmers via a social networking site. The researchers compared users' ages with reputation scores, then tracked topics users discussed. The team also examined how knowledgeable older users were about new technologies.

The findings are good news for seasoned programmers. Older users scored higher in reputation, were familiar with a wider range of subjects and were more up-to-date than younger users. Ph.D. student Patrick Morrison presented a paper on the findings.

## SMART SYSTEM FOR INSULIN DELIVERY

A new drug delivery technique developed at NC State and UNC-Chapel Hill could improve diabetes management and ultimately aid in the treatment of cancer. The innovative process involves a sponge-like material that is injected into a patient's bloodstream. The material, a matrix containing nanocapsules made from a porous polymer, releases insulin when it senses a rise in blood sugar.

Researcher Zhen Gu, of the joint biomedical engineering program, says the smart drug delivery system mimics the function of healthy cells that produce insulin. In lab tests using mice, researchers found the sponge matrix was effective at managing blood sugar for up to 48 hours.

The research team includes colleagues at the Koch Institute for Integrative Cancer Research at MIT and the Department of Anesthesiology at Boston Children's Hospital. Published online in *ACS Nano*, the research was supported by the Leona M. and Harry B. Helmsley Charitable Trust Foundation, and the Tayebati Family Foundation.

## MENTAL HEALTH TREATMENT PAYS OFF

Investing in outpatient mental health treatment is a bargain for society, NC State researchers report. Conducted in collaboration with RTI International and the University of South Florida, the research shows that outpatient treatment significantly reduces arrest rates for people with mental health problems and saves taxpayers money.

"This study shows that providing mental health care is not only in the best interest of people with mental illness, but in the best interests of society," says Sarah Desmarais, a psychology faculty member at NC State.

Researchers identified 4,056 people who had been hospitalized for mental illness in 2004 or 2005 and then tracked them from 2005 to 2012. They determined which individuals were receiving government-subsidized medication and which were receiving government-subsidized outpatient services, such as therapy. The researchers also determined who was arrested during the seven-year period.

The team then compared criminal justice costs with mental health

treatment costs. Individuals who were arrested received less treatment, and each cost the government approximately \$95,000 during the study period. Individuals who were not arrested received more treatment, and cost the government approximately \$68,000. "It costs about \$10 less per day to provide treatment and prevent crime. That's a good investment," Desmarais says.

The findings were published in the journal *Psychiatric Services*. Lead author is Richard Van Dorn of RTI. The Florida Agency for Health Care Administration supported the research.

## PARTNERSHIP PROMOTES WIRELESS TECHNOLOGY

NC State's Office of Technology Transfer and the Wireless Research Center of North Carolina are collaborating to commercialize wireless technology research at the university. The partnership focuses on fields such as computing, medical, defense, materials and energy technologies.

"We believe this partnership drives commercial value for our research in a manner not previously explored, at a time when wireless technology is at the center of many existing and new fields," says Dinesh Divakaran, licensing associate at NC State.

WRCNC has industry experts as well as sophisticated test chambers and equipment that will accelerate development and commercialization of many NC State projects. The center began as an economic development initiative by the Town of Wake Forest and the GoldenLEAF Foundation. WRCNC also conducts product and regulatory studies, research, regulation mapping and planning, and intellectual property expansion.

*continued*

times were still alive at season's end. Only 17 percent of the less genetically diverse colonies survived.

"Forty-eight percent survival is still an alarmingly low survival rate, but it's far better than 17 percent," says entomologist David Tarpy. Now beekeepers can consider breeding strategies to help colonies survive, he adds.

The research was published online in the journal *Naturwissenschaften*. The work was supported by the USDA Cooperative State Research, Education and Extension Service, the USDA Agricultural Research Service, the N.C. Department of Agriculture and Consumer Services and the National Honey Board.



*Cannibalistic tadpoles provide important data.*

## CANNIBALISTIC TADPOLES OFFER EVOLUTION INSIGHT

**A** carnivorous, cannibalistic tadpole may play a role in understanding the evolution and development of digestive organs and lead to better

diagnosis and prevention of intestinal birth defects, according to new research at NC State.

Developmental biologist Nanette Nascone-Yoder, graduate student Stephanie Bloom and postdoc Cris Ledon-Rettig looked at two frog species that differ in diet and last shared a common ancestor about 110 million years ago. One is an aggressive species of frog that is carnivorous — and cannibalistic — in the tadpole stage.

The team exposed frog embryos to molecules that changed their gut development, prompting the carnivore frogs' systems to function more like their non-carnivore cousins and vice-versa.

"Understanding how and why the gut develops different shapes to adapt to different diets and environments during evolution gives us insight into what types of processes can be altered in the context of human birth defects, another scenario in which the gut also changes its shape and function," Nascone-Yoder says.

The findings appear in *Evolution and Development*. James Hanken, Carlos Infante and Anne Everly from the Harvard Museum of Comparative Zoology contributed to the work. The research was funded in part by the National Science Foundation.

## BETTER UNDERSTANDING OF FACEBOOK BEHAVIOR

**E**mployers are increasingly using Facebook to screen job applicants and weed out candidates they think have undesirable traits. But a new study from NC State shows that those companies may have a fundamental misunderstanding of online behavior and, as a result, may be eliminating desirable job candidates.

Researchers tested 175 study participants to measure the personality traits that companies look for in job candidates, including conscientiousness, agreeableness and extroversion. The

participants were then surveyed on their Facebook behavior, allowing researchers to see which Facebook behaviors were linked to specific personality traits.

The results likely surprise many corporate human resource professionals. "Companies often scan a job applicant's Facebook profile to see whether there is evidence of drug or alcohol use, believing that such behavior means the applicant is not conscientious or responsible and self-disciplined," says psychology professor Lori Foster Thompson.

But there's no significant correlation between conscientiousness and an individual's willingness to post content

on Facebook about alcohol or drug use, she says. Companies that are looking for extroverts — such as those hiring in sales or marketing — may be doing themselves a great disservice. The findings were published online in *Cyberpsychology, Behavior and Social Networking*. Co-authors were faculty member Adam Meade and doctoral student Will Stoughton.

## LIFE IS POSSIBLE; BARELY

**L**ife as we know it is based upon the elements of carbon and oxygen. Now a team of physicists, including one from NC State, is looking at the conditions necessary to the formation of those two elements in the universe. They've found that when it comes to supporting life, the universe leaves very little margin for error.

Carbon and oxygen are produced when helium burns inside of giant red stars. The key to carbon formation is an excited state of carbon-12 known as the Hoyle state. Oxygen is produced by the combination of another alpha particle and carbon.

NC State physicist Dean Lee and German colleagues had previously confirmed the existence and structure of the Hoyle state with a numerical lattice that allowed the researchers to simulate how protons and neutrons interact. These protons and neutrons are made up of elementary particles called quarks. The light quark mass is one of the fundamental parameters of nature, and this mass affects particles' energies.

In new lattice calculations done at the Juelich Supercomputer Centre, the physicists found that just a slight variation in the light quark mass will change the energy of the Hoyle state, and this in turn would affect the production of carbon and oxygen in such a way that life as we know it wouldn't exist.

Published in *Physical Review Letters*, the work was supported by the U.S. Department of Energy, the European Union HadronPhysics3 Project, the European Research Council and several German funding agencies.

## LOOK AND LEARN

**B**y tracking facial expressions, researchers at NC State assess the emotions of students engaged in interactive online learning — and predict the effectiveness of online tutoring sessions.

The research is part of larger efforts to develop artificial intelligence software, says computer scientist Kristy Boyer. "The program, JavaTutor, will not only respond to what a student knows, but to each student's feelings of frustration or engagement. This is important because research shows that student emotion plays an important role in the learning process."

Researchers used the automated Computer Expression Recognition Toolbox, or CERT, to evaluate the facial expressions of 65 college students engaged in one-on-one online tutoring sessions. CERT was able to identify facial movements associated with learning-centered emotions, such as frustration or concentration. The automated program's findings were consistent with expert human assessments more than 85 percent of the time. The researchers used observational data from CERT along with student self-assessments and test results to develop models that could predict how effective a tutorial session was, based on facial expressions.

The team includes Ph.D. student Joseph Grafsgaard; undergraduate student Joseph Wiggins; Eric Wiebe, professor of science, technology, engineering and math education; and James Lester, professor of computer science. The National Science Foundation supported the research.

# ANNUAL REPORT

## FY13 KEY ACCOMPLISHMENTS in Research, Innovation and Economic Development

### NC STATE RESEARCHERS HONORED

**Dr.** Carl C. Koch was recently elected to the National Academy of Engineering. *(Read more on page 21.)* He joins 11 other faculty members previously elected to this prestigious group: Drs. B. Jayant Baliga, Donald L. Bitzer, Jerome J. Cuomo, Joseph M. DeSimone, Keith E. Gubbins, Carol K. Hall, Thom Joel Hodgson, Frances S. Ligler, R. Wayne Skaggs, James A. Trainham, III, and Paul Zia. Dr. Baliga is also a recipient of the President's National Medal of Technology and Innovation, and Cuomo is also a recipient of the previously named President's National Medal of Technology.

NC State has 10 members of the National Academy of Sciences: Drs. David E. Aspnes, Ellis B. Cowling, Joseph M. DeSimone, Major M. Goodman, Fred Gould, Todd R. Klaenhammer, C.S. Levings, III, Thomas F. Malone, Trudy Mackay, and Ronald R. Sederoff.

Dr. Yuntian Zhu was elected as a new Fellow of the American Association for the Advancement of Science. There are now 52 NC State faculty members who hold this honor.

Dr. Andrey V. Kuznetsov was selected for the prestigious Humboldt Research Award from the Alexander von Humboldt Foundation, which recognizes the achievements of outstanding academics worldwide. *(Read more on page 23.)*

Drs. Daniel Dougherty and Carla Frohlich received Early Career Research Awards from the U.S. Department of Energy. Dr. Kenan Gundogdu received a Young Investigator Award from the Office of Naval Research. Drs. William Enck, Mark Hoefer, Fanxing Li, Emerson Murphy-Hill, Gregory Reeves, David Ricketts, and Wengqiao Yuan are recent recipients of the National Science Foundation's Faculty Early Career Development program. Dozens of NC State faculty have received this recognition.

Drs. Michael Escuti, Jason Haugh, Carla Mattos, and Veena Misra have received the Presidential Early Career Award for Scientists and Engineers (PECASE). NC State has three individual winners of the Presidential Awards for Excellence in Science, Mathematics and Engineering Mentoring (PAESMEM): Drs. Laura Bottomley, Christine Grant, and Winsor E. Alexander.

NC State is represented in the American Academy of Arts and Sciences by Drs. William R. Atchley, Joseph M. DeSimone, and Trudy Mackay. Dr. Mackay is also a member of The Royal Society of the United Kingdom.



**ABOVE:** *Technology is the backbone of the new James B. Hunt, Jr. Library, taking students, faculty, staff and partners into new realms of discovery.*

### SUCCESS ABOUNDS AT NC STATE

**NC** State launched eight new startups in FY2013. This brings the total to more than 100 startups from technology and concepts developed through research by NC State faculty, staff and students.

More than 400 products have been commercialized based on NC State inventions. The Office of Technology Transfer's survey indicates that our startups have created more than 3,250 jobs in North Carolina and more than 6,800 worldwide, and raised more than \$1.5 billion in investments. The majority

of NC State's active startups are headquartered in North Carolina, contributing to the economic development of our state.

In the first two years of the Chancellor's Innovation Fund, 11 projects received funding. From these projects, two startups have launched, five commercial licenses have been executed, and \$2.8 million has been awarded in additional development funds. Six additional projects have been selected for funding in FY2014, the third year of the Chancellor's Innovation Fund: allergy relief for man's best friend; predicting outcomes in canine lymphoma; range-enhanced RFID; on-site production of fertilizer from water and air; folio filer portfolio system; and a comfortable sleep-quality monitor.

More than 60 officials from Eastman Chemical and NC State attended the grand opening of the Eastman Innovation Center on Centennial Campus. Eastman joins eight other new partners on Centennial Campus: TopQuadrant, Bandwidth, US DOE Nuclear Engineering University Program, GridBridge, Inc., Hanesbrands, Inc., Freese and Nichols, Mann + Hummel, and Arcametrics.

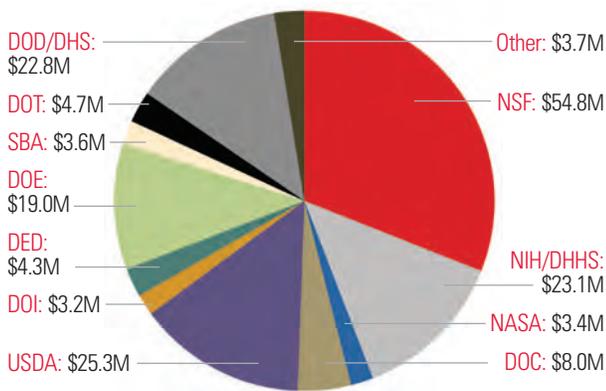
NC State's 125th anniversary celebration came to a close with an innovation symposium, Transforming Economies, in late February. Academic industry and government leaders from North Carolina and beyond gathered to discuss the important role that public universities such as NC State play in improving states' economies.

Also as part of the anniversary, NC State also hosted a Military Appreciation Event to celebrate those who serve and to showcase our support through research, education, and outreach activities.

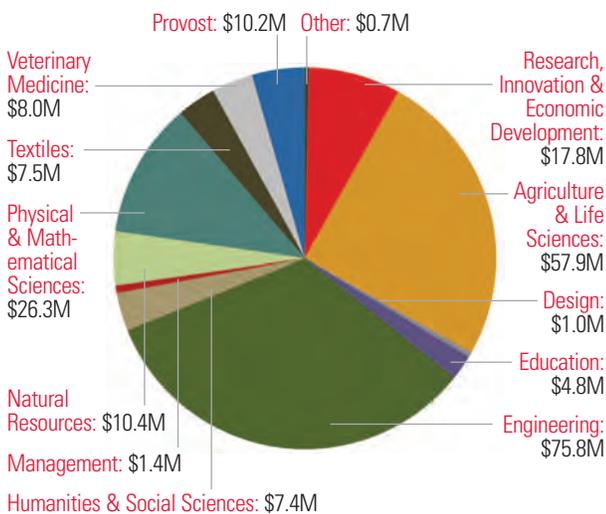
The university's Economic Development Partnership played an integral role in recruiting the following companies to North Carolina: MetLife (Wake and Mecklenburg Counties); IPREO Holdings (Wake County); PlyGem (Columbus County); Nutrovonics (Durham County); Crossview (Durham County); SunStone Water Group (Franklin County); Southern Lithoplate (Franklin County); Woodgrain Millwork (Caldwell County); Varonis (Wake County); Mann+Hummel (Wake County); NL Diagnostics (Cabarrus County); and 3 Phoenix/Zeiss Optronics (Wake County).

# ANNUAL REPORT

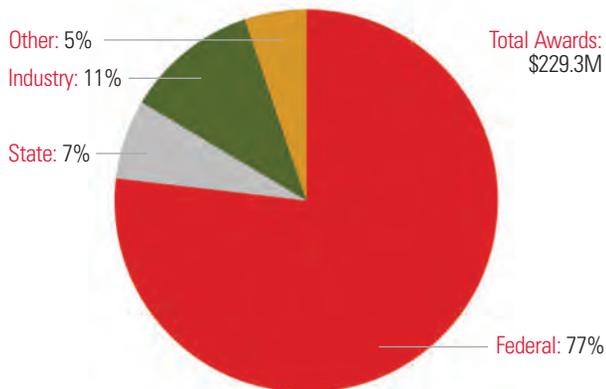
## AWARDS BY FEDERAL AGENCIES, FY13



## AWARDS BY NC STATE UNIT, FY13



## AWARDS BY SOURCE, FY13



## NC STATE STARTUPS, FY13

- BioCentric Media
- CellSentry
- LingCast
- mAssured Technology
- Nirvana Sciences
- Novocor Medical SystemS
- Polymer Braille
- Tethis

*"One of NC State's strengths is supporting the state's economic vitality. One of the most obvious aspects of that work is the university's ability to get research into 'the real world' where it creates new jobs."*

— NC State Chancellor Randy Woodson

## TECHNOLOGY TRANSFER & INNOVATION IMPACTS

|                                     | FY13   | FY09-13 TOTAL |
|-------------------------------------|--------|---------------|
| • Intellectual Property Disclosures | 238    | 950           |
| • Patents Filed                     | 145    | 693           |
| • U.S. Patents Issued               | 37     | 199           |
| • Foreign Patents Issued            | 70     | 226           |
| • Commercialization Agreements      | 111    | 432           |
| • Startups Launched                 | 8      | 32            |
| • License Revenue Received          | \$6.8M | \$28.4M       |

## CENTENNIAL CAMPUS PURSUES INNOVATION

Centennial Campus continues to create an atmosphere for innovation:

- The James B. Hunt, Jr. Library opens, earning "library of the future" designation by *Time* magazine and international acclaim for its design that encourages collaboration and information accessibility.
- The new Springboard Innovation Hub helps corporate, government and nonprofit partners "connect the dots" in working with NC State.
- The building known as Corporate Research I is re-named the Poulton Innovation Center in honor of former NC State Chancellor Bruce Poulton, who helped launch Centennial Campus.
- The new Eastman Innovation Center opens and awards the first two rounds of innovation grants to NC State faculty and students.
- The Nanosystems Engineering Research Center for Advanced Self-Powered Systems of Integrated Sensors and Technologies (ASSIST), funded by the National Science Foundation, begins development of wearable nanotechnologies that monitor individual health conditions.

# CREATIVE STATE

## PLOTTING A PLANET'S POTENTIAL

The Long View made the short list of the world's top animation projects. The gesture-based interactive installation developed in the College of Design was selected for an international festival.

Developed by art and design students under the faculty guidance of Patrick FitzGerald, the Long View is one of 14 projects featured in a gallery at SIGGRAPH 2013, an annual conference to explore advances in computer-generated animation and visual effects, held in California in July.

The project allows viewers to rearrange animated elements on a screen projection of a planet. The artists hope the installation encourages participants to think about their impact on the environment. The Long View was created using Flash, a physics-based gaming engine, and Microsoft Kinect, a popular input device.

"The planet exhibits visual and behavioral changes over time and evolves as human technology and industrialization advance or increase," FitzGerald says. "Viewers can play with these ecosystems to change them in some way. The piece itself loops, and metaphorically creates a conundrum for the viewer as to man's long-term relationship to the earth."

## LANDSCAPE COMES TO LIFE

Each semester in Will Hooker's small-scale landscape design studio, students build a sculpture made primarily of bamboo. The students gain hands-on experience with construction while learning how design ideas become reality.

This spring, the J.C. Raulston Arboretum commissioned Hooker's horticultural science class, co-taught this semester with Anne Spafford, to build a sculpture to commemorate the opening of the new walk in its Asian Valley during this year's Gala in the Garden.

Everyone in the class, including Hooker and Spafford, submitted sketches. The class chose the idea submitted by Justin Durango a Chinese dragon flowing in and out of the ground plane, and consisting of a 9-foot-tall head, three body loops, and an 8-foot-long tail with a rotating double spiral ending.

In total, the Asian dragon project took 15 days to build and install, with the class and 26 other volunteers putting in close to 1,200 hours of labor to complete the task. "All involved were totally exhausted but very pleased with the results," Hooker says.

## OBSERVING EARTH: MAPPING AND MORE

The view from the top floor of Jordan Hall extends toward downtown Raleigh, sweeping over a landscape of tall trees concealing homes, shops and streets under a canopy of green. It's no surprise that the Center for Earth Observation set up shop here.

"We live in space," says Hugh Devine, the center's director. "Everything happens somewhere, so it's all our domain."

On a typical day in the center, you might see a data visualization program to find the optimal locations for food distribution centers in poor neighborhoods where

## Creative State

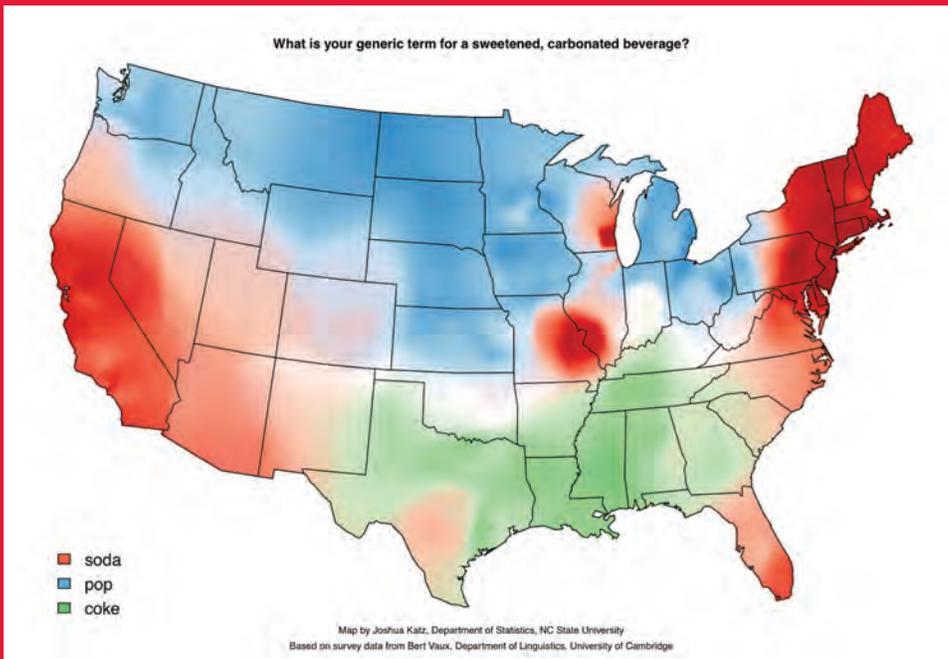


• **TOP:** *The Long View* earned a spot in an international gallery featuring animation graphics. • **MIDDLE:** *This Asian dragon*, a project of Will Hooker's landscape design studio, graces the J.C. Raulston Arboretum. • **BOTTOM:** *The Center for Earth Observation* provides a wide variety of data visualization, some in 3-D.

access to affordable food is limited. Or you may observe a virtual reality program that could be used to help train firefighters.

In fact, the uses of geospatial technology are nearly limitless. "It's tied into things as far flung as environmental engineering, natural resource management, archeology, city planning, landscape architecture, bioinformatics and law enforcement," Devine says. "It touches anything that involves transportation, mapping, moving and locational data."

To prove it, he points to collaborations the center has with more than 20 departments at NC State as well as with the Hunt Library and the Nature Research Center at the Museum of Natural Sciences.



ABOVE: This is just one of the maps NC State graduate student Joshua Katz developed as a data visualization project. His efforts have drawn international attention to how data can be presented in creative ways.

## Show Me the Data

Millions take their dialects seriously. Just ask NC State statistics graduate student Joshua Katz.

In a June post in The Abstract, NC State's research blog, Tracey Peake wrote about maps Katz produced to illustrate results of a survey by Bert Vaux of the University of Cambridge. The maps show regional word choices and pronunciation across the United States. Y'all vs. you. Soda vs. pop.

After being picked up by *Business Insider* and other online outlets, the maps went viral — garnering more than 30 million hits on some of the nation's top sites in just the first 10 days.

Katz brought data visualization to the mainstream through interviews with the BBC, the *Wall Street Journal*, *New York Daily News*, etc. "It's good exposure for statistics, for thinking about data in creative ways," he explains in *The News & Observer*.

And, Katz recently tweeted, the publicity helped him land a stint working for *The New York Times'* graphics department this fall.

## results.

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