IDEaS

INQUIRY, DISCOVERY IN ENGINEERING AND SCIENCE FALL 2013 COLLEGE OF ENGINEERING AND SCIENCE

One of five Clemson NSF CAREER Award winners, Delphine Dean

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CLEMSON
College of ENGINEERING AND SCIENCE

FROM THE DEAN

When my appointment as dean became effective, we were in the middle of the production cycle for this fall issue of *IDEaS*. I became very excited as I read the list of articles planned for it. All of our feature stories deal with young faculty engaged in research supporting Clemson's 2020 Road Map. This 10-year strategic plan, among other things, serves the public good by focusing on some of the grand challenges of the 21st century — national priorities such as health, advanced materials, transportation, information technology, energy and sustaining the environment.

For example, John Saylor, a professor in mechanical engineering, is levitating water drops — research that could offer coal miners better protection from the clouds of dust and diesel fumes inherent to their work environment. Although not an epidemiologist, Saylor devotes careful attention to coal miners' lungs. (See "A Drop of Water. A Speck of Coal," page 6.)

Johnell Brooks, associate professor in automotive engineering, is studying individuals' capabilities and limitations in order to design automotive systems that are safe and efficient yet attractive for the user. Aging Americans often prepare financially for successful retirement, but few give much thought to how driving changes with age. (See "Drive Able," page 10.)

And the feature concerning our NSF CAREER awardees further illustrates some of the work being done by our outstanding young faculty: Melissa Smith, in electrical and computer engineering, is looking for ways to manage and optimize large-scale applications running on heterogeneous, multi-paradigm computer systems. Haiying (Helen) Shen, also in electrical and computer engineering, is investigating how information from social networks may be used to create efficient and cooperative large-scale distributed data sharing systems. Automotive engineering associate professor Fadi Abu-Farha is researching the manufacturing of lightweight materials for use in automotive components. Jeffrey N. Anker, assistant professor in analytical chemistry, is developing a powerful high-resolution chemical imaging system that combines the advantages of X-ray imaging with the chemical sensitivity of optical methods. Delphine Dean, associate professor in bioengineering, is exploring how mechanical variability at the nanoscale and microscale affects macroscale properties of tissues. From hybrid computing systems to medical imaging, the research being conducted by these awardees will have a lasting impact on the public good.

As dean of the College of Engineering and Science, one of my responsibilities is to support the goals of the University's 2020 Road Map, and I've given much thought to how the College of Engineering and Science can be a driving force in this journey. Here are some of the most salient ways:

- Grow the research enterprise through direct investments in infrastructure, faculty and staff
- Enhance the Clemson educational experience and excellence in STEM education by expanding allocations to STEM programs and infrastructure
- Advance entrepreneurial and innovation experiences for all students and faculty in collaboration with other colleges and industry
- Expand economic development and outreach programs through private corporate partnerships and develop close connections with Clemson's innovation campuses

I invite your input, as well, as we endeavor to create a culture of diversity and collaboration, entrepreneurship and growth. If we are successful, our students, faculty and staff will have served our state and country well.

— Anand Gramopadhye, Dean

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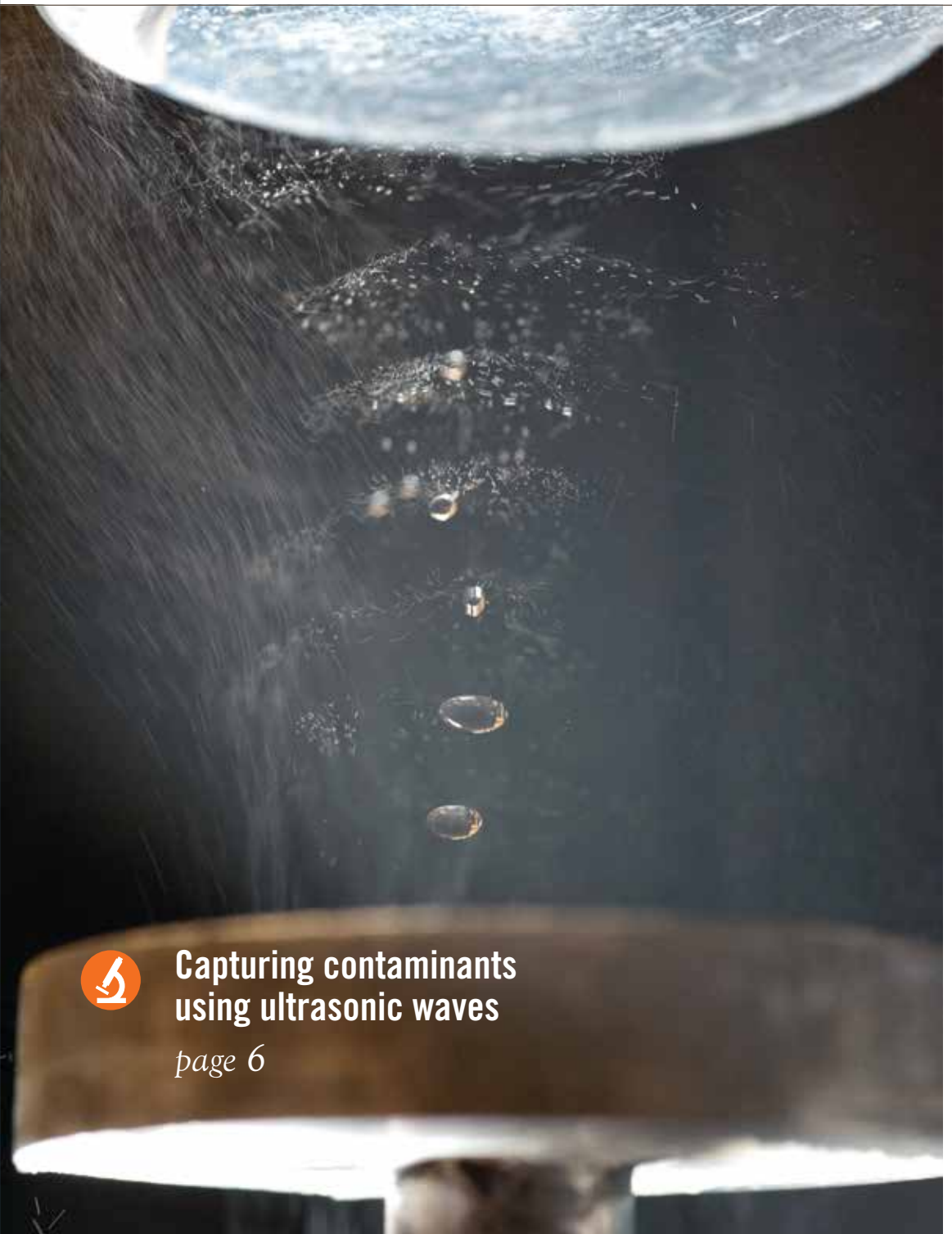
INQUIRY, DISCOVERY IN ENGINEERING AND SCIENCE FALL 2013 COLLEGE OF ENGINEERING AND SCIENCE



Capturing contaminants using ultrasonic waves

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A CONVERSATION WITH THE DEAN

After serving a decade as chairman of Clemson's industrial engineering department, Anand Gramopadhye was named dean of the College of Engineering and Science on July 1.

"I am excited and humbled by this opportunity," says Gramopadhye. "Any successful enterprise represents a team effort, so one of my key responsibilities as dean is establishing an open, nurturing environment that encourages everyone to bring his or her best ideas to the forefront. Developing solutions to the grand challenges facing our community, state and nation will require the pursuit of cutting-edge research that engages virtuoso talent."

Here, Dean Gramopadhye shares some thoughts about his vision for the college.

Clemson's land-grant tradition

"After being appointed dean, I had the opportunity to reflect on how the land-grant traditions of Clemson impact the mission of a 21st-century college of engineering and science. Our founder, Thomas Green Clemson, envisioned an institution that would help build the material resources of our state. Traditionally, this has been accomplished through excellent research and scholarship, coupled with an extension service for sharing the new knowledge and technology with our citizens. While this model is still in place, Clemson has added a new dimension by creating innovation campuses at strategic locations throughout South Carolina to facilitate closer collaboration with key economic players. Consider, for example, our investments in automotive and transportation research at the Clemson University International Center for Automotive Research (CU-ICAR), the advanced materials research being conducted at our Advanced Materials Center, the restoration industries, and environmental and sustainable technologies at the Clemson University Restoration Institute (CURI), and the biomedical research at the Clemson University Biomedical Engineering Innovation Campus (CUBEInc). These innovation campuses allow us to connect with industry locally, nationally and globally, and the College of Engineering and Science needs to be fully engaged with all of these, taking a leadership role."

Gramopadhye Fast Facts

- Research focuses on solving human-machine system design problems and modeling human performance in such technologically complex systems as health care, aviation and manufacturing
- Principal investigator on more than 75 research grants and awards, generating more than $45 million in funding
- More than 300 publications and a Fellow of the Institute of Industrial Engineers
- Recognized twice by the National Academy of Engineering through the Frontiers in Engineering Program as one of the top 60 engineers in the country
- Editor in chief of the *International Journal of Industrial Ergonomics*
- Earned a bachelor's degree in production engineering in 1987 from the University of Bombay, India, a Master of Science in 1989 and a Ph.D. in 1992, both in industrial engineering from the State University of New York, Buffalo

On the nature of the college

"The key to understanding the nature of our college can be found in its very name — engineering and science. This combination sets the stage for a unique, collaborative environment — a synergy that gives faculty the freedom to push boundaries and explore innovative solutions. I think that we need to build bridges beyond our college and, just as important, that these efforts need to be institutionalized if we are going to be successful. One example could be a partnership that would lead to a graduate degree in business engineering or in entrepreneurship and innovation. To be successful, the global citizen of the future must have experience, not only in his or her primary discipline, but also skills beyond. We can only provide those experiences for our faculty and students if we look at collaborative opportunities that exist on the education, research and service fronts. Such collaboration is key if we are going to move this college forward."

"(Our) innovation campuses allow us to connect with industry locally, nationally and globally, and the College of Engineering and Science needs to be fully engaged with all of these, taking a leadership role."

Collaboration is an approach that underscores Gramopadhye's philosophy and vision. Under his leadership, the industrial engineering department joined corporate and industry partners in several strategic educational and research initiatives that have increased enrollment, research and scholarship.

Corporate partnerships, for example, led to the establishment of the college's successful Master of Engineering program in capital project supply chain and logistics. Other collaborations have resulted in a health systems research initiative and additional applied research in various global areas, including India, China and the broader Asia-Pacific region. All of these accomplishments reflect an engaged, dynamic industrial engineering department, benefiting from partnerships initiated under Gramopadhye's leadership.

On the relationship between college and department

"The critical work of a university or college happens in the department. Teaching happens in the department; research happens in the department; scholarship happens in the department. That's where the best faculty interact with our students. To ensure the success of this work, the college should serve as a catalyst, making sure the necessary resources are available to the departments, faculty, staff and students. To make this happen, the college should function in a servant/leadership role, marshaling assets and providing appropriate incentives and guidance."

In addition to serving as department chair, Gramopadhye was also Clemson's associate vice president for workforce development. In that role, he helped create the Center for Workforce Development, which partners with statewide K-12 institutions, technical colleges, industry and other academic institutions and centers inside and outside the state to address STEM — science, technology, engineering and math — issues to meet the needs of South

Carolina's 21st-century knowledge economy. The center is home to the National Science Foundation Advanced Technical Education Center for Automotive and Aviation Education.

On the need for STEM experiences

"I'm sure everyone has heard President Obama talk about the need for STEM education. Investing in STEM programs means investing in infrastructure, bringing world-class facilities to our students, using technology, and developing an innovative curriculum that embraces novel approaches based on pedagogical research. We want to create the global engineers and scientists of the future. To do so successfully requires creative pedagogies, for instance, appropriately implementing online education and training so that we can enhance — and extend — what we fondly refer to as the Clemson experience."

According to Interim Provost Nadim Aziz, the former chair of civil engineering who has worked with Gramopadhye for more than a decade, "Dr. Gramopadhye brings with him a wealth of leadership experience and the entrepreneurial skills necessary for building partnerships and developing strong research and educational programs. These attributes are essential to position the College of Engineering and Science for national and international recognition as a leader in engineering and science education, research and technology innovation."

On developing and maintaining intellectual capital

"An educational institution is defined by its intellectual capital. In my view, intellectual capital is the students, faculty and staff. One of the key areas that I will focus on as dean is development. If we are going attract new and retain existing talent, we need to make sure that we have the resources to keep faculty and staff in the Clemson family. We also need to attract the best students. Given the state of our economy, funds are limited. Creating new professorships, looking for endowment opportunities to provide scholarships and seeking new research opportunities will be some of my major focus areas. If we are successful, I believe we will have resolved two issues: We will have retained the top talent, and we will have solved the business problems which tend to plague most state institutions year after year.

"I am excited about our possibilities. We want to be known for addressing the grand challenges facing us; creating world-class educational and research infrastructure, experiences and programs for our students; and graduating students who will be recognized nationally and internationally as leaders, innovators and entrepreneurs."

A DROP O
A SPECK

F WATER. OF COAL.

Ultrasonic waves and dancing water droplets could help protect miners' lungs.

by Neil Caudle

Steven Fredericks thumbs the plunger of a syringe, expels a few squirts to clear air from the tip of the needle, and lowers the needle toward a polished metal disk. When a new drop appears at the tip of the needle, an invisible force seems to seize it and float it in air. Fredericks sets the syringe aside and twists a knob on an amplifier nearby. We hear nothing from the hardware, but the drop begins to vibrate, dancing. It leaps and darts, jolted from side to side. As Fredericks fine-tunes the voltage, the dancing calms, the drop aquiver, as though from its frantic exertion.

Fredericks, who helped assemble the equipment, is a master's student working in the lab of John R. Saylor, a professor in the Department of Mechanical Engineering. Fredericks has just demonstrated how to levitate a drop. He does it with unheard sound.

The force that lifts and holds the drop is inaudible to humans but would madden a dog. It is an ultrasonic standing wave field — one wave emitted and another reflected, matched in their coming and going so that in their symmetrical embrace the drop is trapped and held in place, pulsing like a heartbeat.

It's a clever trick that a savvy magician might try on the stage. But drop levitation, a technique developed in part by Saylor's collaborator at Boston University, R. Glynn Holt, has more to offer than sleight of hand.

Where it's dark as a dungeon

Hold in one part of your mind the gentle levitation of one silvery drop and in another its opposite: a vast, craggy underworld where enormous machines with burr-like cutters gnaw the bones of a mountain, shearing coal from the walls of a mine gallery, crushing the coal into chunks and great billowing clouds of black dust.

People are working here, sometimes a mile below daylight. A ventilation system forces fresh air down a duct to them, exhausting a stale, dusty flow. And spray heads drench the workspace with water to settle the dust. But airflows and sprays do not capture all of the floating coal dust particles. Nor do they capture all of the particles from the exhaust of diesel engines that power the mining machines. These particulate contaminants flow into the coal miners' lungs.

Saylor is not an epidemiologist, but he devotes careful attention to coal miners' lungs. He says our bodies can trap and expel most of the largest particles from coal dust and diesel exhaust.

But particles having a size on the order of a micrometer in diameter elude our defenses. Cigarette smoke, coal dust and diesel exhaust all carry a heavy load of particles in this size range. "When you take a massive cutter and use it to grind coal into pieces that can be moved to the surface, you're going to create particles of all sizes," Saylor says. "Particles in this especially hazardous size range can navigate the twists and turns of our nasal passages, reach the most distal recesses of the lungs, and stay there. And that's what causes black lung disease.

What if you could, with an ultrasonic standing wave, levitate not just one drop of water but millions, suspending them long enough to intercept most of the dangerous particles from coal dust and diesel exhaust?

According to the National Institute for Occupational Safety and Health (NIOSH), 1,003 miners died from coal workers' pneumoconiosis — black lung disease — in 1999 alone. From 1995 to 1999, 26.2 percent of recorded exposures to coal dust exceeded recommended levels. And some 30,000 miners in the U.S. are exposed to unsafe levels of particulates from diesel exhaust, a carcinogen.

The main defense against these deadly threats? Tiny drops of water.

Bubbles and drops

Saylor has long had an interest in bubbles and drops, and a spray, he says, is nothing but a lot of drops. He also studies what he calls the nexus of water and energy, the inescapable fact that producing energy with conventional fuels requires vast amounts of fresh water. Coal mining is a case in point. If Saylor and his students can devise a way to make sprays more efficient in coal mines, they may help save water and lives.

Which brings us back to the levitated drop.

What if you could, with an ultrasonic standing wave, levitate not just one drop of water but millions, suspending them long enough to intercept most of the dangerous particles from coal dust and diesel exhaust? What if the drops and particles began crowding together so tight that their accumulating weight would sink them safely to a drain?

This is exactly what Saylor and his students have done in his lab. Using their drop-levitation technique, they have created what Saylor calls an accretion disk, where drops and particles collect.

As Fredericks works drop by drop, Weiyu Ran, one of Saylor's Ph.D. students, works with many drops — with sprays. Saylor and Ran have designed and constructed a small-scale scrubber, a device that forces sprays and a flow of particle-laden air to combine in an enclosed chamber. By creating accretion disks inside this chamber using ultrasonic energy, far more particles are removed from the air than would otherwise be the case.

Scaling it up

So at least in the lab, the method works. But what about in coal mines? Saylor is looking for ways to scale up the technology for testing in mine-like conditions. Mining operations would probably balk at the electricity required to power a very large wave field, because errant voltage in a dusty mine might spark an explosion.

So an ultrasonic standing wave field may not be practical for treating whole underground rooms. There is also the problem of the volumetric flow rate of air, which is enormous in mines compared to values employed in the lab.

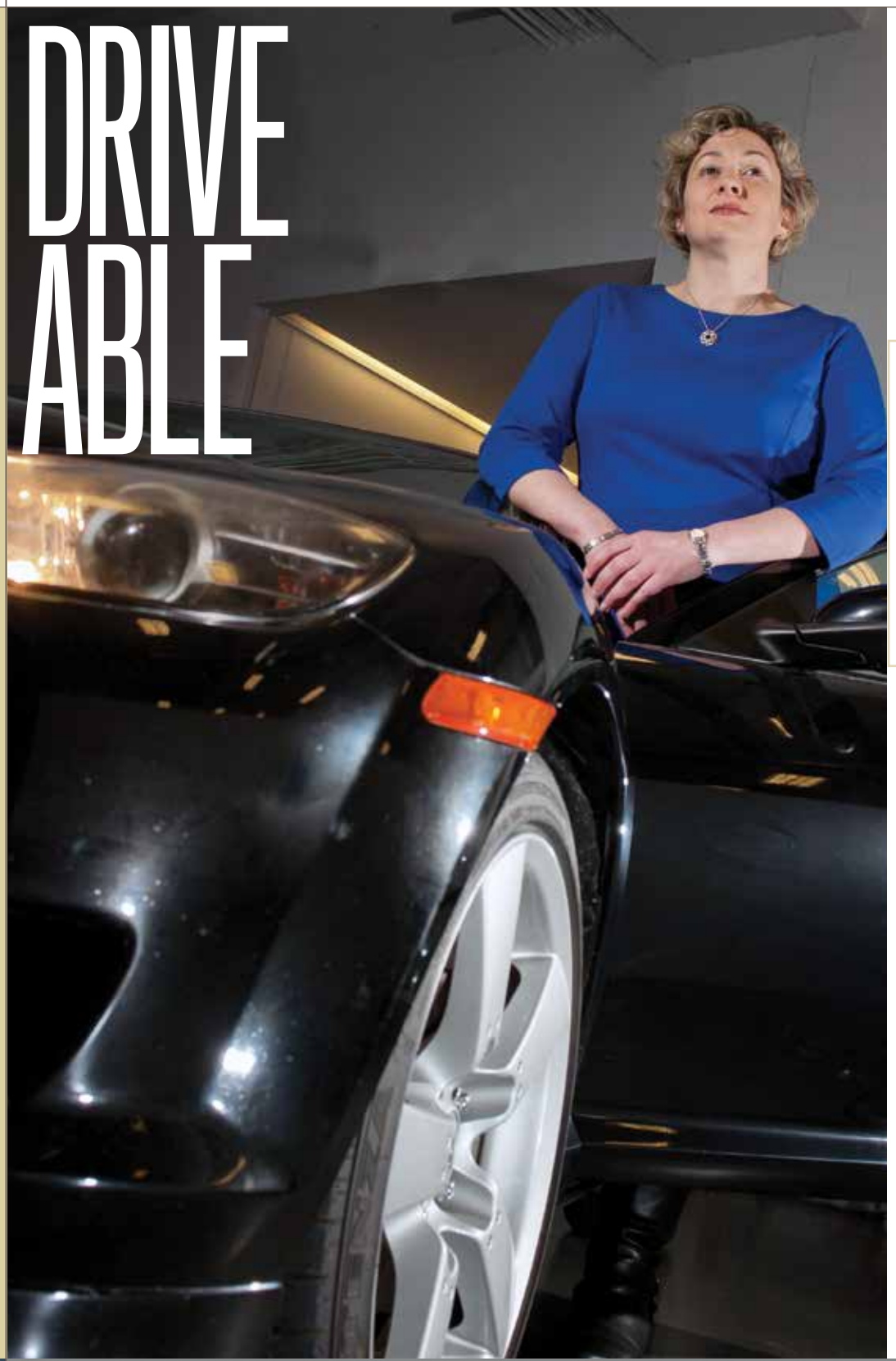
"The first step may be to use our device in a smaller compartment," Saylor says, "like the cab of a mining vehicle, or in a scrubber like those used to reduce air pollution from smokestacks."

Getting to that stage will require cooperation from industry and government, and Saylor is starting with NIOSH's Office of Mine Safety and Health Research in Pittsburgh. Meanwhile, he and Ran are preparing to publish their data from the small scale ultrasonic scrubber. While the results so far are encouraging, Saylor knows that scaling up will mean taking the science to another level, analyzing in detail the complex interaction of particulates and drops in wave fields of various sizes.

This will take some time, and the clock is ticking for people who work in the mines. "Black lung disease has been increasing, not decreasing," Saylor says. "What would be very satisfying to me would be saving lives."

John R. Saylor is a professor of mechanical engineering in the College of Engineering and Science.

DRIVE ABLE



Johnell Brooks works to keep wounded warriors, wreck-prone rookies and slowing seniors safer on the road.

by Lauren J. Bryant

From the sweaty-palmed 16-year-old who just passed his driving test to the slower-moving 86-year-old who still takes herself to the doctor, driving is the key to independence in America. Yet few, if any, of us are ready for the end of driving.

"As you age, you prepare for so many things," says Johnell Brooks, associate professor in the Department of Automotive Engineering. "You prepare for where you want to live, you prepare for financial security. Few people, however, plan for how driving is going to change as they age, or for the end of their driving careers."

A Midwesterner by birth (she comes from Nebraska), Brooks moved to South Carolina while in high school and became a three-time Clemson University graduate. With a Ph.D. in psychology, Brooks is a human-factors psychologist who studies "individuals' capabilities and limitations in order to make systems that are safe, efficient and satisfying for the user."

In Brooks' case, those systems are automotive. Her goal is to "do anything I can to keep people driving safely as long as possible." That means adolescents and senior citizens, but also injured veterans, women, short people or tall, thin, obese — in other words, "people, who come in all different shapes and sizes with all different abilities."

From psych to engineering

When Brooks started out as a faculty member at Clemson, she was part of the psychology department, where she used the University's driving simulator to carry out her projects. An actual full-size vehicle parked on the third floor of Clemson's Brackett Hall, the simulator was connected to computers and surrounded by large, standing screens. Using this setup, Brooks and her colleagues and students conducted driving-related research, including studies of visual limitations during night driving and of distracted driving due to multitasking.

After several years of working "hand-in-hand" with engineering faculty and students, Brooks moved from the psychology department to the Department of Automotive Engineering in January 2012. She is also a member of the Clemson University International Center for Automotive Research (CU-ICAR), a 250-acre research campus that puts Clemson among the top 10 automotive colleges and universities in the United States, according to the "car people" website *edmunds.com*. Along the way, she collaborated with physicians and occupational therapists at Roger C. Peace Rehabilitation Hospital (RCP) of the Greenville Health System.

The driving simulator scenarios Brooks had developed were ideal for helping seniors trying to relearn how to drive after significant medical events, but the University's driving simulator proved too big, expensive and complicated to work in a clinical setting. So Brooks worked with the Utah-based company DriveSafety to design and develop a smaller, sleeker unit, now called the DriveSafety CDS-250 Clinical Driving Simulator.

"We had wanted to create a simulation system optimized for use by clinicians with their patients," says Douglas Evans, CEO of DriveSafety. "Dr. Brooks and her team brought unique insight and expertise to help make it possible."

The resulting intellectual property, with the support of the Clemson University Research Foundation, has been licensed to DriveSafety for commercialization.

Making data work for patients

Today, Brooks' major laboratory is based in the RCP Hospital, about 30 miles from the Clemson campus. But her research projects still begin on the University side, where she and her team, including primary collaborator Paul Venhovens, work with DriveSafety to develop scenarios to test various driving-related problems. After deciding what components a scenario will have and what metrics will be used to provide objective feedback, the scenario is tested with university volunteers, then transitioned over to the hospital system. That transition, Brooks says, is a "very iterative process."

Brooks' research projects still begin on the University side, where she and her team, including primary collaborator Paul Venhovens (shown seated), work with DriveSafety to develop scenarios to test various driving-related problems.

Brooks explains that computerized driving simulators have sensors that collect constant streams of data about an individual's driving performance as he or she navigates various digital driving scenarios.

"Academics think a ton of data is a wonderful thing," Brooks says. "But how do you present complex data to patients in a way that's meaningful — or to clinicians who may not have a background in statistics?"

The solutions Brooks and her colleagues have come up with are usually visual. For example, for drivers being evaluated on how they drive within a traffic lane, the team came up with a simple color-coding scheme.

"We made color-coded sections of the lane: green for the center zone, yellow if someone is veering toward the edge, red if any part of the vehicle is touching the edge," Brooks explains.

"Instead of talking about centimeters and 'deviations from the center position,' therapists can talk about how many times a person was in the red zone." The simulator that Brooks helped design is now used in 26 research facilities and clinical settings — three in Europe, two in Australia, two in Hawaii and 19 in the continental United States. A couple of the simulators are in university settings, and one is in a pharmacy school where it's used to study the effects of prescriptions on driving performance.

But most of the simulators are in military and VA hospitals where a significant number of patients are wounded warriors who have blast injuries, loss of lower limbs, traumatic brain injury or post-traumatic stress disorder. That came as a surprise to Brooks.

The realization that physical and occupational therapists in military and veterans' hospitals were using the simulator steered Brooks' research in a new direction. For the last couple of years, she says, she and Clemson engineering students have been using the simulator primarily to develop and test designs for hand controls. Hand controls are adaptive devices used to drive a car, instead of using one's legs and feet to control the gas and brakes.

Brooks says the DriveSafety simulator is a perfect tool for engineers, therapists and, most of all, patients, to test how different hand-control designs work. For one thing, she contends, the simulator is a lot safer. Typically, patients learned to use hand controls by driving in big parking lots, according to Brooks. "But just think about where military hospitals are located; most of them are in big cities," she says. "So the veterans were having to learn how to use the controls in congested, busy parking lots and frequently in high-density traffic."

With the simulator, military veterans try different designs of hand controls and get comfortable with operating the gas and brake on hills and around curves in the digital scenarios, before they ever go out on a real road. "They can really get the nuances down of how hard to press for gas and brake and which direction you press," Brooks says. "It's just so different for someone who has already learned to drive with their feet to have to transfer that knowledge to their hands."

From racetrack to lab

To further develop the simulator for use by veterans with lower limb injuries, Brooks turns to Zeke Massie, whom she calls a "subject-matter expert." A retired Marine Corps veteran, Massie has been paralyzed from the armpits down for 18 years, following a motorcycle accident. He lives in Atlanta, Ga., where he's also been involved in motorsports since 1997.

Recalling his own days of having to learn how to drive again, Massie says, "When Johnell told me she was working on a simulator, I thought it was such a good idea, a super idea." Massie now visits Clemson several times a year. His initial visits were focused on helping Brooks and her students improve how people in wheelchairs would transfer onto the driving simulator's seat. More recently, he's been helping with various projects including hand-control development, seat-belt design and designs for cars that better accommodate wheelchair-to-car transfers. Massie says his biggest contribution is his life experience.

"The Clemson students are really smart kids, but they don't live the way I do. I've been in my chair for almost as long as a lot of these kids have been alive," he says. "They have great ideas, but sometimes they are far from what is really useable. I know what works. I don't want them to waste time going down the wrong track, so I get in there, and we brainstorm."

For veterans who do not have lower limb injuries but do have traumatic brain injuries (TBI) or post-traumatic stress disorder (PTSD), the driving simulator is used in a different way, Brooks explains. Scenarios that seem benign to civilian drivers — things such as potholes, dead animals in the road or large trucks boxing in a car stuck in traffic on an expressway — can be triggers for returning vets.

"Veterans expect IEDs," she says. "These soldiers who are reintegrating into civilian driving and the therapists who work with them have really motivated us to develop these scenarios in the simulator."

Ultimately, Brooks believes the key to her success has been her ability to blur the lines between psychology, engineering and medicine. A social scientist spanning the worlds of hospital clinics and research laboratories, Brooks believes it's at "the intersection of different disciplines where the most interesting work happens. When we bring different fields together, we're able to look at and solve problems with a broader perspective."

"Being a human-factors psychologist involved in a team like this, seeing the students think about how they need to design and apply concepts for different user groups, and seeing patients in the hospital use products and services we developed, has got to be the most rewarding job on the planet," Brooks says.

Johnell Brooks is an associate professor of automotive engineering in the College of Engineering and Science.

The Start of Something Good

NSF Early CAREER Development awardees pursue the future of research.

Edited by Heidi Coryell Williams

It's the most sought-after recognition an emerging science, engineering or mathematics faculty member can receive: a National Science Foundation Faculty Early Career Development (CAREER) grant.

A CAREER award is the NSF's most prestigious in support of early career-development activities, providing a financial stipend to support research activity for a period of five years. The NSF, an independent federal agency, supports fundamental research and education across all fields of science and engineering. (In fiscal year 2012, its budget was $7 billion, and its funds reached all 50 states through grants to nearly 2,000 colleges, universities and other institutions.)

As any professor who's applied for a CAREER grant can attest, a submission for this award is much more than a research proposal: It's a career development plan. The goal is to fund faculty members early in their careers to promote their development into teacher-scholars. The scientists and researchers who receive the awards are widely considered the most likely to become the academic leaders of the 21st century.

Each year, NSF receives about 50,000 competitive requests for funding and makes about 11,500 new funding awards. Since 2005, Clemson has been home to more than 30 CAREER Award recipients, and for the 2013-2014 academic year five Clemson professors received the award.

The CAREER grants awarded at Clemson this spring represent a broad spectrum of interests and applications — from harnessing the power of giant computer systems to innovative medical advances to developing lighter-weight materials for modern car construction.

The researchers of today. The academic leaders of tomorrow. Meet the CAREER awardees of Clemson University.

Fadi Abu-Farha
Amount: $400,000
Low-cost manufacturing of lightweight sheet components for the automotive sector

Jeffrey N. Anker
Amount: $526,000
High-resolution spectrochemical imaging through tissue

Delphine Dean
Amount: $400,000
Hierarchical mechanical models of cell constructs

Haiying (Helen) Shen
Amount: $400,000
A new efficient and cooperative large-scale distributed data sharing system

Melissa Smith
Amount: $450,000
Harnessing hybrid computing resources in PetaScale computing and beyond

Fadi Abu-Farha

Low-cost manufacturing of lightweight sheet components for the automotive sector

Lightweight materials — things like aluminum and magnesium — are considered a key component of building cars that consume less fuel. Sounds simple enough, but these metals take longer to manufacture than conventional steel stamping. The problem becomes, how can higher-cost, lower-yield materials be incorporated into the consumer-driven automotive sector — a marketplace that is sensitive to productivity and cost?

Fadi Abu-Farha, associate professor of automotive engineering, has been awarded a CAREER grant to research manufacturing lightweight materials for use in automotive components. His goal is to develop a process that will allow car makers to manufacture these hard-to-form alloys at a lower cost and with a higher yield than can be done currently.

That manufacturing process is something Abu-Farha calls "Hot-Blank Cold-Die," or HB-CD, and it forms low-density, lightweight materials like aluminum and magnesium alloys into automotive body components. HB-CD involves complex material deformation characteristics that have not been adequately studied and are not fully understood.

"This research project will tackle these issues," Abu-Farha explains. If successful, the HB-CD will enable the manufacture of aluminum and magnesium parts at production rates similar to those of conventional steel stamping. What makes HB-CD so attractive is its simplicity compared to warm- and hot-forming processes.

The impact of his work is expected to stretch beyond automotive applications to other transportation sectors. For example, there will be "greater utilization of aluminum and magnesium sheets in airline manufacturing with significant short-term and long-term energy savings," Abu-Farha said.

The outreach component of his CAREER award will reach an age group that's well below driving age: He plans to collaborate with The Children's Museum of the Upstate in Greenville. Projects and activities that aim to excite young children about advanced materials and manufacturing will be designed and incorporated into a museum display, becoming building blocks for a greater goal of inspiring and training the next generation of engineers, researchers and innovators.

Jeffrey Anker

High-resolution spectrochemical imaging through tissue

As people live longer and their bodies work harder, knee, hip and other replacement surgeries are becoming an increasingly popular and preferred option to limited mobility.

Jeffrey Anker, assistant professor of analytical chemistry, is developing a method to non-invasively measure chemical concentrations on films that can be applied to the surface of implanted medical devices. The technique uses a combination of X-rays and visible luminescence for high-resolution chemical mapping. He is especially interested in pH and oxygen as indicators for bacterial metabolic activity, and his CAREER award will fund work on high-resolution spectrochemical imaging through tissue.

"The CAREER project will investigate the fundamental aspects of the image resolution, chemical sensitivity and required X-ray dose and time," Anker says. "We expect that the method will be for early detection and monitoring of implant infections."

The project also has an outreach component to stimulate high school students' interest in chemical analysis by starting a chemical-sensing robot competition with help from a local high school teacher.

Anker is the seventh faculty member affiliated with the Center for Optical Materials Science and Engineering Technologies to have received the CAREER award, which is more than any other Clemson center.

The CAREER grant will fund a five-year investigation into the fundamental aspects of the imaging technique. Better yet, Anker expects that the grant will lead to more funding down the road. The National Science Foundation, the National Institutes of Health and the Department of Defense are likely candidates for future funding, as his research continues and scientific discovery unfolds.

Delphine Dean

Hierarchical mechanical models of cell constructs

Delphine Dean, an associate professor in the Department of Bioengineering, has a reputation for taking her students to distant places to accomplish big things.

Dean and her students traveled to Tanzanian hospitals recently to deliver temperature-sensor devices built into warming blankets — blankets designed to keep preemies at just the right temperature and save lives.

Dean's CAREER award is a bit more complicated, but shares the goal of improving health through innovative medical technologies. The Hierarchical Mechanical Models of Cell Constructs project "aims to improve understanding of how mechanical variability at the nano- and micro-scale affects macroscale properties of tissues."

Being able to model the mechanical responses of cells to physical stimuli is important for many reasons, Dean explains, but namely because it allows scientists to better understand a variety of diseases. Being able to predict the mechanical behavior of cells in response to pathological conditions and medical treatments could help in the prevention and treatment of disease.

Dean is using clustering and machine vision algorithms to build mechanical models of vascular smooth muscle cell constructs with tunable levels of geometric complexity.

"These tunable models can then be used to assess the level of structural detail that is required for accurate prediction of biomechanical behavior observed in specific sets of experimental conditions," she explains.

It's one of the "grand challenges" of biomedical research, Dean says. "How to create and assess in vitro cell cultures that accurately reflect in vivo cell responses."

There are technical challenges to assessing mechanical properties of cells inside 3-D cultures in response to different stimuli — machine vision, experimental design and mechanical modeling and in the fusion of these domains. The project will adapt a new, novel technique, band excitation atomic force microscopy (BE-AFM), for use in fluids with living cells. These novel methods are expected to advance the state of the art in modeling of biological tissues.

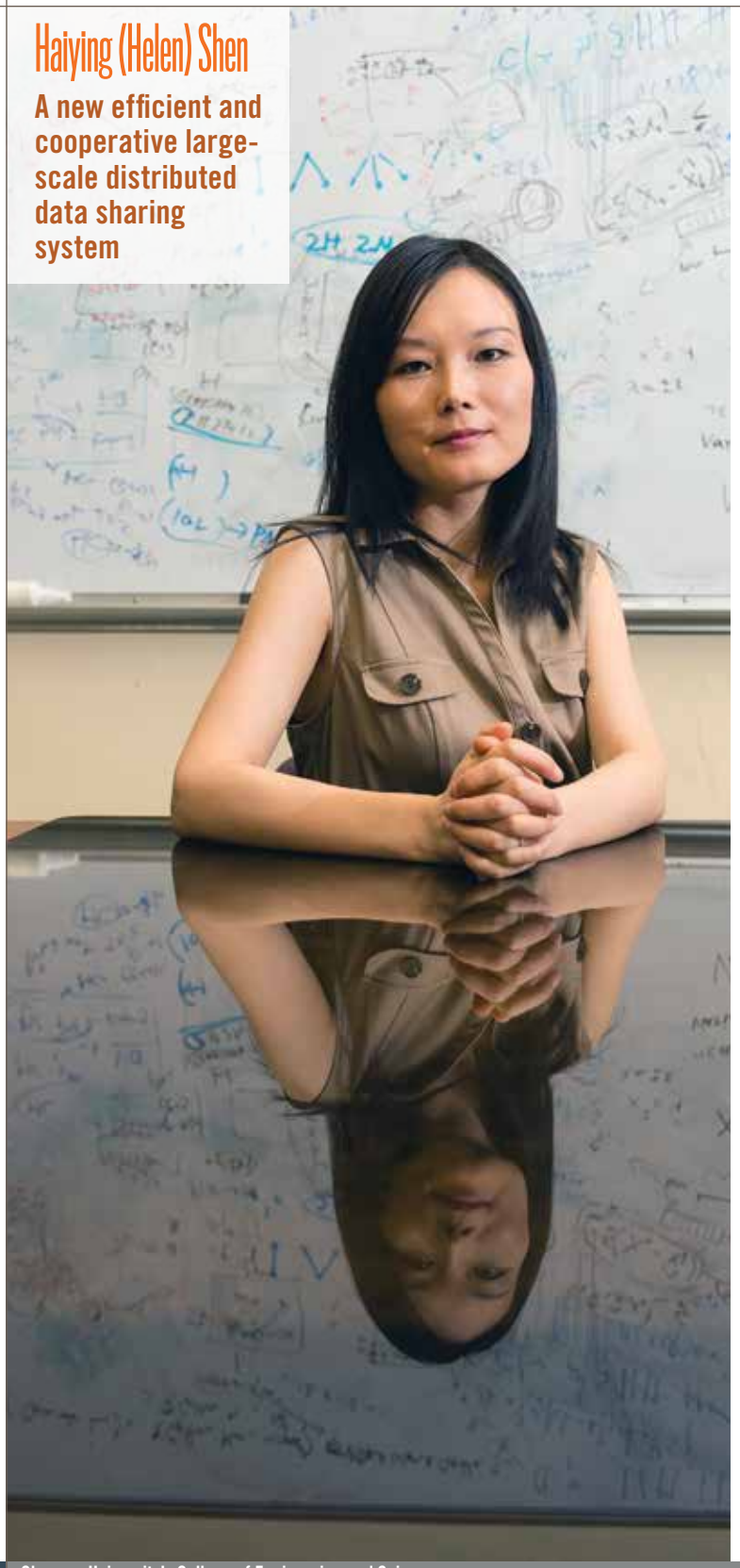
"These studies will bridge the knowledge gap between actual cell and tissue structure and the simplified mechanics models currently used to describe them," she explains.

The long-term educational goal of her project is to increase South Carolina student and parent awareness of engineering and computation studies and, thereby, increase the number of students who choose engineering as a career.

A team of Creative Inquiry students involved in undergraduate research will work with her to develop videos and workshops related to the research. These tools should increase student and parent enthusiasm for engineering careers at the high school, undergraduate and graduate levels. And so, the foundation will be laid for the next generation of learners, explorers and researchers.

Haiying (Helen) Shen

A new efficient and cooperative large-scale distributed data sharing system



Data sharing is the answer to a wide array of information technology woes, which is why millions of dollars are spent on commercial servers to deliver data. **Haiying (Helen) Shen**, associate professor of electrical and computer engineering, whose work is at the forefront of computing design, is working to improve these types of data sharing systems.

There's peer-to-peer technology, which allows user computers to cooperate with one another and share content between themselves. But this is an expensive solution, in many cases. Although there are opportunities to find cost savings, Shen argues that wider use of peer-to-peer technology is held back by several limitations. "One is that nodes may misbehave, selfishly receiving content but not contributing in return, or distributing corrupted or malicious content into the system, to be further spread by unsuspecting users," she explains. "Another limitation is that locating content is difficult, due to the wide distribution of nodes and the lack of a central index."

Shen's CAREER project seeks to address these limitations by making use of information obtained from something most everyone is familiar with these days: social networks. Shen is investigating how information from social networks may be used to create efficient and cooperative large-scale distributed data sharing systems — systems that support many social, commercial and cultural activities.

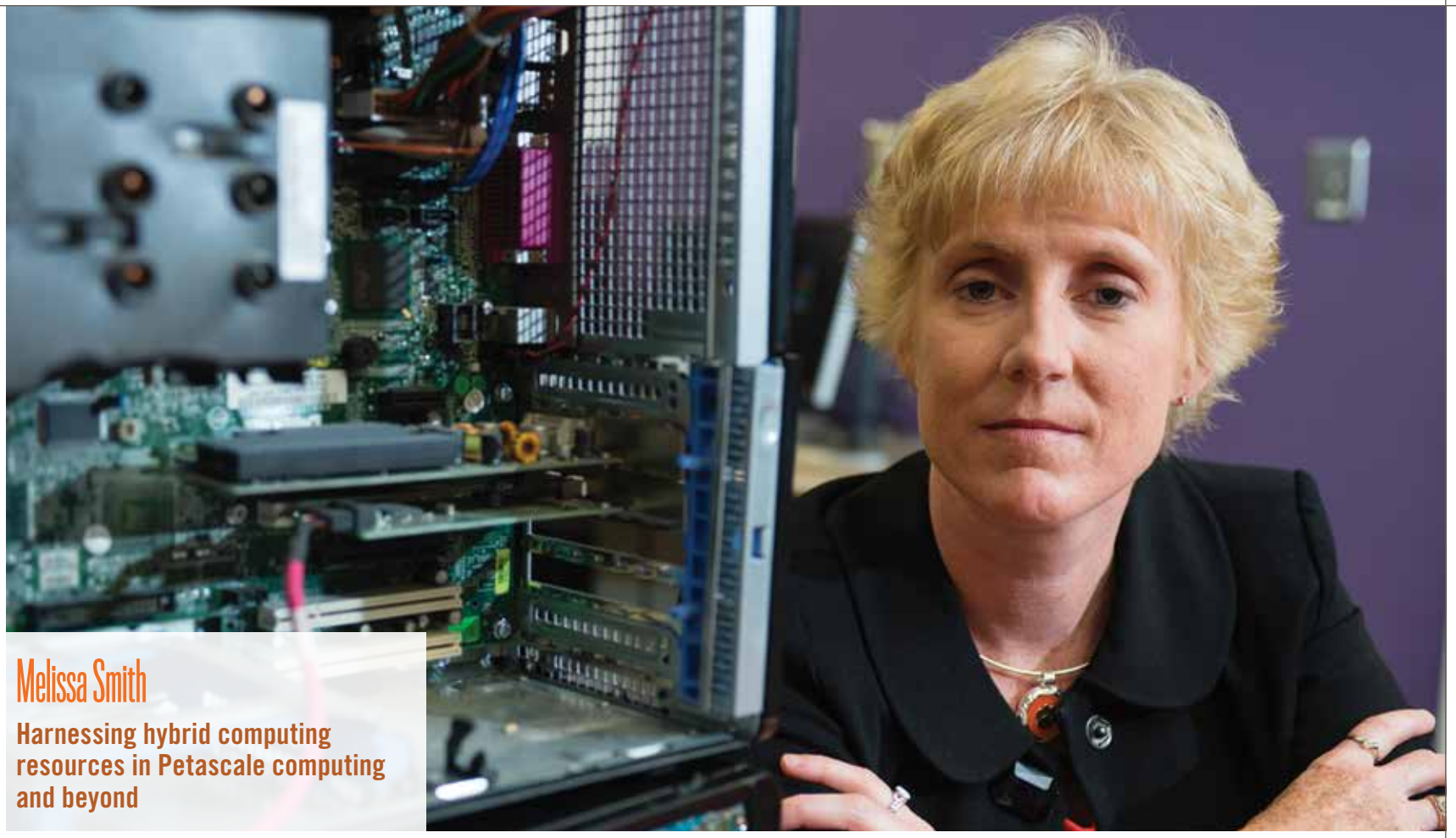
In 2010, Shen won a $200,000 Microsoft Research Faculty Fellowship grant for her work in distributed computing. Her research has spanned peer-to-peer and content-delivery networks, cloud computing, mobile computing and wireless sensor networks. Her CAREER grant will allow her to continue efforts to improve information accessibility worldwide while bettering supercomputing capability.

She hopes to address two primary challenges facing existing large-scale distributed systems that use the Internet to deliver a variety of data (including software and audio-video content) to end users: locating data quickly and cost-efficiently, and enforcing cooperative node behaviors.

"Social network-based approaches seek to build social networks into data sharing systems in order to leverage the real-world friend properties of mutual trust and common interest," she offers. "Current methods only make use of a very superficial level of social network properties, and cannot support the broad goal of enabling all nodes to share data freely and efficiently."

Shen's project addresses these shortcomings. Areas of investigation include infrastructures for data searching, cooperation enhancement mechanisms and algorithms for data server selection. Potential benefits of the work include savings in the costs of infrastructure and energy consumption for data distribution.

Ample educational opportunities for graduate and undergraduate students are part of Shen's project, which also collaborates with other educational programs for underrepresented student recruitment. Along with outreach to K-12 students, the project could forever change the way we share information.



Melissa Smith

Harnessing hybrid computing resources in Petascale computing and beyond

The world's fastest computers process so quickly, their calculations are measured in something called petaflops: One petaflop is a thousand trillion calculations per second.

But big computers require huge memories and equally massive amounts of storage. That means they also require big performance solutions.

That's where **Melissa Smith** comes in. The associate professor of electrical and computer engineering has received a CAREER grant to research heterogeneous supercomputing systems and new approaches that are essential for the efficient use of this raw computing power "to develop, deploy and optimize large-scale applications." The grant will support a "rigorous study of hybrid computing systems to formulate a modeling framework useful for managing and optimizing large-scale applications running on heterogeneous, multi-paradigm systems."

In 2004, Smith started collaborating with the then-newly formed Future Technologies Group at the Oak Ridge National Laboratory where she conducted research on emerging computing architectures including reconfigurable computers, multi-core and optical processors. She joined Clemson in 2006, but she has continued to collaborate with some of the top research scientists at ORNL and across the country in areas of heterogeneous high-performance computing, distributed sensor networks, system performance modeling and analysis, and high-speed data acquisition systems.

Smith's proposed methods for optimizing and accelerating applications on heterogeneous computing systems are expected to substantially impact the field of large-scale computing beyond the application areas demonstrated in the research.

"The study focuses on the inter-node parallelism of the applications across a mix of heterogeneous nodes and the intra-node parallelism on the multi-paradigm nodes," her proposal explains.

Smith has already taken her field of study to some of the youngest students accessible: She initiated the Clemson Elementary School Future Engineers program in 2008. Her CAREER grant incorporates outreach aimed at this youngest generation of emerging engineers, and it aims to generate educational modules suitable for classroom use in the undergraduate and graduate curriculum. Honors undergraduate thesis and Creative Inquiry programs will also have access to her work. Ultimately, she hopes to attract more women and minority students to her research and the field of engineering.

News from Around the College

CES students awarded Goldwater Scholarships

Two Clemson students have been awarded the Barry M. Goldwater Scholarship for Excellence in Science, Mathematics and Engineering, and a third has received an honorable mention.

Scott Cole, a junior bioengineering major from Williamstown, N.J., and **Julie Robinson**, a junior chemical engineering major from Cary, N.C., were awarded scholarships. **Brenden Roberts**, a junior physics major from West Columbia, was given an honorable mention.

Each year, colleges and universities nominate four juniors or sophomores to receive the scholarship. Over the past five years, 13 Clemson students have won a scholarship and five have been named honorable mentions. This year, 271 scholarships were awarded from 1,107 nominations.

The Goldwater Scholarship covers the cost of tuition, room and board, fees, and books, up to a maximum of $7,500 for an academic year. The federally endowed scholarship program is designed to encourage outstanding students to pursue careers in the fields of mathematics, the natural sciences and engineering.

Scott Cole


Julie Robinson


Brenden Roberts


Brian Powell (left)

Powell receives DOE Early Career Award

Environmental engineering and earth sciences assistant professor **Brian Powell** has received a 2013 Early Career Research Award from the Department of Energy. These awards support the research programs of outstanding scientists early in their careers and stimulate research in the disciplines supported by the DOE Office of Science. Powell's award will fund his "Examination of Actinide Chemistry at Solid-Water Interfaces to Support Advanced Actinide Separations." This study of the chemical and physical properties of actinide bonding and reactivity is essential for the development of an improved nuclear fuel cycle by understanding how radioactive elements move through the environment.

NSF sponsors Clemson "Smart Grid" research

Duke Energy Distinguished Professor **Ganesh Venayagamoorthy** received a National Science Foundation grant to fund his research in smart grid optimization and intelligent control. The electrical and computer engineering professor is developing advanced computational intelligence methods to monitor, optimize and control large areas of a power network. His project, "Computational Intelligence Methods for Dynamic Stochastic Optimization of Smart Grid Operation with High Penetration of Renewable Energy," will include solar farms and wind farms and controllable network transformers. The behavior of renewable energy sources is uncertain and variable, and it is difficult for current static optimization methods to efficiently utilize these energy resources in a smart grid power system. Venayagamoorthy's project proposes a novel controller that will help provide economical, reliable and secure power systems that can accommodate renewable energy sources.


Miguel Larsen

Clemson's Larsen makes the Top 100

When *Discover* magazine named its Top 100 science stories for 2012, earlier this year, **Miguel Larsen** came in at No. 85. Clemson physicist Larsen, and his colleague, **Gerald Lehmacher**, led a team known as the Anomalous Transport Rocket Experiment (ATREX). This group monitors tracers from suborbital NASA rockets to gather information about the hard-to-study upper jet stream. Their work will allow scientists to better model electrical activity that can interfere with signals from satellites and spacecraft.

"Our overall focus is on the classical understanding of how our atmosphere works," Lehmacher says. "We are still discovering the natural processes of our world, and that kind of knowledge generation is exciting because it connects physical theory with dynamics at the edge of space."

To find the full article, visit *discovermagazine.com*.

Clemson's "Brewcovery" team includes (from left to right): Holly Garret, Alex Pellett and David Thornton. Faculty adviser, Terry H. Walker, is not pictured.

Clemson cooks up second place in business plan competition

Clemson placed second in the ACC Clean Energy Challenge, a business plan competition encouraging students to develop business plans for new clean energy companies. Focus areas included renewable energy, energy efficiency improvements and advanced fuels/vehicles. The Clemson "Brewcovery" team developed a bio-separation and bio-digestion system to create energy and additional products from food industry and brewery waste while reducing the carbon footprint of these facilities. Brewcovery's team includes biosystems engineering graduate student **David Thornton**, sustainable agriculture graduate student **Alex Pellett**, environmental engineering alumna **Holly Garret** and **Terry H. Walker**, professor, biosystems engineering.

Clemson supercomputer is fifth among U.S. universities

Clemson University's Palmetto Cluster ranks fifth on the list of university-owned supercomputers in the United States, according to the June 2013 Top500 list of international supercomputers.

"Clemson is on the move in a big way," said **Jim Bottum**, Clemson's vice provost and chief information officer. "This ranking shows tremendous progress toward Clemson's goal of becoming a top-20 public university; but even more important is how this enables and empowers our faculty, students and staff to conduct competitive, engaging and collaborative work in a global environment." Bottum said he was brought to Clemson to build a world-class cyberinfrastructure for education, research and service. However, he maintains that enabling learning and discovery is more than just offering compute cycles; it requires creating a collaborative environment where IT specialists work in partnership with faculty and students to create an advanced cyberinfrastructure that serves the needs of a multidisciplinary set of programs. The Palmetto Cluster is an example of the collaborative partnerships driving Clemson's progress.

For more information, visit *citi.clemson.edu/palmetto* or to see the full list, go to *top500.org/list/2013/06*.

Gilbert demonstrates accessible voting technology on Capitol Hill

Clemson University researchers recently showed lawmakers on Capitol Hill an electronic voting system that can help resolve current technological challenges at the polls and restore voter confidence.

Professor **Juan Gilbert**, Presidential Endowed Chair in Computing, leads the human-centered computing division in the School of Computing at Clemson. He developed "Prime III" to ensure voting accessibility for all people, including individuals with disabilities.

Prime III allows voters to cast ballots by touch and/or by voice. The voting technology also produces old-fashioned simplicity with paper ballots for backup verification.

"It's a universal design that makes it usable by as many people as possible, regardless of their age, ability or situation," Gilbert said. "You don't have a disability machine, but one single voting machine."

Juan Gilbert (left) shows U.S. Rep. James Clyburn the Prime III accessible voting technology.

News from Around the College

WISE honored for girls' engineering program

Clemson University's Women in Science and Engineering Program (WISE) has received the 2013 National Engineers Week Foundation and Women in Engineering Programs and Advocate Networks (WEPAN) Introduce a Girl to Engineering Award. The award honors organizations for outstanding outreach efforts as a part of National Engineers Week and Introduce a Girl to Engineering Day.

WISE encourages females in engineering and science majors to prepare for, obtain and succeed in their careers by offering mentoring, advising and networking opportunities.

"The award is a national seal of approval," said **Serita Acker**, director of the WISE program. "With Clemson being the top engineering school in South Carolina, it shows that we have a strong desire for diversity and want to expose everyone to opportunities in engineering, science and math."

WISE collaborated with Lockheed Martin, a global security and aerospace company, and Girl Scouts from Mountains to Midlands to present its 13th annual Introduce a Girl to Engineering and Science Day.

Established in 1990, WEPAN is a national not-for-profit organization that works to transform culture in engineering education to attract, retain and graduate women.

Fluor gift supports industrial engineering graduate program

Clemson University's industrial engineering graduate program will increase its scope internationally, a direct benefit of Fluor Corporation's philanthropic foundation, which has committed $1.5 million in its continuing support of the University.

The Fluor Foundation gift will establish the Fluor-Clemson International Capital Projects Supply Chain Partnership Endowment, funding additional applied research in broader global geographic areas of the world, including India, China and the rest of the Asia-Pacific region.

"This gift is a great example of an innovative partnership between academia and industry that benefits not only our students, but also could have an impact on industry around the world," said Clemson University President James F. Barker. "This positions Clemson to have the premier program in supply chain logistics not just nationally, but internationally."

Clemson's successful Master of Engineering program in capital project supply chain and logistics, within the industrial engineering department, will benefit from the increased global reach by the addition of region-specific content to the curriculum and attracting a more diverse student population.

Urban named to Sirrine Endowed Chair

Clemson University's College of Engineering and Science has named **Marek W. Urban** to the J.E. Sirrine Textile Foundation Endowed Chair in Advanced Fiber-Based Materials.

Urban came to Clemson from the University of Southern Mississippi's School of Polymers and High Performance Materials, where he was a professor of polymer science and engineering. There, he directed the National Science Foundation-funded Materials Research Science and Engineering Center (MRSEC), which focuses on response-driven polymeric films. He also serves on the NSF Executive Committee for MRSECs in the U.S. Urban is an active member of numerous professional organizations including the American Chemical Society, American Institute of Physics, Federation of Societies for Coatings Technologies, American Association for the Advancement of Sciences and the Society for Applied Spectroscopy.

He has a prolific record of publication, and his research has been featured in numerous media outlets, including *The New York Times*, *Forbes* Magazine, BBC, NBC, Discovery Channel and *USA Today*.

Leadership Changes

The College of Engineering and Science began the 2013-14 academic year with new faces in key leadership positions.

Jim Coykendall is the new chair of the Department of Mathematical Sciences. He comes to Clemson from North Dakota State University where he has worked since 1996 and served as the James A. Meir Professor since 2003. He was associate chairman of math for three years and chaired the department from 2007 to 2009. His research interests include commutative algebra and number theory. Coykendall earned a bachelor's degree with honors from the California Institute of Technology and a Ph.D. from Cornell University.

Chemistry professor **R. Karl Dieter** is now serving as chairman of the department. Before joining the Clemson faculty in 1985, he was an assistant professor of chemistry at Boston University. He was an American Cancer Society Postdoctoral Fellow at Cornell University and has spent much of his career at the intersection of discovery and medicine. He is recognized as a leading scientist in organocopper chemistry, having developed a special class of organocuprate reagents that play a powerful role in pharmacology research.

In the current academic year, **Mark D. Leising** will be serving as the chair of the Department of Physics and Astronomy. Interim chairman since 2011, Leising first joined the Clemson faculty in 1991 but has served sabbatical appointments at the Max Planck Institut für Extraterrestrische Physik in Germany (1997-1998) and the Observatoire du Midi-Pyrénées /CESR in France (2005). His research is focused on gamma-ray astrophysics, supernovae, classical novae and nuclear astrophysics. He has authored or co-authored scores of journal articles and served on NASA and NSF peer review panels 13 times.

James Martin has been appointed chair of the Glenn Department of Civil Engineering. Martin comes from Virginia Tech, where he was professor of civil and environmental engineering and director of the Disaster Risk Management Institute, which reaches across disciplinary boundaries to address emerging global disaster risk and resilience challenges. His primary research and teaching interests include geotechnical earthquake and foundation engineering, soil and site improvement, seismic hazard analysis and thermo-active foundations. He has directed field and laboratory engineering research programs for more than 20 years.

Rajendra "Raj" Bordia has been named chair of the materials science and engineering department. He comes to Clemson from the University of Washington. Previously he was a research scientist in the central research and development department of DuPont. He earned an undergraduate degree at the Indian Institute of Technology in Kanpur and holds master's and doctorate degrees from Cornell University.

Bordia's research focuses on fundamental and applied studies in the processing and properties of complex material systems, primarily ceramics, for energy, environment, health and high-temperature applications.

E-magine Your Future

Clemson University hosted more than 350 middle school and high school students, parents and teachers at the second annual E-magine Your Future this spring at Clemson's Memorial Stadium.

The program is designed to inspire middle and high school students to consider a degree in engineering and science. College of Engineering and Science student organizations and departments challenged the middle and high school participants with 12 hands-on activities, including building stents, creating circuits, understanding why planes fly, how buildings can be made to withstand vibrations and the use of cryptography.

CES faculty and recruiters also encouraged students to begin their academic preparations in middle and high school to create a seamless transition to college and maximize their chance of success.

Sponsors of the program include Clemson University, Clemson University's Center for Workforce Development, Greenville County Schools, Greenville Regional Education Center and Roper Mountain Science Center.

For more information, contact Scott Schiff at *schiffs@clemson.edu* or Brad Putman at *putman@clemson.edu* or go to *clemson.edu/emagine.*

Martine LaBerge, former acting dean, congratulates the 2013 Thomas Green Clemson Academy inductee, Bryant Barnes (left), and Outstanding Young Alumnus, Thomas Macdonald.

Clemson honors three at annual banquet

Clemson University's College of Engineering and Science recently inducted a new member into its prestigious engineering and science academy and recognized two young alumni. At the 18th annual engineering and science banquet, the Thomas Green Clemson Academy of Engineers and Scientists welcomed Bryant G. Barnes to its distinguished ranks. Barnes graduated from Clemson University in 1976 with a bachelor's degree in electrical and computer engineering. Three years later, he earned a master's degree in business administration from the University of South Carolina.

Barnes had begun working for the Rock Hill Telephone Company in his teens — sweeping floors, cleaning equipment and recycling telephones. In 1979, he began his professional career with the company, which today is known as Comporium. He was elected president in 2002, and a year later he assumed the additional role of chief executive officer.

Barnes was instrumental in helping to establish the Optoelectronics Research Center of Economic Excellence in Clemson's Holcombe Department of Electrical and Computer Engineering. He is currently a member of the Clemson University Foundation Board of Directors, and he is a tireless ambassador for the College of Engineering and Science, keeping other constituents informed about the progress and needs of the academic departments.

During the banquet, the college also honored two former students with its Outstanding Young Alumni Award. The 2013 honorees are Thomas G. Macdonald and Rakchart Traiphol.

Macdonald received two Clemson degrees, the M.S. and Ph.D. degrees in electrical engineering in 1998 and 2001, respectively. As a graduate student, he excelled both as a researcher and as a leader among campus peers. Recognition of his excellence in research included the only Armed Forces Communications and Electronics Association Fellowship awarded anywhere in the country in 1998. Today, Macdonald leads the Advanced SATCOM Systems and Operations Group in the Communications Systems and Cyber Security Division at the MIT Lincoln Laboratory. The group plays a significant role in the synthesis, design, development and testing of the nation's protected satellite systems.

Traiphol earned his doctorate in chemistry in 2003 and returned to Thailand to join the faculty of Naresuan University, where today he is a tenured assistant professor of chemistry. He has established a vibrant, internationally recognized research effort in the physical chemistry of light-emitting and absorbing polymers. Traiphol has authored or co-authored more than 30 peer-reviewed journals and has won multiple awards from Naresuan University and the National Research Council of Thailand. Traiphol has maintained ongoing connections to Clemson by raising the funds to provide yearlong fellowships for several graduate students from Thailand to study here.

Martine LaBerge, former acting dean of Clemson's College of Engineering and Science, observed, "Those singled out for inclusion in the academy and recognized as Outstanding Young Alumni illustrate what can be attained through diligent application of talent, hard work and dedication. We are extremely proud of all of these honorees."

McClam receives double honor

Marguerite McClam, a 1992 civil engineering graduate, has been named the 2013-14 president of the South Carolina Society of Professional Engineers, and she has been recognized as a Fellow of the National Society of Professional Engineers. Established in 2000, the Fellows program recognizes professional engineers who provide long-term service at the chapter, state and national levels of the society, as well as to the profession and the community. McClam is the first woman from South Carolina to be presented with this esteemed honor.

She currently is the president and owner of the Palmetto Consulting Engineering Group Inc. The firm provides planning, design and engineering consulting services to support a community's infrastructure needs. This includes water supply and distribution; wastewater treatment and collection; storm water management; land planning and zoning assistance; and environmental permitting and compliance for water, land and air.

McClam has been an instrumental and important volunteer of MathCounts at the local, state and national levels. She served as a Columbia and South Carolina coordinator, acted as a National Head Scorer and sits on the MathCounts National Board of Directors. MathCounts is an organization that provides fun and challenging math programs for U.S. middle school students to increase their interest in, and aptitude for, mathematics.

McClam received the SCSPE Young Engineer of the Year Award in 1998 and 12 years later was named SCSPE Engineer of the Year.

From there and back again

Michelle Minus Mapp '91

Engineering analysis graduate Michelle Mapp began her career with the U.S. Navy as a research analyst for the commission that eventually ordered the Navy base in North Charleston closed.

Twenty years later, she finds herself working in a former naval supply building on the old base site.

Mapp is executive director of the Lowcountry Housing Trust, a nonprofit community development organization that finances affordable housing efforts in a five-county area. The driving focus of the trust is to stabilize neighborhoods by constructing homes for people with middle-class or low incomes.

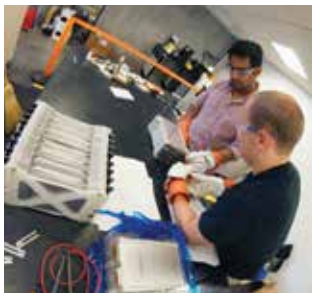
The pathway that took the Charleston native from there and back again was one of life-expanding opportunities that fueled her passion to use her experience and knowledge to better the world along the way. Mapp has earned master's degrees in engineering management and public administration. She's worked with computer software and logistics companies, and even taught math in high school through South Carolina's Program of Alternative Certification for Educators.

As a result of that teaching experience, Mapp began to see a role she could play in helping to improve communities and housing opportunities in the area. Her work with the trust has expanded to healthy food initiatives in an area that includes Beaufort, Berkeley, Charleston, Dorchester and Georgetown counties.

"Clemson prepared me to be so much more than just an engineer," she shares. "It prepared me to be a very well-rounded professional no matter the career path I would ultimately take."

She attributes her participation in the University's Program for Engineering Enrichment and Retention (PEER) as an important influence in her success, and she served as a mentor in the program as a result of learning the value of giving back.

Departments



Automotive Engineering

Imtiaz Haque, Ph.D.
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clemson.edu/centers-institutes/cu-icar

Fast Facts

Tenured/tenure-track faculty: 14

Enrollment: (Spring 2013)

Undergraduate	0
Master's	116
Doctoral	44

Degrees awarded: (12/12; 5/13)

Undergraduate	0
Master's	11
Doctoral	8

Research expenditures: $2 million

Research thrusts: systems integration, vehicle manufacturing, vehicle design and development, vehicular electronics

Bioengineering

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Fast Facts

Tenured/tenure-track faculty: 20

Enrollment: (Spring 2013)

Undergraduate	269
Master's	35
Doctoral	83

Degrees awarded: (12/12; 5/13)

Undergraduate	63
Master's	24
Doctoral	6

Research expenditures: $7 million

Research thrusts: biomaterials engineering, bioelectrical engineering

Chemical and Biomolecular Engineering

Douglas Hirt, Ph.D.
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Fast Facts

Tenured/tenure-track faculty: 12

Enrollment: (Spring 2013)

Undergraduate	184
Master's	0
Doctoral	35

Degrees awarded: (12/12; 5/13)

Undergraduate	36
Master's	0
Doctoral	1

Research expenditures: $2 million

Research thrusts: advanced materials, kinetics and catalysis, energy, chemical and biochemical separations, molecular modeling and simulation, biosensors and biochips

Chemistry

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Fast Facts

Tenured/tenure-track faculty: 33

Enrollment: (Spring 2013)

Undergraduate	144
Master's	2
Doctoral	86

Degrees awarded: (12/12; 5/13)

Undergraduate	22
Master's	0
Doctoral	6

Research expenditures: $3.6 million

Research thrusts: analytical, inorganic, organic physical chemistry, chemical education, interdisciplinary and nontraditional areas: polymer and materials chemistry, solid-state chemistry, bioanalytical chemistry, bioorganic and medicinal chemistry, computational chemistry, chemical physics

Glenn Department of Civil Engineering

James R. Martin, Ph.D.
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Fast Facts

Tenured/tenure-track faculty: 23

Enrollment: (Spring 2013)

Undergraduate	435
Master's	72
Doctoral	56

Degrees awarded: (12/12; 5/13)

Undergraduate	141
Master's	41
Doctoral	5

Research expenditures: $3 million

Research thrusts: sustainable and resilient infrastructure

School of Computing

Robert M. Geist III, Ph.D.
Interim Director

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Fast Facts

Tenured/tenure-track faculty: 38

Enrollment: (Spring 2013)

Undergraduate	412
Master's	134
Doctoral	68

Degrees awarded: (12/12; 5/13)

Undergraduate	61
Master's	67
Doctoral	3

Research expenditures: $1.7 million

Research thrusts: computing foundations, data analytics, software engineering, cyberinfrastructure, networking, bioinformatics, computer graphics and animation, eye tracking, visualization, digital arts, intelligent and interactive systems, identity science and affective computing, virtual environments, human/computer interaction, pedagogical tools using tablet PCs and handheld devices

Holcombe Department of Electrical and Computer Engineering

Darren Dawson, Ph.D.
Department Chair

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Fast Facts

Tenured/tenure-track faculty: 33

Enrollment: (Spring 2013)

Undergraduate	452
Master's	78
Doctoral	85

Degrees awarded: (12/12; 5/13)

Undergraduate	95
Master's	26
Doctoral	9

Research expenditures: $2.8 million

Research thrusts: optoelectronics, cyberinfrastructure, wireless communications, computer networks, nanoelectronic materials processing, biochips, semiconductor lasers, optical systems, integrated circuit design, high-performance computing, computer security, robotics, image processing, biological modeling, situation and threat assessment, power systems

Engineering and Science Education

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Fast Facts

Tenured/tenure-track faculty: 5

Enrollment: (Spring 2013)

Undergraduate	0
Master's	0
Doctoral	8

Degrees awarded: (5/12)

Undergraduate	0
Master's	0
Doctoral	1

Research expenditures: $325,000

Research thrusts: student motivation, problem solving, equity and gender issues in STEM disciplines, physics identity development, modeling of large-scale data, social capital, students' academic and career development and success

Environmental Engineering and Earth Sciences

Tanju Karanfil, Ph.D.
Department Chair

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tkaranf@clemson.edu

clemson.edu/ces/eees

Fast Facts

Tenured/tenure-track faculty: 23

Enrollment: (Spring 2013)

Undergraduate	167
Master's	73
Doctoral	36

Degrees awarded: (12/12; 5/13)

Undergraduate	37
Master's	14
Doctoral	3

Research expenditures: $2.6 million

Research thrusts: environmental chemistry, environmental fate and transport, hydrogeology, nuclear environmental engineering and science, biosystems engineering, process engineering, sustainable systems

Industrial Engineering

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Fast Facts

Tenured/tenure-track faculty: 11

Enrollment: (Spring 2013)

Undergraduate	262
Master's	142
Doctoral	31

Degrees awarded: (12/12; 5/13)

Undergraduate	70
Master's	42
Doctoral	6

Research expenditures: $1.5 million

Research thrusts: supply chain optimization and logistics, human factors and safety in health care and in technologically complex environments, education and learning systems

Departments

Materials Science and Engineering

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clemson.edu/mse

Fast Facts

Tenured/tenure-track faculty: 16

Enrollment: (Spring 2013)

Undergraduate	98
Master's	9
Doctoral	46

Degrees awarded: (12/12; 5/13)

Undergraduate	25
Master's	6
Doctoral	7

Research expenditures: $5.3 million

Research thrusts: manufacturing, characterization and structure/property/performance relationships of ceramics, glasses, polymers, photonics/optics, fiber-based materials, thin films, metals

Mathematical Sciences

Jim Coykendall, Ph.D.
Department Chair

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Fast Facts

Tenured/tenure-track faculty: 67

Enrollment: (Spring 2013)

Undergraduate	163
Master's	29
Doctoral	95

Degrees awarded: (12/12; 5/13)

Undergraduate	34
Master's	14
Doctoral	5

Research expenditures: $827,320

Research thrusts: algebra and discrete mathematics, applied analysis, biomathematics, computational mathematics, experimental statistics, operations research, probability and statistics

Mechanical Engineering

M.K. "Ram" Ramasubramanian, Ph.D.
Department Chair

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Fast Facts

Tenured/tenure-track faculty: 27

Enrollment: (Spring 2013)

Undergraduate	619
Master's	87
Doctoral	63

Degrees awarded: (12/12; 5/13)

Undergraduate	136
Master's	32
Doctoral	5

Research expenditures: $1.6 million

Research thrusts: transportation, energy, design, materials, manufacturing, fluids, complexity, multi-scale modeling

Physics and Astronomy

Mark Leising, Ph.D.
Department Chair

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Fast Facts

Tenured/tenure-track faculty: 27

Enrollment: (Spring 2013)

Undergraduate	83
Master's	10
Doctoral	54

Degrees awarded: (12/12; 5/13)

Undergraduate	11
Master's	8
Doctoral	5

Research expenditures: $2 million

Research thrusts: astronomy and astrophysics, atmospheric and space physics, materials physics, surface physics, theoretical quantum physics

50 FOR 50

Clemson's College of Engineering and Science is grateful to all the donors, both individual and corporate, who have invested significant capital in the college to endow faculty positions. Endowed faculty positions make each department within our college more attractive to potential candidates and provide annual income to the faculty members for research, travel and professional development. But we're not done! Our strategic plan for the college calls for 50 new Distinguished Professors, which will allow us to recruit and retain the highest quality faculty members to engineering and science. Our students deserve the best and our stakeholders expect it. Let's get going!

Faculty Name	Title
Murray Daw	Robert Adger Bowen Professor in Physics
Apparo Rao	Robert Adger Bowen Professor in Physics
OPEN*	Robert Adger Bowen Professor of Environmental Engineering
Narendra Vyavahare	Hunter Endowed Chairs of Bioengineering (shared)
Darren M. Dawson	McQueen Quattlebaum Professor of Electrical and Computer Engineering
Ronnie Chowdhury	Eugene Douglas Mays Professor of Transportation Engineering
C. Hsein Juang	Glenn Professorship in Civil Engineering
-	Alumni Distinguished Professor of Chemistry
William F. Moss	Alumni Distinguished Professor of Mathematical Sciences
Terry Tritt	Alumni Distinguished Professor of Physics & Astronomy
OPEN*	Westinghouse Distinguished Scientist of Environmental Systems Engineering
Paul Venhovens	BMW Endowed Chair in Systems Integration
OPEN*	BMW Endowed Chair in Manufacturing
OPEN*	J. E. Sirrine Textile Foundation Endowed Chair of Optical Fibers
Marek Urban	J. E. Sirrine Textile Endowed Chair in Advanced Fiber-Based Materials
Zoran Filipi	Timken Trustee Chair for Design and Development in CU-ICAR
Todd Hubing	Michelin Chair of Vehicular Electronics
OPEN*	Hansjorg Wyss Endowed Chair for Regenerative Medicine
OPEN*	Thomas F. Hash Endowed Chair in Sustainable Development
Scott Mason	Fluor Corporation Endowed Chair in Supply Chain and Logistics
OPEN*	C. Tycho Howle Chair in Collaborative Computing Environments
Karen Burg	Hunter Endowed Chairs of Bioengineering (shared)
Denis Brosnan	George J. Bishop, III Endowed Chair in Ceramic & Materials Engineering
Michael Pursley	Milton W. and Betty M. Holcombe Chair in Electrical and Computer Engineering
Ya-Ping Sun	Frank Henry Leslie Endowed Chair of Natural Sciences
Georges Fadel	ExxonMobil Employees Chair in Engineering
Eric G. Johnson	Comporium and Palmetto Net Chair of Optoelectronics

Faculty Name	Title
Robert A. Latour, Jr.	McQueen-Quattlebaum Professor
Timothy Devol	Toshiba Endowed Professorship in Nuclear Engineering
OPEN*	C. Tycho Howle Director of the School of Computing
Kumar Venayagamoorthy	Duke Energy Distinguished Professorship of Power Engineering
Elham Makram	SC Electric & Gas Professor of Power Engineering
OPEN*	S.E. Liles Jr. Distinguished Professor of Construction Engineering
David Zumbrunnen	Warren H. Owen-Duke Energy Assistant Professorship of Engineering
OPEN*	Warren H. Owen-Duke Energy Assistant Professor of Electrical and Computer Engineering
Melur Ramasubramanian	D.W. Reynolds Professor in Mechanical Engineering
Keith Corzine	Warren H. Owen-Duke Energy Distinguished Professorship of Electrical and Computer Engineering
	Bell Distinguished Professorship
Stephen Foulger	Gregg-Graniteville Endowed Professorship
OPEN*	Jerry E. and Harriett Dempsey Professorship of Waste Management
Mica Grujicic	Wilfred P. & Helen S. Tiencken Engineering Professorship
	Kentwool Distinguished Professorship in Natural Fibers
OPEN*	Ernest R. Norville Endowed Chair in Biomedical Engineering
Darryl Desmarteau	Tobey-Beaudrot Chaired Professor of Chemistry
Phillip Brown	J.R. Swetenburg, Sr. Professor of Textile Engineering
Amod Ogale	Dow Chemical Professor
Mark Thies	Dow Chemical Professor
Rajendra Singh	Houser-Banks Distinguished Professor
	David A. Brown '66 Endowed Scholar in Mechanical Engineering
OPEN*	Samuel R. Rhodes Professor of Electrical and Computer Engineering
OPEN*	SmartState Endowed Chair in Biofabrication Engineering
Richard Swaja	Endowed Chair in Regenerative Medicine at MUSC

*OPEN chairs and professorships have searches planned or under way.

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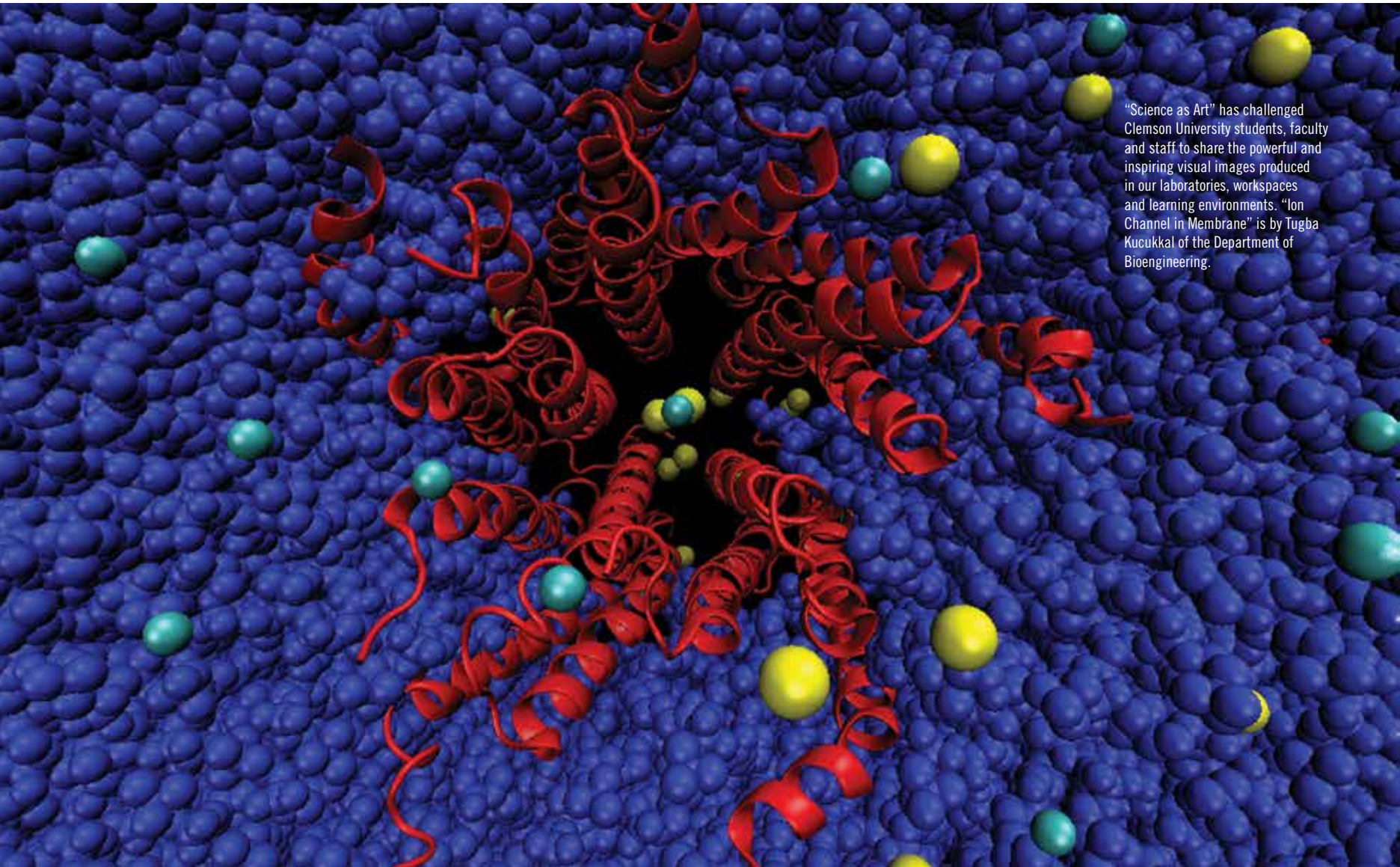

"Science as Art" has challenged Clemson University students, faculty and staff to share the powerful and inspiring visual images produced in our laboratories, workspaces and learning environments. "Ion Channel in Membrane" is by Tugba Kucukkal of the Department of Bioengineering.