IDEaS

INQUIRY, DISCOVERY IN ENGINEERING AND SCIENCE

COLLEGE OF ENGINEERING AND SCIENCE SPRING 2011

in this issue:

CLEMSON
College of ENGINEERING AND SCIENCE

INQUIRY, DISCOVERY IN ENGINEERING AND SCIENCE

IDEaS

SPRING 2011

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

On the cover: Mark Thies considers Clemson a natural fit for hosting the 2010 World Conference on Carbon, which attracted more than 400 delegates from around the world to discuss the element's modern-day applications. Flip to page 2 for more information.

Right: Industrial engineering department chair Anand Gramopadhye talks with David Seaton, CEO, Fluor Corp. and Ken Smith, senior vice president, Fluor Government Group. Read about the partnerships Fluor Corp. and other companies are forming with Clemson to optimize supply chain and logistics procedures on page 9.

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CLEMSON
College of ENGINEERING AND SCIENCE

From the Dean

This fall, I had the opportunity to participate in the first Automotive Transatlantic Summit, which brought together government representatives, vehicle manufacturers, suppliers, universities and research centers. The goal was to exchange experiences and find common ground in the ongoing evolution of the automotive sector. The summit was held at the Automotive Intelligence Center (AIC) in Bilbao, Spain, and I represented the Clemson University International Center for Automotive Research (CU-ICAR). Both AIC and CU-ICAR integrate knowledge, technology and industrial development in partnerships geared to revolutionize the automotive design and manufacturing sector of the transportation industry. The summit mirrored the makeup of both the AIC and CU-ICAR, which represent partnerships among government, industry and academia.

This issue of *IDEaS* offers a view of several different kinds of Clemson partnerships — a coming together of sometimes apparently disparate groups for the pursuit of a common educational or research endeavor. With these partnerships, the whole truly is greater than the sum of its parts; the synergy can be both motivational and inspiring.

Our cover feature, an overview of the carbon research taking place at Clemson, points out the importance of interdisciplinary partnerships — groupings that are garnering international attention, bringing a world conference to the University's doorsteps.

Collaboration is the key to providing unique educational experiences for our students, expanding scientific knowledge and improving economic development.

There is also a feature on the Clemson Institute of Supply Chain Optimization and Logistics. This S.C. Center of Economic Excellence represents a financial investment by the Palmetto State, coupled with a $2 million match by Fluor Corp. With a focus on finding the most efficient and economical way for companies to move raw materials, products and people, this collaboration of state government, industry leaders and academia is having a substantial, positive economic impact.

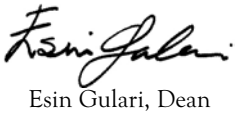
Another story describes the unique partnership between the federal government and professors in our young Department of Engineering and Science Education. Three assistant professors were awarded National Science Foundation CAREER grants — quite an accomplishment for a group of faculty who are in the early stages of their academic and research careers.

Our final feature describes the partnership between Clemson and national research laboratories. Students in the University's nuclear engineering program are taking advantage of this relationship to build invaluable work experience through student internships.

We're continuing to nurture current relationships while welcoming new partners. In the News and Notes section, you'll learn that an Academy Award-winning director has joined our faculty. We look forward to watching him bring fresh perspectives and enthusiasm to our digital production arts graduate program.

Collaboration is the key to providing unique educational experiences for our students, expanding scientific knowledge and improving economic development — all are tenets for which CES stands.

Sincerely,



Esin Gulari, Dean
College of Engineering and Science
Clemson University

Global Exposure to the Elements

By Tom Hallman

About 6,000 years ago, somewhere in Mesopotamia – historians still argue the exact location – someone happened upon the happy understanding that charcoal was an excellent source of fuel for smelting ores of copper, zinc and tin.

That discovery, the birth of the Bronze Age, was the first recorded industrial use of carbon.

It was far from the last.

Today at Clemson, researchers in virtually every corner of the College of Engineering and Science explore new uses for the ubiquitous element, and they're drawing the attention of scientists across the globe – quite literally.

The world – or at least the carbon-studying portion of it – converged on Clemson last July for the 2010 World Conference on Carbon. More than 400 delegates from dozens of countries convened for lectures and discussions about the element's applications in electronics, energy, transportation, medicine and dozens of other fields.

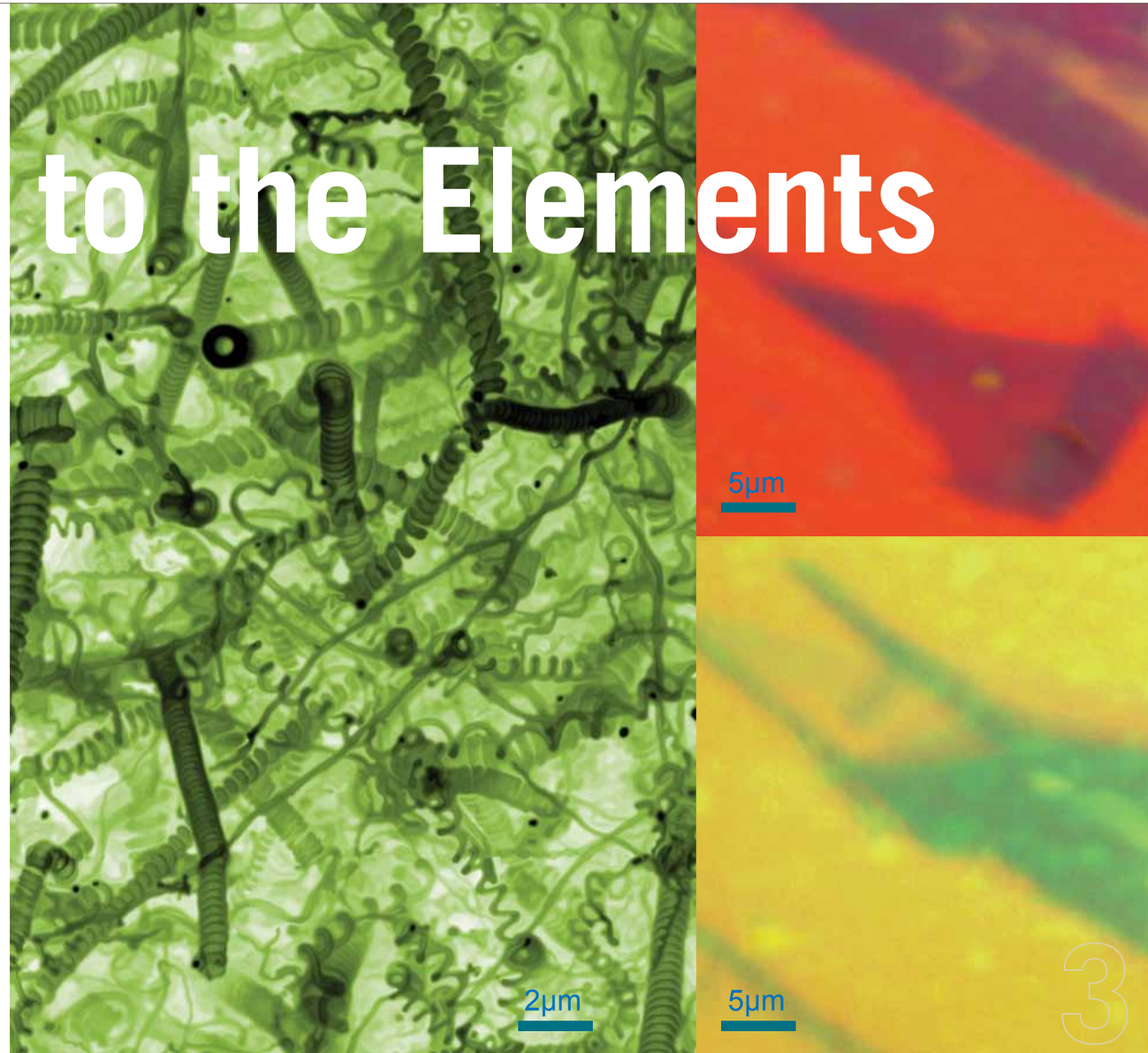
"Carbon research is at the heart of so many disciplines, it's a fundamental part of science and technology today," Clemson President Jim Barker remarked while welcoming the group. "We're honored to host the world's scientists for a conference of this stature. It's exciting for Clemson to be in the center of it."

The carbon conference moves annually among Asia, Europe and America. Having summered the previous season along the beaches of Biarritz, France, it was brought to the shores of Hartwell Lake in large part because of a cluster of Clemson scientists and engineers for whom carbon is the building block of research.

"We have a very strong carbon community here," says Mark Thies, a professor of chemical engineering and chairman of the conference. "We have more than a dozen faculty and a hundred graduate students from all over the world focused on various aspects of carbon research.

"So on the one hand, you might wonder why, after Biarritz, the playground of the rich in Europe, the conference might come to Clemson. But on the other hand, it was quite a natural fit," he says.

Clemson's carbon research ranges from traditional applications, such as carbon filtration in water treatment, to recent advances in nanotechnology – which is science at a scale of 10^{-9}, or one-billionth the size of the things you can see with an optical microscope.



Right: From Apparao Rao's lab, this image of coiled carbon nanotubes was taken with a Hitachi S4800 electron microscope.

Far Right: Single sheets of carbon called graphene have been synthesized using a vapor-phase method as part of the study of quantum confinement effects in carbon nanostructures. These photos were taken with an optical microscope.

Left: Mark Thies researches the thermal applications of carbon in his lab.

Top Right: Apparao Rao studies the properties of carbon nanotubes.

Bottom Right: Amod Ogale examines the aerospace and automotive applications of high-strength carbon fibers and composites.

Thies, himself, works to improve the properties and lower the cost of high thermal conductivity fibers. "Copper electronic components can fail when they get too hot, when you can't dissipate that energy," he says. "But carbon fibers can resolve overheating issues."

A leader in developing nanoscale materials, physics professor Apparao Rao has created methods of synthesizing carbon nanotubes with different morphologies. Rao and his team have gained international recognition for advancing electromechanical nanosensors that can warn of toxic chemicals in the air. He also has invented a way to make tiny, shock-absorbing carbon springs that can protect delicate electronics like cell phones and has explained many of the fundamental properties of nanostructures through Raman spectroscopy.

"Our studies with carbon nanotubes have been ongoing for quite some time. Each step along the way has led to the next breakthrough, and each time we've learned more about how they grow and what their applications could be," Rao says.

High-strength carbon fibers and composites for aerospace and automotive applications are among the research interests of professor Amod Ogale. He also studies super-strong carbon fibers for nuclear reactor safety. "Steel alloys currently used internally in reactors melt at the peak temperature of 2,500 degrees Fahrenheit, where carbon-fiber/carbon-matrix composites do not," says Ogale, the director of Clemson's Center for Advanced Engineering Fibers and Films.

The world — or at least the carbon-studying portion of it — converged on Clemson last July for the 2010 World Conference on Carbon.

Ya-Ping Sun, the Frank Henry Leslie Professor of Chemistry, studies carbon dots – tiny materials that work with magnetic-imaging techniques for the early detection and diagnosis of breast cancers. The dots also are potential light sources – more efficient than traditional bulbs while generating less heat.

"The commercial and biological applications for this are numerous," Sun says. "There's a lot of potential to continue the research so we can understand the fundamental properties better and also look at real-world applications."

Around the corner from Sun, Stephen Creager, chemistry department chairman, synthesizes carbon nanofoams for use as electrode supports in hydrogen fuel cells, which could power tomorrow's automobiles.

"Electrochemical power sources, particularly batteries, have driven extensive research in the past few decades in an attempt to improvise systems of high-energy density and long shelf life," Creager says.

While carbon has long served as a filter in water treatment, Tanju Karanfil, environmental engineering and earth science department chairman, investigates how carbon nanomaterials can improve the process to develop new, more efficient water treatment systems.

"Given the increasingly stringent water quality standards and public concern over environmental issues, environmental engineers are aggressively pursuing innovative, selective and versatile treatment technologies for solving current pollution problems and preventing new ones," Karanfil says.

"There are so many applications for carbon research, it's easy to wonder what's next," Thies says. "Scientists have discovered two new forms of carbon in the past 20 years. It seems like anything is possible with this material." *

Coming of Age

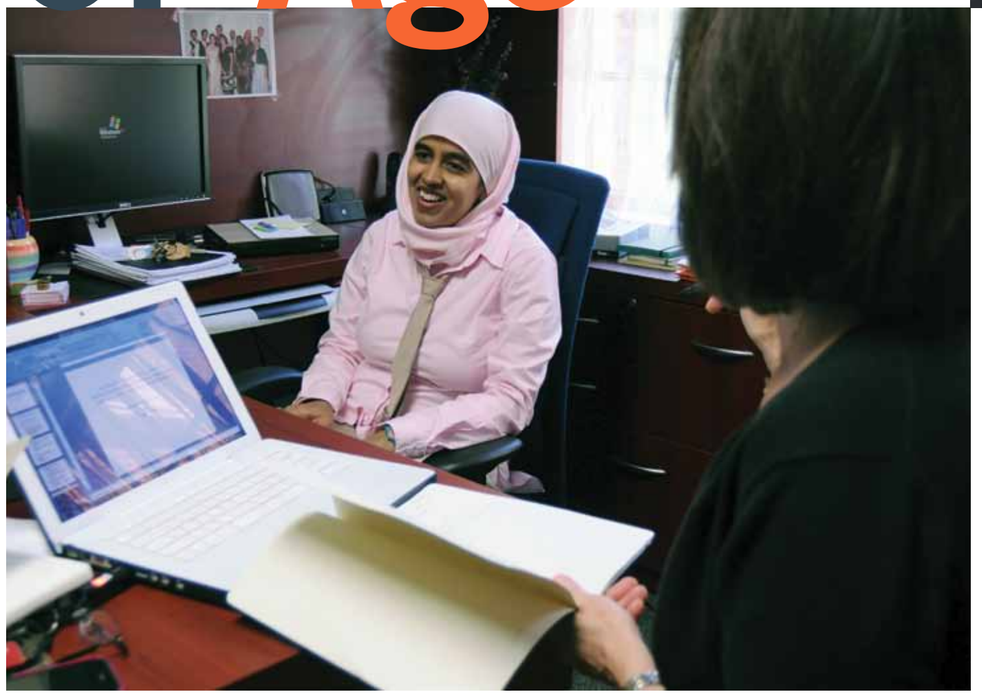
By Lauren Turner

As Clemson University's engineering and science education department (ESE) approaches its fourth anniversary, several faculty in the young department are celebrating milestone accomplishments.

Founded in 2006, ESE is a relatively new department that is building upon the successes of Clemson's chemistry education Ph.D. program. The unique academic structure of the College of Engineering and Science — which encompasses math, the physical sciences and engineering — offers a one-of-a-kind research environment. The ultimate goal of the department is to change the culture of science, technology, engineering and math (STEM) education — both at the undergraduate and graduate levels — by preparing future faculty, developing research-validated curricula and providing avenues for underrepresented groups to excel.

Even though most of the ESE faculty are only in their second or third year as assistant professors, each has received funding from the National Science Foundation (NSF) to support their research. The department already has three NSF CAREER awardees in its ranks. Assistant professor Zahra Hazari is pursuing research that focuses on the development of a positive "physics identity" that will improve student performance in science classes. Assistant professor Julie Trenor is exploring the social factors that influence underrepresented students' decisions to enter engineering fields. Assistant professor Lisa Benson is examining how motivation influences a student's ability to learn and succeed in engineering-related subjects.

Hazari's research primarily focuses on females and underrepresented groups in physics. A physics identity is a theoretical framework that analyzes gender differences in persistence, which is providing critical insight into understanding how to inspire and engage students in their physics classes. Using classroom case studies, Hazari will identify "personally meaningful learning experiences" that high school students have reported in physics lessons. She then will develop lesson plans with detailed activities that connect physics to real-world contexts.



Opposite page: Zahra Hazari is interested in how students can improve performance in science classes by developing a positive "physics identity."

Left: Julie Trenor is studying how social capital impacts the choice to study and start a career in engineering.

Below: Lisa Benson is conducting NSF-funded research to understand how engineering students find their motivation to learn and succeed.

Trenor is applying the theory of social capital to better understand undergraduate engineering students' academic and career choices related to engineering. Social capital is defined as resources gained from relationships, which can help the students achieve goals they might not be able to reach on their own (i.e., networking). Trenor plans to develop a conceptual model for understanding how engineering undergraduates develop, access and activate social capital in making education and career-related decisions based on data collected at six institutions.

Benson's NSF-funded research on student motivation is directed toward three goals. First, she seeks to identify and understand the factors that contribute to engineering students' motivation to learn and succeed, comparing them across criteria for different student types (by demographics, choice of major, etc.). Second, she'll study the correlation of the effects of student motivation on the development of problem-

Engineering and Science Education Faculty

Jeffrey R. Appling
Associate Professor, Chemistry Education
Research Interests
- Developing new materials and methods to improve science instruction and the study skills of science students
- Success and retention of underprepared students in science and engineering

Lisa C. Benson
Assistant Professor, Engineering and Science Education and Bioengineering
Research Interests
- Student-centered active learning in undergraduate engineering, assessment of motivation and how motivation affects student learning
- Using Tablet PC technology as a research tool and to enhance student learning

Melanie Cooper
Alumni Distinguished Professor, Chemistry Education
Research Interests
- The effect of interventions and educational environments on problem solving and metacognition
- Development of assessment systems for conceptual understanding

Zahra Hazari
Assistant Professor, Engineering and Science Education and Mathematical Sciences
Research Interests
- Reforming pedagogy in physics education in an effort to improve critical educational outcomes for underrepresented groups in physics — especially females

Geoff Potvin
Assistant Professor, Engineering and Science Education and Mathematical Sciences
Research Interests
- Graduate education and career success in physical science
- Female retention and other traditionally underrepresented groups in physics
- Identity development and recruitment of physicists

Julie Martin Trenor
Assistant Professor, Engineering and Science Education
Research Interests
- Ethnicity and educational experiences in engineering
- Generational status in college and educational experiences in engineering
- Family roles and students' academic and career decisions
- Undergraduate research and students' academic and career decisions

solving and critical-thinking skills, and tracking those changes over time. She will also use the collected data to develop a theory for the many factors for which motivation may affect undergraduate engineering students. Finally, she'll create a robust instrument to assess engineering students' motivation throughout the undergraduate experience to translate the research to practice. Ultimately, Benson will develop a course and workshop series to train engineering graduate students and educators in the underlying theory and use of the motivation assessment instrument. Outcomes will lead to a more diverse student population in all engineering disciplines through a deeper understanding of what motivates students to pursue a certain engineering discipline over others and how that motivation affects the learning of important skills.

Interim ESE chair Melanie Cooper has been selected as the 2010-2011 winner of the Outstanding Undergraduate Science Teacher Award (OUSTA) from the Society for College Science Teachers (SCST). The society is a national organization that promotes the scholarship of college science teaching. The OUSTA honors 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." She is recognized as a leader in developing instruments for measuring learning and devising new technologies and curricula based on the results of those assessments.

One of Cooper's NSF-funded projects is to develop a new general chemistry curriculum, *Chemistry, Life, the Universe and Everything* (CLUE). Based on research on teaching and learning, CLUE provides students with the fundamental concepts that are needed to understand chemistry. The new curriculum is currently piloted in Cooper's general chemistry classes. Student success and retention in the new curriculum for the fall 2010 and spring 2011 terms will be compared to that of students who took classes in the traditional curriculum.

One tool that Cooper utilizes in her new curriculum for basic chemistry is a learning device called OrganicPad, which was developed for another NSF-funded project. This interface uses Tablet PCs to allow students to draw molecules and structures. The device recognizes what the students are drawing and tells them if it is correct or not. OrganicPad bridges the gap between the conceptual understanding of molecular structures and tactile learning that is necessary for long-term retention.

With the SCST recognition of Cooper and the NSF CAREER awards for Hazari, Trenor and Benson, it appears that the faculty are well on their way to making their vision a reality. As the ESE department matures, along with its young faculty, it will no doubt become a hub for changing the culture of teaching and learning. *

THE CLEMSON INSTITUTE OF SUPPLY CHAIN OPTIMIZATION AND LOGISTICS IS UNIQUELY POISED TO HELP BUSINESS STAY ON THE MOVE.

Clemson Delivers

By Charreau Bell

Moving goods and services and delivering product to the customer can be an incredibly complex and expensive proposition for providers. From making sure raw materials are in place for production to final delivery to retail markets, supply chain and logistics impact the bottom line at every step of the process. The Clemson Institute of Supply Chain Optimization and Logistics (CISCOL) researchers are helping government, business and industry partners address these issues.

An institute that fosters interdisciplinary collaboration, CISCOL has become a catalyst for partnership and diversity in the fields of supply chain and logistics and has generated a number of innovative initiatives.

Clemson University's unique location along the booming I-85 industrial corridor in the Upstate of South Carolina allows CISCOL to provide essential support to companies and manufacturers. South Carolina is now home to several multinational companies, and even local businesses have extensive international footprints. The Upstate, alone,

Above left: Mary E. Kurz is investigating how to improve health care supply chains in which pharmaceutical availability impacts medication delivery to patients.

Above right: Teams of professors and graduate students work with industry partners to pinpoint ways to strengthen the supply chain process. Ph.D. student Ashley Childers worked with Kevin Taafe to streamline stocking policies at Lockheed Martin.

has more than 250 international firms and enjoys the highest level of foreign capital investment per capita in the nation. In this environment, the role of supply chain and logistics is critical to their success.

"We wanted to be the go-to organization in South Carolina for supply chain and logistics," says William G. Ferrell, director of CISCOL, a professor of industrial engineering and associate dean of the graduate school. "The best solution to any problem comes through collaborative investigation. We wanted to make this a center where supply chain researchers in business, mathematics and computer science would know they could find that collaboration."

"The field of supply chain and logistics focuses on finding the most efficient and economical way for companies to move raw materials, products and people," Ferrell adds. "These concepts can manifest themselves in any number of ways in business, including how goods flow through a production system, scheduling the system and distributing the products. CISCOL helps optimize the supply chain and logistics for a company, which can be the difference between profitability and bankruptcy."

CISCOL has also been the catalyst for Clemson's participation in the National Science Foundation-funded Center for Excellence in Logistics and Distribution (CELDi). CELDi's mission is to provide integrated solutions to logistics problems through modeling, analysis and intelligent-systems technologies. The CELDi organization currently consists of nine universities, including the University of Arkansas, Arizona State University, Clemson University, Lehigh University, the University of Missouri, the University of Oklahoma, Oklahoma State University, Texas Tech University and Virginia Tech. There are also more than 30 industry members.

In 2007, Clemson's leadership in supply chain and logistics led to the creation of an S.C. Center of Economic Excellence (CoEE) in Supply Chain Optimization and Logistics at Clemson. This was a financial investment by the state of South Carolina with a $2 million match by the Fluor Corp. This CoEE program enabled the College of Engineering and Science to recruit Scott J. Mason, a world-class scholar and researcher in the area of supply chain, as the first Fluor Endowed Chair of Supply Chain Optimization and Logistics in the industrial engineering (IE) department.

"The addition of Mason to an already excellent group of researchers clearly elevates the profile of the supply chain and logistics effort at Clemson," says Anand K. Gramopadhye, professor and chair of the department. Clemson's IE faculty have documented research successes in a variety of supply chain and logistics fields, such as capital projects; manufacturing; retail and consumer products; and military, medical and information technology.

> "We wanted to be the go-to organization in South Carolina for supply chain and logistics," says William G. Ferrell.

These three initiatives – CISCOL, CELDi and CoEE – have also dramatically increased the research capabilities of the department. The CISCOL center promotes interdepartmental collaboration and currently has partnerships and projects with the civil engineering department and the management department in Clemson's College of Business and Behavioral Science.

One initiative sparked by the establishment of the CoEE was the internationally acclaimed Master of Engineering in IE with a focus in capital projects supply chain. Students include professionals working in the supply chain in companies such as Boeing, UPS and BMW.

Clemson's presence in supply chain and logistics has evolved one step at a time. "Research in traditional distribution and logistics began before CISCOL," says Ferrell. "But our CoEE and CELDi have given us the opportunity to move into the areas of construction and health care, which aren't traditional IE fields. We would have never developed such far-reaching and diversified research directions if we hadn't created CISCOL. There is no doubt – it started everything." *

Scott Mason named Fluor Endowed Chair of Supply Chain and Logistics at Clemson

Scott J. Mason (center, pictured with Fluor Corp.'s CEO David Seaton, left, and D. Michael Steuert, Fluor Corp.'s CFO, right) has been appointed the inaugural Fluor Endowed Chair in Supply Chain and Logistics in Clemson University's industrial engineering department.

An expert in modeling large-scale systems who has extensive industrial experience, Mason comes to Clemson from the industrial engineering department at the University of Arkansas, where he also was chairman of graduate studies and associate department head.

Fluor Corp. contributed $2 million to match $2 million from the S.C. Centers of Economic Excellence (CoEE) program to fund the chair. It is one of 16 such positions funded through the CoEE program.

The study of supply chain and logistics involves finding the most efficient, economical way to move goods or people to market in business and industry. The field affects all aspects of business, from the flow of raw materials and scheduling production to manufacturing and distributing finished goods.

Mason began his career in the semiconductor industry then joined the University of Arkansas industrial engineering department, where he was twice named Faculty Member of the Year.

Mason has been both the technical vice president of networking and general co-chair of the Industrial Engineering Research Conference. He received his Ph.D. in industrial engineering from Arizona State University and his B.S. and M.S. from the University of Texas.

This Research Is RADIOACTIVE

By Ron Grant

Until 2000, Clemson's Nuclear Environmental Engineering and Science (NEES) program focused on health physics, radiation detection and measurements, risk assessment and radioactive waste management. At the turn of the millennium, Clemson expanded the program to include a radiochemistry emphasis. A 30-year decline in the number of trained nuclear scientists and radiochemists meant an insufficient work force to support the nation's current needs. One of the first recruits into the expanded program was Brian Powell.

"My undergraduate degree is in chemistry, and I didn't really have any sort of nuclear background at all when I was approached about the new program," explains Powell, assistant professor in environmental engineering and earth science. "As an undergraduate, I had written a paper bashing Yucca Mountain and another extolling the virtues of cold fusion, but that pretty much summed up my nuclear expertise. Clearly, I had a lot to learn."

One of the most valuable learning experiences Powell encountered during his graduate studies took place at the Savannah River National Laboratory, where he completed student internships. "Working at a national lab is just an incredible opportunity," shares Powell. "It's where the smartest people are doing the most advanced work with the most sophisticated equipment available."

When Powell completed his Ph.D. at Clemson, he took postdoc positions at Lawrence Berkeley National Laboratory and later at Lawrence Livermore National Laboratory. "I had actually intended to work at one of the national laboratories for most of my career," offers Powell. "However, I found that I missed interacting with students." Three years after completing his Ph.D., Powell returned to Clemson to head the environmental radiochemistry emphasis area.

Traditional nuclear engineering programs exist in stand-alone departments or under the auspices of a mechanical engineering department, but at Clemson, this discipline is being carried out in an unusual and highly effective way.

"Our program is unique in that we're a nuclear program imbedded in an environmental department, which is a logical fit if you think about it," observes Powell. "The critical issues facing the industry today concern radioactive contaminants in the environment, so we're perfectly situated to explore those phenomena and their impacts."

Members of Powell's research group may be spending a great deal of time at the Savannah River National Lab. He recently received a three-year, $1.2 million grant from the U.S. Department of Energy (DOE) to study how plutonium, a byproduct of used nuclear fuel, interacts with soil.

Powell recently received a three-year, $1.2 million grant from the U.S. Department of Energy to study how plutonium, a byproduct of used nuclear fuel, interacts with soil.

The research has implications for nuclear cleanup efforts and could help the DOE more accurately estimate the risk posed by long-term nuclear waste disposal.

Powell will use both experimental and computational studies to gain a better picture of how plutonium moves through soil. He will study plutonium interaction with soils from the energy department's Savannah River Site in South Carolina and its Hanford Site on the Columbia River in the state of Washington. He'll then combine that research with quantum-mechanical calculations and X-ray absorption spectroscopy to determine exactly how plutonium interacts with minerals and soils.

"I had actually intended to work at one of the national laboratories for most of my career," offers Powell. "However, I found that I missed interacting with students."

A good deal of the research conducted in the NEES radiochemistry group involves collaboration with national labs. In fact, according to Powell, relationships with the national labs are critical components of the program. While the collaboration offers great press for the labs, students benefit as well. They are able to work at the national labs on a specific project related to their thesis, but they gain experience working in that particular lab's culture. The interesting thing about the labs is that they're all different. Powell has worked at three of these facilities and visited all of them.

"For example, Lawrence Berkeley National Laboratory is a very academic research laboratory, essentially a university without classes," says Powell. "They don't do any classified work. The opposite extreme of that is the Savannah River National Lab, which is an industrial facility. Being exposed to the differences in culture is a revelation to the students in terms of the environmental issues involved and how each facility works from a unique philosophical and practical perspective."

Due to the decline in the number of trained radiochemists, the average age of the work force at these labs has been significantly increasing. Exposing young students to the national labs during their graduate work may help to bridge the work-force gap and bring in the next generation of nuclear scientists and radiochemists. ✻

News and notes

Clemson University breaks ground on $98 million wind turbine testing facility

Clemson has broken ground at what will be the world's largest wind turbine drivetrain testing facility, marking another milestone in South Carolina's burgeoning wind-energy industry.

Members of the S.C. Legislature, the state's congressional delegation and industry executives joined University officials at the Clemson University Restoration Institute in North Charleston to mark the official start of construction of the $98 million one-of-a-kind project.

The testing facility will be housed in a former Navy warehouse adjacent to existing rail and ship-handling infrastructure. Planning and construction of the facility is under way, and it is expected to begin operating in 2012.

It will be capable of full-scale, highly accelerated testing of advanced drivetrain systems for wind turbines in the 5MW to 15MW range with a 30 percent overload capacity.

Engineering program ranked 17th by recruiters

Clemson University's engineering program ranks 17th among those at the nation's colleges in a recent study by *The Wall Street Journal*. The ranking is based on a survey of recruiters with the nation's largest public and private companies, nonprofit organizations and federal agencies.

A total of 479 recruiters, who hired more than 43,000 new college graduates in the previous year, responded to the survey. They were asked to identify — based on their experiences — schools with bachelor's degree graduates who were the best-trained, educated and most able to succeed on the job.

The Wall Street Journal chose to survey recruiters rather than relying on test scores, college admission rates or graduates' starting salaries because recruiters' perceptions matter all the more, given that employers today are visiting fewer schools — partly due to the weak economy. The newspaper aimed to "identify the schools that are most likely to help students land a job in key careers and professions — in areas that are growing, pay well and offer high levels of satisfaction."

Clemson's ranking places it in distinguished company, ahead of such engineering schools as UCLA, Carnegie Mellon and the Rensselaer Polytechnic Institute.

Oscar winner to direct digital production arts at Clemson

Jerry Tessendorf, winner of the Academy Award for Technical Achievement in 2008, has been named director of Clemson's digital production arts program, a graduate program for professionals in the film, video and gaming industries.

Tessendorf is also a professor of visual computing in the School of Computing, and he teaches and performs research in animation and rendering for visual effects production.

The American Academy of Motion Picture Arts and Sciences bestowed Tessendorf and three colleagues an Oscar for technical achievement in 2008 in recognition of their development of custom fluid dynamics tools. The tools allow artists to create realistic animation of liquids and gases. The system also includes a unique scripting language for working with volumetric data.

Tessendorf's film credits include "Titanic," "Waterworld," the "X-Men" series, "The Lion, the Witch and the Wardrobe," the "Night at the Museum" series and "Superman Returns." Most recently he was principal graphics scientist at Rhythm & Hues Studios.

Sixth CoES researcher receives NSF CAREER award

In the fall 2010 edition of *IDEaS*, Clemson's College of Engineering and Science announced five National Science Foundation (NSF) CAREER awards. A sixth award was presented late in the funding cycle.

Sean Brittain, assistant professor in physics and astronomy, will use his NSF CAREER award to explore a significant component of the search for our own cosmic origins. Building on his previous work, Brittain will use high-resolution, near-infrared spectroscopy to peer into the inner disks surrounding a class of young stars referred to as Herbig Ae/Be stars.

Previously acknowledged Clemson awardees include **Zahra Hazari**, assistant professor of engineering and science education; **Julie Trenor**, assistant professor of engineering and science education; **Gang Li**, assistant professor of mechanical engineering; **Brian Dominy**, assistant professor of chemistry; and **Laine Mears**, assistant professor of mechanical and automotive engineering.

The Faculty Early Career Development (CAREER) Program is the NSF's most prestigious awards in support of the early career-development activities of teacher-scholars.

Computer engineering professor receives Microsoft award

Assistant professor of electrical and computer engineering **Hai Ying (Helen) Shen** has won a $200,000 Microsoft Research Faculty Fellowship grant for her work in distributed computing.

Microsoft Corp. provides the grants to young faculty who are exploring innovative, high-impact research that has the potential to help solve challenging societal problems.

Shen's research spans peer-to-peer and content-delivery networks, grid computing, mobile computing and wireless sensor networks. Her distributed computing research focuses on two goals, including anytime access to information and services anywhere around the world and the pooling of globally distributed resources for cooperative use to achieve greater supercomputing capability.

Clemson professors elected Fellows

John Ballato, a professor of materials science and engineering, has been named a Fellow of the International Society for Optics and Photonics. The International Society for Optical Engineering awards this honor to scientists "who have made considerable technical and scientific contributions in optics, photonics, optoelectronics and imaging." Ballato was cited for achievements in novel optical materials and optical fibers.

The founder of Clemson's Center for Optical Materials Science and Engineering Technologies (COMSET), Ballato holds 25 U.S. and foreign patents; has been principal investigator for sponsored programs, gifts and contracts valued at more than $35 million; and has more than 200 publications and 2,000 citations to his credit. His research ranges from optical fiber fabrication to photonic communication systems.

As director of COMSET, Ballato oversees interdisciplinary research conducted by 25 faculty members from five departments at Clemson. COMSET's focus is the science and engineering of light and the development of advanced materials, devices and systems that generate, transmit, manipulate and utilize light.

Juan E. Gilbert, a professor and chairman of the Human-Centered Computing Division in Clemson's 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 upon 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."

Gilbert's research interests include developing applications involving voice texting and electronic voting. His team is currently testing "Voiceing," an application that allows drivers to speak — rather than type — text messages. Also in development is Prime III, a voting system touted as the world's most-accessible voting technology, which is being tested with the elderly and disabled.

Gift creates leadership program for engineering students

Bob Hambright '70 believes he has a simple, effective solution to most of the world's problems: good leadership.

"I think most of the problems in the world today can be attributed to poor leadership," says the retired construction management executive. "I also think good leadership and stewardship are the answers to most of the problems facing the world today."

That philosophy is the cornerstone of the vision Hambright and members of the Clemson faculty have for a new program to instill leadership skills in engineering students.

Jump-started by a $100,000 gift from Hambright and his wife, Susan — in conjunction with his former employer, Balfour Beatty Construction LLC — the Bob and Susan Hambright Leadership Program in Engineering will support selected junior and senior engineering students in industry-led leadership training programs. In the future, it also may help fund on-campus symposia and conferences open to all Clemson engineering students.

Gift endows Clemson chair in sustainable development

More than a decade ago, as a senior executive with one of the world's largest engineering and construction firms, **Tom Hash** (ME '69) first embraced the concept of sustainable development. But it was the birth of his and wife Becky's first grandchild that brought the issue home.

"Bechtel Corp. adopted sustainability as one of its core values, and I became very interested in it," says Hash. "The birth of our first grandchild made it personal as we thought about the future of the next generation. That's when Becky and I began looking at how we could help jump-start the sustainable development program."

A week after their fourth grandchild joined the family, the Hashes made a $2 million gift to endow a chair in sustainable development.

The Thomas F. Hash '69 Endowed Chair in Sustainable Development will be the first such position in Clemson's Center of Economic Excellence (CoEE) in Sustainable Development. The center was created last year to develop new technologies to foster sustainability, protect the state's natural resources and encourage smart growth.

As a CoEE, the sustainable research program gift is matched by $2 million in state funds. State and private funds are matched dollar-for-dollar to create CoEEs in research areas that will advance the S.C. economy.

Haque named founding chairman of new automotive engineering department

Imtiaz Haque has been named founding chairman of a new automotive engineering department, located at the Clemson University International Center for Automotive Research (CU-ICAR) campus in Greenville.

Haque will continue as executive director of the Carroll A. Campbell Jr. Graduate Engineering Center at CU-ICAR. He has been in that post since 2009 and is responsible for building industrial partnerships and guiding the faculty in the academic program at the 250-acre automotive and motorsports research campus.

"The interdisciplinary nature of automotive engineering was the impetus for the creation of this department, and Imtiaz is the clear choice to lead it. I'm delighted he agreed to lead this important endeavor," says Esin Gulari, dean of the College of Engineering and Science. "Imtiaz has been an integral part of the success of the automotive engineering program, and he's uniquely positioned to give the new department a solid foundation."

The Clemson Board of Trustees approved the creation of the automotive engineering department last summer, using existing staff, equipment and facilities. The unit was previously managed autonomously through the mechanical engineering department.

The department will continue to offer both master's and doctoral degrees in automotive engineering and conduct automotive-focused industry- and government-sponsored research. It currently has 114 graduate students and 12 faculty members.

College Contacts

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

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COLLEGE OF ENGINEERING AND SCIENCE SPRING 2011

Highlights from our departments

Above: Brian Powell and one of his students discuss data collected for his radiochemistry research.

On the cover: Julie Trenor, an assistant professor in the engineering and science education department, studies how family and ethnicity affect educational experiences in engineering classes.

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

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Fast Facts

Tenured/tenure-track/research faculty: 11

Enrollment:		
	Undergraduate	-
	Master's	70
	Doctoral	39
Degrees awarded (May and Dec. 2010):		
	Undergraduate	-
	Master's	24
	Doctoral	3

Research expenditures: $2.9 million
Research thrusts: systems integration, vehicle manufacturing, vehicle design and development, vehicular electronics

Unveiling the inaugural Deep Orange car.

Faculty Highlights

Paul Venhovens, BMW Chair for Systems Integration, led a team of students to develop and exhibit the first vehicle prototype as part of the Deep Orange program. This prototype was unveiled in Greenville during Motorsports on Main, sponsored by the American LeMans Series. The Deep Orange vehicle made a guest appearance in Pasadena, Calif., last fall where it was on display at the Art Center College of Design's (ACCD) classic car show. It was a second homecoming of sorts, as ACCD students collaborated with students from the Clemson University International Center for Automotive Research (CU-ICAR) on design and handling. The vehicle was also shown in Las Vegas for the Specialty Equipment Manufacturers Association Show and the Los Angeles Auto Show, one of the largest shows of its kind in the country.

Deep Orange is an integrated research, education and collaboration program in which students go through an entire vehicle development process from market research to proof of concept. The end result of this two-year cycle is a fully functional vehicle that highlights sustainable cutting-edge technology. Partnerships with the automotive industry are a hallmark of the program.

Joachim G. Taiber, research professor at CU-ICAR, has been coordinating the effort to bring an Institute of Electrical and Electronics Engineers (IEEE) conference on electric powered cars to the campus in Greenville. IEEE has approved the conference site, and plans are under way for a 2012 gathering.

The event will bring together experts from across the globe in technical development, design, manufacturing and government-related fields of the electric vehicle sector. Prior to his engagement at Clemson University, Taiber was leading the Information Technology Research office of the BMW Group Information Technology Research Center, also located on the CU-ICAR campus.

Todd Hubing, Michelin Chair in Vehicular Electronics, received the IEEE Electromagnetic Compatibility Society's Laurence G. Cumming Award in 2010. He also became a Fellow of the Applied Computational Electromagnetics Society.

Tom Kurfess, BMW Chair in Manufacturing, received the 2010 SME Education Award. He was also elected to the board of directors of the Society of Manufacturing Engineers and the National Center for Manufacturing Sciences.

Laine Mears received an NSF CAREER Award to research model-based control methods for machining processes in which material is removed by high shear-rate cutting.

Assistant professor of automotive engineering **Mohammad Omar** received the SAE Foundation Young Manufacturing Leadership Award for 2009 and the SME Outstanding Young Manufacturing Award for 2011. He has also published two textbooks entitled *The Automotive Body Manufacturing Systems and Processes* and *Dedicated Processing Routines for Industrial Thermal Imaging: An Automated, Non-Intrusive Inspection Approach*.

Assistant professor of automotive engineering **Pierluigi Pisu** published a textbook entitled *Hierarchical Model-Based Diagnostics: Theoretical Results and Applications to Vehicle Systems*.

Adjunct associate professor **Julian Weber** published a textbook entitled *Automotive Development Processes*.

John Ziegert, Timken Chair in Vehicle Design and Development, was elected to the board of directors of the North American Manufacturing Research Institute.

Student Achievement

Doctoral student **John Limroth** received the 2009 National Transportation Research Center Inc. Student of the Year award. Master's student **Michael Arant** received the center's 2009 Outstanding Student Researcher award.

Satyam Vyas and **Marshall Saunders** received the 2009 SEMA Fellowship.

Bioengineering

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Fast Facts

Tenured/tenure-track faculty: 18

Enrollment:		
	Undergraduate	204
	Master's	28
	Doctoral	84
Degrees awarded (May and Dec. 2010):		
	Undergraduate	29
	Master's	6
	Doctoral	9

Research expenditures: $5.2 million
Research thrusts: biomaterials, tissue regeneration, emerging technologies for health care, bioimaging

Karen Burg

Department Overview

Through an agreement with Greenville Hospital System University Medical Center (GHS-UMC), the bioengineering department has acquired 29,135 square feet of newly built space in Greenville for its bioengineering translational research program. Strategically located above three floors occupied by clinical vascular/cardiovascular and orthopaedic surgeons, the space houses research and training facilities, translational/incubator space, meeting and networking accommodations for scientists and clinicians, and state-of-the-art surgical-skills facilities.

This program is aimed at providing the environment essential to further develop clinically relevant technology aimed at improving patient care and disease diagnosis conducted by faculty and students. This strategic expansion, which will clearly position the University and South Carolina as national leaders in translational medical research, includes multi-investigator research laboratories supplemented by clinical and industrial participation.

Faculty Highlights

Karen Burg, Hunter Endowed Chair, professor of bioengineering and director of the Institute for Biological Interfaces of Engineering at Clemson University, is the president-elect of the leading professional society in the biomaterials science and engineering field, the Society for Biomaterials. This professional society promotes advances in all phases of materials research and development by encouraging cooperative educational programs, clinical applications and professional standards in the biomaterials field.

Assistant professor of bioengineering **Ning Zhang** was awarded a three-year, $947,394 Department of Defense (DOD) award to study regeneration in spinal cord injury (SCI). SCI is associated with devastating and irreversible neurological dysfunction in humans and can lead to motor and sensory deficits; chronic severe pain; and bladder, bowel and sexual dysfunction — significantly lowering quality of life. The goal of Zhang's project is to regenerate the spinal cord in chronic-stage patients by reconstructing the blood vessel network and conditioning the SCI lesion site into a sustained, scar-free and permissive environment.

Professor of bioengineering **Xuejun Wen** was awarded the prestigious $4 million Hansjörg Wyss Endowed Chair in Regenerative Medicine after an international search. His research laboratory focuses its efforts to regenerate functional and safe human tissues by combining the principles of biomaterials science, biological science, stem cell biology, tissue engineering and regenerative medicine with the advanced techniques of molecular and cell biology.

Naren R. Vyavahare, Hunter Endowed Chair, professor of bioengineering and director of the NIH COBRE SCBiomat, received the 2010 Clemson University Alumni Award for Outstanding Achievements in Research. Vyavahare is a recognized leader in cardiovascular research in the United States and around the world. For the past 18 years, his research has focused on cardiovascular pathology and implant development. His pioneering work addressing the prevention of degradation of bioprosthetic pig valves (often used to replace diseased heart valves) is clinically used on St. Jude Medical EPIC bioprostheses.

Student Achievement

Doctoral student **Vince Beachley** was awarded an American Heart Association Mid-Atlantic Affiliate Predoctoral Fellowship for his project "Biomimetic Waved/Aligned Nanofiber Vascular Implants with Optimized Compliance for Improved Patency." The two-year fellowship will fund investigation of tubular structures, degradable tissue-engineered grafts conditioned in bioreactors and in vivo evaluations of vessel patency.

Doctoral students in the CU-MUSC joint bioengineering program **Erin Pardue** and **Xiaowei Li** were awarded American Heart Association Predoctoral Fellowships; both scored in the first percentile of reviewed applications. Pardue will study "The Influence of Fibulin-1C on Hematopoietically Derived Cell Populations in Heart Valves" in **Scott Argraves'** lab, and Li will study "Engineering Blood Vessel Network and Manipulating Endogenous Stem Cells for Brain Regeneration after Stroke" in **Xuejun Wen** and **Ning Zhang's** lab.

Van Tran, a graduate student under the advisement of **Xuejun Wen**, was awarded a Vietnam Education Foundation fellowship for using selective laser sintering technology for bone tissue regeneration.

Doctoral students **Eleni Katsanevakis** and **Emily Ongstad** have been selected as 2010-2011 Presidential Scholars at MUSC.

Suzanne Parks, a Ph.D. student, was awarded an NSF Graduate Research Fellowship to study tissue engineering approaches to cardiovascular applications. She will pursue her doctoral research in the laboratory of **Richard Visconti** on orthopaedic biomaterials.

Undergraduate **Carl Alex Lindburg** was awarded the Undergraduate Student Award at the 2010 Annual Meeting of the Biomedical Engineering Society. Lindburg is conducting undergraduate research in the laboratory of **Delphine Dean** on "Effect of Radiation on Articular Cartilage Using a Murine Model."

Chemical and Biomolecular Engineering

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Fast Facts

Tenured/tenure-track faculty: 10

Enrollment:

Undergraduate	155
Master's	1
Doctoral	29

Degrees awarded (May and Dec. 2010):

Undergraduate	35
Master's	1
Doctoral	5

Research expenditures: $2.2 million

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

Scott Husson

Department Overview

Based on the sciences of chemistry, biology, physics and mathematics, the Department of Chemical and Biomolecular Engineering (ChBE) is at the forefront of nanotechnology, energy and fuels, and "green" engineering, and it leads the way in medical and health-related research. Advanced materials, novel catalysts and biomedical devices are just a few of the exciting new fields in which graduates are making pivotal contributions to the future of the planet and mankind.

In response to the national trend of greater diversity in areas of employment for chemical engineers, ChBE implemented emphasis areas in energy studies; environmental engineering; polymeric materials; business management; and applied engineering, mathematics and science. ChBE students interested in careers in medicine or biotechnology may select a formal concentration in biomolecular engineering. Approximately 55 percent of undergraduate students co-op at companies such as BASF, Dow Chemical, Kimberly-Clark, Michelin, Milliken, NASA and RocheCarolina. In addition, study-abroad opportunities abound, including a summer laboratory course in Vienna, Austria.

There are numerous opportunities for undergraduate and graduate research. Strong departmental programs exist in advanced membranes, bioelectronics, biosensors and biochips, biofuels, biological separations, kinetics and catalysis, molecular modeling and simulation, nanomaterials, polymer science and engineering, supercritical fluids, and interfacial science and engineering.

Faculty Highlights

Scott Husson was the 2010 recipient of the FRI/John G. Kunesh Award from the AIChE Separations Division. This award, sponsored by Fractionation Research Inc., recognizes outstanding contributions to the academic, scientific, technological, industrial or service areas involving separations technologies from individuals under the age of 40. Husson was recognized for the development of bioseparation membranes with improved performance arising from the use of surface-initiated, atom-transfer radical polymerization for the creation of nanolayers.

David Bruce and **Mark Thies** have been working with TECHFISH LLC, a small 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, Dow Chemical Professor, has been named to the editorial advisory board of *Applied Biochemistry and Biotechnology*.

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 high-productivity and high-resolution methods for their recovery and purification. Development of these materials is essential to 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 NIH work is to understand the roles of nanolayer structure, membrane pore structure and novel polymer chemistry on protein binding, with the major objective to accelerate the use of membrane chromatography in initial protein-capture steps.

Student Achievement

Several Ph.D. students were awarded travel grants to present their research at the 2010 SACNAS National Conference. The award recipients and their presentation titles are: **Milagro Marroquin**, "Development of inverted colloidal crystal membrane adsorbers" **(Scott Husson**, adviser); **David Esguerra**, "Molecular design of carbonaceous oligomers for thermal management applications" **(Mark Thies**, adviser); and **Jose Orellana**, "Polylactic acid-cellulose nanocrystal composite films" **(Chris Kitchens**, adviser**).** SACNAS is a society of scientists dedicated to fostering the success of Hispanic/Chicano and Native American scientists — from college students to professionals — in attaining advanced degrees, careers and positions of leadership.

Chemistry

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Fast Facts

Tenured/tenure-track faculty: 24

Enrollment:

Undergraduate	138
Master's	0
Doctoral	93

Degrees awarded (May and Dec. 2010):

Undergraduate	19
Master's	1
Doctoral	10

Research expenditures: $5.2 million

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

Brian Dominy

Department Overview

The chemistry program is one of the largest and most active on the Clemson campus. More than 20 faculty members direct the research of about 100 graduate students with the assistance of approximately 15 postdoctoral and visiting scientists. In addition, several faculty are primarily engaged in undergraduate instruction and chemical education research. Faculty members also manage the department's Nuclear Magnetic Resonance Resource Center, Molecular Structure Center and additional computing resources.

The research activities of the faculty include projects in the traditional areas of analytical, inorganic, organic and physical chemistry as well as a broad range of interdisciplinary and nontraditional areas — polymer and materials chemistry, solid-state chemistry, bioanalytical chemistry, bioorganic and medicinal chemistry, computational chemistry, chemical physics, chemical education and other areas.

Faculty Highlights

Brian Dominy has won a five-year, $588,000 NSF CAREER award for "Computational Modeling of Protein Evolvability." Dominy's research employs computational methods to discover which mutation pathways are most likely taken in evolution of enzymes. Understanding these rules could have broad applications ranging from the molecular engineering of new protein catalysts for use in harsh industrial syntheses inaccessible to natural enzymes, to aiding in the development of new drugs that successfully evade or inhibit the natural evolution of protein targets (i.e., avoiding drug resistance).

Darryl DesMarteau was selected as a member of the 2010 group of American Chemical Society (ACS) Fellows. DesMarteau joins Melanie Cooper as the second member of the Clemson faculty to join this group, which recognizes members for their contributions to the chemical sciences and outstanding service to ACS.

Ken Marcus has been named a Fellow of the Royal Society of Chemistry (RSC), Europe's largest professional and academic society for chemistry. As an analytical chemist, Marcus studies the chemical components of materials. His current research deals with the characterization of dietary supplements/nutraceuticals and methods for separating proteins in complex mixtures using novel polymer fibers. Instruments developed in Marcus' lab are sold by several manufacturers. With 46,000 members worldwide, the London-based RSC is the largest organization in Europe for advancing the chemical sciences.

Andrew Tennyson joined Clemson as an assistant professor of chemistry last summer. Tennyson earned his undergraduate degree from the University of Chicago and his doctoral degree from Massachusetts Institute of Technology. He worked for two years as a postdoctoral scientist at the University of Texas-Austin before coming to Clemson. His research is in the general area of organometallic chemistry.

Carl Heltzel and **Jacob Schroeder** joined the chemistry faculty in 2010 to teach general organic chemistry.

Student Achievement

Clemson's student chapter of the ACS will receive the ACS Honorable Mention Award for activities conducted during the 2009-2010 academic year. This is the second year in a row the group has been selected for this award. The chapter will be honored at the spring 2011 ACS National Meeting.

Wendy Queen (Ph.D. '09) has received a postdoctoral research associateship award from the National Research Council to work with Craig Brown at the National Institute of Standards and Technology Center for Neutron Research in Gaithersburg, Md. Her research is currently focused 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

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Fast Facts

Tenured/tenure-track faculty: 20

Enrollment:		
	Undergraduate	503
	Master's	66
	Doctoral	44
Degrees awarded (May and Dec. 2010):		
	Undergraduate	148
	Master's	41
	Doctoral	3

Research expenditures: $2.1 million

Research thrusts: resilient and sustainable infrastructure, applied fluid mechanics, construction engineering and management, construction materials, geotechnical engineering, structural engineering and transportation systems engineering

The first five SMP Fellows are (from left to right): Brian Machmer, David Duncan, Caitlyn Davis-McDaniel, Sarah Dalton and Larry Simonson.

Department Overview

Civil engineering (CE) has been taught at Clemson since the University was founded, with the first civil engineer graduating in 1896. The department was established in 1932 when the engineering department became the School of Engineering.

The CE department offers comprehensive B.S.C.E., M.S. and Ph.D. programs. Undergraduate students can choose technical electives to complete an "emphasis" in a particular subdiscipline, such as environmental or structural engineering.

Student organizations include the American Society of Civil Engineers (ASCE), the Institute of Transportation Engineers and the Chi Epsilon Honor Society.

Many undergraduate students participate in research through Clemson's Creative Inquiry (CI) program. Last year, one-third of students receiving a B.S. from the department had participated in research as undergraduate students. These activities keep students on the cutting edge of the profession and are regarded by students and employers as very rewarding.

Last spring, the CE department advisory board adopted a project to modernize and expand Lowry Hall. With this move, the board set in motion a flurry of activities to kick off a campaign for fundraising. Based on a study by the CE faculty and staff, the expansion is student-centric and includes well-equipped, modern classrooms, such as an immersion classroom, enhanced laboratory space and a Capstone Design lab.

Faculty Highlights

Professor **Lance Bell's** service project benefiting the everyday lives of people living in Cange, Haiti, will represent the University in a competition for state recognition. *Clemson Engineers for Developing Countries (CEDC): Water System Design for Cange, Haiti* was selected to be Clemson's nominee for the S.C. Commission on Higher Education Service-Learning Award for 2010. CEDC, a CI group of students advised by Bell, took on the challenge to engage students in service learning projects.

C. Hsein Juang will chair the organizing committee of ASCE's GeoRisk 2011. The goal of GeoRisk is to provide an opportunity for participants to learn more about how to explicitly consider risk and uncertainty in order to improve the value and scope of their work and to better serve the public.

David Wingard has joined the department as the Asphalt Rubber Technology Service (ARTS) program administrator. Wingard will promote the use of scrap tire applications through research and education in South Carolina. The ARTS program is a partnership with the S.C. Department of Health and Environmental Control.

Student Achievement

The first five student participants were selected to become Fellows in the National Science Foundation-funded Science Master's Program (SMP) in sustainable and resilient infrastructure. The students started last August and will complete the SMP in 18 months. A total of 14 Fellows will take courses and conduct research in select areas and then complete an internship with an industry or government partner. Unlike a traditional civil engineering master's program, the SMP curriculum will involve interdisciplinary course work that focuses on broader issues involving current national infrastructure problems. The new SMP program is in line with the department's focus on resilient and sustainable infrastructure. The first five Fellows are **Brian Machmer**, **David Duncan**, **Caitlyn Davis-McDaniel**, **Sarah Dalton** and **Larry Simonson**.

Alumni news

Marguerite McClam (B.S. '92) has been recognized as the S.C. Society of Professional Engineers' (SCSPE) 2010 Engineer of the Year.

McClam is president and co-owner of Palmetto Consulting Engineering Group Inc., managing two offices in Chapin and Irmo. She is also a partner in McClam & Associates Inc., a general contracting firm in Little Mountain.

Her areas of expertise include the oversight of operations, marketing, design of water and wastewater systems, land development, air permitting and zoning issues. She is responsible for the design and compliance of all mining projects and special permitting processes.

Prior to her association with Palmetto Consulting Engineering Group, she was employed by Stevens and Wilkinson of South Carolina Inc., the S.C. Department of Health and the Environmental Control and the Water Resource Institute.

McClam is active in numerous engineering, environmental and water organizations, including the National Society of Professional Engineers, the SCSPE, the American Council of Engineering Companies, the American Water Works Association and the Water Environment Association.

She serves on the board of directors for the National MathCounts Foundation, is the coordinator of the SCSPE MathCounts State and Columbia Chapter, and is past president of the SCSPE Educational Foundation Inc.

School of Computing

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Fast Facts

Tenured/tenure-track faculty: 28

Enrollment:		
	Undergraduate	338
	Master's	115
	Doctoral	55
Degrees awarded (May and Dec. 2010):		
	Undergraduate	53
	Master's	53
	Doctoral	7

Research expenditures: $2.2 million

Research thrusts: computing foundations, software engineering, cyberinfrastructure and networking, bioinformatics, computer graphics and animation, eyetracking, visualization, digital arts, intelligent and interactive systems, electronic health records, biometrics, virtual environments, human/computer interaction, pedagogical tools using Tablet PCs and handheld devices

Jerry Tessendorf

Faculty Highlights

Robert Geist has been named a distinguished educator by the Association for Computing Machinery (ACM), the world's largest educational and scientific computing society. This honor recognizes ACM members who have achieved significant accomplishments or have made a significant impact on the computing field.

Juan Gilbert has been selected to serve on the Computer and Information Science and Engineering Advisory Committee of the National Science Foundation.

In an initiative led by **Robert Geist, Don House** and **Jerry Tessendorf**, Clemson University has been named a CUDA Research Center by NVIDIA. The focus of the center is computer graphics research on real-time modeling and rendering of natural phenomena, including all components of biophysical ecology, atmospherics, photon transport, and air and water flow.

Assistant professor **Damon L. Woodard** has been named co-director of research programs for the Office of the Director of National Intelligence's Center of Advanced Studies in the Identity Sciences (CASIS). The aim of the center is to strengthen biometric identification — the measurement of physical characteristics to confirm a person's identity. Woodard has been invited to give a presentation at the upcoming Oak Ridge Associated Universities Conference on Research and Education Partnerships Opportunities in Security and Intelligence. This talk will highlight the research, education and outreach accomplishments of CASIS.

Professor **Jerry Tessendorf** gave an invited lecture at the American Physical Society Division of Fluid Dynamics Annual Meeting. His lecture was entitled "Fluid Simulation in the Movies: Navier and Stokes Must Be Circulating in Their Graves."

The USA Computing Olympiad, for which **Brian Dean** serves as associate director, held its summer 2010 "training camp" at Clemson, where the top 15 high school computer science students in the United States gathered for a week of intensive lectures and computational problem-solving practice. Training paid off with a big win at the International Olympiad in Informatics — the most prestigious algorithmic programming competition at the high school level — in Waterloo, Canada. The U.S. team, comprised of the top four students from the summer training camp, received more gold medals and more combined points than any of the other 83 countries competing at the event.

Student Achievement

Graduate students **Hanan Alnizami**, **Jerone Dunbar** and **Josh Ekandem** — along with faculty member **Juan Gilbert** — exhibited their work in human-centered computing at the USA Science and Engineering Festival Expo in Washington, D.C.

The programming team, CLEMSON1, placed first out of 28 teams competing at their site in the Southeast Regional ACM programming contest held recently in Savannah, Ga. Team members were **Chris Corsi**, **Ben Cousins** and **Brandon Pelfrey**.

Doctoral student **Jamie Lyle** presented her research, "Soft Biometric Classification Using Periocular Region Features," at the IEEE Fourth International Conference on Biometrics Theory, Applications and Systems in Arlington, Va. Her paper was considered for a Best Student Paper award.

Doctoral student **Philip Miller** also presented his research, "Performance Evaluation of Local Appearance Based Periocular Recognition," at the IEEE Fourth International Conference on Biometrics Theory, Applications and Systems. He also traveled to Istanbul, Turkey, to present his research entitled "On the Fusion of Periocular and Iris Biometrics in Non-ideal Imagery" at the IAPR 20th International Conference on Pattern Recognition.

Gravitons, a film by students in the digital production arts M.F.A. program, was accepted to the 2010 Red Stick International Animation Festival in Baton Rouge, La.

Doctoral student **Liang Dong** was awarded an internship by the Association for the Advancement of Artificial Intelligence to develop a Web service, AINewsFinder, to alert readers to current stories about AI that appear in various news sources.

Luke Segars, **Sally K. Wahba** and **Yvon Feaster** held a one-day computer science outreach workshop for local fifth- through eighth-grade girls. The program focused on teaching the students basic computer science concepts using CSUnplugged activities, along with basic programming skills using Scratch programming language.

Approximately 60 Pendleton High School computer science students paid a visit to the department. After a welcome from many of the faculty, the students enjoyed a tour of the virtual environments lab, the savage graphics lab and the digital production arts lab. They also learned about the Intelligent River© project. This event was organized by the Dependable Systems Research Group, advised by **Jason O. Hallstrom** and supported by the Computer Science Graduate Student Association.

Electrical and Computer Engineering

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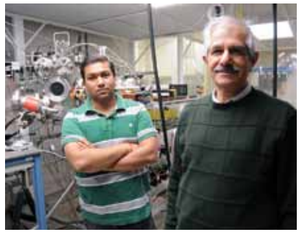
Fast Facts

Tenured/tenure-track faculty: 32

Enrollment:	Undergraduate	375
	Master's	70
	Doctoral	80
Degrees awarded (May and Dec. 2010):		
	Undergraduate	72
	Master's	18
	Doctoral	7

Research expenditures: $2.5 million
Research thrusts: optoelectronics, cyberinfrastructure, wireless communications, computer networks, nanoelectronic materials processing, biochips, semiconductor lasers, optical systems, integrated circuit design, high-performance computing, computer security, robotics, image processing, biological modeling, situation and threat assessment, power systems



Rajendra Singh

Department Overview

Clemson University has maintained a traditionally rich background in fundamental and applied engineering as the research areas have focused on increasingly narrower topics within the subject disciplines. This heritage provides Clemson's Department of Electrical and Computer Engineering (ECE) with the breadth to offer a sound undergraduate education. At the same time, the specialization of faculty provides a stimulating environment for research.

As one of the larger departments on campus, ECE plays a major role in degree production, sponsored research activity and service to the community. The graduate programs offer a variety of opportunities for development through research, specialized formal course work and teaching experience. Graduate students may earn the M.Engr., M.S. or Ph.D. degrees in both electrical and computer engineering.

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

The research activities of the Holcombe Department of Electrical and Computer Engineering are clustered into four major areas, including communications, electronics, computer systems and intelligent systems. The department occupies more than 20,000 square feet of research space with approximately 9,000 square feet located in the state-of-the-art Fluor Daniel Engineering Innovation Building.

Faculty Highlights

Rajendra Singh, D. Houser Banks Professor of the Holcombe Department of Electrical and Computer Engineering and director of the Center of Silicon Nanoelectronics, has been selected by *Photovoltaics World* as one of 10 global Champions of Photovoltaic Technology.

Rod Harrell (ECE), **Brian Holman** (ECE) and **Igor Luzinov** (materials science) – along with KEMET researchers – have been awarded the John D. Moynihan Best Paper Award at the 2010 Capacitor and Resistor Technology Symposium for "Electrical Characterization of Polymer Tantalum Capacitors with Poly (3,4-ethylenedioxythiophene) Cathode."

Assistant professor **Hai Ying Shen** was named a Microsoft Research Faculty Fellow. Since 2005, Microsoft Research has recognized scientists with exceptional talent for research and innovation, identifying them as emerging leaders in their fields. Shen focuses on distributed computer systems and networks, and her research spans peer-to-peer and content delivery networks, grid computing, mobile computing and wireless sensor networks.

Lin Zhu, the Warren Owen Assistant Professor of Electrical and Computer Engineering, has been selected to participate in the Defense Advanced Research Projects Agency (DARPA) Young Faculty Awards (YFA) program. Through YFA, DARPA identifies junior faculty and introduces them to the needs of the Department of Defense and DARPA's program development process. Zhu is also the recipient of a 2010 Oak Ridge Associated Universities (ORAU) Ralph E. Powe Junior Faculty Enhancement Award. These awards provide seed money to junior faculty to fund their research at ORAU member institutions and enrich their professional growth.

The power engineering research group, led by SCE&G Professor of Electrical and Computer Engineering **Elham Makram**, has received a U.S. Department of Energy (DOE) grant that will have a major impact on South Carolina's power industry work force. The DOE is underwriting an effort to develop three online certificate programs and an online Master of Engineering program to provide engineering graduates with courses in power, renewable energy and principles of power systems.

Student Achievement

Doctoral students **Andrew Clarke**, **Douglas Dawson** and **Nicholas Watts** have been awarded *Inquiry, Discovery in Engineering and Science* (*IDEaS*) graduate teaching assistantships (GTA). The College of Engineering and Science, in partnership with the ECE department, is proud to announce the inaugural year of the GTA program, which was developed to meet the needs of increasing Ph.D. stipend levels and provide additional instructional support for general engineering.

Engineering and Science Education

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Fast Facts

Tenured/tenure-track faculty: 6

Enrollment:	Master's	n/a
	Doctoral	n/a
	Certificate	20
Degrees awarded (May and Dec. 2010):		
	Master's	n/a
	Doctoral	n/a
	Certificate	12

Research expenditures: $2.2 million
Research thrusts: epistemologies, learning mechanisms and systems, diversity and inclusiveness, assessment

Zahra Hazari

Faculty Highlights

Lisa Benson and **David Bowman** were awarded NSF funding from the Cyberinfrastructure Framework for 21st Century Science and Engineering Venture Fund. Only 20 such NSF-funded awards are bestowed annually. It will supplement their project in which they are studying engineering students' problem-solving strategies and how they impact students' academic preparation and performance. The supplemental project is called "CU Thinking: Research to Practice" and focuses on transferring the novel software being used in the project to the classroom. MuseInk©, the software developed by Bowman, captures students' work and their reflections on their thought processes on a Tablet PC. The project will help instructors and students use the software as well as research findings to improve students' problem-solving strategies and conceptual understanding of complex ideas.

Zahra Hazari was recently awarded an NSF CAREER award to study physics identity development in physics classes and the NSF Gender Research in Science and Engineering award to study how sustainability topics can stimulate female interest in engineering professions.

Melanie Cooper, interim chair of the engineering and science education department, is the 2010-2011 winner of the Society for College Science Teachers (SCST) Outstanding Undergraduate Science Teacher Award. The SCST said, "In addition to an extensive body of chemical education research and a prolific publication record in areas such as learning gains associated with cooperative learning and metacognition, Cooper is recognized as a leader in developing instruments for measuring learning and devising new technologies or curriculum-based methods on those measurements.

Student Achievement

Sonia Miller Underwood, a Ph.D candidate working with **Melanie Cooper,** was featured in the article "A Forum for Graduate Students: Organizing and Presenting a Symposium at an ACS National Meeting" in the May 2010 issue of the American Chemical Society's *Graduate Student Bulletin*. The article describes Underwood's development of a novel symposium designed to highlight graduate student research from across the globe. She and 15 other graduate students described their current research endeavors and solicited formative feedback from audience members. This symposium constitutes the first of its kind for the ACS and is currently being evaluated as a model for replication in other divisions in the organization.

Environmental Engineering and Earth Sciences

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Fast Facts

Tenured/tenure-track faculty: 16

Enrollment:	Undergraduate	65
	Master's	74
	Doctoral	24
Degrees awarded (May and Dec. 2010):		
	Undergraduate	9
	Master's	14
	Doctoral	6

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

Stephen Moysey's students test equipment for subsurface imaging.

Faculty Highlights

Tim DeVol received a U.S. Department of Homeland Security education award to develop nuclear forensics teaching capabilities. The DHS also recognized **Brian Powell** with a three-year junior faculty award for his research efforts.

Larry Murdoch and **Stephen Moysey** were selected by the Department of Energy to study CO_2 storage. They plan to apply reservoir deformation techniques — developed in part at the Clemson well field — and high-performance computing to CO_2 sequestration and possibly oil and gas production.

Tanju Karanfil received an NSF award for his research entitled "Quantitative Structure-Adsorbability Relationships for the Adsorption of Organic Chemicals by Carbon Nanotubes." The award will enable Karanfil to study the interactions between organic contaminants and carbon nanotubes.

Olin Mefford, **Chris Kitchens** and **Brian Powell** were awarded NSF funding for their proposal for defining the potential source term of nanoparticles in natural systems to be used in a quantitative risk assessment.

Stephen Moysey has received two grants from the Department of Defense to investigate the influence of soil moisture on the detection of abandoned landmines using ground-penetrating radar (GPR). Included in the project is the purchase of a very unique GPR system that will place Clemson as a national leader in subsurface imaging. This basic science research has important military and humanitarian applications as abandoned landmines injure or kill thousands of people around the world every year.

Brian Powell and **Yuji Arai** will lead a three-year project entitled "Development of a Self-Consistent Model of Plutonium Sorption: Quantification of Sorption Enthalpy and Ligand-Promoted Dissolution," which was selected for funding by the DOE Office of Science, Biological and Environmental Research. The project will focus on development of a mechanistic model of plutonium reactions at solid water interfaces.

Leslie Grady was selected as the recipient of the 2010 Industrial Water Quality Lifetime Achievement Award from the Water Environment Federation. This award recognizes the work his research group did in trying to understand the factors controlling the biodegradation of synthetic organic compounds as well as the work the industrial water quality group at CH2M HILL did in putting this knowledge into practice.

Student Achievement

Graduate students and members of Clemson's chapter of Engineers Without Borders **Jose Alfaro**, **Jim Chamberlain** and **Christina Anderson** began last summer with two international trips to West Africa and Central America. Alfaro led a group of 10 students and one adult to Liberia where they established an integrated rice/tilapia pond, repaired a rabbit nursery, built a peanut sheller and taught local villagers how to construct an anaerobic digester for sustainable production of fuel. Chamberlain and Anderson led seven students and six adults to El Salvador to continue the design of a potable water system extension to several villages. The students surveyed for the new water lines and drilled a test well using a manual rotary drill rig that was donated to the local villagers.

John Kroon, a hydrogeology graduate student, has been selected as the 2010 recipient of the Donald A. and Mary O'Nesky Named Grant of the American Association of Petroleum Geologists. This award was made in support of Kroon's thesis research, "Molecular Biogeochemistry of Lower Huron and Cleveland Shales in Eastern Kentucky and Southern West Virginia."

Ph.D. student **Ben Sharp** was selected as one of the recipients of the prestigious 2010 EPA STAR Fellowship.

Ph.D. student **Jose Alfaro** received the NSF graduate research fellowship for students in science, engineering, mathematics, technology and social sciences.

Darryl Jones received the Best Master Thesis award from the American Water Works Association at its annual meeting in Chicago.

Christopher Patterson has been named one of seven national NAGT Outstanding TAs for 2010.

Ph.D. student **Kelly Grogan** received the 2010-2011 Robert S. Landauer Fellowship for graduate students in health physics.

Industrial Engineering

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Fast Facts

Tenured/tenure-track faculty: 13

Enrollment:	Undergraduate	180
	Master's	135
	Doctoral	45
Degrees awarded (May and Dec. 2010):		
	Undergraduate	40
	Master's	10
	Doctoral	5

Research expenditures: $1.2 million
Research thrusts: supply chain optimization and logistics, human factors and safety in health care and in technologically complex environments, education and learning systems

Maria Mayorga

Department Overview

The industrial engineering department (IE) offers accredited programs leading to B.S., M.S., M.Engr. and Ph.D. degrees that promote excellence in scholarship, research and IE education. Study is 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 also seen several programmatic initiatives that have resulted in significant growth, garnering national and international attention. These include the online M.Engr. degree in IE and the endowed chairs program 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, plus it houses the NSF-sponsored IUCRC 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 student experience. Clemson University has become a leader through its international research and collaboration, and the IE department has created a dynamic environment in its classrooms and laboratories.

Faculty Highlights

Scott J. Mason is the inaugural Fluor Endowed Chair in Supply Chain Optimization and Logistics. Fluor Corp. contributed $2 million to match $2 million from the S.C. Centers of Economic Excellence program to fund the chair. Prior to joining Clemson, Mason spent 10 years in the IE department at the University of Arkansas. He received his Ph.D. from Arizona State University after earning his B.S. and M.S. from the University of Texas at Austin. Mason's areas of focus include optimization; algorithms; and operations planning, scheduling and control of capital project supply chains, and large-scale systems modeling. He is an associate editor for *IEEE Transactions on Electronics Packaging Manufacturing*, a senior member of the Institute for Industrial Engineers and a member of INFORMS.

Maria Mayorga won the CoES Collaboration Award last spring. This award recognizes notable interdisciplinary contribution to the college. These collaborative efforts align with two of Clemson's emphasis areas — automotive and transportation technology and general education. Mayorga has also been elected to the Institute of Industrial Engineering Operations Research Division board of directors for the 2010-2011 term.

Student Achievement

Paul Goethals and adviser **Rae Cho** won the INFORMS awards for Best Paper in Conference and Best Paper in Track at the 46th annual meeting of the Southeastern Chapter for the Institute of Operations Research and Management Sciences.

Graduate student **Sunarin Chanta** received the best paper award in the operations research track at the IIE Annual Conference and Expo 2009 held in Miami, Fla.

Kapil Chalil Madathil and **Indraneel Dabhade** won awards for excellence in advanced education in technician training for the aircraft maintenance industry from the American Association of Community Colleges along with NSF support. These honors were conferred at the 17th Advanced Technological Education Principal Investigator's Conference in Washington, D.C.

School of Materials Science and Engineering

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Fast Facts

Tenured/tenure-track faculty: 14

Enrollment:	Undergraduate	111
	Master's	18
	Doctoral	57
Degrees awarded (May and Dec. 2010):		
	Undergraduate	30
	Masters	12
	Doctoral	8

Research expenditures: $5.6 million
Research thrusts: manufacturing, characterization and structure/property/performance relationships of ceramics, glasses, polymers, photonics/optics, fiber-based materials, thin films and metals

Olin (Thomas) Mefford

Department Overview

Research in the School of Materials Science and Engineering (MSE) is as diverse as its faculty interests. MSE faculty conduct research on ceramics, glasses, polymers, photonics, medical textiles, biomaterials, fiber science, thin films and metallurgy.

The department is comprised of expert collaborators who work with nearly every CES department and across colleges as their support of numerous University centers and institutes demonstrates. Their ability to create stronger, lighter and more efficient materials makes MSE researchers attractive research partners with broad design, process, characterization and manufacturing experience.

Clemson's MSE program is one of a small group of MSE programs in the country where faculty and students not only work with but actually make many of the materials they design and test – from optical glass and fibers to bricks, bio-polymer fiber scaffolds, space fabrics and nanograined metallic materials. While computational materials science is also employed in the design and evaluation of materials in systems, the school also provides a sound foundation in the study of chemistry, structure and property relationships. Hands-on experience of realizing fundamental principles of science and engineering is taught through laboratory training. Such balance to class and lab focus is a key part of the Clemson MSE curriculum.

Faculty Highlights

The U.S. Department of Energy (DOE) awarded **Jian Luo** a grant to investigate "Multiscale Modeling of Grain Boundary Segregation and Embrittlement in Tungsten for Mechanistic Design of Alloys for Coal Fired Plants."

Olin T. Mefford, assistant professor, **Christopher Kitchens** (chemical engineering) and **Brian Powell** (environmental engineering) are conducting research on "Evaluation of Nanoparticle Behavior during Transitions from Engineered to Natural Systems."

Kathleen Richardson and **Igor Luzinov,** along with their colleagues from MIT and Physical Sciences Inc., received a U.S. DOE award to develop "Compact, Highly Sensitive and Selective, Mid-infrared Chemical Sensors" in addition to a Defense Threat Reduction Agency award to study "Gradient Films from Shape-Memory Nanofoams for Waveguide Coating."

John Ballato was named the 2010 Sigma Xi Outstanding Researcher of the Year at Clemson University. He also won the 2010 Richard M. Fulrath Award from the American Ceramic Society. The Fulrath Award promotes technical and personal collaborations between professional Japanese and American ceramic engineers and scientists and encourages a greater understanding among the diverse cultures surrounding the Pacific Rim.

Student Achievement

Ryan Need and **James Haley** were awarded prestigious scholarships from TMS and AIST. These awards were advertised to students through the National Material Advantage Student Association. Haley was awarded one of the STEEL 2010 AIST scholarships, consisting of $5,000. It is awarded to engineering students expecting to graduate in 2013 and includes a paid internship at a North American steel company during the summer of 2012 and a possible second scholarship of $5,000 in the student's last year. Need's scholarship was given by the TMS Structural Materials Division. A $2,500 scholarship, it recognizes full-time undergraduate applicants in their sophomore or junior year majoring in metallurgical and/or materials science and engineering.

Mathematical Sciences

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Fast Facts

Tenured/tenure-track faculty: 39

Enrollment:	Undergraduate	272
	Master's	67
	Doctoral	54
Degrees (May and Dec. 2010):		
	Undergraduate	34
	Master's	29
	Doctoral	13

Research expenditures: $960,441
Research thrusts: algebra and discrete mathematics, applied analysis, biomathematics, computational mathematics, operations research, probability and statistics

Clemson Calculus Challenge

Department Overview

Clemson's Department of Mathematical Sciences provides major contributions to the instructional and research mission of the University. Class enrollments average 6,000 to 7,000 students per semester in more than 320 sections of math sciences courses, ranging from beginning freshman to cutting-edge graduate-level research courses. Mathematical instruction and research are led by more than 77 faculty members and 120 graduate students.

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 of particular interest for the department.

For the sixth consecutive year, the department hosted the Clemson Calculus Challenge, a calculus-exclusive competition based on the advanced placement (AP) calculus AB syllabus. Recognized with $30,000 in NSF funding, the 2010 competition involved 229 high school math students from the Southeast with most students coming from Georgia, North Carolina and South Carolina. Teams of high school students worked together in pursuit of individual $500 Clemson University scholarships.

Faculty Highlights

Warren P. Adams received the Clemson University 2010 Alumni Award for Outstanding Achievement in Research.

Robert L. Taylor served as assistant chief reader at the AP reading for statistics.

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

Herve Kerivin collaborated with Telecom Bretagne on multi-optimization problems during a three-month funded visit to France.

Hugh MacMillan was named the 2010-2011 American Mathematical Society Congressional Fellow and will spend the year in Washington, D.C., doing mathematical advisory work.

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

Calvin Williams served on the advisory board of the Southeast section of the Centers for Ocean Sciences Education Excellence.

Student Achievement

Abigail Bowers contributed a research talk in the special session on "Algorithm analysis, design and computation for turbulent flows" at the 2010 SIAM annual meeting in Pittsburgh, Penn.

Mariah Magagnotti contributed a student poster at the 2010 SIAM meeting.

Catherine Trentacoste was funded to attend a two-week number theory workshop in Barcelona, Spain.

Erin Doolittle was funded 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.

Justin Peachey presented his research and attended the Soria Summer School in Computational Mathematics in Soria, Spain, last summer.

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.

Wittawat Kositwattanarerk presented the research paper "Pseudocodewords and Tanner Graph Representation" at the 2010 IEEE International Symposium on Information Theory.

Mechanical Engineering

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Fast Facts

Tenured/tenure-track faculty: 23

Enrollment:	Undergraduate	584
	Master's	104
	Doctoral	67
Degrees awarded (May and Dec. 2010):		
	Undergraduate	130
	Master's	34
	Doctoral	6

Research expenditures: $5.8 million
Research thrusts: automotive engineering; bioengineering and biomaterials; design, dynamics and controls; fluid mechanics, materials and materials processing; solid mechanics; thermodynamics; heat transfer and combustion


Gang Li

Department Overview

The Department of Mechanical Engineering (ME) has one of the largest academic programs in South Carolina. It has significant strengths in the theoretical and applied, computational and experimental areas of mechanical engineering and in many interdisciplinary domains. The faculty are very active and well-known for their research and scholarly contributions in design, manufacturing, mechanics, bio-technology, fluid- and energy-related issues, and the nano and MEMS areas. Faculty are also involved in the development of a systems engineering certificate program and nuclear engineering degree and minor programs. Members of the faculty are helping to set up a large-scale wind turbine testing area in Charleston, and proposing novel alternative energy approaches as well.

The department has seen unprecedented growth in the last few years with 13 new faculty joining its ranks and the creation of a graduate program in automotive engineering that focuses on systems integration to meet the challenges of the global automotive marketplace. A new 90,000-square-foot, unique facility houses the new program.

Seven ME faculty members are ASME Fellows, one is an SME Fellow and one is an ANS Fellow. The department currently has six NSF CAREER Fellows and one NSF PECASE winner.

Faculty Highlights

Associate professor and graduate coordinator **Richard Miller** received an NSF research grant of $219,487. His project is entitled "A Priori Analysis of Subgrid Molecular Transport Effects on High-Pressure Turbulent Combustion Modeling." The award is from the combustion, fire and plasma systems division.

Assistant professor **Lin Ma** received a continuing research grant of $45,000 from the Automotive Research Center (U.S. Army Center of Excellence). This project is entitled "Enhanced Fluid Properties and Minimization of Radiator Fan Power Consumption in Military Ground Vehicle Cooling Systems."

Gregory Mocko received a research grant of $10,000 from the S.C. Space Grant Consortium to support a project entitled "Establishing Objective Metrics and Protocols to Analyze Quality of Engineering Requirement Statements."

Chenning Tong received an NSF research grant of $389,533 to fund a project entitled "Collaborative Research: Measurements and Modeling of Subgrid-Scale Turbulence in the Atmospheric Surface Layer."

Mohammed Daqaq and **Gang Li** received an NSF research grant of $250,000 for their project entitled "A Novel Concept for Micro-power Generation Using Flow-induced, Self-excited Oscillations." Inspired by harmonica music, the project involves designing and optimizing a scalable wind energy harvester.

Richard Figliola will coordinate efforts to develop improved support decisions for treating children born with only one functioning heart ventricle. The Paris-based Leducq Foundation has awarded researchers at the Medical University of South Carolina, Clemson University and a collaboration of other institutions in the United States and Europe $6 million to establish a Transatlantic Network of Excellence. Patients with this condition require radical and complex heart surgeries to alter blood flow in order to live. This network will use computational fluid-flow models of a patient's own anatomy to allow physicians to perform virtual surgeries and to observe the effects of different decisions based on the patient's individual data.

Jean-Marc Delhaye has become a Fellow of the American Nuclear Society in recognition of outstanding contributions to the advancement of nuclear science and technology. He was also elected an ASME Fellow, the highest grade of membership in the American Society of Mechanical Engineers.

Jay Ochterbeck chaired the 15th International Heat Pipe Conference. The conference was held at Clemson University and hosted more than 100 people from across the United States, as well as Japan, Libya, France, Belgium, Korea, Russia, South Africa, Great Britain, China, Italy, Canada, Taiwan, The Netherlands and Spain.

Student Achievement

Caleb Edwards, Colin Smith, Gregory Dasher, Jon Brown, Robert Akins, Robert Lester, Simone Neuhoff, Samantha Thoe and **Tyler Garrett** took a trip to Mexico last summer as part of their senior design project under the advisement of **Joshua Summers** and **Beshoy Morkos**. A part of the the 2010 Industrial Outreach Program, the trip involved collaboration with students from West Virginia University and six Mexican universities to solve industry design problems.

The Clemson Formula SAE team competed at the national level and finished 35th out of 140 participants at events in Michigan. The formula team won the Xtreme College rivals competition beating Mississippi State.

Beshoy Morkos and **Benjamin Caldwell** were selected to receive a Teaching Fellowship from the ASME. This two-year fellowship enables Ph.D. students to become instructors.

Ph.D. candidates **Chiradeep Sen** and **Steven Bower** were selected by the ME department to receive endowed teaching fellowships.

Ph.D. candidate **Latoya McDonald** received an NSF graduate supplement.

Ph.D. students **Timothy Reeves**, **Carl Lamar** and **James Mathieson** received an S.C. Space Grant Consortium Fellowship.

Physics and Astronomy

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Fast Facts

Tenured/tenure-track faculty: 23

Enrollment:	Undergraduate	91
	Master's	5
	Doctoral	58
Degrees awarded (May and Dec. 2010):		
	Undergraduate	18
	Masters	2
	Doctoral	2

Research expenditures: $2.5 million
Research thrusts: astronomy and astrophysics, atmospheric and space physics, biophysics, condensed matter physics


Patrick Johnson

Department Overview

Classical physics encompasses the fields of mechanics, heat and thermodynamics, electricity and magnetism, acoustics and optics. Modern physics is concerned with the study of atoms and molecules; atomic nuclei; elementary particles; the properties of liquids; crystalline solids and other materials in addition to the nature of planets, stars, galaxies and the large-scale structure of the universe.

The undergraduate physics curricula are designed to provide students with a strong background in the classical areas of physics as well as introduce the more important aspects of modern physics. The B.S. in physics provides a good basis for graduate study or industrial work in areas such as engineering physics and applied science.

Graduate study in physics and astronomy for either the Ph.D. or M.S. degree is a great opportunity for students who want

- to pursue a research career in physics, astronomy or closely related fields;
- to be expert teachers of these subjects; or
- to gain broad-based technical expertise for other careers.

Graduate students spend a good deal of their time engaged in forefront research, conducted under the mentorship of our world-class faculty. Most graduate students also teach physics and/or astronomy classes.

After graduation, our M.S. and Ph.D. recipients take diverse career paths. Some join faculty in research universities and teaching colleges. Others work in research positions at places such as national research laboratories, NASA, the Department of Energy, national observatories, and the U.S. Navy or Air Force. Graduates also work for numerous private companies in research and development or in management. Also, many of our international students return to positions such as these in their home countries.

Faculty Highlights

Assistant professor **Fivos Drymiotis** was awarded the Prince Award for Innovation in Teaching at the 2010 Victor Hurst Convocation. The annual award is named for Clemson President Emeritus Philip Prince and recognizes outstanding teachers who demonstrate creative and novel teaching methods in the classroom.

Jens Oberheide and **Antony Valentini** are the newest members of the physics and astronomy faculty. Oberheide's skill set as a modeler and his expertise in atmospheric tides are highly complementary to the atmospheric and space physics group. His areas of research include atmospheric and geo-space physics and climate and weather of the sun/Earth system. Valentini has published books entitled *Quantum Theory at the Crossroads* and *Pilot-Wave Theory of Physics and Cosmology*. His appointment will enable the University to quickly vault to a position of global leadership in the field of foundations of physics.

Emil Alexov has been awarded a $420,605 grant from the National Institutes of Health.

Student Achievement

Patrick Johnson was presented a $10,000 check from the Astronaut Scholarship Foundation by retired Apollo 16 moonwalker Charles Moss Duke Jr. The first research paper Johnson wrote when he entered Clemson University as a 16-year-old freshman was a treatise on electromagnetic launchers for space flight. Johnson is the first Clemson University student to earn the scholarship. Established in 1984 by the six surviving astronauts of America's original Mercury program, the scholarship is given to students "who exhibit motivation, imagination and exceptional performance in the science or engineering field of their major."

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