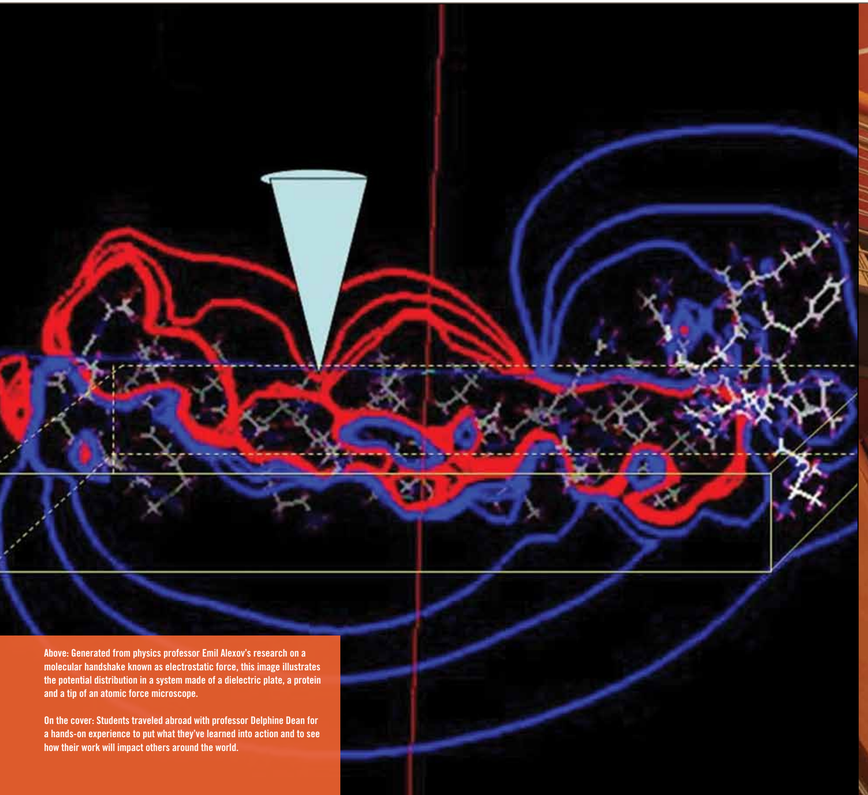
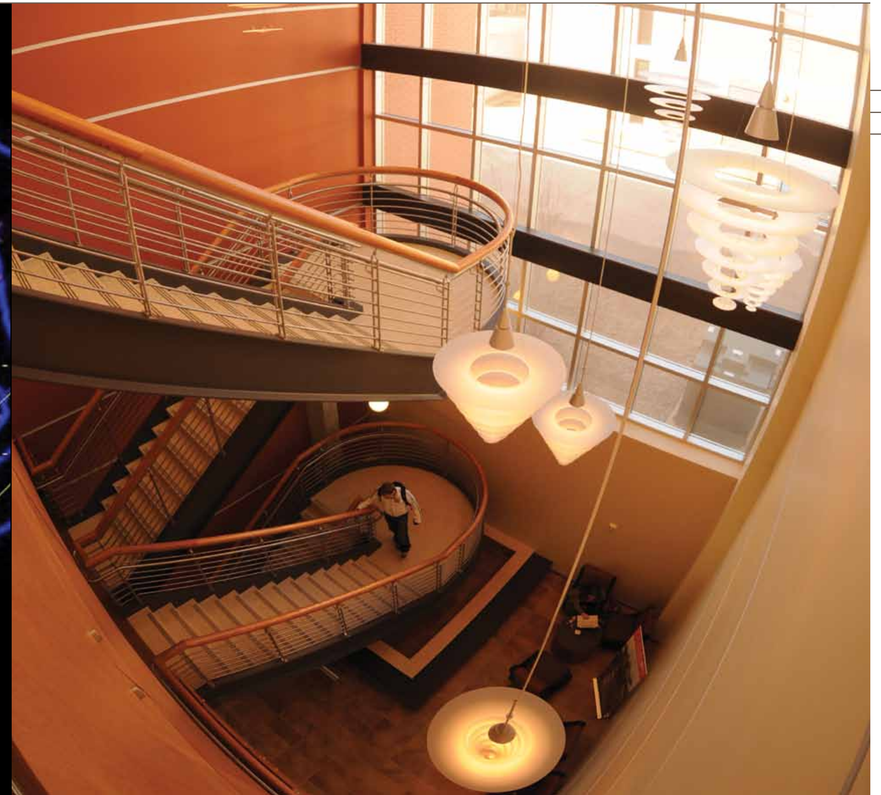


Above: Generated from physics professor Emil Alexov's research on a molecular handshake known as electrostatic force, this image illustrates the potential distribution in a system made of a dielectric plate, a protein and a tip of an atomic force microscope.

On the cover: Students traveled abroad with professor Delphine Dean for a hands-on experience to put what they've learned into action and to see how their work will impact others around the world.



IDEaS

INQUIRY, DISCOVERY IN ENGINEERING AND SCIENCE

COLLEGE OF ENGINEERING AND SCIENCE FALL 2011

in this issue:

CLEMSON
College of ENGINEERING AND SCIENCE

From the Dean

The 2011-12 academic year marks the beginning of an exciting journey for our University and college. The Clemson 2020 Road Map is a 10-year strategic plan that calls for investments in faculty hires, student engagement, upgraded facilities and technology, and faculty and staff compensation. Fulfilling Clemson's responsibility to students and South Carolina means

- generating talent for the new economy by recruiting and retaining outstanding students and faculty,
- providing an exceptional educational experience grounded in engagement,
- driving innovation — through research and service — that stimulates economic growth and solves problems,
- serving the public good by focusing on emphasis areas that address some of the great challenges of the 21st century — national priorities such as health, energy, transportation and sustainable environment.

The College of Engineering and Science (CES) is in a unique position to contribute to this plan. We like to think of ourselves as the "driving force" of Clemson's 2020 Road Map, and this edition of *IDEaS* explains why.

We like to think of CES as the "driving force" of Clemson's 2020 Road Map.

Our cover story speaks to two of the national priorities mentioned above — energy and sustainable environment. The Clemson University Wind Turbine Drivetrain Test Facility (CU-DTF) is currently under construction and will make significant contributions to this evolving industry while providing a number of positive outcomes for the state and the nation.

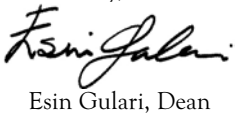
This edition also describes our new master's program in sustainable and resilient infrastructure. The new degree is an interdisciplinary program that blends civil engineering (including environmental issues), business, policy and architecture to provide a holistic perspective of the nation's infrastructure throughout its life.

Our "Clemson Couple" feature relates to the work being done by a married faculty-pair working in a joint bioengineering program of Clemson University and the Medical University of South Carolina. These two are seeking ways to improve health and well-being through the development of novel biomedical materials and scaffolds, biomedical device design, fabrication and testing, drug delivery, cellular/tissue engineering and stem cell biology.

Yet another feature describes the molecular electrostatic work of one of our biophysicists whose research is sponsored by a five-year, $2.2 million grant from the National Institute of General Medical Sciences, a part of the National Institutes of Health.

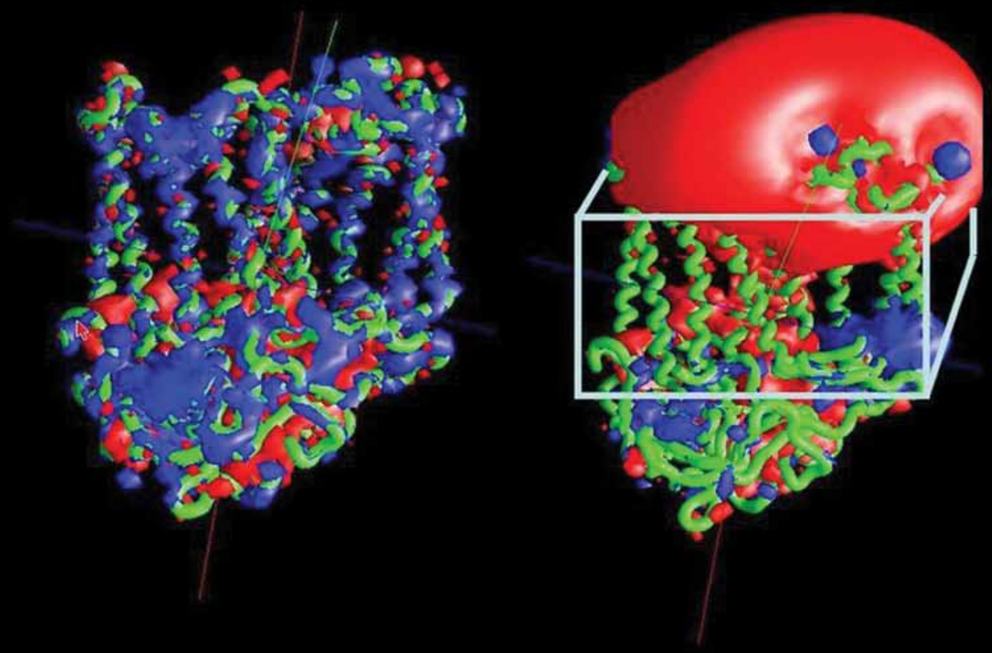
We are indeed on an exciting journey, and I'm looking forward to the ride.

Sincerely,



Esin Gulari, Dean
College of Engineering and Science
Clemson University

Molecular Handshakes



By Tom Hallman

Meandering about your body right now are billions of molecules, all going about their business and interacting with one another to make you — well, your biological system — work right.

Every now and then, one of those little interactions goes awry, and the resulting confusion can lead to big problems — including severe disease.

To get to the bottom of it all, scientists first need to understand more about the way these molecules interact. One such way is a kind of molecular handshake known as electrostatic force.

"Electrostatics is the major force between molecules," says Clemson biophysicist Emil Alexov, one of the scientists studying these interactions. "With that, you can understand how they function in the cell and how disease affects their functionality."

Molecules naturally carry tiny electrical charges, and scientists have been testing the effects of these charges ever since physicist J.J. Thomson discovered the electron in his work on cathode rays in 1897.

Applying those rules to the molecules in your body is more dicey, mainly because there are so many charged particles at work — and they're all moving targets.

"The living cell is a very complicated system comprised of biological macromolecules such as DNA, RNA and proteins," Alexov says. "They constantly interact with each other to maintain the function of the cell, and the driving force is the electrostatics.

"Each of these atoms has a charge, and they're all in water — not a homogeneous medium — so you're working with millions of atoms whose positions are not defined," he says. "Because of that, accurate calculations of electrostatic fields and energies are crucial for successful modeling of virtually all biological processes and many other phenomena occurring in nanosystems and nanodevices."

The software for Alexov's project, called DelPhi, was developed specifically to handle the math of the Poisson–Boltzmann equation.

Doing the Math

Predicting how electrostatic forces interact in the billions of molecules of your body boils down to one basic thing:

Math.

But to crunch the kind of numbers that Emil Alexov plugs into his software program requires considerably more processing prowess than most computers could ever muster.

No one scientist, in fact, is ever likely to have that kind of supercomputer hanging around his lab.

But Clemson does boast one of the country's — not to mention the world's — most powerful supercomputers. Called the Palmetto Cluster, it operates as a shared resource for faculty and student research.

Because it's shared, it's known as a "condominium" cluster: a large number of powerful multicore nodes, each with a significant amount of memory. A high-bandwidth connection between the nodes allows scientists to wield significant processing power on what is essentially a time-share basis — much like a beachfront condominium.

Ranked No. 96 on the June 2011 list of the Top500 Worldwide Supercomputing Sites, the performance of the Clemson Palmetto Cluster is rated at more than 115 trillion floating-point operations per second — aka teraFLOPS. It's jointly funded by the University and research grants secured by participating faculty, and the cluster is operated by Clemson Computing and Information Technology (CCIT).

Alexov's electrostatics research is one of the biggest users of the Palmetto Cluster. Other scientists who depend on that computing power include the following researchers:

Richard Miller's (mechanical engineering) research involves the large-scale simulation and modeling of turbulent air-hydrocarbon mixing and reaction at both atmospheric pressure and supercritical pressures relevant to modern and forthcoming gas turbines and diesel engines. Models are used in large eddy simulations, and probability density function methods are of particular interest.

Dvora Perahia's (chemistry) research takes a physical chemistry approach, which is applied to study the structure and dynamics of polymers and different complex fluids. Polymers with different properties are studied, including: polyelectrolytes, semifluoro polymeric liquid crystals, conducting polymers, rod-like highly conjugated polymers, and onodispersed di-block and tri-block co-polymers.

Paul Wilson (economics) uses the Palmetto Cluster to undertake computationally and data-intensive methods for nonparametric estimation that would have otherwise been impossible. The new resources are helpful for theoretical work aimed at developing new methods for estimation and inference about efficiency in production settings. Wilson is now able to apply these new methods while making more efficient use of the very large amounts of available data on U.S. commercial banks to examine industry structure.

To determine how all these charged particles will behave requires some complicated math. Based on nearly century-old mathematical theories, the Poisson-Boltzmann equation — a differential equation that describes electrostatic interactions — serves as the basis for Alexov's work. It allows scientists to calculate the corresponding energies for molecules and geometrical objects immersed in water or other solutions.

But to make that equation function on a scale necessary to study living organisms, where the stakes are high and the variables nearly infinite, you need a really big computer and some top-flight software.

Luckily for Alexov, the computer is located right on campus and is known as Clemson's Palmetto Cluster. It's ranked among the top 100 supercomputers in the world, and Alexov's research team is one of its largest users.

The software for his project, called DelPhi, was developed specifically to handle the math of the Poisson–Boltzmann equation. Alexov served for five years as senior researcher in the lab of its creator, Barry Honig of Columbia University. At Clemson, part of Alexov's work is to improve the software's speed and accuracy, continuously adapting the program so that scientists around the world may apply it to the rapidly changing areas of computational biophysics and bioinformatics.

It's all highly specialized, but in this field of research, he says, "It's the only way to get the job done."

"You couldn't achieve this with laboratory experiments," Alexov says. "If you had to do this experimentally in a lab, it would cost you a billion dollars. Modeling is much faster, much cheaper."

It has other benefits as well.

"With proper mathematical modeling, studies can be performed on a large number of cases so it will have more validity," according to Alexov. "In an experiment, the results are specific to the object you're studying, but we can apply this model to numerous cases to provide more reliable data."

An indication of the importance that scientists put on his work is the support Alexov has garnered. His research is sponsored by a five-year, $2.2 million grant from the National Institute of General Medical Sciences, a part of the National Institutes of Health. The project is an international collaboration with the Italian Institute of Technology.

The research is sponsored by a five-year, $2.2 million grant from the National Institute of General Medical Sciences.

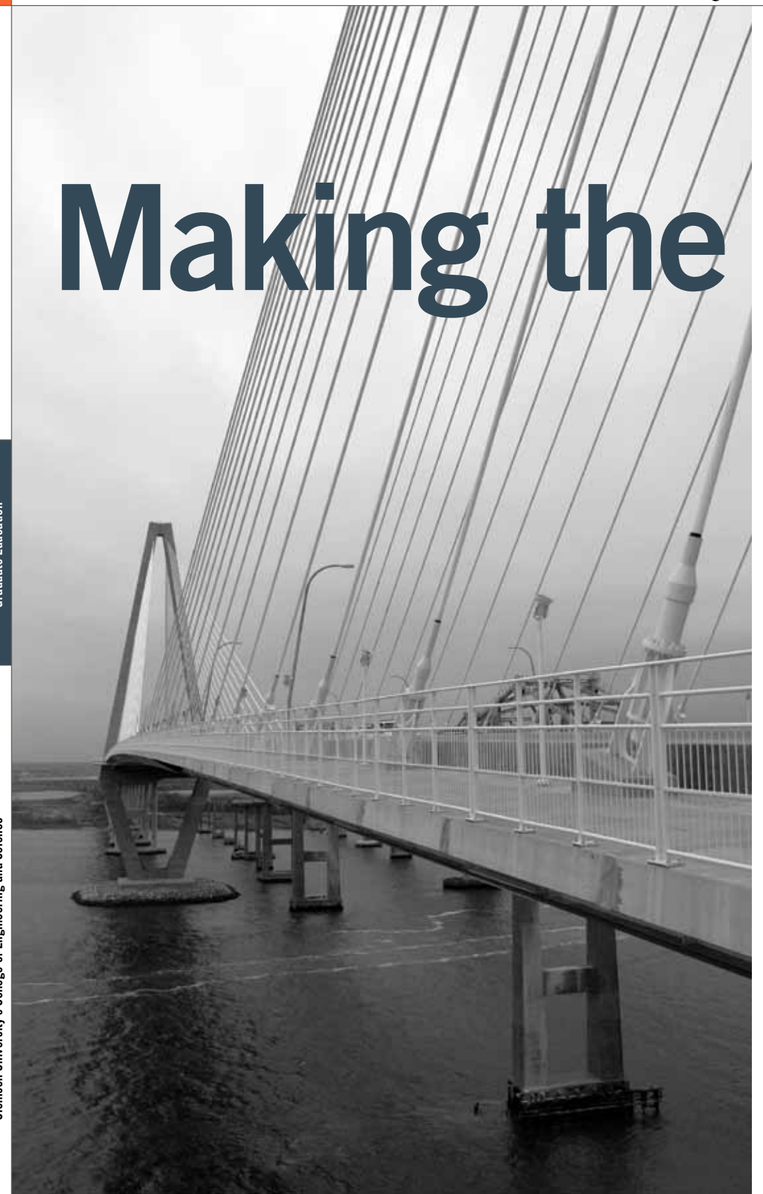
Ultimately Alexov's team, which includes several Clemson graduate and undergraduate students, will develop new capabilities in the DelPhi software to allow scientists to study areas previously inaccessible to them.

At the same time, they work directly with scientists engaged in laboratory experiments so they may better understand the molecular mechanisms of biological systems.

Portions of Alexov's work are devoted to estimating pKa values of amino acids, which play an important role in defining the characteristics of proteins, and probing disease-causing and missense mutations, which can keep proteins from functioning.

"Modeling is a very efficient and fast approach to deliver important biological information," Alexov says. "Currently we can calculate the electrostatic potential and the corresponding energies and carry detailed analysis of the structure-function relationships in a relatively short period of time. As this ability develops, it will help us shorten the time for developing new treatments for human diseases." *

Alexov reviews the results of his latest research with one of his graduate students.



Making the Grade

By Anne McKenzie-Jenkins

IN 2009, the American Society of Civil Engineers gave the U.S. infrastructure a whopping grade of D. If business as usual merits a D, it's going to take a lot more than studying harder to pull up that grade. But what exactly?

Creativity, innovation and ingenuity?

Cultural changes?

A paradigm shift?

A holistic approach?

Nothing less than a renaissance — driven by the determination and expertise of Clemson University?

In order to find the right answers, Clemson's civil engineering department introduced the Science Master's Program in Sustainable and Resilient Infrastructure (SMP) in the fall of 2010. Funded by a $700,000 National Science Foundation (NSF) grant, the cross-disciplinary program is an innovative approach to rebuilding our nation's infrastructure. With funding for 14 fellowships, the program seeks to

- prepare STEM graduate students to meet the national need for a more sustainable and resilient infrastructure,
- ensure that one-third of the 14 SMP-funded students are from underrepresented groups in STEM areas,
- establish a self-sufficient graduate program in sustainable and resilient infrastructure that will continue after NSF SMP funds end,
- facilitate internships and research experiences to address industry needs in sustainable and resilient infrastructure,
- develop and disseminate new knowledge in sustainable and resilient infrastructure through research and publications.

This cross-disciplinary approach to learning gives SMP students the chance to experience different specialty fields of study.


Chowdhury


Heine


Klotz


Lee


Pickett


Rangaraju

An advisory committee for the SMP composed of representatives from more than 15 private and public partners held their first meeting in December 2010, which also included Clemson SMP students and faculty representing civil engineering, environmental engineering, earth sciences, business management, ethics and policy, and architecture.

Response to the program has been immediate and enthusiastic — nine fellows spent the summer of 2011 in the field as interns, and five more fellows were fully engaged by fall 2011. "We're preparing a generation of engineers who will examine the nation's

Steering Team

Ronald D. Andrus
Principal Investigator
Associate Professor
Civil Engineering

Nadim M. Aziz
Professor and Chair
Civil Engineering
Director of the Resiliant Infrastructure Focus Area
Clemson University Restoration Institute

Ronnie Chowdhury
Associate Professor
Civil Engineering

Ulrike Heine
Assistant Professor
School of Architecture

Leidy Klotz
Assistant Professor
Civil Engineering

Cindy Lee
Professor
Environmental Engineering and Earth Sciences

Wei Chiang Pang
Assistant Professor
Civil Engineering

Gregory M. Pickett
Interim Associate Dean
College of Business and Behavioral Science
MBA Program

Prasada Rangaraju
Associate Professor
Civil Engineering

Sustainable and Resilient Infrastructure Thesis Research Projects

- **Pavements and Urban Heat Island Effect**
  David Duncan
- **Robust Structural Health Monitoring**
  Sarah Dalton
- **Liquefaction Hazard Mapping and Planning**
  Lawrence Simonson
- **Pile Foundation Centrifuge Testing**
  Brian Machmer
- **Bridge Collapse Risk Analysis**
  Caitlyn Davis-McDaniel
- **Levee Scour Protection**
  Earnest Johnson
- **Greywater Treatment Options**
  David Christopher
- **Net-Zero Energy Buildings**
  Kelly Sprague
- **Concrete with Industrial By-Products**
  David Lowe

One of the NSF SMP fellows, Earnest Johnson (pictured at left), spent a portion of his spring and summer working as an intern with the U.S. Army Corps of Engineers (USACE) in Vicksburg, Miss. With the historic spring flooding on the Mississippi River, the timing of Johnson's internship proved to be serendipitous — he had the opportunity to inspect levees just when their capacities were mightily tested.

Johnson spent considerable time with Don Ward, a USACE engineer who works on levees and coastal protection services. He also spent some time at the USACE Coastal and Hydraulics Lab (CHL), where he conducted research involving longshore and multigrain sediment transport.

"This experience has been invaluable," observes Johnson. "It's like reading about Santa Claus as a kid, and then one day you actually intern in the North Pole and see how it all happens in person. I was able to see how what I'm studying applies to real-life situations."

Left: Clemson graduate student Earnest Johnson (from left) and intern Thuy Thi Vu inspect a Vicksburg levee with CHL scientists David King, Susan Morang, Irene Watts and Andrew Morang.

infrastructure throughout its life – from the planning stages, design and construction, through operation, maintenance and rehabilitation," says Ron Andrus, an associate professor of civil engineering and principal investigator on the project.

This cross-disciplinary approach to learning gives SMP students the chance to experience different specialty fields of study. Nadim M. Aziz, professor and chair of civil engineering and director of the resilient infrastructure focus area of Clemson's Restoration Institute, believes this freedom and the opportunity to rub shoulders with industry professionals are the key differentiators for the program's advantages. "They're interacting with their industry role models while we're filling a niche for students seeking a broader perspective."

According to assistant professor Leidy Klotz, this innovative program is also transforming Clemson University for the better. "With sustainability and resilience at the core of this program, we're putting Clemson on the national radar of prospective graduate students," he says.

Graduates of the program will be well-prepared leaders and true renaissance thinkers who are ready to help the nation pull up the grade on its infrastructure and beyond. *

Windfall

By Charreau Bell

With some of the most powerful offshore gusts in the United States, South Carolina is becoming a top resource for wind-produced electric power.

According to the U.S. Department of Energy (DOE), wind power is poised to become a major contributor to America's electricity supply within the next 20 years. And to make sure the concept comes to fruition, President Obama issued a challenge to derive at least 20 percent of the nation's energy from wind power by 2030.

An architectural rendering of the Clemson Wind Turbine Drivetrain Test Facility.

Recognizing the Palmetto State's central location, a uniquely talented research presence and a highly skilled workforce, the DOE has granted funding for a state-of-the-art wind turbine testing facility in Charleston. Spearheaded by the Clemson University Restoration Institute with major leadership provided by principal investigator Imtiaz Haque, the Clemson University Wind Turbine Drivetrain Test Facility (CU-DTF) is specifically being established to initiate and nurture the clean energy effort for South Carolina.

Haque, who is chair of Clemson's automotive engineering department, describes the impact of this facility on the surrounding region. "As the wind-energy market evolves along the East Coast, South Carolina provides the geography and environment to serve as a hub for the wind-energy manufacturing cluster in the Southeast." CU-DTF takes Clemson's strengths of research and education and combines them with the University's belief in maintaining long-term partnerships with industry leaders.

The Charleston facility will use Highly Accelerated Life Testing methodology to test the reliability and limits of the drivetrains intended for use with wind turbines using two test rigs. One for 15 MW turbines and the other for 7.5 MW turbines, the rigs are used to simulate the environment and actual forces that the wind-turbine drivetrain would encounter in the field. Knowing how the drivetrains will perform in various weather conditions is essential because they are the mechanisms that convert the rotation of the turbine blades into electrical energy.

Haque believes the research information provided by these tests is vital for developing wind-turbine technology. He explains, "Our objective is to accelerate the development of advanced drivetrains by gaining a more in-depth understanding of gearbox/generator assemblies. The data gathered from these tests will generate new knowledge and lead to improved design for a more efficient and durable wind turbine."

Testing in a controlled environment – like that of CU-DTF – instead of outdoors on an actual wind turbine offers numerous advantages and will ultimately reduce wind turbine costs and increase the quality of mass-produced units and foster the ubiquity of wind turbines in the global marketplace.

CU-DTF takes Clemson's strengths of research and education and combines them with the University's belief in maintaining long-term partnerships with industry leaders.

The facility is designed to be international in scope, accommodating drivetrains from anywhere in the world. CU-DTF will also boast the distinction of being the world's only facility equipped to test the large drivetrains of the most recent and cutting-edge wind turbines. Haque says, "The CU-DTF design is especially unique in that it will be able to test large-scale wind turbine drivetrains up to 15 MW. No comparable facility exists."

Located at the former U.S. Naval Complex in North Charleston, CU-DTF has access to a unique industrial and academic environment due to its proximity to a deepwater port, railway infrastructure and interstates.

CU-DTF represents a $45 million investment from the DOE and $53 million of matching funds from partners including the Charleston Naval Complex Redevelopment Authority, the S.C. Department of Commerce, the state of South Carolina, the city of North Charleston, the Savannah River National Laboratory, Fluor Corp., S.C. Electric and Gas Co., EcoEnergy and other private donors.

In addition to advancing wind-turbine technology, the facility will also bring direct economic benefits to South Carolina. It is expected to generate more than 800 jobs and stimulate economic activity in the surrounding area. The DOE estimates that South Carolina could gain 10,000 to 20,000 new jobs related to the wind power industry over the next 20 years.

Haque states, "It's difficult to overstate what this facility represents for South Carolina. From an economic development standpoint, the testing facility will bring benefits statewide." He continues, "Clemson, together with the industry that will grow around the testing facility, will drive wind energy research nationwide." *

National and state dignitaries joined University President Jim Barker in turning orange sand to celebrate the groundbreaking of the Wind Turbine Drivetrain Test Facility.

U.S. Senator Lindsey Graham speaks with news crews about the impact the $98 million facility will have on South Carolina and the rest of the nation.

Hand-in-Hand

By Greg Wilson

There is a long history of chemistry between two of the nation's top research bioengineers at Clemson University.

Xuejun Wen, Hansjörg Wyss Endowed Chair and a professor in the Clemson-MUSC bioengineering program, and his wife, Ning Zhang, assistant professor of bioengineering at Clemson, share a lifelong love of research that began for each in their middle school chemistry labs.

"Scientists were my role models," says Wen, who is a native of China. "I found in middle school that I liked mixing things up in the chemistry lab, making new stuff. Making polymers — as I do today — is quite similar to what I did then."

Zhang, the 2011 recipient of a National Science Foundation (NSF) CAREER award, found her path to the chemistry lab was more direct — both of her parents were university chemistry professors.

"I visited their labs and got interested in mixing things together to produce new things," Zhang says. "I knew even then, when I was young, that I wanted to become a researcher."

Today, the couple works together in Charleston through a joint bioengineering program between Clemson University and the Medical University of South Carolina. Their research focuses on a wide variety of novel biomedical materials and scaffolds, biomedical device design, fabrication and testing, drug delivery, cellular/tissue engineering, stem cell biology and regenerative medicine.

Wen says the ultimate goal of his research is developing new strategies for organ repair and tissue regeneration — in addition to enhancing the principles and techniques of regenerative medicine — all with the goals of easing suffering and enhancing human health.

A medical doctor, Wen says finding ways to ease pain and suffering is the greatest reward of his research.

"I have several technologies that have already been tested in animals for the treatment of Parkinson's and spinal cord injuries, which could eventually help many people," Wen says. "I love basic science, but by the time I retire, I want to be a physician who has used some of the technologies I developed to help my patients."

Zhang agrees the potential application of their research is what drives her in the lab.

"Knowing the materials we produce, the strategies we develop will eventually alleviate or improve the treatment of disease or injury — this is the most energizing part of my research," she says. Her recent NSF CAREER award funds research on regenerating brain tissue after strokes. Zhang proposed the development of an injectable hydrogel-based delivery system to manipulate neural stem cells for structural regeneration at brain lesion sites. She expects her work to have an impact in the fields of biomaterials, tissue engineering, neuroscience, stem cell biology and engineering, and regenerative medicine.

As a couple, Wen and Zhang bring different educational backgrounds, approaches and strengths to the research process due to the different paths each took to work in the field of bioengineering research.

Wen's initial academic interests were dentistry and facial cranial surgery — fields that are combined in a single program in China. But, despite having the top score on the entrance exam, he was passed over for the

Wen and Zhang have brought such a diverse combination of disciplines to a bioengineering research laboratory and produced impressive results.

program. He adjusted his focus and pursued another program where he earned his medical degree and discovered his interests in bioengineering.

"There are very few bioengineers with a background in medicine and engineering," Wen says. "I feel comfortable in the field because I'm knowledgeable in both areas. I always approach research from a surgeon's point of view, so that's why I aim to design something that will eventually help patients."

Zhang came to bioengineering from the field of materials science engineering and polymers. "I was motivated — in part by my husband — to enter the field of bioengineering when I was thinking about my Ph.D."

> "Clemson is the pioneer in bioengineering — one of the first in the world," Wen says. "Everyone in the world knows Clemson, and it's an honor to come here and work."

Bringing such a diverse combination of disciplines to a bioengineering research laboratory has produced impressive results.

From research on bone and cartilage regeneration to investigations into stem cell genetic engineering, the couple's work has resulted in eye regeneration and helping soldiers speed up their recovery from battlefield wounds.

Wen and Zhang are pioneers in their field. With more than 30 patents and more than 100 professional publications between them, both have garnered more than a few significant awards during their relatively short careers. Both have received the Clemson Board of Trustees Faculty Award (Wen has won it twice), NSF CAREER awards and the Wallace H. Coulter Early Career Translational Research Award in Bioengineering.

In addition to the accolades listed above, Zhang has also accepted the Outstanding Student Research and Travel Award from the Society for Biomaterials.

Wen's other honors include: Clemson's McQueen-Quattlebaum Faculty Achievement Award, the Sigma Xi Outstanding Young Investigator of the Year and the Stem Cell Research Award from the Michael J. Fox Foundation for Parkinson's Research.

The couple recently returned to China to visit the graduate school where they met.

"The research environment is a pretty good place for people to meet," Wen says. "They share similar interests, collaborate on projects and spend lots of time together. That's how we met."

After they married, Wen and Zhang continued to work together throughout graduate school. They chose to bring their teamwork to Clemson despite six other job offers.

"Clemson is the pioneer in bioengineering — one of the first in the world," Wen says. "Everyone in the world knows Clemson, and it's an honor to come here and work."

He adds, "We collaborate on lots of our projects, got our Ph.D.s in the same area at the University of Utah. Her project was on the brain and mine focused on the spinal cord — both centered on the central nervous system — before we came to Clemson. Her background is not in biology but in polymer science, which makes us a good team. And her English is much better than mine. She's a good writer and gives me constructive suggestions on all my proposals. She's the best person to help me in my writing and work."

This does not mean the pair is always in agreement in the laboratory.

"We do have disagreements," Wen says. "Sometimes we disagree on which approach to take or what technology should be used. After all, we are in experimental science. Sometimes we even bet each other on which of our hypotheses will work better."

So far their collaborations, including the sharing of patents and co-authoring a number of publications, are a testimony to two scientists who work so well together.

When not in the lab, the couple enjoys spending time with their children — a six-year-old and a six-month-old — and playing volleyball. *

News and notes

Five CoES researchers receive NSF CAREER awards

The Faculty Early Career Development (CAREER) award is the National Science Foundation's (NSF) most prestigious recognition program that supports the early career-development activities of young teacher-scholars. Five College of Engineering and Science faculty received CAREER grants this spring, and their work presents a broad spectrum of interests and applications — from student motivation to brain-tissue regeneration.

Beshah Ayalew, assistant professor of automotive engineering, is investigating the use of alternative radiative drying and curing processes in large-scale manufacturing where substantial energy savings and emission improvements are possible. For example, in automotive manufacturing, current convection-dominated paint booth operations account for 33 percent to 46 percent of the energy consumption and about 40 percent of the carbon dioxide emissions per car. Proposed radiative drying and curing processes require much less energy, create nearly no pollution from volatile organic compounds and give parallel reductions in carbon dioxide emissions compared to current bake ovens. Ayalew's goal is to optimize energy use and productivity without sacrificing product quality. This research will impact other manufacturing processes like robotic welding, spray painting and spray forming and may also be applied to irradiative disinfection, pollution mitigation and medical radiotherapy.

While academic performance is the most common metric used to gauge student success, it is not an all-encompassing representation of the learning experience. **Lisa Benson**, assistant professor in engineering and science education, believes that while student motivation is related to academic performance, it also plays a major factor in progress toward critical thinking and problem solving. Her work will help educators understand factors in student development that contribute to motivation such as expectations, values, goals, attitudes, cognition and academic performance. Understanding these relationships will address the greatest challenges facing engineering educators, which are increasing interest in engineering, creating a more diverse engineering workforce and preparing students for a future of rapid technological change and globalization.

Today, many critical electronic devices, such as wireless sensors, pacemakers, spinal stimulators and artificial organs are becoming smaller and more energy efficient by requiring only minute amounts of power to function. Assistant professor of mechanical engineering **Mohammed Daqaq** is looking at ways to turn these electronic devices into self-powered units by developing scalable micropower generators that can scavenge mechanical energy from the surrounding environment and transform it into electricity via different electromechanical coupling mechanisms. The ambient energy can generally result from mechanical stimuli similar to the vibrations of structures, the strain in a vehicle's tire, ocean waves, wind, human motion, muscle stretching or even bodily fluids. Such self-powered electronics will facilitate detection of structural damage to avoid sudden catastrophic failures of structures and will undoubtedly improve the quality of life for many patients living with implantable appliances.

Leidy Klotz, an assistant professor of civil engineering, is exploring ways to help engineers make better decisions in building design. At stake is a potentially vast amount of energy. The U.S. Department of Energy estimates that buildings represent 40 percent of the nation's primary energy consumption. Klotz focuses specifically on how designers choose the techniques they employ in energy-efficient design. His research centers around "net-zero design," meaning buildings that will result in no net emissions of greenhouse gases because of improved energy efficiency combined with the use of on-site renewable energy. And because his research relies on psychological concepts like choice architecture, cognitive bias and irrationality, he often collaborates with undergraduate students from Clemson's psychology department in addition to his engineering students — a novelty among most engineering research projects.

Bioengineering assistant professor **Ning Zhang** is using her NSF CAREER grant to study brain-tissue regeneration after a patient has become incapacitated by stroke. Current treatments, which have focused on anti-inflammation and neuroprotection with pharmacological agents, have failed to produce clear improvements in the mortality and neurological outcome. Zhang's proposed development is an injectable hydrogel-based delivery system to manipulate brain-resident endogenous neural stem cells for structural regeneration at brain lesion sites. She expects the work to have an impact in the fields of biomaterials, tissue engineering, stem cell biology, and engineering neuroscience and regenerative medicine.

Student service project in Haiti wins top state award

A project to bring fresh water to the people of the earthquake-ravaged nation of Haiti has earned Clemson Engineers for Developing Countries the S.C. Commission on Higher Education Service Learning Project of the Year award.

The team of civil engineering students traveled to Haiti in 2010 to design and build water delivery systems in rural areas — an assignment they had begun to study even before the magnitude 7.0 earthquake.

About 30 students were actively involved in design, logistics, training and fundraising efforts for the project.

The S.C. Commission on Higher Education Service Learning Award honors college programs that address community issues, evaluating them on the degree to which they enhance the students' learning and how they are integrated into the academic program.

Chowdhury named Mays Professor of Transportation Engineering

Ronnie Chowdhury, associate professor of civil engineering, has been named the Eugene Douglas Mays Professor of Transportation Engineering.

Chowdhury is an expert in intelligent transportation systems, a field that uses information technology in conjunction with roads and vehicles to address problems like traffic congestion, safety and fuel consumption. His research also includes vehicle-infrastructure integration, security and energy, with sponsorships from the NSF, the U.S. Department of Transportation, state departments of transportation and national transportation centers.

Gilbert named Fellow of science association

Juan E. Gilbert, a professor and chairman of the human-centered computing division in the School of Computing, has been named a Fellow of the American Association for the Advancement of Science.

The world's largest general scientific society and publisher of the journal *Science*, the association bestows the honor on individuals for "distinguished efforts to advance science or its applications."

It cited Gilbert for "communicating and interpreting technology to the public, innovations in the field of human-centered computing and leadership in broadening participation in computing."

At Clemson, Gilbert's division seeks to develop computer solutions to real-world problems and to understand how computer technologies affect society. His research interests include applications such as voice texting and electronic voting.

Burg elected president of scientific society

Bioengineering professor Karen Burg has been elected president of the Society For Biomaterials, a professional society for scientists and engineers who study cells, tissues and organs and their interactions with natural and synthetic materials, including implanted prosthetic devices.

Burg, who holds the Hunter Endowed Chair in Bioengineering, is director of the Institute for Biological Interfaces of Engineering and interim vice provost for research and innovation at Clemson.

With a focus on reconstruction of breast tissue following cancer surgery, Burg's research into tissue engineering, biofabrication and absorbable polymers has led to 11 issued or pending U.S. patents. Her work is funded by the NSF and the Department of Defense, among others.

Clemson students receive NSF Graduate Research Fellowships

Eight Clemson students have received NSF graduate research fellowships and nine others earned honorable mentions in the national fellowship competition.

Fellows receive three years of support for their graduate studies: an annual stipend of $30,000, a $10,500 allowance for tuition and fees, and opportunities for international research and professional development. The program recognizes and supports outstanding students who are pursuing research-based master's and doctoral degrees in NSF-supported science, technology, engineering and mathematics disciplines.

Clemson's 2011 awardees are

- Toni Bloodworth, a computer science graduate student from Anderson;
- Michael Esposito, a civil engineering senior from Prospect, Ky.;
- James Grayson, a civil engineering graduate student from Okatie;
- Jennifer Ann Johnson, a civil engineering senior from Hilton Head Island;
- Kristina Kesel, a biochemistry senior from Charlotte, NC;
- Laila Roudsari, a bioengineering senior from Charleston;
- Kemper Talley, a physics senior from Easley;
- Daniella Triebwasser, a plant and environmental sciences graduate student from Fort Mill.

Clemson University inaugurates Canada Center

Canada's ambassador to the United States, Gary Doer, visited Clemson recently to help launch the University's new Canada Center. The center will support and coordinate Clemson's collaborations with Canadian institutions and provide a framework for developing more extensive ties to America's largest trading partner and closest ally.

"The links between Canada and South Carolina — our trade, investment, tourism and friendships — are growing," Doer says. "Closer bilateral relations make our nations stronger and more competitive in today's globalized economy. The launch of the new Canada Center at Clemson University and the academic and research ties that are being nurtured by this institution will play an important role in advancing this strong partnership."

INQUIRY, DISCOVERY IN ENGINEERING AND SCIENCE

IDEaS

FALL 2011

IDEaS is produced biannually for the College of Engineering and Science at Clemson University by the Office of Creative Services.

On the cover: The latest CES graduate degree responds to President Obama's challenge to bring the nation's infrastructure up to par. Turn to page 6 to read more about professors, such as Prasada Rangaraju (pictured), who are answering the call.

Right: Wind energy is a major part of our energy future. Flip to page 9 to find out more about Clemson's new $98 million role in converting this sustainable natural resource into power.

Contributors

EXECUTIVE EDITORS
Esin Gulari
Ron Grant
Rebecca Shepherd

DESIGNERS
Dave Dryden
Christine U. Prado

PHOTOGRAPHERS
Craig Mahaffey
Patrick Wright

WRITERS
Charreau Bell
Tom Hallman
Anne McKenzie-Jenkins
Greg Wilson

CLEMSON
College of ENGINEERING AND SCIENCE

College Contacts

College of Engineering and Science Administration
Dr. Esin Gulari
Dean
College of Engineering and Science

Dr. R. Larry Dooley
Associate Dean
Research and Graduate Studies

Dr. E.R. (Randy) Collins
Professor and Associate Dean
Undergraduate and International Studies

College of Engineering and Science
109 Riggs Hall
Box 340901
Clemson, SC 29634-0901
clemson.edu/ces

Left to right: Dr. R. Larry Dooley, Dr. Esin Gulari, Dr. E.R. (Randy) Collins

CLEMSON
College of ENGINEERING AND SCIENCE

CLEMSON
College of ENGINEERING AND SCIENCE

Office of the Dean
109 Riggs Hall
Box 340901
Clemson, SC 29634-0901

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IDEaS

INQUIRY, DISCOVERY IN ENGINEERING AND SCIENCE

COLLEGE OF ENGINEERING AND SCIENCE FALL 2011

Highlights from our departments

College Structure Is Key to Collaboration

The College of Engineering and Science is made up of 14 separate schools and departments, but the unique structure of combining engineering and science programs within one college has led to an uncommon ability to provide a team-based, integrated approach to teaching and research. Scientists and engineers working together to find more efficient solutions is the structure of Clemson University's College of Engineering and Science.

Automotive Engineering

Imtiaz Haque, Ph.D.
Department Chair
864-283-7217
sih@clemson.edu
clemson.edu/centers-institutes/cu-icar

Fast Facts

Tenured/tenure-track faculty: 10

Enrollment:	Undergraduate	-
	Master's	66
	Doctoral	41
Degrees awarded (Spring 2011):		
	Undergraduate	-
	Master's	1
	Doctoral	3

Research expenditures: $5,163,445
Research thrusts: systems integration, vehicle manufacturing, vehicle design and development, vehicular electronics


Laine Mears

Faculty Highlights

Beshah Ayalew, assistant professor of automotive engineering, has received the NSF CAREER Award for his proposal entitled "Control of Processes Actuated with Mobile Radiant Sources." He is the second faculty member to receive this prestigious award in the department.

The project targets energy-efficient radiative drying and curing processes for large-scale manufacturing lines and will potentially play a transformative role in reducing total energy use and carbon dioxide emissions from manufacturing lines. It addresses the fundamental problem of controlling moving radiant sources as it impacts other processes such as robotic welding and spray forming. Other potential applications are pollution mitigation and medical radiotherapy. This project includes strong educational and outreach components built around the theme of control for energy efficiency. Planned activities include new course development, undergraduate research opportunities, utilization of Clemson's Creative Inquiry program to involve undergraduates – including minorities and women – in the research, and summer science teacher workshops and success camps.

Ayalew joined Clemson in 2006 as a developer of the M.S. and Ph.D. programs in automotive engineering. He teaches courses in modeling and control of automotive systems, and his research interests lie in the general area of dynamic systems modeling and advanced robust control, including manufacturing process control, fluid power and electro-mechanical systems, vehicle dynamics, vehicle testing systems and hydraulic/electric hybrid drivetrains.

Laine Mears, assistant professor of automotive engineering, was honored with two prestigious awards this spring. He received the Ralph R. Teetor Award – the top educational award of the Society of Automotive Engineers (SAE) – and the 2011 Governor's Young Researcher Award for Excellence in Scientific Research.

Presented annually, the Teetor award encourages young faculty to develop new concepts in teaching, engage in research programs and participate in local partnerships with industry. Mears is the third Clemson faculty member to win the Teetor award since it was established in 1965.

Seeking to "create an atmosphere where teachers can meet and exchange views with practicing engineers," the award included a trip to Detroit for the SAE World Congress plus a tour, a series of meetings and alternative-fuel vehicle test drives at the GM Research facility.

Mears joined Clemson in 2006 as one of the developers of the M.S. and Ph.D. programs in automotive engineering. He teaches modeling and analysis of automotive manufacturing processes, automotive manufacturing quality control and automation integration in manufacturing. His research is in manufacturing process control, equipment diagnostics and intelligent machining systems.

Mohammad Omar was promoted to associate professor, received early tenure and was honored with the college's top engineering teaching award – the Murray Stokely Award for Excellence in Teaching. He joined Clemson in 2006 as one of the developers of the M.S. and Ph.D. programs in automotive engineering. His research and teaching focus on automotive manufacturing systems, quality control and non-destructive testing methods. An outcome of Omar's efforts in education is the 2011 publication of the only textbook in the area of automotive manufacturing entitled *Automotive and Systems with John Body Manufacturing Processes*, published by John Wiley.

Bioengineering

Martine LaBerge, Ph.D.
Department Chair
864-656-5556
laberge@clemson.edu
clemson.edu/ces/bio

Fast Facts

Tenured/tenure-track faculty: 20

Enrollment:	Undergraduate	206
	Master's	23
	Doctoral	85
Degrees awarded:		
	Undergraduate (through August 2011)	54
	Master's (through May 2011)	12
	Doctoral (through May 2011)	22

Research expenditures: $5,879,634
Research thrusts: biomaterials engineering, bioelectrical engineering


Delphine Dean with one of her students in Tanzania

Faculty Highlights

Assistant professor **Ning Zhang** was awarded an NSF CAREER grant to study brain-tissue regeneration after stroke by the NSF's chemical, bioengineering, environmental and transport systems division. Zhang proposed the development of an injectable hydrogel-based delivery system to manipulate brain-resident endogenous neural stem cells for structural regeneration at the brain lesion site. She expects the work to have an impact in the fields of biomaterials, tissue engineering, stem cell biology and engineering, neuroscience and regenerative medicine.

Karen Burg, Hunter Endowed Chair of Bioengineering and interim vice provost for research and innovation, has been elected president of the Society For Biomaterials (SFB).

Professor **Xuejun Wen's** work on the biofabrication of intervertebral discs is featured in the MIT *Technology Review*. He is the Hansjörg Wyss Endowed Chair and a professor of bioengineering.

Student Achievement

Well before the spring semester began, three bioengineering seniors were already doing course work abroad. **Marci Elpers**, **Britton McCaskill** and **Lauren Sosdian** worked in Tanzania as part of their senior project and the Creative Inquiry course taught by assistant professors **Delphine Dean** and **John DesJardins**.

During the previous semester, the students designed a temperature-sensor and heating-blanket system for premature babies in areas where standard neonatal incubators are unavailable. Currently, premature babies in Tanzania are kept together in small rooms heated to approximately 40 degrees Celsius.

According to Dean, who accompanied the students, "Numerous problems with infections arise from the heat and humidity." She adds that the key to the students' design was to make the device using only inexpensive parts that are readily available in Tanzania. "One of the trip's goals was to investigate which parts we could get in the three towns we visited," she says.

The students worked with technicians at each hospital to ensure that the device could be manufactured in Tanzania. Sosdian notes, "It was a really good opportunity to survey the potential market for our device so we could make changes before the design of the final product. The entire experience has shaped the rest of my time here at Clemson and my future."

The American Institute for Medical and Biological Engineering recognized **Christian Kotanen**, a graduate student in **Anthony Guiseppi-Elie's** lab, with a travel award for his presentation at the organization's 20th Annual Event in Washington, D.C.

Laila Roudsari accepted the SFB C. William Hall Scholarship at its annual meeting in Orlando, Fla. Roudsari is a student in **Karen Burg's** lab

The honorable mention for the SFB STAR Award was awarded to **Jeremy Zhang** for his presentation at the organization's annual meeting. Zhang is a graduate student in associate professor **Ken Webb's** lab.

Brittany Banik, a senior in **Frank Alexis's** lab, was awarded a Howard Hughes Medical Institute (HHMI) international summer research experience at Nanyang Technical University in Singapore. The HHMI grant includes travel expenses and a stipend to cover housing and meals.

Five of the eight students selected to represent the University at the 2011 Atlantic Coast Conference Meeting of the Minds Undergraduate Conference are students in the department. Bioengineering seniors are **Brittany Banik** and **Kevin Keith** from **Frank Alexis's** lab, **Alex Owczarczak** from **Delphine Dean's** lab, and **Tim Laird** and **Aesha Desai** from a Creative Inquiry class taught by Dean and **David Kwartowitz**.

An NSF graduate research fellowship was awarded to seniors **Laila Roudsari** and **Laura Datko**.

American Heart Association Predoctoral Fellowships were awarded to **Vince Beachley**, **Xiaowei Li** and **Erin Pardue**. All are doctoral students in the CU-MUSC joint bioengineering program.

Chemical and Biomolecular Engineering

Douglas Hirt, Ph.D.
Department Chair
864-656-0822
hirtd@clemson.edu
clemson.edu/ces/chbe

Fast Facts

Tenured/tenure-track faculty: 10

Enrollment:	Undergraduate	155
	Master's	1
	Doctoral	29
Degrees awarded:	Undergraduate	49
	Master's	0
	Doctoral	3

Research expenditures: $1,954,292

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

Mark Thies

Faculty Highlights

Mark Thies and **Amod Ogale** co-chaired CARBON 2010, the Annual World Conference on Carbon, at Clemson University. The international conference is held once every three years in the United States; it is held in Asia and Europe during the other two years. About 400 delegates from more than 40 countries presented more than 550 papers. The international conference was organized by the Center for Advanced Engineering Fibers and Films and was co-sponsored by the American Carbon Society and CES in addition to 13 companies.

Scott Husson and **Chris Kitchens** received a three-year NSF grant to run a 10-week summer research experiences for undergraduates (REU) program for a talented and diverse group of undergraduates from across the nation. The intellectual focus of this REU site is advanced functional membranes. The program will engage promising young students in research aimed at providing membrane-based solutions to grand societal challenges, such as improving the quality and cost of health care, producing a cleaner and safer environment, and improving materials for energy conversion and storage.

David Bruce and **Mark Thies** have been working with TECHFISH LLC, a startup company in Charleston, to develop a process for the recovery and purification of lignin, which can then be used as a fuel source. The project addresses the opportunity of increasing biomass feed to electricity-generating power furnaces with the goal of reducing greenhouse gases. The team has recently been awarded a Phase II SBIR grant from the Department of Energy totaling $1 million.

Anthony Guiseppi-Elie was a keynote presenter last spring at the 2011 International Conference on Frontiers of Characterization and Metrology for Nanoelectronics held on the MINATEC campus in Grenoble, France. His talk was entitled "Frontiers of More than Moore in Bioelectronics and the Required Metrology Needs." He has also been named to the Board of Directors of the Council for Frontiers of Knowledge.

Scott Husson received a grant from the National Institute of General Medical Sciences to develop high-performance membranes for chromatography-based protein purifications. The rapidly growing public demand for protein therapeutic products requires new, higher productivity, higher resolution methods for their recovery and purification. Development of these materials is essential to the production of lower cost therapeutic products for improved public health. Husson's group has demonstrated in earlier work that membrane chromatography fulfills these requirements. They have developed strategies to overcome historically low protein-binding capacities by grafting high-capacity polymer nanolayers from base membrane supports. A goal of the work is to understand the roles of nanolayer structure, membrane pore structure and novel polymer chemistry on protein binding, with the major objective of accelerating the use of membrane chromatography in initial protein-capture steps.

Student Achievements

At spring commencement, Clemson University's Norris Medal was awarded to ChBE senior **Jennifer Moffitt**. The Spartanburg native also received the prestigious Barry M. Goldwater Scholarship and the Eastman Award for Excellence in Chemical Engineering. Moffitt conducted undergraduate research entitled "Phase Behavior of Cellulose Nanocrystal Dispersions" with professor **Christopher Kitchens** and earned Calhoun College Honors.

Moffitt has accepted a position in the research and development department at Eastman Chemical Co. and plans to pursue a Ph.D. in chemical engineering while working. The Norris Medal was established under the terms of the will of D.K. Norris, a life trustee of Clemson University. The medal is given each year to the graduating student who is deemed to be the best all-around by Clemson's scholarships and awards committee.

This year's Clemson University Robert J. Rutland Institute for Ethics held the 10th Annual J.T. Barton Jr. Ethics Essay Scholarship Competition focused on the BP oil spill in the Gulf of Mexico. ChBE senior **Allison Foreman** received third prize for her essay entitled "What ethical obligations did BP have to protect workers like Ed when they were hired?"

Clemson's National Scholars Program (NSP) provides a full scholarship to about a dozen top undergraduates annually. ChBE graduated three seniors last spring who were members of this prestigious group – **Allison Foreman**, **Jennifer Moffitt** and **Ray Smith**. Each year, the NSP invites seniors to present Awards of Distinction to the faculty and advisers who have served as mentors in helping the students develop intellectually, professionally and personally. Foreman and Moffitt presented their awards to professor **Charlie Gooding**.

Junior **Adam Klett** received a fellowship from the Atlantic Coast Conference Inter-institutional Academic Collaborative (ACCIAC) Fellows Program in Creativity for research he has conducted with professor **Mark Thies**. Klett's work focuses on the sulfur/iodine cycle to split water into hydrogen and oxygen for the purpose of mass-producing hydrogen as a replacement for petroleum-derived fuels.

Chemistry

Stephen Creager, Ph.D.
Department Chair
864-656-4995
screage@clemson.edu
chemistry.clemson.edu

Fast Facts

Tenured/tenure-track faculty: 24

Enrollment:	Undergraduate	138
	Master's	-
	Doctoral	93
Degrees awarded:	Undergraduate	19
	Master's	1
	Doctoral	10

Research expenditures: $3,789,047

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

Stephen Creager and Mike Henson

Faculty Highlights

In labs across South Carolina, scientists are investigating ways to use microbes to create a new fuel that will replace gasoline in cars and light trucks. The key components are as novel as they are unlikely: living microbes that, when stimulated with electricity, will turn carbon dioxide – the plentiful compound best known as a destructive greenhouse gas – into an alcohol-based fuel.

"This research will be focused mostly on the bench scale and will provide insight into how to do it at the commercial production level," says **Stephen Creager**, chairman of Clemson's chemistry department. "As with other biofuels, a scalable, reliable process – along with production costs and volumes – will be the issues."

The research is part of a U.S. Department of Energy initiative that involves scientists at South Carolina's research universities.

Clemson's contributors – electrochemist Creager and microbiologist **Mike Henson**, a research associate professor in the biological sciences department – are trying to determine the best mix of microorganisms and chemical reactions to ramp up the fuel-making process. Researchers at the Medical University of South Carolina and the University of South Carolina are working on other pieces of the puzzle.

The research may lead to an industrial process to produce light motor fuels that could replace gasoline without having to modify engines.

Student Achievement

Clemson's student member chapter of the American Chemical Society (ACS) has been selected to receive the ACS Honorable Mention Award for activities conducted during the 2009-2010 academic year. This is the second year in a row they have been selected for this award.

Wendy Queen, a 2009 chemistry Ph.D. graduate, has received a Postdoctoral Research Associates Award from the National Research Council to work with professor Craig Brown at the National Institute of Standards and Technology Center for Neutron Research located in Gaithersburg, Md. Her studies focus on understanding the physics and chemistry underpinning H_2/CO_2 interactions in new adsorbent systems, such as Metal-Organic Frameworks and activated carbons.

Civil Engineering

Nadim M. Aziz, Ph.D.
Department Chair
864-656-3002
aziz@clemson.edu
clemson.edu/ce

Fast Facts

Tenured/tenure-track faculty: 20

Enrollment:	Undergraduate	466
	Master's	69
	Doctoral	44
Degrees awarded:	Undergraduate	143
	Master's	35
	Doctoral	5

Research expenditures: $2,904,828
Research thrusts: sustainable and resilient infrastructure


Leidy Klotz

Faculty Highlights

Leidy Klotz, assistant professor of civil engineering, received an NSF CAREER grant to study irrationalities of designers to support their decisions for net-zero energy buildings. The outcome will affect how energy-related decisions are made at the planning and design stages. The project will bridge engineering and behavioral sciences to advance understanding of how irrationalities influence design decisions. The project's research and educational components support the department's focus on sustainable and resilient infrastructure. Klotz is an expert on sustainability and has received research funding from the U.S. Department of Energy and the NSF.

Ronnie Chowdhury, associate professor of civil engineering, was named the Mays Professor of Transportation. Chowdhury is an expert in intelligent transportation systems. He also conducts research in vehicle-infrastructure integration, security and energy. His research is funded by the NSF, the U.S. Department of Transportation, state departments of transportation and national transportation centers.

Professor **C. Hsein Juang** is chairing the organizing committee for GeoRisk 2011. A program made possible by the American Society of Civil Engineers (ASCE), GeoRisk 2011 will allow participants to learn more about explicitly considering risk and uncertainty in order to improve the value and scope of their service to the public.

The Clemson Engineers for Developing Countries (CEDC): Water System Design for Cange, Haiti, project involves a group of students advised by **Lance Bell** and has recently earned the S.C. Commission on Higher Education Service Learning Project of the Year award. The Clemson group took a team of civil engineering students to Haiti in 2010 to design and build water-delivery systems in rural areas – an assignment that they had begun to study even before the magnitude 7.0 earthquake struck the country. About 30 students were actively involved in design, logistics, training and fundraising efforts for the project. CEDC was featured in our fall 2010 issue.

Student Achievement

Three civil engineering students received NSF Graduate Research Fellowships, and two others received honorable mentions in the national competition. Fellows receive three years of support for their graduate studies, including an annual stipend of $30,000, a $10,500 allowance for tuition and fees, and opportunities for international research and professional development. The program recognizes and supports outstanding students who are pursuing research-based doctoral degrees in NSF-supported science, technology, engineering and mathematics disciplines. This brings the number of NSF Fellows in the civil engineering department to five. The 2011 awardees are **Michael Esposito**, a senior from Prospect, Ky.; **James Grayson**, a graduate student from Okatie; and **Jennifer Johnson**, a senior from Hilton Head Island.

Jennifer Johnson, who earned a degree in civil engineering last spring, received the Algernon Sydney Sullivan Award. The award is given "in recognition of the recipient's influence for good, excellence in maintaining high ideals of living and genuine and disinterested service to others." The award, named in honor of the first president of the New York Southern Society, was established by an agreement between the society and Clemson University. Johnson has received several scholarships and fellowships, including the Federal Highway Administration Dwight D. Eisenhower Transportation Graduate Fellowship, the Heritage Classic Foundation Scholarship, the Tau Beta Pi Lindeburg Scholarship, the American Public Transportation Foundation Louis T. Klauder Scholarship and the Society of Women Engineers Ada I. Pressman Memorial Scholarship. She was recognized by the civil engineering department as both outstanding junior and outstanding senior. Her ePortfolio was twice named the University's Best General Education ePortfolio, and she received the Thea McCrary Student Award for Outstanding Service from the President's Commission on the Status of Women.

Clemson's ASCE student chapter earned the first place trophy at the Carolinas Conference for 2011. The annual competition was held at North Carolina State University. Eight schools, including The Citadel, University of South Carolina, Duke University, University of North Carolina-Charlotte, North Carolina State University, North Carolina A&T and the Georgia Institute of Technology competed in 16 events. The Clemson's Carolinas Conference Chair was Clemson student **David Duncan**. Professor **Stephen Csernak** is the chapter adviser, and professors **Scott Schiff** and **Brad Putman** advised the Steel Bridge and the Concrete Canoe teams respectively.

School of Computing

Larry F. Hodges, Ph.D.
Director of the School of Computing
864-656-7552
lfh@clemson.edu
clemson.edu/ces/computing

Fast Facts

Tenured/tenure-track faculty: 25.5

Enrollment:	Undergraduate	338
	Master's	115
	Doctoral	55
Degrees awarded:	Undergraduate	53
	Master's	53
	Doctoral	7

Research expenditures: $1,927,157
Research thrusts: computer science: computing, foundations, software engineering, cyberinfrastructure and networking, bioinformatics; visual computing: computer graphics and animation, eyetracking, visualization, digital arts; human centered computing: intelligent and interactive systems, electronic health records, biometrics, virtual environments, human/computer interaction, pedagogical tools using tablet PCs and handheld devices


Juan Gilbert

Faculty Highlights

Juan E. Gilbert, a professor and chairman of the human-centered computing division within the School of Computing, has been named a Fellow of the American Association for the Advancement of Science. The world's largest general scientific society and publisher of the journal *Science*, the association bestows the honor on individuals for "distinguished efforts to advance science or its applications."

Robert Geist delivered the keynote address in computer graphics at the International Symposium on Visual Computing this past summer.

Student Achievement

Ph.D. student **Toni Bloodworth** received an NSF Graduate Fellowship Award. The fellowship program recognizes and supports outstanding graduate students in NSF-supported science, technology, engineering and mathematics disciplines who are pursuing research-based master's and doctoral degrees in the United States and abroad.

Ph.D. students **Jamie Lyle** and **Jessica Jones** received Science, Mathematics and Research for Transformation scholarships. The scholarship provides recipients and their universities with full tuition and education-related fees, a health insurance reimbursement allowance for up to $1,200 and a book allowance of $1,000 per academic year. Recipients complete summer internships at Department of Defense (DoD) facilities nationwide and are guaranteed employment at a DoD facility after graduation.

Ph.D. student **Dennis Lingerfelt** received an IBM Ph.D. Fellowship award. IBM received several hundred applications and selected fewer than 100 recipients. The award "covers a $20,000 stipend as well as a $10,000 education allowance." Lingerfelt's focus for the 2011-12 academic year will be I/O system virtualization, specializing in GPU virtualization within the context of IBM's Virtual Computing Initiative.

Gabriel Paul Fair, a senior computer science major, received the 2011 Dr. Martin Luther King Jr. Excellence in Service Award from the University for his work with Students for Environmental Action.

The following students were recognized at the 2011 School of Computing Awards Ceremony. **Aubrey Lawson** and **Patrick Ofriel**, Outstanding Sophomores in Computing; **Christopher Malloy** and **Zachary Welch**, Outstanding Juniors in Computing; **Ian Wood**, Outstanding Senior in Computer Science; **Matthew Clay**, the Cullinet Software Award for Outstanding Senior in Computer Information Systems; **Christopher Corsi** and **Austen Hayes**, the DuPont Best Undergraduate Project in Computing; **Lin Li**, Outstanding Graduate Teaching Assistant; Manan Gupta, Outstanding Master's Student in Computer Science; and **Heather Harton** and **Aqueasha Martin**, Outstanding Ph.D. Students in Computer Science.

Electrical and Computer Engineering

Darren Dawson, Ph.D.
Department Chair
864-656-5924
ddarren@clemson.edu
clemson.edu/ces/ece

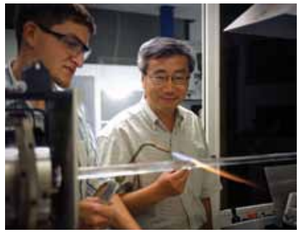
Fast Facts

Tenured/tenure-track faculty: 31

Enrollment:	Undergraduate	370
	Master's	72
	Doctoral	82
Degrees awarded:	Undergraduate	92
	Master's	37
	Doctoral	9

Research expenditures: $2,643,145

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 threat assessment, power systems



Liang Dong

Faculty

ECE graduate studies and research programs include a spectrum of activity reflecting the interests and expertise of the faculty. Particularly noteworthy is the breadth of education across the faculty, the balance between experience and youth, the record of recent publications and the research funding obtained in recent years. More than 40 faculty members are known nationally and internationally and teach and perform research in a broad range of topics in electrical and computer engineering. Among them are IEEE Fellows, two endowed chairs, seven named professors and several young faculty members who have won prestigious national and international awards and grants.

Faculty Highlights

Professors **Liang Dong** and **John Ballato** have recently received major grants from the Air Force Office of Scientific Research (AFOSR) and the Missile Defense Agency (MDA) to investigate the use of advanced optical fibers for high-power lasers. Fiber-based lasers typically require less power and are more compact and lightweight than chemical, gas and other types of lasers; hence, these lasers can be used in a wide variety of applications and platforms and bring tremendous benefits to a variety of military operations. This technology can also be used for many other applications including precision machining, optical communications, medical applications and spectroscopy.

As part of the AFOSR High-Energy Laser (HEL) Multidisciplinary Research Initiative (MRI) program, principal investigator (PI) Dong and Co-PI Ballato will receive approximately $1.4 million over the next three years. If the project is successful, a potential two-year, $1.1 million extension will be made available for a total of $2.5 million over five years.

The primary focus of the HEL MRI program is to enhance the capabilities of the U.S. institutions of higher education to perform basic science and engineering research related to lasers, optics, laser interaction physics and advanced concepts necessary for national defense applications.

The MDA has instituted the Missile Defense Agency Science and Technology Advanced Research (MSTAR) program to fund relevant, advanced research at qualified, accredited domestic colleges, universities or other institutions of higher learning and to support the training of future missile defense scientists and engineers. As part of the MSTAR program, Dong and Ballato will receive approximately $800,000 over the next three years to investigate the feasibility and design of all-solid photonic-bandgap fibers for use in singly polarized high power lasers.

Guigen Zhang, a professor in both the bioengineering and electrical and computer engineering departments, has received a $100,000 Grand Challenges Explorations grant from the Bill and Melinda Gates Foundation. Awarded through a program to support innovative global health research, the grant will help fund Zhang's work to create low-cost diagnostic tools for doctors in developing countries.

Inexpensive, simple and rugged medical tools are important in remote, underdeveloped areas. Zhang focuses on the use of tiny biosensors to replace more expensive and delicate mechanical and electrical devices.

Zhang's grant is part of the Gates Foundation's fourth funding round of Grand Challenges Explorations, an initiative to help scientists around the world explore new and largely unproven ways to improve health in developing countries. From almost 2,700 proposals, just 78 grants were awarded to scientists in 18 countries on six continents.

Student Achievement

Michael Juang, a Ph.D. electrical engineering student, was awarded a 2011 National Defense Science and Engineering Graduate (NDSEG) Fellowship, from a field of more than 2,900 submitted applications. Juang is investigating adaptive transmission protocols for wireless communication systems and has already published one conference paper on the subject and is preparing another. The NDSEG Fellowship is sponsored and funded by the DoD.

Chunrong Song was awarded the 2011 Chinese Government Award for Outstanding Self-financed Students Abroad. The award was established in 2003 by the Ministry of Education and the China Scholarship Council to encourage research excellence and to recognize the achievement in all fields among Chinese students abroad. Song is currently a Ph.D. student in electrical engineering with an emphasis in radio-frequency and micro-electro-mechanical systems devices.

Engineering and Science Education

Melanie Cooper, Ph.D.
Interim Department Chair
864-656-2573
cmelani@clemson.edu
clemson.edu/ese

Fast Facts

Tenured/tenure-track faculty: 7

Enrollment:	Undergraduate	n/a
	Master's	n/a
	Doctoral	n/a
	Certificate	20
Degrees awarded:	Undergraduate	n/a
	Master's	n/a
	Doctoral	n/a
	Certificate	3

Research expenditures: $268,805

Research thrusts: epistemologies, learning mechanisms and systems, diversity and inclusiveness, assessment

Melanie Cooper

Department Overview

The Department of Engineering and Science Education (ESE) offers CES graduate students the opportunity to earn a Certificate in Engineering and Science Education. This program is designed for graduate students who seek experience in preparation for an academic career, who wish to further their understanding of the education process in engineering and science, or who are interested in engineering and science education research. This certificate program specifies a range of courses (minimum of 11 credits) that may be selected to address specific research questions or interests.

Faculty Highlights

Melanie Cooper, chemistry professor and interim department chair of ESE, has been selected as the 2010-2011 winner of the Outstanding Undergraduate Science Teacher Award from the Society for College Science Teachers (SCST). This award is given by the SCST, a national organization that promotes the scholarship of college science teaching. The SCST notes that the award is based upon Cooper's "extensive body of chemical education research and a prolific publication record in areas such as learning gains associated with cooperative learning and metacognition." The society also notes that she is recognized as a leader in developing instruments for measuring learning and devising new technologies or curriculum-based methods on those measurements.

Cooper has also been recognized by her colleagues and the Class of 1939 as one of Clemson University's brightest faculty members with the Class of 1939 Award for Excellence. The award recognizes faculty members for the highest achievement of service to the student body, the University and the community. She received a $5,000 stipend and became an honorary member of the class. Her name was also inscribed on the Class of 1939 bell monument in the Carillon Garden.

Student Achievement

Cheryl Cass, an ESE postdoctoral research associate, recently received an Apprentice Faculty Grant by the American Society for Engineering Education (ASEE). The apprentice faculty program provides mentoring to individuals preparing for a career in engineering education. Cass presented her work focusing on the intersection of science identity and engineering persistence at the ASEE annual conference in Vancouver, British Columbia.

Environmental Engineering and Earth Sciences

Tanju Karanfil, Ph.D.
Department Chair
864-656-1005
tkaranf@clemson.edu
clemson.edu/ces/departments/eees

Fast Facts

Tenured/tenure-track faculty: 20

Enrollment:	Undergraduate	61
	Master's	63
	Doctoral	**26**
Degrees awarded:	Undergraduate	0
	Master's	15
	Doctoral	5

Research expenditures: $2,453,758
Research thrusts: environmental chemistry, environmental fate and transport, hydrogeology, nuclear environmental engineering and science, process engineering, sustainable systems, environmental assessment


Brian Powell

Faculty Overview

Tanju Karanfil received an NSF grant for his proposal entitled "Formation of Halonitromethanes and Nitrosamines during Ozonation in Drinking Water." In addition, Arch Chemicals Inc. made a gift award to the University to support Karanfil's research on formation of disinfection by-products in swimming pools.

David Freedman received a grant from the NSF-SBIR program. He is working with Bioremediation Consulting Inc. in Watertown, Mass., on a project entitled "Development and Characterization of a Bioaugmentation Culture to Remediate Chlorinated Ethenes in Low pH Ground Water." Freedman is also working on a project sponsored by Olin Corp. entitled "Laboratory Evaluation of Bioremediation for Groundwater at the Lake Charles Site."

Brian Powell and emeritus research professor **Fred Molz** received funding to expand their project "Iodine, Radium and Strontium Geochemistry in Wetland and Subsurface Sediments." The project is sponsored by Savannah River Nuclear Solutions through the S.C. Universities Research and Education Foundation and focuses on understanding biogeochemical controls of radionuclide subsurface fate and transport.

The 19th Annual Clemson/David S. Snipes Hydrogeology Symposium was held at Clemson last spring. This year's event attracted more than 300 attendees from around the Southeast. The theme sessions covered innovative techniques for groundwater and soil remediation using oxidation technologies, CO_2 sequestration, constructed wetland treatment systems, well and stream monitoring networks, bioremediation, stream and watershed hydrology, and Clemson's geology undergraduate Creative Inquiry projects.

Scott Brame was, as in the past years, the main organizer and coordinator of this event. Professor **Larry Murdoch** gave a talk on hydromechanics. **Shelley Miller** discussed life cycle analysis, and **Ron Falta** and **Jim Castle** gave presentations related to carbon dioxide sequestration. Graduate students giving oral presentations included **Dave Hisz**, **Richie Hall**, **Dan Matz**, **Seth Shantz**, **Shannon Thompson**, **Curtis Gebhard**, **Jim Chamberlain**, **Xiaoling Liu**, **Fei Chen**, **Vijay Santikari**, **Adam Mangel** and **Zuolin Liu**. **Na Hai** presented a poster.

Professor **Larry Murdoch** was elected chair of the Board of Directors of the Consortium of Universities for the Advancement of Hydrologic Science Inc. (CUAHSI). CUAHSI is an NSF-funded consortium of 126 universities with research programs in hydrology and water science.

John Wagner received the S.C. Science Council's highest award for a science educator, the Catalyst Award for Educational Excellence.

Leslie Grady was the recipient of the 2010 Industrial Water Quality Lifetime Achievement Award from the Water Environment Federation.

Brian Powell was selected to receive the prestigious 2011 Outstanding Young Investigator Award for the Clemson University chapter of Sigma Xi.

Dean emeritus **Gene Rich** was presented with South Carolina's Order of the Palmetto, the highest civilian award given by the state, for his contributions to environmental engineering practice and education in the Palmetto State.

Student Achievement

Professors **Jim Castle** and **Scott Brame** and graduate assistant **Catherine Ruprecht** accompanied 21 Clemson undergraduate students as they participated in a one-week field trip to Andros Island in the Bahamas. Andros is famous among geologists as a world-class location for studying modern carbonate sediments and the third-longest barrier reef in the world.

Jia Hu's doctoral dissertation "Exploring Formation and Distribution of Halonitromethanes in Drinking Waters" was selected as one of the best doctoral dissertations completed in 2010 by the American Water Works Association. Her research adviser, **Tanju Karanfil**, was recognized with a plaque at the ceremony.

Peng Luo, a Ph.D. candidate, was chosen to receive a 2010-2011 Roy G. Post Foundation Graduate Student Scholarship in the amount of $5,000.

Daniel Lewis, an M.S. student, received the Blue Ridge Foothills District Scholarship from the Blue Ridge Foothills District Chapter of the S.C. American Water Works Association and the Water Environment Association of South Carolina.

Viet Duc Dang and **Ting Shao** were the recipients of Graduate Student Awards from the Division of Environmental Chemistry of the American Chemical Society. Each year, the division recognizes up to 25 graduate students nationwide.

Ph.D. student **Jim Chamberlain** was made a Paul Harris Fellow by Rotary Club International for his work in El Salvador. For the past three years, Chamberlain has taken Clemson engineering students down to survey, prepare and design drinking water supply systems for rural developing communities.

Industrial Engineering

Anand K. Gramopadhye, Ph.D.
Department Chair
864-656 4716
agramop@clemson.edu
clemson.edu/ces/ie

Fast Facts

Tenured/tenure-track faculty: 11

Enrollment:	Undergraduate	215
	Master's	155
	Doctoral	45
Degrees awarded:	Undergraduate	60
	Master's	5
	Doctoral	6

Research expenditures: $1,212,337
Research thrusts: supply chain optimization and logistics, human factors and safety in health care and in technologically complex environments, education and learning systems


Scott Mason

Department Overview

The industrial engineering program is accredited to award B.S., M.S., M.Engr. and Ph.D. degrees in industrial engineering. The department promotes excellence in scholarship, research and industrial engineering education, broadly focused in supply chain, optimization and logistics; human factors and safety in health care and technologically complex environments; and education and learning systems.

The department has several programmatic initiatives that have resulted in significant growth, garnering esteem on both national and international levels. These include the online M.Engr. in industrial engineering and the SmartState Endowed Chair in Supply Chain. In addition, the department is home to two institutes, the Clemson Institute of Supply Chain, Optimization and Logistics and the Human Factors and Ergonomics Institute. The department is also home to an NSF-sponsored Industry and University Cooperative Research (IUCRC) program satellite center in engineering logistics and distribution and the Center for Excellence in Quality.

Finally, to engage undergraduate students in research, the faculty is implementing a new Creative Inquiry paradigm to enrich the undergraduate experience. Clemson has become a leader through its international research and collaboration, and the industrial engineering department has played a significant role in bringing the world's talent to our doorstep.

Faculty Highlights

William G. Ferrell has been elected a Fellow of the Institute of Industrial Engineers. During his time at Clemson, Ferrell has focused his research activities toward applying rigorous approaches to real supply-chain logistics problems in industry and the world outside of academia. This led him to establish the Clemson Institute for Supply Chain Optimization and Logistics that serves as a liaison between Clemson's wealth of expertise and the needs of S.C. industry. To expand this effort, he founded and directs Clemson's Center for Excellence in Logistics and Distribution, an NSF IUCRC. All research within the center is funded by industry or government entities wishing to partner with University experts to find innovative solutions for difficult, real-world logistics problems. Two of Ferrell's recent projects include developing a model that determines the minimum cost outbound logistics solution for a distribution center and building a decision support system to assist green belts in selecting and implementing appropriate Six Sigma tools for problems they encounter.

Student Achievement

Paul L. Goethals graduated from Clemson last spring with a Ph.D. in industrial engineering. In the span of the 30 months it took to earn the degree, 12 of his papers were published in archival journals, and six were published in refereed conference proceedings. Seven additional journal papers currently remain in various stages of revision or review.

For his accomplishments, he was awarded the department's, the college's and the University's Best Researcher of the Year award. Goethals also sought every opportunity to share his research with colleagues, giving a total of 11 presentations at eight national or international conference venues.

While attending the 46th annual meeting of the Southeastern INFORMS Conference in 2010, a paper he wrote with his adviser, **Byung Rae Cho**, was selected as both the Best Paper in Track and the Best Paper in Conference from 111 submitted manuscripts. For his research efforts in applications associated with nanotechnology and military protective armor systems, Goethals was also awarded the 2010-2011 General Omar Bradley Fellowship in Mathematics.

Upon graduation, Goethals began his assignment as an assistant professor in the Department of Mathematical Sciences at the U.S. Military Academy in West Point, N.Y.

School of Materials Science and Engineering

Igor Luzinov
Interim Director
864-656-5958
luzinov@clemson.edu
clemson.edu/mse

Fast Facts

Tenured/tenure-track faculty: 14.5

Enrollment:	Undergraduate	110
	Master's	16
	Doctoral	56
Degrees awarded:	Undergraduate	27
	Master's	8
	Doctoral	3

Research expenditures: $7,819,536

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

Jian Luo

Faculty Highlights

Marian Kennedy and **Julie Trenor**, assistant professors of engineering and science education, received an NSF award to run the Research Experience for Undergraduates (REU) site at Clemson University. The summer REU will be run by the School of Materials Science and Engineering until 2013. This program brings 11 undergraduate students from across the nation to engage in research projects with Clemson faculty. These programs are highly competitive, and the grant was awarded to the school for both its cutting-edge research and faculty commitment to undergraduate mentoring. The research and program activities of this REU site are designed to give participants positive research and social experiences and to encourage them to pursue graduate studies and research careers.

This past summer, **Jian Luo's** research group participated in a Multidisciplinary University Research Initiative (MURI) program entitled "Tailoring of Atomic-scale Interphase Complexions for Mechanism-Informed Materials Design." This five-year, $7.5 million MURI project is funded by the U.S. Office of Naval Research and will be led by Lehigh University (Martin Harmer, PI), with participation from Clemson University, Carnegie-Mellon University, University of Illinois at Urbana-Champaign and Kutztown University of Pennsylvania. The results of this MURI project and the methodology developed will have a broad impact with the potential to create "designer" materials with unique property sets and/or vastly improved specific properties and performance such as enhanced oxidation, corrosion and impact resistance, as well as improved energy generation and storage systems. As a major participant of this project, Luo's group at Clemson is expected to receive $1.25 million of research support and will lead several research thrusts, including thermodynamic modeling and theory development, as well as experimental studies of metals (structural alloys) and ceramics (solid-oxide fuel-cell materials).

John Ballato and chemistry professor **Joe Kolis** received an extension for their project "Eye-Safe Polycrystalline Lasers," which is funded by the DoD Joint Technology Office. The focus of the project is transparent ceramic and single crystalline sesquioxide materials (Y_2O_3, Sc_2O_3 and Lu_2O_3) as the enabling materials in high-energy, solid-state laser systems. These materials are of interest because they have enhanced thermal conductivity over incumbent materials such as yttrium aluminum garnet.

Konstantin Kornev and **Igor Luzinov** received funding from the Air Force Research Laboratory to investigate approaches to creating self-cooling gradient shell for body armor. This work aims at developing novel, smart-textile materials for advanced, lightweight, self-cooling protective clothing by creating a laminated structure with a prescribed permeability gradient.

John Ballato has become a Fellow of the International Society for Optics and Photonics (SPIE). The society was founded in 1955 to advance light-based technologies. Serving more than 180,000 constituents from 168 countries, the society advances emerging technologies through interdisciplinary information exchange, continuing education, publications, patent precedent, and career and professional growth.

Student Achievement

Benn Gleason, a Ph.D. candidate, won first place in the industry-judged Outstanding Student Paper competition presented at the SPIE Optifab meeting held last spring in Rochester, N.Y. The award was presented for his paper "Using Design of Experiments to Improve Precision Molding of Chalcogenide Glasses" and comes with a $1,000 cash prize given by the American Precision Optics Manufacturer's Association. This year's winner was selected from a field of 42 submitted papers representing authors from seven countries.

Mathematical Sciences

Robert L. Taylor
Department Chair
864-656-3434
rtaylo2@clemson.edu
clemson.edu/math

Fast Facts

Tenured/tenure-track faculty: 46

Enrollment:	Undergraduate	272
	Master's	61
	Doctoral	63
Degrees awarded (2009-2010):		
	Undergraduate	47
	Master's	26
	Doctoral	4

Research expenditures: $805,089

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

Clemson Calculus Challenge

Department Overview

The Department of Mathematical Sciences provides major contributions to the instructional and research mission of the University. Enrollments average 7,000 to 8,000 students per semester in more than 350 sections of math sciences courses, ranging from beginning freshman courses to cutting-edge research courses at the graduate level. More than 85 faculty members and approximately 120 graduate students lead mathematical and statistical instruction and research.

Prominent research activities include publications (more than 100 per year), invited presentations (30 or more national and international talks each of the past three years), national and international professional involvement of the faculty, and funded research (approximately $1 million per year). Computational modeling, biomathematics and stochastic modeling are some of the standout areas of study within the department.

The eighth annual Clemson Calculus Challenge took place last April. The department hosted 266 students from 34 regional high schools. Both the number of student contestants and the amount of schools attending were the highest in the history of the event. There were team awards and individual prizes that included $500 scholarships to the University.

Faculty Highlights

Jim Brannan received CES's 2011 Award for Outstanding Teaching in the Sciences.

Robert L. Taylor served as chair of the National Test Development Committee for Advanced Placement in Statistics.

Xuhong Gao presented three invited talks in China and was a major speaker at the Cryptography Workshop in Beijing, China.

Assistant professor **Jan Medlock** published "Protecting the Herd from H1N1" in *Science* and received national recognition for the optimal modeling for the distribution of limited vaccine.

Associate professor **Calvin Williams** served on the advisory board for the Centers for Ocean Science Education Excellence.

Assistant professor **Elena Dimitrova** received the department's Faculty Teaching Award in April.

Student services coordinator **Kris Hunnicutt** received a Board of Trustee Exceptional Staff Award in May.

Student Achievements

Catherine Trentacoste received the University's Outstanding Graduate Teaching Assistant Award for 2011.

Erin Doolittle has received funding to study at Telecom Bretagne in France in conjunction with her dissertation research on optimization problems.

Dania Zantout and **Chris Johnson** were funded for two months of research study at the Hausdorff Research Institute for Mathematics in Bonn, Germany.

Frank Volny presented a research talk at the 35th International Symposium on Symbolic and Algebraic Computation in Munich, Germany.

Lori Layne presented a research talk entitled "Stability Properties of Biologically Relevant Boolean Functions" at the Cha-Cha Days conference at the College of Charleston.

Mechanical Engineering

Georges M. Fadel, Ph.D.
Interim Chair
864-656-5640
fgeorge@clemson.edu
clemson.edu/ces/me

Fast Facts

Tenured/tenure-track faculty: 23

Enrollment:	Undergraduate	542
	Master's	96
	Doctoral	58
Degrees awarded (May 2011):		
	Undergraduate	76
	Master's	77
	Doctoral	19

Research expenditures: $2,615,422

Research thrusts: automotive engineering, bioengineering and biomaterials, design, dynamics and controls, fluid mechanics, materials and materials processing, solid mechanics, thermodynamics, heat transfer and combustion

Mohammed Daqaq

Faculty News

Assistant professor **Mohammed Daqaq** won a prestigious NSF award for $410,000 to support his project entitled "CAREER: Electromechanical Transduction of Vibratory Energy Harvesters in Random and Nonstationary Environments." This grant will allow Daqaq to explore ways to transform wireless sensors, pacemakers, spinal stimulators and artificial organs into self-powered units. He plans to accomplish this by developing scalable micropower generators that can scavenge mechanical energy from the surrounding environment and transform it into electricity via different electromechanical coupling mechanisms.

Mica Grujicic, the Wilfred P. and Helen S. Tiencken Professor of Mechanical Engineering, won a 2011 Emerald Literati Network Award for Excellence. His article entitled "The Effect of Up-armoring of the High-mobility Multipurpose Wheeled Vehicle on Off-road Vehicle Performance" was published in *Multidiscipline Modeling in Materials and Structures*. Grujicic also received Clemson's Alumni Award for Outstanding Achievement in Research.

Professors **James Gibert**, **Georges Fadel** and **Mohammed Daqaq** won an Outstanding Paper Award at the 2011 Emerald Literati Network Awards for Excellence. Their article entitled "Effect of Height-to-width Ratio on the Dynamics of Ultrasonic Consolidation" appeared in the Rapid Prototyping Journal.

Two new professors will join the faculty in 2012. **Huijiuan (Jane) Zhao** received her Ph.D. from the University of Illinois at Urbana-Champaign and is currently working at Oak Ridge National Lab. She will join the department in January. Her research area is solid mechanics. **Yue (Sophie) Wang** received her Ph.D. from Worcester Polytechnic Institute and will join the department in August after spending one year as a postdoctoral associate at the University of Notre Dame. Her research area is dynamic systems and controls.

Student Achievement

Anna d'Entremont and **Shannon Edd** received NSF graduate research fellowships this year. d'Entremont is continuing her education at UCLA, and Edd is headed for Stanford. **John Triana** received an honorable mention.

Physics and Astronomy

Mark Leising, Ph.D.
Interim Department Chair
864-656-5304
lmark@clemson.edu
clemson.edu/ces/physics-astro

Fast Facts

Tenured/tenure-track faculty: 21

Enrollment:	Undergraduate	94
	Master's	2
	Doctoral	61
Degrees awarded (August 2010 to May 2011):		
	Undergraduate	15
	Master's	3
	Doctoral	6

Research expenditures: $2,752,641

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

Frontiers of Quantum Physics conference

Faculty Highlights

Last spring, Clemson University and the Perimeter Institute sponsored a conference on the frontiers of quantum physics. **Antony Valentini** and **Murray Daw** hosted the meeting, and world leaders in the field presented lectures on various topics such as physical axioms for quantum theory, the application of collapse theories, the Broglie-Bohm theory, cosmology, understanding probability and classicality in the many-worlds interpretation, understanding the structure of possible hidden-variables theories, making collapse theories Lorentz invariant, reconstructing quantum theory from general probabilistic and operational frameworks, new perspectives on black-hole information loss and the problem of time.

Facilities

Clemson Planetarium

After nearly 50 years of operation, the planetarium in the Kinard Laboratory of Physics temporarily closed in December 2010 for renovation. Since then, a new platform, carpet and seats have been installed. The theater now has 39 seats plus spaces for wheelchairs. In March 2011, a Digistar 4 system from Evans and Sutherland was installed. The new planetarium presented shows for Clemson employees, campers and laboratory students this summer and will open for school field trips and evening shows in the fall.

Student Achievement

Priyanka Bhattacharya won a student poster award and a cash prize at the 37th Federation of Analytical Chemistry and Spectroscopy Societies conference held in Raleigh, N.C. Fifteen out of 500 students were awarded for their research presentations at this international conference.

Kemper Talley has received several awards on the departmental, college and University levels over the past few years, including the Goldwater Fellowship. He recently received an award from the NSF Graduate Research Fellowship Program for his future graduate studies.

The research achievements of physics students **Matthew Stone**, **Mercy Lard** and **James Turner** were highlighted by the Council on Undergraduate Research (CUR) in January 2011. Their recognized achievements account for three of the 128 entries within the discipline of physics and astronomy selected by the CUR since 2002.

Ramakrishna Podila was awarded the Outstanding Continuing Graduate Student Fellowship by Clemson University in April 2011.

Bethany Johns graduated with a Ph.D. in astrophysics in 2010 and was awarded the Bahcall Fellowship of the American Astronomical Society. This is the premier position in science policy in astronomy.

Department Contacts

Automotive Engineering
6 Research Drive
Greenville, SC 29607
Phone: 864-283-7217
clemson.edu/centers-institutes/cu-icar
sih@clemson.edu
Dr. Imtiaz Haque, Chair

Bioengineering
301 Rhodes Research Center
Clemson University
Clemson, SC 29634-0905
Phone: 864-656-5556
Fax: 864-656-4466
clemson.edu/ces/bio
laberge@clemson.edu
Dr. Martine LaBerge, Chair

Chemical and Biomolecular Engineering
127 Earle Hall
Clemson University
Clemson, SC 29634-0909
Phone: 864-656-0822
Fax: 864-656-0784
clemson.edu/ces/chbe
hirtd@clemson.edu
Dr. Douglas Hirt, Chair

Chemistry
219 Hunter Laboratories
Clemson University
Clemson, SC 29634-0973
Phone: 864-656-4995
Toll Free: 888-539-9954
Fax: 864-656-6613
chemistry.clemson.edu
screage@clemson.edu
Dr. Stephen Creager, Chair

Civil Engineering
Lowry Hall
Clemson University
Clemson, SC 29634-0911
Phone: 864-656-3002
Fax: 864-656-2670
clemson.edu/ce
aziz@clemson.edu
Dr. Nadim M. Aziz, Chair

School of Computing
100 McAdams Hall
Clemson University
Clemson, SC 29634-0974
Phone: 864-656-7552
Fax: 864-656-0145
clemson.edu/ces/computing
lfh@clemson.edu
Dr. Larry F. Hodges, Director

Holcombe Department of Electrical and Computer Engineering
105 Riggs Hall
Clemson University
Clemson, SC 29634-0915
Phone: 864-656-5924
Fax: 864-656-5917
clemson.edu/ces/ece
ddarren@clemson.edu
Dr. Darren Dawson, Chair

Engineering and Science Education
105 Holtzendorff Hall
Clemson University
Clemson, SC 29634-0902
Phone: 864-656-2573
Fax: 864-656-1327
clemson.edu/ese
cmelani@clemson.edu
Dr. Melanie Cooper, Interim Chair

Environmental Engineering and Earth Sciences
L.G. Rich Environmental Laboratory
342 Computer Court
Anderson, SC 29625
Phone: 864-656-1005
Fax: 864-656-0672
clemson.edu/ces/eees
tkaranf@clemson.edu
Dr. Tanju Karanfil, Chair

Industrial Engineering
110 Freeman Hall
Clemson University
Clemson, SC 29634-0920
Phone: 864-656-4716
Fax: 864-656-0795
clemson.edu/ces/ie
agramop@clemson.edu
Dr. Anand K. Gramopadhye, Chair

School of Materials Science and Engineering
161 Sirrine Hall
Clemson University
Clemson, SC 29634-0922
Phone: 864-656-5958
Fax: 864-656-5973
clemson.edu/mse
luzinov@clemson.edu
Dr. Igor Luzinov, Interim Director

Mathematical Sciences
O-110 Martin Hall
Clemson University
Clemson, SC 29634-0975
Phone: 864-656-3434
Fax: 864-656-5230
clemson.edu/math
rtaylo2@clemson.edu
Dr. Robert L. Taylor, Chair

Mechanical Engineering
100 Fluor Daniel EIB
Clemson University
Clemson, SC 29634-0921
Phone: 864-656-2482/5640
Fax: 864-656-4435
clemson.edu/ces/me
fgeorge@clemson.edu
Dr. Georges Fadel, Interim Chair

Physics and Astronomy
118 Kinard Laboratory
Clemson University
Clemson, SC 29634-0978
Phone: 864-656-5304
Fax: 864-656-0805
clemson.edu/ces/physics-astro
lmark@clemson.edu
Dr. Mark Leising, Interim Chair

CLEMSON
College of ENGINEERING AND SCIENCE