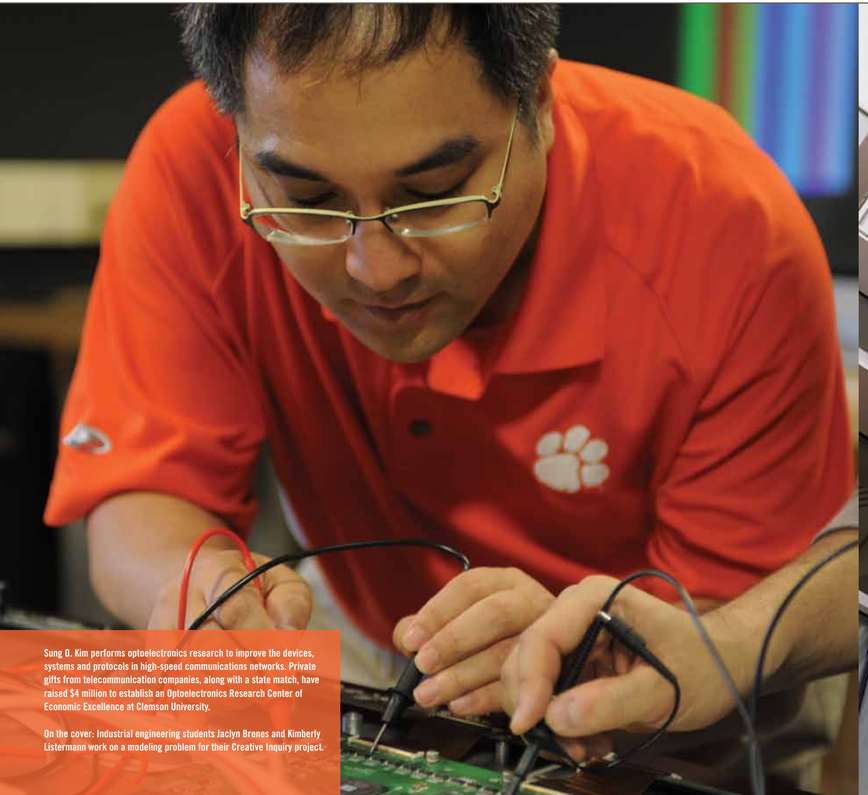


Sung O. Kim performs optoelectronics research to improve the devices, systems and protocols in high-speed communications networks. Private gifts from telecommunication companies, along with a state match, have raised $4 million to establish an Optoelectronics Research Center of Economic Excellence at Clemson University.

On the cover: Industrial engineering students Jaclyn Brenes and Kimberly Listermann work on a modeling problem for their Creative Inquiry project.

IDEaS

INQUIRY, DISCOVERY IN ENGINEERING AND SCIENCE

COLLEGE OF ENGINEERING AND SCIENCE SPRING 2010

in this issue:

CLEMSON
College of ENGINEERING AND SCIENCE

From the Dean

I'm writing this column after a weeklong stay in Antarctica. As a member of the National Science Board, I was invited to review a broad spectrum of scientific research activities being conducted at the Crary Science and Engineering Laboratory at McMurdo Station and at the new Amundsen-Scott South Pole Station.

It was an honor to be part of a delegation that met with scientists there who are working in disciplines that include biology; physics; medicine; and atmospheric, earth and ocean sciences. Measuring and observing natural phenomena in extreme conditions call for multidisciplinary expertise. Logistical challenges require the convergence of scientific and engineering knowledge, and the technical diversity of the Antarctic research teams reminded me of the breadth of the programs in Clemson's College of Engineering and Science. Our administrative structure provides a home to all the traditional engineering disciplines and the physical sciences of chemistry, mathematics, physics and astronomy.

One of the stories in this edition of *IDEaS* concerns a group of engineers and scientists whose work emulates nature's diversity. We have a team of biologists, chemists, bioengineers, material scientists and electrical engineers working on the same project. The National Science Foundation's Office of Emerging Frontiers in Research and Innovation has awarded Clemson University researchers funding to study how butterflies and moths feed. The team is trying to create an artificial probus that can be used for medical diagnostics and therapeutic pharmaceutical delivery. The research is part of an ongoing project to develop fiber-based medical devices in Clemson's School of Materials Science and Engineering and the Center for Advanced Engineering Fibers and Films.

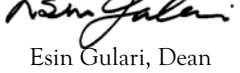
We're excited to share the news that Clemson has received a $9.3 million, five-year National Institutes of Health (NIH) grant to establish a Center of Biomedical Research Excellence (COBRE) for Tissue Regeneration. Faculty from the Medical University of South Carolina and the University of South Carolina will also collaborate, providing expertise in medicine and developmental biology. The NIH's decision to fund this COBRE center underscores Clemson's potential to contribute significantly to the body of knowledge in a critical research field strongly tied to the University's biotechnology and biomedical sciences emphasis area.

Technology transfer is a two-way street — and it's a critical component of a new approach in our automotive engineering master's and doctoral degree programs. Entrepreneurs and industry partners now have an open innovation platform to showcase future technologies. "Deep Orange" is transforming the Carroll A. Campbell Jr. Graduate Engineering Center into an innovative model OEM (original equipment manufacturer) and supplier. Students, faculty and participating partners will engineer and manufacture a new vehicle prototype each year, giving the students experience in vehicle design, development, prototyping and production planning from entry into the program until graduation.

In the "Clemson Couples" feature, we highlight a faculty pair who have built a nurturing personal relationship that goes hand-in-hand with their successful academic careers. This story concerns an entirely different kind of interdisciplinary collaboration.

In the Antarctic, surviving the harsh climate often depends on working together. Collaboration is the key to finding solutions to challenges that affect our quality of life as well. This issue of *IDEaS* is all about our strong spirit of collaboration at Clemson and how we're working together to thrive in the uncertain climate of the future.

Sincerely,



Esin Gulari, Dean
College of Engineering and Science
Clemson University

Going from Green to Deep Orange

By Sandy Woodward

A new, long-term initiative at the Clemson University International Center for Automotive Research (CU-ICAR) will advance the University's automotive engineering graduate research and education program and position graduates ahead of the competition for jobs and automotive industry leadership.

Called Deep Orange for its commitment to Clemson-style competitiveness, the framework will transform the Carroll A. Campbell Jr. Graduate Engineering Center (CGEC) — which houses the automotive engineering master's and doctoral degree programs — into an innovative model OEM (original equipment manufacturer) and supplier. Students, faculty and participating partners will engineer and manufacture a new vehicle prototype each year, giving the students plenty of experience with vehicle design, development, prototyping and production planning from their entry into the program until graduation. The first Deep Orange vehicle is scheduled for completion next spring.

Each project will focus on leapfrogging the latest vehicle technologies by eliminating the constraints and the "we've-always-done-it-that-way" legacies that pervade the automotive industry. Without these constraints and by applying a systems engineering approach, researchers, students and industry partners can freely and quickly explore the optimal integration of new technologies.

"This concept sets us apart," says Imtiaz Haque, executive director of the CGEC. "Deep Orange embodies the term of systems integration. It provides entrepreneurs and

"Deep Orange is the very essence of what this program has committed to provide for the automotive and motorsports industries — based on what industry leaders told us they needed."

— Imtiaz Haque, executive director of the Campbell Graduate Engineering Center


8:32 a.m.


9:29 a.m.


9:35 a.m.


10:22 a.m.


12:01 p.m.


1:29 p.m.

A typical morning at CGEC:

8:04 a.m. Hung instructs his students on redesigning the wiring harness for the seat controls before the day starts.

8:32 a.m. The morning officially begins with a general meeting to motivate the teams.

9:29 a.m. The class breaks up into groups to work on the individual tasks.

9:35 a.m. Venhovens works with the body-in-white and powertrain teams on finding space for traction batteries.

10:22 a.m. The body-in-white team updates the CAD model of the floor.

12:01 p.m. The teams gather at the car to discuss the changes in the assembly process.

industry partners with an open-innovation platform to showcase future technologies through intensive proof-of-concept collaboration, involving each graduate student. Through this initiative, they'll have a clear understanding of how to innovate and develop projects, and the resulting experience will prepare them to lead the future of the industry.

"Deep Orange will deepen our understanding of the challenges we face and the solutions we need to seek as we bring disparate technologies together," says Haque. "This is the very essence of what this program has committed to provide for the automotive and motorsports industries — based on what industry leaders told us they needed."

Systems integration involves making sure that the multiple systems that make up the automobile work together — that modifications or improvements in one aspect of the design do not negatively affect the others. The automotive engineering graduate program comprises four major research thrusts, including manufacturing, design and development, vehicle electronic systems and systems integration. Each thrust is led by an endowed chair who was recruited in highly publicized, internationally competitive searches.

"We took our time pulling together this outstanding faculty leadership team," Haque says. "In addition to the chairs, we've recruited top-quality faculty with expertise in all aspects of automotive engineering. This is the payoff — a unique approach to fulfilling the CU-ICAR vision of being the premier automotive and motorsports research and education facility in the world."

Paul Venhovens, the BMW Endowed Chair in Automotive Systems Integration, will lead the Deep Orange initiative. He came to Clemson from BMW's research and development headquarters in Munich, Germany, where he led functional concept design initiatives.

"We're very excited for our students and for the companies that will ultimately hire them," Venhovens says. "When our students graduate, they will have been directly and intimately involved in the development of various aspects of a vehicle in a research and education environment that encourages creativity and entrepreneurship, responsiveness to market demands, consumer preferences and issues of sustainability," says Venhovens. "It'll also expose students to the capabilities and limitations of certain technologies, including functional interdependencies and conflicts. These aspects are often ignored in single-focus, traditional engineering programs."

Venhovens adds that the beauty of the Deep Orange project is its flexibility. "This is a fluid curriculum that allows us to think outside of conventional course work and focus on the product and the consumer's needs. Each year's project will be unique, with different challenges and

"This is a fluid curriculum that allows us to think outside of conventional course work and focus on the product and the consumer's needs."

—Paul Venhovens, BMW Endowed Chair in Automotive Systems Integration

Clemson awards its first Ph.D. in automotive engineering

Among the more than 1,000 degrees awarded during the 2009 winter graduation at Clemson University was the first Ph.D. in automotive engineering — earned by John Limroth of Austin, Texas.

"The recognition and attention associated with being the first Ph.D. graduate are nice," says Limroth, "but I am more excited to be graduating with the experience I received from a premier program that has an international focus."

Limroth has already started working at Michelin as a tire-performance research engineer.

Clemson launched its automotive engineering program in 2006 at the CU-ICAR campus. The program awarded nine master's degrees in 2009.


1:49 p.m.


3:30 p.m.


4:52 p.m.

A typical afternoon at CGEC:

1:29 p.m. The teams get together for an update on the status of the project.

1:49 p.m. A video conference is in progress with the seat supplier on modifying the seat frame.

2:23 p.m. The group jointly decides to change the interior seating concept.

3:30 p.m. Hung works with the interior group on packaging the new seat.

4:52 p.m. New CAD data from the seat supplier arrives for the integration tasks.

5:21 p.m. Venhovens calls to thank the supplier for the quick reaction.

5:49 p.m. Venhovens and Hung discuss the progress of the day.

parameters for success. The scope of the experience that this initiative will provide for our students will be very attractive to the industry."

Collaboration with private-sector and government partners is a cornerstone of the CU-ICAR program, and Deep Orange leaders plan to collaborate with a wide array of automotive and motorsports colleagues. For example, the 7,500-member Specialty Equipment Market Association (SEMA) formed a partnership with Clemson University in August, focusing on the Deep Orange initiative as the centerpiece of the overall relationship. The Deep Orange vision was formally presented to an international industry and media audience during a high-profile technology briefing session at the 2009 SEMA Show in Las Vegas in November.

"For SEMA, Deep Orange can demonstrate the integration of specialty equipment, aftermarket performance components, total-vehicle systems and modules, offering new opportunities for SEMA-member companies to directly participate," Haque says. "We'll also work with academic institutions with complementary expertise — Deep Orange will enable us to collaborate with anyone."

As for students, Deep Orange offers the opportunity of a lifetime. According to Ph.D. candidate Marshall Saunders, "Deep Orange gives us the opportunity to design a vehicle using innovative methods that will apply to the OEM of the future. The opportunity for us to work with suppliers and manufacturers, designing and implementing new products into our vehicle is a great experience that prepares us for the demands of working for an OEM or other automotive or motorsports company." *

Investing in Our Health

By Susan Polowczuk

According to U.S. Census Bureau projections, the aging baby boomer population will expand the elderly population by 75 percent in the next two decades. That's more than 74 million people — 74 million reasons the National Institutes of Health (NIH) is investing $9.3 million over the next five years to establish a Center for Biomedical Research Excellence (COBRE) for Tissue Regeneration at Clemson University.

Center of Biomedical Research Excellence for Tissue Regeneration

The investigators and their research:

Naran Vyavahare, Director

Hunter Endowed Chair and professor of bioengineering at Clemson University

- Applies chemistry, biochemistry and engineering principles to the development of biomaterials, including primary syntheses of therapeutic polymers for biomaterial use and development of natural protein/tissue-derived biomaterials
- Studies biomaterial-protein interactions with advanced spectroscopic instruments

Ken Webb, Spinal Tissue

Associate professor of bioengineering at Clemson University

- Develops biomaterial scaffolds that can be implanted at sites of spinal cord injuries to promote regeneration — leading to improved recovery of motor and sensory function

Bruce Gao, Heart Tissue

Associate professor of bioengineering research at Clemson University

- Adds to the current knowledge of the electrical coupling between bone marrow stem cells and heart muscle cells
- Will contribute to the recent effort in regenerative medicine to restore the function of a damaged heart using the patient's own cells

Anand Ramamurthi, Vascular Tissue

Associate professor of bioengineering at Clemson University and adjunct associate professor of regenerative medicine and cell biology at MUSC

- Researches the development of biomaterials and innovative therapeutic technologies to enable regenerative repair of vascular tissues and their elastic fiber networks when damaged by disease or trauma
- Engineers tissue *in vitro*, producing functional elastic vascular tissue replacements

Susan Lessner, Vascular Tissue

Assistant professor of cell biology and anatomy at the USC School of Medicine and a core faculty member in the USC biomedical engineering program

- Focuses on understanding and controlling new capillary growth in the atherosclerotic plaque as a potential means to reduce the risk of heart attack and stroke

"The center's research focus will be on tissue regeneration through cell-biomaterials interactions with the goal of restoring functional tissues," says Naren Vyavahare, Hunter Endowed Chair, professor of bioengineering and director of the new center. "End-stage organ failure and tissue loss create health care costs of nearly $400 billion annually in the United States."

Faculty from Clemson University's bioengineering department will collaborate with faculty from the Medical University of South Carolina (MUSC) and the University of South Carolina (USC), providing expertise in medicine and developmental biology.

The center is funded by the NIH National Center for Research Resources Institutional Development Award program that seeks to broaden the geographic distribution of NIH funding for biomedical and behavioral research. The program also aims to increase the number of NIH-funded biomedical researchers in the nation and to strengthen the biomedical research capacity of individual universities. The ultimate goal is to create world-class core facilities and to provide funding and mentoring for early career researchers already in place to make them successful, independent NIH-funded investigators.

The first group of early-career investigators includes Bruce Gao and Ken Webb, associate professors of bioengineering at Clemson; Susan Lessner, assistant professor of cell biology and anatomy at USC; and Anand Ramamurthi, associate professor of bioengineering with the Clemson-MUSC Bioengineering Program and adjunct associate professor of regenerative medicine and cell biology at MUSC.

> "This new Clemson COBRE will significantly improve our collaborative efforts in South Carolina to recruit, train and retain researchers with cross-disciplinary skills in the area of regenerative medicine."
>
> —Clemson University President James F. Barker

South Carolina already is home to a growing medical-device cluster, making Clemson the perfect choice for such a center.

"This new Clemson COBRE will significantly improve our collaborative efforts in South Carolina to recruit, train and retain researchers with cross-disciplinary skills in the area of regenerative medicine," says Clemson University President James F. Barker. "This recognition from the NIH is a great honor and speaks to the rich history and outstanding quality of research from our bioengineering department."

One of Clemson's emphasis areas focuses on using biotechnology and biomedical science to combine research expertise with opportunity for economic growth in the state. Chris Przirembel, vice president for research and economic development at Clemson, says the NIH's decision to fund this center illustrates the University's potential to contribute significantly to the body of knowledge in this critical research field.

"It's very gratifying that the NIH recognizes Clemson's research strength in this important field. Each year, thousands of Americans — and even more people worldwide — suffer or lose their lives due to organ failure," says Przirembel. "The dedication of professor Vyavahare and his colleagues to alleviate suffering is inspiring to all of us. The potential exists for their discoveries to lead to the development of new products, spurring the creation of a new biomedical-related industry segment to provide additional jobs. The potential positive outcomes of this research are endless." ✻

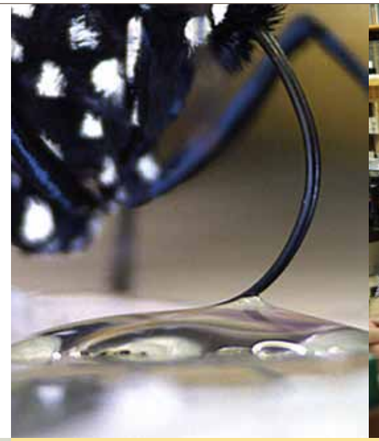
Clemson researchers Naran Vyavahare, Ken Webb and Bruce Gao will collaborate with other researchers from MUSC and USC in pursuit of excellence in tissue regeneration.

The Butterfly Effect

By Brandon Watt

It's not often that you find a team of biologists, chemists, bioengineers, material scientists and electrical engineers working on the same project, but that's the exact makeup of an eclectic group of researchers that was recently awarded $2 million from the National Science Foundation's Office of Emerging Frontiers in Research and Innovation (EFRI). The group is studying the way butterflies and moths feed in order to develop a new class of fiber-based devices capable of probing and transporting previously impossible-to-reach liquids, such as those drawn from a single cell or tissue.

"Right now, we have a real challenge of collecting fluids from miniscule places – such as a cell or a gland – without damaging them," says principal investigator Konstantin Kornev, an associate professor in the School of Materials Science and Engineering.



Left: A close-up of the proboscis of a monarch butterfly drinking from a drop of water.

Right: Peter Adler (right) discusses the proboscis anatomy of the butterflies being studied with Charles Beard.

Left: Kenneth Christensen discusses the sensors his team developed with undergraduate Laura Simpkins as they prepare to print femtoliter volumes onto a fiber-based device.

Right: Konstantin Kornev prepares to examine the wetting properties of a butterfly proboscis.

Co-investigators include Peter Adler, professor of entomology, soils and plant science; Kenneth Christensen, assistant professor of chemistry; Richard Groff, assistant professor in electrical and computer engineering; and Alexey Vertegel, assistant professor of bioengineering. The project is a collaboration between the School of Materials Science and Engineering and the Center for Advanced Engineering Fibers and Films.

The biologists on the team are working on the proboscis anatomy, biopolymer materials and sensilla, which are tiny sensory organs that distinguish different chemicals in food.

Chemists and bioengineers are developing the principles of chemical analysis of biofluids, which is challenging due to limited supply. "Imagine the tiny amount of liquid you can collect from a cell – which is about 10 times smaller than the diameter of your hair," Kornev explains.

The materials scientists and electrical engineers are designing an artificial proboscis and developing the principles of its manipulation. They're also studying how to pierce a cell without destroying the cell.

Kornev is impressed with the diverse group he has assembled for the project and sees many opportunities for his team. "You have to think outside the box," Kornev says. "There are no rules established yet, and you have to solve a very unusual problem."

This is where Kornev sees the advantages of having such an eclectic group of researchers. "This kind of project requires lots of imagination, and it adds new knowledge to your own discipline – making it richer and broader," he concludes. ✻

Power Couple

By Jill Becker

Martine LaBerge and Paul Joseph met and fell in love over a broken leg.

It was 1991, and Joseph, an assistant professor of mechanical engineering in Clemson's College of Engineering and Science (CES), had been asked to consult on a court case involving a motorcyclist who was suing his doctor after a rod used to repair his fractured leg had severed. Needing to learn more about the tribology and function of the device, Joseph was directed to LaBerge, then an assistant professor in the bioengineering department.

"Yes, that's how we met," remembers LaBerge. "Paul was a newly appointed faculty member, and I explained what he was looking at in relation to the biomechanics of the problem."

LaBerge's specialty just happens to involve the biomechanics of such medical devices.

Obviously, it turned out to be a match made in heaven. But, was it love at first sight? Both say no, claiming their relationship was all business at first.

Both also claim to be fuzzy on the exact details of how their relationship blossomed from there. "I don't remember. I'm getting old," LaBerge jokes — but both clearly relish the end result, as well as the benefits of being able to work together at a place like Clemson.

"It's difficult for spouses in academia to work at the same university," says Joseph. "But Clemson is a nurturing place for couples and supports dual employment."

LaBerge concurs. "Clemson has served as a catalyst for our marriage — and for others," she says, referring to the handful of other dual-career CES couples, including Dan and Agneta Simionescu, Xuejun Wen and Ning Zhang, Brian and Delphine Dean, and Ken Webb and Jeoung Soo Lee.

"You're very lucky if you're a person in this job and your spouse understands your work," says Joseph, explaining why, when so many workplaces frown upon married co-workers, happy unions seem to thrive at Clemson. "We have a very large department. Between the teaching, working with grad students, committee work and all the unexpected things that come up, this job is demanding and takes a lot of time and energy. And to have your spouse appreciate that and understand that it's hard not to think about work all the time is invaluable. Luckily, Martine gets it. She understands the job better than anyone."

"We have quite a few professional couples in our department," notes LaBerge, who as chair of the bioengineering department actively assists couples interested in dual careers at Clemson. "Clemson is very supportive of initiatives like this. As long as it fits the University's mission, we encourage it and help out as much as we can. Personally, working together with Paul has made my life and our relationship easier. It relieves the pressure because we know what the other is going through. Without Paul's support and understanding, I couldn't do this."

But factoring in working together, sneaking off for the occasional lunch out, and even commuting to and from work together from their home in Seneca, is it too much of a good thing? "No," says Joseph. "At the workplace, Martine plays the role of my colleague, not my wife. And we try hard not to take our work home with us. Although she is admittedly better at that than I am."

Joseph explains the advantages of a new composite material used in Michelin's Tweel™ Project to a colleague.

Paul F. Joseph joined the mechanical engineering department in 1990. His research expertise is in analytical and computational approaches in fracture mechanics, contact mechanics and visco-elasticity.

His current research includes fracture mechanics with contact and friction; combined analytical and numerical approaches in fracture, contact and lubrication; precision glass lens molding; glass fiber extrusion; sand-tire interaction and tire mechanics — with a particular interest in the Michelin Tweel™. These projects range from mathematical evaluation of interface fracture parameters, to predicting how a molded glass lens changes shape upon cooling, to the design of wheels for the next lunar rover.

He has served as the department's Honors coordinator for 10 years. He has also received teaching awards and a Best Paper Award from the ASME *Journal of Electronic Packaging*.

Martine LaBerge's research expertise is focused on the tribological evaluation and characterization of natural and artificial surfaces used in the design of implants for orthopaedic and vascular applications. Her research addresses the fundamental lubrication and wear problems encountered with artificial tribological models. Boundary and elastohydrodynamic lubrication are especially targeted through the design of alternative bearing surfaces.

Current research projects include investigating the wear performance of total knee joint replacements, total knee joint design and dynamic contact mechanics, the effect of phospholipidic boundary lubrication on the subsurface failure of natural and artificial materials, the use of elastomeric composites as alternative bearing surfaces, the effect of artificial lubricant rheology on the wear of tested materials, the tribology of vascular implants and their effect on restenosis and smooth-muscle-cell biochemical response, and surface design for lubrication improvement.

LaBerge discusses the knee joint developed in her lab with research scholar Michele Spinelli.

In fact, getting to work together with her future spouse was a major factor in LaBerge's decision to turn down an opportunity to join the Canadian astronaut program (she originally hails from Canada). "Having Paul here kept me at Clemson," she admits, "because I feel like if you have a supportive husband, you have a successful career."

Indeed, both Joseph and LaBerge maintain that being at the same school ultimately enhances both their work performance. "I know Paul's strengths and weaknesses, and he knows mine," says LaBerge. "Working together helps us be better team members and collaborators."

> "It's difficult for spouses in academia to work at the same university. But Clemson is a nurturing place for couples and supports dual employment."
>
> —Paul Joseph

And that connection extends to their home life as well, where, along with their nine-year-old son, William, they bond over activities like cooking, fishing, working in the garden and trips to the beach.

"Working with Paul," LaBerge says with a smile, "I really have the best of both worlds." *

News and notes

Clemson lands funding to develop next-generation wind turbines

The next-generation wind turbines and drive trains will be tested by Clemson's College of Engineering and Science (CES) and the Clemson University Restoration Institute in a move that is expected to create hundreds of jobs and place one of the most important sites for wind energy research and development in South Carolina.

A $45 million grant from the U.S. Department of Energy – combined with $53 million of matching funds – will build and operate a large-scale wind turbine drive train testing facility at the institute's research campus on the former Navy base in North Charleston, S.C.

The award is the largest single grant ever received in the University's history and represents an enormous economic development opportunity for the region.

The University's partners are the Charleston Naval Complex Redevelopment Authority, the S.C. Department of Commerce, the state of South Carolina, S.C. Public Railways, the S.C. State Ports Authority, RENK AG, Tony Bakker and James Meadors.

Planning and construction of the facility will begin in the first quarter of 2010 with a targeted operational date in the third quarter of 2012. The Department of Energy estimates that South Carolina could gain 10,000 to 20,000 new jobs related to the wind power industry during the next 20 years.

Researchers receive EPA grant to study carbon emission storage

Clemson University researchers **Ron Falta** and **Larry Murdoch** have received $891,000 through an Environmental Protection Agency grant to study the safe storage of carbon dioxide in geological formations located deep below the earth's surface.

With carbon dioxide emissions from burning fossil fuels believed to be the leading cause of global warming, geologic storage of the gas is one of the most promising alternatives for reducing emissions using current technology.

Falta and Murdoch will focus on the behavior of carbon dioxide dissolved in saltwater at high pressure and methods to keep it safely away from shallow drinking water aquifers.

Professor named American Chemistry Society Fellow

Clemson University Alumni Distinguished Professor of Chemistry **Melanie Cooper** has been named to the inaugural class of American Chemical Society Fellows. Cooper was among 162 honorees who were chosen for excellence in their contributions and distinctive service to the society and to the broader world of chemistry.

Cooper's research has focused on the development of effective ways for students to learn science. One of the outcomes of her research is the development and assessment of evidence-driven, research-validated curricula. "Chemistry, Life, the Universe and Everything" (CLUE) is a new general-chemistry curriculum that uses the emergence and evolution of life as the scaffold to teach chemical principles. Cooper was awarded an NSF grant of $500,000 for a three-year project to develop CLUE. She says many students do not have a deep understanding of fundamental chemistry principles, and this does not prepare them for further study in chemistry or other areas like biological sciences.

Her research focuses on how students learn and develop the cognitive skills that will allow them to develop an understanding of chemistry concepts and problem-solving rather than relying on memorization and algorithms that are not transferrable to new situations. Her research has looked at problem-solving in a wide variety of areas, including laboratories and large-enrollment lectures.

Researcher teams up internationally with Marie Curie Fellowship

Chemical engineering professor **Mark C. Thies** has received a Marie Curie Fellowship to develop molecular models for advanced-carbon materials that have the potential to be used in strong, yet lightweight transportation vehicles, wind turbines and more energy-efficient aircraft.

The award has enabled Thies to work with Doros Theodorou of the National Technical University of Athens in Greece. It will support the team's collaboration for the next two years.

Safety expert honored by American Psychological Association

Scott Shappell, a professor of industrial engineering, has been elected Fellow of the American Psychological Association (APA). The title is bestowed upon APA members who have shown evidence of outstanding contributions and significant impact in the field of psychology on a national and international level.

Shappell is known for his research in the areas of human error, human factors safety-management systems and fatigue effects on performance. He is the co-developer of the Human Factors Analysis and Classification System and Human Factors Intervention Matrix, groundbreaking tools used to identify and prevent human causal factors associated with accidents in high-risk industries such as aviation, mining and medicine.

Researcher regenerates brain tissue in traumatic injuries

An injectable biomaterial gel may help brain tissue grow at the site of a traumatic brain injury, according to findings by a Clemson University bioengineer.

Research by assistant professor of bioengineering **Ning Zhang** shows that the biomaterial gel made up of both synthetic and natural sources has the potential to spur the growth of a patient's own neural stem cells in the body, structurally repairing the brain injury site. In previous lab studies, Zhang has demonstrated the reconstruction of a complete vascular network at the injury site as an initial step toward brain tissue regeneration.

The researcher says current approaches to traumatic brain injury have been focused on managing the primary injury using hypothermia or neuroprotection with pharmacological agents, all with limited success. With this new procedure, the hydrogel is injected into the lesion site to direct the response of neural stem cells in the brain to regenerate normal brain tissue. The current research is supported by a $220,000 grant from the U.S. Department of Defense.

DOE funds Clemson clean energy research

Associate professor of chemical and biomolecular engineering **David Bruce** will participate in a multi-university Energy Frontier Research Center. Funded with $12.5 million from the U.S. Department of Energy, the Center for Atomic-Level Catalyst Design focuses on the development of new catalysts for the production of clean fuels and chemicals from renewable sources.

Bruce said that most renewable fuels now must be subsidized by government entities to be cost-competitive with fossil fuels. The materials that will be developed by the catalyst design center will enable renewable fuels to be produced at a lower cost and allow more of the feedstock to be converted into usable fuel and chemical products, which will further reduce the carbon footprint of new production processes.

Clemson, nine other S.C. schools to lead groundbreaking research in organ replacement

Clemson University is joining nine other S.C. higher education institutions in a research program that offers new hope for the thousands of individuals whose lives are threatened by organ failure. More than 100,000 people are on the waiting list for organ transplants.

A $20 million NSF grant will create a statewide alliance in the field of tissue biofabrication, which could lead to the ability to produce human organs. The award is one of the largest in the state's history.

Principal investigator **Larry Dooley** will lead the Clemson research team, which will work with faculty at the Medical University of South Carolina (MUSC) to develop a critical mass of in-state research expertise in tissue biofabrication. **Yong Huang**, mechanical engineering assistant professor, will serve as leader of the research thrust to build a three-dimensional "vascular tree" — the first crucial step in the process of fabricating complete organs. Clemson Computing and Information Technology also will play a significant role in the cyber-infrastructure necessary for collaboration among the institutions.

In addition to Clemson, the alliance includes the state's two other research universities, MUSC and the University of South Carolina, as well as Claflin University, Furman University, S.C. State University, the University of South Carolina-Beaufort, Voorhees College, Denmark Technical College and Greenville Technical College. The S.C. Research Authority will serve as the fiscal agent of the award.

Professor selected to 50 Most Important African Americans in Technology list

Human-centered computing chairman **Juan E. Gilbert** has been selected as one of the "50 Most Important African-Americans in Technology" for his efforts in research, education and outreach.

The selection was made by eAccess Corp., a San Francisco-based publisher.

Two of Gilbert's pet research projects have made the successful transfer to business. The first is his research in electronic voting spawned by the "hanging chad" controversy in the 2000 presidential election. The result is a first-of-its-kind accessible voting system called Prime III. Gilbert explains it as a multimodal system where votes are privately and securely taken by touch, voice or both. The technology, called Universal Design, allows all people — disabled or not — to vote on the same machine. Gilbert has testified to the U.S. Senate's Rules and Administration Committee and the U.S. Election Assistance Commission Board of Advisors.

The second project is a data-mining and software-analysis tool that allows education admissions officers to address diversity and capacity in admissions while maintaining academic standards and adhering to the law — all done in a shorter period of time than traditional methods.

State, donors fund Optoelectronics Center of Economic Excellence

Private gifts from telecommunication companies Comporium and PalmettoNet of South Carolina — along with a state match — have raised $4 million to establish an Optoelectronics Research Center of Economic Excellence in the Holcombe Department of Electrical and Computer Engineering. The field of optoelectronics focuses on improving the devices, systems and protocols used in high-speed communication networks.

The new center will be supported by the PalmettoNet Endowed Chair in Optoelectronics and the Comporium Fund for Excellence in Optoelectronics. It will be the nexus for a community of scholars and entrepreneurs with shared interests and expertise in optoelectronics research, which is the study of the interaction of light with electronic devices using photons and electrons. The center will strengthen the research program in the Center for Optical Materials Science and Engineering Technologies (COMSET), and it will be located along with COMSET and the Electron Microscope Facility at the Advanced Materials Research Laboratory in Anderson County.

Space-related radiation research could help reduce fractures in cancer survivors

A research project looking for ways to reduce bone loss in astronauts may yield methods of improving the bone health of cancer patients undergoing radiation treatment.

It is well documented that living in the microgravity environment of space causes bone loss in astronauts, but until recently, little was known about the effects of space radiation on bones. **Ted Bateman** leads a project funded by the National Space Biomedical Research Institute to understand radiation-induced bone loss and to determine which treatments can be used to reduce that loss and lower the risk of fractures.

Bateman and his colleagues at Clemson and Loma Linda University have discovered in experiments with mice that bone loss begins within days of radiation exposure through activation of bone-reducing cells called osteoclasts. Under normal conditions, these cells work with bone-building cells — called osteoblasts — to maintain bone health.

Once a person loses bone, their long-term fracture risk depends on their ability to recover lost bone mass. For older cancer patients, early introduction of bisphosphonates and other forms of treatment could help greatly since the process of regaining bone mass can be more difficult due to lower activity levels.

INQUIRY, DISCOVERY IN ENGINEERING AND SCIENCE

IDEaS

SPRING 2010

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

On the cover: Paul Venhovens (center) leads a research program that focuses on the technical interaction of the various complex systems that make up today's automobile.

Right: Konstantin Kornev examines the wetting properties of the proboscis of a monarch butterfly. Read more about this fascinating research on page 10.

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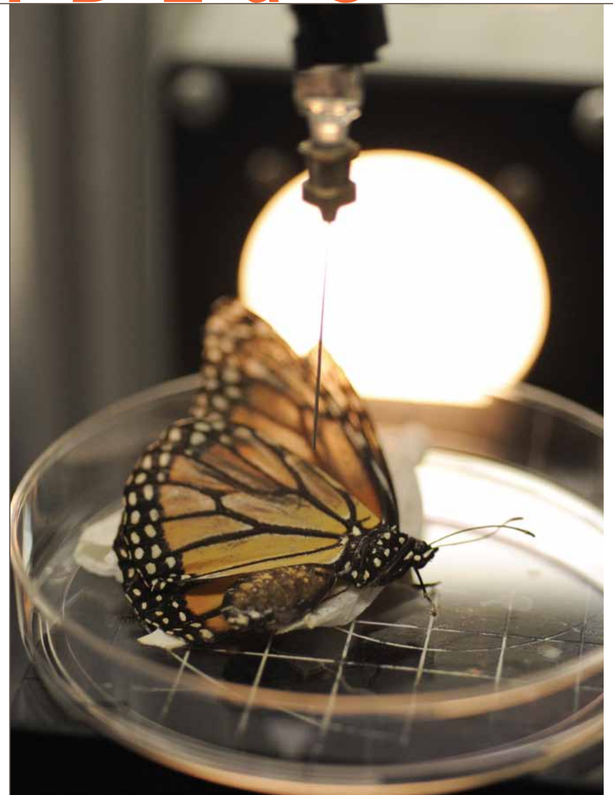

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Left to right: Dr. R. Larry Dooley, Dr. Esin Gulari, Dr. E.R. (Randy) Collins

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INQUIRY, DISCOVERY IN ENGINEERING AND SCIENCE

COLLEGE OF ENGINEERING AND SCIENCE SPRING 2010

Highlights from our departments

College Structure Is Key to Collaboration

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

Bioengineering

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Fast Facts

Tenured/tenure-track faculty: 22

Enrollment:	Undergraduate	157
	Master's	22
	Doctoral	80
Degrees awarded:	Undergraduate	25
	Master's	6
	Doctoral	9

Research expenditures: $5,154,035
Research thrusts: biomaterials, tissue regeneration, emerging technologies for health care, bioimaging

On October 15, 2009, Clemson University announced that the NIH would fund a $9.3 million Center of Biomedical Research Excellence (COBRE) for tissue regeneration. Hunter Endowed Chair and professor **Naren Vyavahare** is the principal investigator and director of the center.

Facilities

The bioengineering department recently expanded its research and education facilities with the opening of the Rhodes Annex. The 29,000-square-foot, three-story addition to Rhodes Hall — home of the department since its establishment at Clemson in the mid-1960s — is part of a development plan unveiled by President Barker in 2007 that includes campuswide facility and information technology improvements.

The annex features classrooms equipped with the latest distance-learning capabilities. It was designed for communication, collaboration and networking among undergraduates, graduate students and faculty. Numerous laboratories include those dedicated exclusively to research that supports the bioengineering B.S. curriculum, such as undergraduate labs for tissue engineering, bioinstrumentation and biomechanics. Several other laboratories are designed to facilitate integration of undergraduate and graduate education.

Faculty Highlights

The National Institutes of Health (NIH) has awarded Clemson $9.3 million to fund a Center of Biomedical Research Excellence (COBRE) to research tissue regeneration. Faculty from the Medical University of South Carolina (MUSC) and the University of South Carolina (USC) will also collaborate, providing expertise in medicine and developmental biology.

The center is funded by the NIH National Center for Research Resources Institutional Development Award program that seeks to broaden the geographic distribution of funding for biomedical and behavioral research. The program aims to increase the number of NIH-funded biomedical researchers in the nation and to strengthen the biomedical research capacity of individual universities. The goal is to create world-class core facilities and to provide funding and mentoring for early career investigators already in place to make them successful and independent NIH-funded investigators.

The theme of the center, SCBioMat, is tissue regeneration through cell-biomaterials interactions using distinctive biomaterials-based approaches. Achieving successful clinical strategies will require fundamental knowledge about cell growth and differentiation and tissue regeneration through multidisciplinary research by bioengineers, molecular biologists, developmental biologists and clinicians.

The center is directed by principal investigator **Naren Vyavahare**, Hunter Endowed Chair and professor of bioengineering. The first group of early-career investigators includes **Bruce Gao** and **Ken Webb**, associate professors of bioengineering at Clemson; **Susan Lessner**, assistant professor of cell biology and anatomy at USC; and **Anand Ramamurthi**, associate professor of bioengineering with the Clemson-MUSC bioengineering program and adjunct associate professor of regenerative medicine and cell biology at MUSC.

Bruce Gao and **Jiro Nagatomi** received NSF Major Research Instrumentation awards totaling $796,056 for development of a laser microbioparticle separator and acquisition of a nano-to-microscale 3-D live-cell imaging system, respectively.

The U.S. Army has awarded **Xuejun Wen**, associate professor of bioengineering, cell biology and orthopaedic surgery in the Hollings Cancer Center in the Clemson-MUSC bioengineering program, a grant for medical research on the use of human albumin plastic to inhibit bacteria and biofilm on orthopaedic implants.

The National Heart, Lung and Blood Institute awarded **Anand Ramamurthi**, associate professor of bioengineering and director of the Cardiovascular Tissue Engineering Laboratory in the CU-MUSC bioengineering program, an R01 for studying cues for cell-mediated regeneration of elastin matrix to stabilize aortic aneurysms.

Student Achievement

An American Heart Association Mid-Atlantic Affiliate Predoctoral Fellowship was awarded to **Vince Beachley**, a graduate student in Xuejun Wen's lab, for his research of biomimetic waved/aligned nanofiber vascular implants with optimized compliance for improved patency. Beachley is in his third year in the Clemson-MUSC bioengineering program in Charleston. The two-year fellowship will fund investigation of tubular structures, degradable tissue-engineered grafts conditioned in bioreactors and *in vivo* evaluations of vessel patency.

The Vietnam Education Foundation has awarded a fellowship to **Van Tran**, a graduate student in Xuejun Wen's lab, to investigate selective laser sintering technology for bone tissue regeneration.

The S.C. Space Grant Consortium Graduate Student Research Program has extended **Laura Bowman**'s fellowship. Her research, under Ted Bateman, examines radiation-induced bone loss of less than 1gy in murine models. Through the same program, graduate student **Brittany McGowan** was awarded a grant for investigating the effects of hydrostatic pressure on the differentia of bone marrow cells into osteoblasts in 3-D cultures, which she will complete under the direction of Jiro Nagatomi.

Biosystems Engineering

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Fast Facts

Tenured/tenure-track faculty: 16

Enrollment:	Undergraduate	54
	Master's	8
	Doctoral	10
Degrees awarded:	Undergraduate	13
	Master's	4
	Doctoral	1

Research expenditures: $1,060,888
Research thrusts: bioprocessing, biofuels, water quality, non-point-source pollution, aquaculture, instrumentation and control, bioseparation, machine design in biosystems engineering

Anand Jayakaran will join a multidisciplinary scientific expedition to Patagonian Chile to develop a conservation plan for Parque Lago Copa — 29,653 pristine acres of rainforest and montane habitats. The expedition will be led by **Patrick McMillan** — also Clemson faculty. The project is an example of a public-private cooperative effort that will serve as a template to protect the critical, irreplaceable and unique natural heritage of that region. Jayakaran will document the hydrologic process that occurs in the region and develop a plan to protect the freshwater resources of Parque Lago Copa. The project is funded by two nonprofit agencies.

Department Overview

Biosystems engineering is a science-based engineering discipline that integrates engineering science and design with applied biological, biochemical and environmental sciences. Biosystems engineers apply engineering analysis and design to solve problems involving biological organisms and natural or controlled ecosystems. The biosystems engineering degree program is unique among engineering disciplines because it incorporates bioprocess, structural and mechanical design.

Graduates in biosystems engineering are well equipped to use their expertise in engineering in many areas that affect our quality of life and environment. They have broad training in mathematics, physics, chemistry and biological sciences, as well as a sound background in the engineering sciences. Biosystems engineers are sought by industry and public service organizations primarily for their ability to apply engineering expertise to living systems and to the management of land and water resources.

Clemson's biosystems engineering program focuses primarily on two areas of research — bioprocessing/applied biotechnology and natural resources/ecological engineering. In the bioprocessing area, researchers are developing ways to improve the biological production of nutraceuticals and pharmaceutical compounds in addition to creating biomaterials and biofuels using natural and modified microorganisms. Biofuels, particularly biodiesel, made from biomass and aquatic organisms are currently topics of significant research. Ongoing investigation also includes the study of hydrogen from biomass via fermentation pathways and electrical energy from microbial fuel cells. A recent $800,000 grant will purchase research equipment to study the derivation of ethanol from cellulosics (switchgrass, sorghum and wood residues). A $14 million pilot plant is being planned in Charleston.

In the natural resources/ecological engineering area, water management and water quality are major thrusts. Clemson researchers focus on nearly every aspect of keeping water (surface runoff as well as ground water) safe from chemical or biological pollutants. Other thrusts include wastewater treatment, land use and low-impact development, best management practices for erosion and storm-water control, watershed modeling to provide predictive models, bacteria modeling (the single most important cause of water impairment in South Carolina) and population dynamics in waterways and aquatic environments.

Facilities

Biosystems engineering research facilities include a fiber-quality lab, an agricultural/chemical/biological lab, aquaculture facilities and a bioprocessing lab containing multiple fermentors, processing equipment and analytical instrumentation. Facilities are located on campus in McAdams Hall, the Biosystems Research Complex and the Clemson Aquaculture Facility. Off-campus facilities include Edisto Research and Education Center (REC) near Blackville, Pee Dee REC near Florence and the Belle Baruch Institute of Coastal Ecology and Forest Science near Georgetown.

Faculty Highlights

A collaborative project to study minimal allowable flows at 18 sites in the Pee Dee was recently chosen for funding. The project is led by **Dara Park** from the Pee Dee REC and also involves **Anand Jayakaran** and **Daniel Hitchcock**. By measuring the manner in which the fish community structure, water quality and bacterial loadings are affected by variations in flow, the group hopes to develop a method to inform the regulation of minimum allowable flows in the rivers and streams of South Carolina. The project is funded by the PeeDee Endowment Fund.

The BioEnergy Research Collaborative (BERC) was recently established to enable consolidated biofuels research efforts among Clemson University, the Savannah River National Lab and the S.C. State University Transportation Center. Matching funds have been enabled through local companies and research organizations including Spinx Corp., Renewable World Energies Inc., Fagen Engineering and S.C. Bio. **Terry Walker** and **Caye Drapcho** participate within BERC, researching switchgrass to ethanol, algal oil to biodiesel, microbial fuel cell technology and ethanol from peach waste. **John Nghiem** and **Nick Rigas**, adjunct biosystems engineering faculty, are also involved within the BERC projects. A recent Department of Energy grant was awarded — totaling more than $2 million — to enable the effort for converting potential feedstocks grown in South Carolina (switchgrass, sweet sorghum and loblolly pine) for potential cellulosic ethanol production.

A USDA Renewable Energy research grant was obtained by local peach producers to determine the feasibility of converting sugar contained in waste peaches to hydrogen gas. The award is based on the research conducted in **Caye Drapcho**'s laboratory by biosystems engineering graduate students **Xioahui Yu** and **Abhiney Jain** and undergraduate student **Kara Kopf**. With the grant, further research will be conducted to optimize the fermentation process and determine ways to recover co-products in support of the biorefinery concept.

Chemical and Biomolecular Engineering

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Fast Facts

Tenured/tenure-track faculty: 9

Enrollment:	Undergraduate	150
	Master's	0
	Doctoral	32
Degrees awarded:	Undergraduate	35
	Master's	1
	Doctoral	4

Research expenditures: $3,916,208
Research thrusts: advanced materials, kinetics and catalysis, chemical and biochemical separations, molecular modeling and simulation, biosensors and biochips

Mark Thies received a Marie Curie Fellowship to develop molecular models for advanced-carbon materials that have the potential to be used in strong, yet lightweight transportation vehicles, wind turbines and more energy-efficient aircraft. Thies was one of only 22 international researchers to be selected for the award by the European Union. This award is designed to encourage collaboration between European and internationally recognized researchers and has enabled Thies to work with Doros Theodorou of the National Technical University of Athens in Greece. The research by Thies and his graduate students is currently funded by both the Air Force and the American Chemical Society and has focused on the synthesis of carbonaceous pitches of novel composition. Such pitches can serve as unique starting materials for high-performance carbon fibers and carbon-carbon composites.

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. It is also leading 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. Students complete an emphasis area or a minor approved by the University. 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 offered in Vienna, Austria.

There are numerous opportunities for undergraduate and graduate research in ChBE. Strong departmental research 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

The U.S. Department of Energy (DOE) awarded $2 million to Clemson University to fund hydrogen research and development that may help change the way we power the country. The money will be used by **James Goodwin**, in collaboration with the Savannah River National Lab, for research on understanding impurities in the production of hydrogen and oxygen streams and the performance of hydrogen fuel cells.

Scott Husson co-chaired the 2009 North American Membrane Society meeting in Charleston, S.C. Husson was also recently elected as a director of the Separations Division of the American Institute of Chemical Engineers. He has also joined the editorial board of the journal *Polymers*.

Douglas Hirt was elected as a fellow of the Society of Plastics Engineers. He joins a group of only 268 members who have been selected for this prestigious honor since 1984. To be elected, a candidate must demonstrate outstanding achievements in the field of plastics engineering, science and technology. Hirt was recognized for his work on additive technologies that modify surfaces of polymeric fibers and films and, more recently, on the development of functional biomaterials.

Anthony Guiseppi-Elie has been named to the National Academies Panel on Electronics and Electrical Engineering of the National Research Council Board on Assessment. This panel has been charged with an external site visit review of the scientific and technical work performed by the National Institute of Standards and Technology Electronics and Electrical Engineering Laboratory. He was also appointed a member of an international biomedical engineering panel of the Higher Education Authority of Ireland to conduct "Reviews of Programme for Research in Third Level Institutions, Cycle 5 Evaluation Process."

Student Achievement

Ph.D. students **Daniel Wandera** and **Bharat Bhut** were recognized at the 2009 North American Membrane Society meeting in Charleston, S.C., for their outstanding research. Wandera won first prize in the student competition for his cross-cutting research project entitled "Preparation of characterization of fouling-resistant, temperature-responsive membranes for treatment of produced water." Bhut won second prize for his cross-cutting research project called "Membrane chromatography: Purification of anthrax protective antigen protein using newly designed weak anion-exchange membranes." Both projects conduct research under the guidance of Scott Husson.

Bharat Bhut also received a runner-up award at the Third Annual Graduate Student Poster Competition at the 2009 Charlotte Biotechnology Conference. The competition involved graduate students currently enrolled at universities across the Carolinas and conducting biotechnology research with the potential for commercialization.

Ray Smith is the 2009 recipient of the ChBE Sophomore Academic Excellence Award. With 83 of 127 credits taken, Smith has a perfect 4.0 GPA.

Chemistry

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Fast Facts

Tenured/tenure-track faculty: 23

Enrollment:	Undergraduate	138
	Master's	0
	Doctoral	93
Degrees awarded:	Undergraduate	19
	Master's	4
	Doctoral	14

Research expenditures: $5,211,766
Research thrusts: analytical, inorganic, organic and physical chemistry; interdisciplinary and nontraditional areas including polymer and materials, solid-state, bioanalytical, bioorganic and medicinal, and computational chemistry; chemical physics and chemical education

Rhett Smith has won a $555,000 NSF CAREER Award to support his research on a new class of polymeric materials that conduct electrical currents and can be used in thin, lightweight and flexible plastic electronic devices, such as organic light-emitting diodes and organic photovoltaic cells. The Faculty Early Career Development (CAREER) program offers the NSF's most prestigious awards in support of the early career-development activities of teacher-scholars who most effectively integrate research and education within the context of the missions of their organizations. Smith plans to increase awareness and participation by developing a polymer-science course, including a service-learning program to enhance outreach efforts in his teaching.

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 approximately 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

Melanie Cooper has been selected as a member of the inaugural group of American Chemical Society (ACS) Fellows. The first class of ACS Fellows share a common set of accomplishments, namely true excellence in their contributions to chemistry and distinctive service to ACS and to society. The group was honored at a special session at the ACS meeting in Washington, D.C., in August.

Cooper is also the winner of Clemson University's Robert S. Campbell Award for Faculty Excellence in Communication Across the Curriculum for 2009.

Julia Brumaghim was honored in late 2008 with the Best Paper for a Young Investigator award by the *Journal of Inorganic Biochemistry*. The editors solicited articles from young investigators and selected the best article among them. The award came with a $1,000 cash prize from Elsevier Publishers.

Brumaghim's article, "Metal Specificity in DNA Damage Prevention by Sulfur Antioxidants," is the lead article in an outstanding set of papers that appear in the journal. Brumaghim's work at Clemson focuses on the biological applications of inorganic chemistry, using a wide range of techniques to determine mechanisms of antioxidant activity and prevention of metal-mediated DNA damage.

Darryl D. DesMarteau was the recipient of the Fifth Biennial Distinguished Service Award in Fluorine Chemistry presented by the ACS, Division of Fluorine Chemistry. The award was presented to DesMarteau at the 19th Winter Fluorine Conference in St. Petersburg Beach, Fla., in early 2009. He was cited for his distinguished service to the division as a member, a leader and a scientist.

Student Achievement

The student members of the ACS have continued their great work over the past 18 months. Nine members attended the Spring National ACS Meeting in Salt Lake City, Utah, and received an honorable mention award for their work during the 2007-2008 academic year.

The 2008-2009 year turned out to be their best ever, and students will be attending the 2010 Spring Meeting in San Francisco both to receive a commendable award and to be recognized as a "Green Chapter."

Most recently, the officers of the chapter traveled to San Juan, Puerto Rico, to attend SERMACS 2009. In addition to attending talks by two Nobel Laureates and a wide range of technical presentations, they also found time to participate in the Festival de Química, which involved presenting chemistry demonstrations to local children in grades K-12 centered on elements of the periodic table. The officers worked with students from the University of Puerto Rico to demonstrate various uses of iron such as supplements in cereals, ferrofluids and photosensitive paper. Overall, the chapter has been quite busy in trying to promote the message of the ACS.

Civil Engineering

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Fast Facts

Tenured/tenure-track faculty: 18

Enrollment:	Undergraduate	476
	Master's	62
	Doctoral	31
Degrees awarded:	Undergraduate	105
	Master's	27
	Doctoral	4

Research expenditures: $2,219,062
Research thrusts: applied fluid mechanics, construction engineering and management, construction materials, geotechnical engineering, structural engineering and transportation systems

Wei Chiang Pang was among the team of researchers who convened in Japan's Miki City this summer to participate in the world's largest earthquake simulation ever performed on a light-frame wooden building. This earthquake experiment was part of the NSF NEESWood project.

Department Overview

The civil engineering department at Clemson University is one of the 20 largest civil engineering departments in the United States. It offers undergraduate and graduate course work in the major fields of civil engineering, providing education in all the major subdisciplines: structural engineering, transportation engineering, hydraulics and hydrology, geotechnical engineering, construction materials, and construction engineering and management.

The department also offers graduate programs leading to the M.S. and Ph.D. degrees with specializations in applied fluid mechanics, construction engineering and management, construction materials, geotechnical engineering, structural engineering and transportation systems.

Faculty Highlights

Prasad Ranagarju, associate professor of civil engineering, is conducting research to determine if rice could help shrink concrete's carbon footprint. Rice hull ash is highly pozzolanic in nature, and its reaction with cement hydration products enhances the strength and durability of concrete. Research shows that its use as a cement replacement material can reduce the carbon footprint of concrete.

Ronnie Chowdhury, associate professor of civil engineering, is leading a new research project funded by the NSF to study energy savings with electric cars and IntelliDrive technology.

Leidy Klotz and **Nadim Aziz** participated in the celebration of the first anniversary of StormStruck: A Tale of Two Homes®, an interactive educational severe weather experience at Walt Disney World®. They also participated in the FLASH leadership briefing that preceded the celebration. The civil engineering department is a partner through the Resilient Homes research program funded by the U.S. Department of Homeland Security through the Savannah River National Lab.

Alumni in the News

Suzanne Aultman, P.E., BSCE '00, MSCE '02, is the 2009 Young Engineer of the Year named by the National Society of Professional Engineers. Aultman is the chief engineer for the Atlanta Division of Metromont Corp.

David S. Rozendale, P.E., BSCE '57, was selected as the first recipient of the Civil Engineering Distinguished Alumni Award, honoring his long and distinguished professional career and his outstanding service to society and to the University.

Student Achievement

Civil engineering students are Traffic Bowl champs for the fourth year in a row. They represented South Carolina at the Southern District ITE Annual Meeting in Birmingham, Ala. Eight other university teams participated in the "Jeopardy" style competition that tests their road engineering mettle.

School of Computing

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Fast Facts

Tenured/tenure-track faculty: 26

Enrollment:	Undergraduate	337
	Master's	103
	Doctoral	48
Degrees awarded:	Undergraduate	39
	Master's	26
	Doctoral	2

Research expenditures:$1,292,435
Research thrusts: computer graphics; high-performance computing; cyberinfrastructure and networking; software engineering; theory and algorithms; image and video analysis; virtual reality, 3-D user interface design and eye tracking; bioinformatics

Assistant professor **Brian C. Dean** is the associate director of the USA Computing Olympiad (USACO), a program that supports high school computing across the United States through online training materials and programming competitions. Every year, the USACO invites the top 15 computer science students in the United States to a weeklong summer training camp, where they receive advanced instruction in computational problem solving techniques and participate in a series of challenging programming contests. The top four students from this group represent the United States at the International Olympiad in Informatics,the most prestigious algorithmic programming competition in the world for high school computer science students. This year, the School of Computing will be hosting the USACO summer training camp for the first time.

Faculty Highlights

Juan Gilbert, professor and chair of the School of Computing's Division of Human-Centered Computing has been named to the 10th annual "50 Most Important African-Americans in Technology" list. Gilbert's research projects are in spoken-language systems, advanced-learning technologies, usability and accessibility, ethnocomputing (culturally relevant computing), and databases and data mining. Two projects have been transferred successfully to business. The first is his research in electronic voting that was spawned by the "hanging chad" controversy in the 2000 presidential election. The result is a first-of-its-kind accessible-voting system called Prime III where votes are taken by touch and/or voice on the same machine, reducing the opportunity for error or security breaches. The technology allows all people – disabled or not – to independently vote on the same machine. The second project is a data-mining and software-analysis tool called Applications Quest that allows education admissions officers to address diversity and capacity in admissions while maintaining academic standards and adhering to the law – all faster than using traditional methods.

Professor **Robert Geist** has been named one of nine 2009 Distinguished Educators by the Association of Computing Machinery, the world's largest educational and scientific computing society.

Professor **Donald House** has been named a faculty fellow in the Hazards Reduction and Recovery Center at Texas A&M University. House is collaborating with the Center on Visual Methods to improve the communication of hurricane information to public officials responsible for making civil defense decisions.

Assistant professor **Damon Woodard** is part of the multi-university team that has created the Center of Academic Studies in the Identification Sciences (CASIS). The aim of the center is to strengthen biometric identification – the measurement of physical characteristics to confirm a person's identity. CASIS is supported by a $2 million grant from the Office of the Director of National Intelligence.

Student Achievement

Doctoral student **Lauren Cairco** received an NSF Graduate Fellowship Award. The NSF Graduate Fellowship Program recognizes and supports outstanding graduate students in NSF-supported science, technology, engineering and mathematics disciplines who are pursuing research-based master's and doctoral degrees in the United States and abroad.

Doctoral student **Kinnis Gosha** received a Graduate Student Fellowship Award from the South East Alliance for Graduate Education and the Professoriate Program at Clemson University. This award, sponsored by the NSF, is designed to aid in enhancing the nation's faculty in science, technology, engineering and mathematics by providing support and professional development opportunities to domestic Ph.D. students from underrepresented groups in these fields.

Doctoral student **Zachary Jones** has been awarded an IBM Ph.D. Fellowship for 2009-2010. The award represents an intensely competitive worldwide program that honors exceptional Ph.D. students who have an interest in solving problems that are important to IBM and fundamental to innovation in many academic disciplines and areas of study. These include: computer science and engineering; electrical and mechanical engineering; physical sciences (including chemistry, material sciences and physics); mathematical sciences (including optimization); business sciences (including financial services, communication and learning/knowledge); and service science, management and engineering.

New Ph.D. student **Wanda Moses** received a fellowship from the National Consortium for Graduate Degrees for Minorities in Engineering and Science Inc. (GEM). The GEM Fellowship's principal activity is the provision of graduate fellowships at the master's and Ph.D. levels, coupled with paid summer internships.

Electrical and Computer Engineering

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Fast Facts

Tenured/tenure-track faculty: 32

Enrollment:	Undergraduate	378
	Master's	83
	Doctoral	65
Degrees awarded:	Undergraduate	90
	Master's	41
	Doctoral	6

Research expenditures: $2,499,842
Research thrusts: communications, electronics, computer systems architecture, intelligent systems

Prior to joining the Clemson ECE department, **Emeka Maduike** worked with Dashiell, LLC, a company located in Houston, Texas, where he was a senior engineering consultant. He also spent time as a former adjunct faculty member at the University of Texas at Tyler.

Five utility companies have combined resources to hire Maduike for 2010. Santee Cooper, Central Electric Co-op, Duke Energy, Progress Energy and SCE&G made gifts to fund this lecturer.

His current research centers on investigating forced-wind energy generation.

Department Overview

Clemson University has maintained a traditionally rich background in fundamental and applied engineering as research areas have focused on increasingly narrower topics within the subject disciplines. This heritage provides the 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. The department offers the M. Engr., M.S. and Ph.D. degrees in both electrical engineering and computer engineering.

ECE research activities center on four primary focus areas:

- Communications — The communications research focus area includes the wireless communications program, applied electromagnetics, computer networks and digital signal processing.
- Electronics — The electronics group has active research projects in the areas of semiconductor devices and materials, metal organic chemical vapor deposition of electronic materials, power electronics, microwave measurements, microwave circuits, integrated circuit design, dielectrics, organic semiconductors and the development of computer-aided VLSI tools.
- Computer Systems Architecture — Computer systems architecture represents the primary research interests of the computer engineering faculty and includes computer architecture, high performance computing, computer security and software engineering.
- Intelligent Systems — The intelligent systems group has active research projects in the areas of computer vision, sensor fusion, sensor networks, robotics, image processing, nonlinear estimation and control, and power systems.

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

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

The Holcombe Department of Electrical and Computer Engineering is pleased to announce the addition of two new faculty: assistant professor **Haiying "Helen" Shen** and visiting lecturer **Emeka Maduike**.

Shen came from the University of Arkansas where she was an assistant professor in the Department of Computer Science and Computer Engineering. Her research interests include distributed and parallel computer systems and computer networks, with an emphasis on P2P and content delivery networks, publish/subscribe systems, wireless networks, wireless sensor networks, high-performance cluster and grid computing, data mining and RFID.

For their paper entitled "Voltage Sag and the Response of a Synchronous Distributed Generator: A Case Study," ECE professor **Edward R. Collins** and ECE alumnus **Jian Jiang** were awarded the IEEE Power and Energy Society Prize Paper Award.

Collins is currently the associate dean for undergraduate studies in the College of Engineering and Science. Jiang, a former doctoral student of Collins, works for AREVA, a world-leading company in nuclear energy. Collins and Jiang received their awards and recognition at the IEEE PES General Meeting in Calgary, Canada.

Student Achievement

Michael Juang, a junior electrical engineering major, was one of three Clemson University students who earned the prestigious Barry M. Goldwater Scholarship for Excellence in Science, Mathematics and Engineering for 2009. Only 278 students were selected for the scholarships from a nationwide pool of more than 1,000.

Computer engineering senior **Bradley Collins** was awarded a Tau Beta Pi scholarship for 2009-2010.

Computer engineering graduate student **Scott Gibson** and electrical engineering senior **Kathryn Young** received the W.M. Riggs Award at the 2009 CES honors and awards ceremony in the spring of 2009.

Engineering and Science Education

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Fast Facts

Tenured/tenure-track faculty: 5

Enrollment:	Undergraduate	1,266
	Master's	0
	Doctoral	0
Degrees awarded:	Undergraduate	n/a
	Master's	n/a
	Doctoral	n/a

Research expenditures: $222,455
Research thrusts: epistemologies, learning mechanisms and systems, diversity and inclusiveness, assessment

Professor **Melanie Cooper** is the recipient of a 2009 Special Grant in the Chemical Sciences from the Camille and Henry Dreyfus Foundation.

Faculty Highlights

Assistant professor **Julie Trenor** was awarded an NSF CAREER award, the foundation's most prestigious award in support of junior faculty who exemplify the role of teacher-scholars. Her work is the first research to extend the concept of social capital (the resources one has embedded in his or her social networks) to better understand how engineering students make academic and career decisions. Trenor will build a conceptual model for understanding how engineering undergraduates develop, access and activate social capital in making academic and career decisions, while identifing and characterizing the potentially distinct mechanisms by which underrepresented students use social ties to link to resources related to engineering studies. She will also implement an education plan that provides research-to-practice training for university engineering outreach, recruitment and retention practitioners and use webinars and workshops as learning forums. Data will be collected from a diverse sample of engineering undergraduates at six institutions across the country.

The Camille and Henry Dreyfus Foundation has recently selected **Melanie Cooper** to receive a 2009 Special Grant in the Chemical Sciences. The award will support Cooper's project entitled "Organic Pad: A Tablet PC-Based Interactivity Tool for Teaching Chemistry." Cooper is one of 21 Special Grant award recipients.

The Camille and Henry Dreyfus Foundation is a leading nonprofit organization devoted to the advancement of the chemical sciences. It was established in 1946 by chemist, inventor and businessman Camille Dreyfus.

Julie Trenor will serve Women in Engineering Program Advocates Network (WEPAN) in a three-year term as president-elect, president and past president. WEPAN is the nation's leading organization and catalyst for transforming culture in engineering education to promote the success of all women. Its membership includes over 600 members from nearly 200 engineering schools, small businesses, Fortune 500 corporations and nonprofit organizations. Prior to her election, Trenor served on the board of directors as director of communications and as chair of the communication committee.

Student Achievement

Industrial engineering senior **Brianne Fleming** won first place in the statewide undergraduate research poster competition at the Louis Stokes South Carolina Alliance for Minority Participation (LS-SCAMP) conference. Fleming's research, entitled "Family Roles of Students in Engineering: A Qualitative Investigation," was conducted through the LS-SCAMP summer research program under the mentorship of **Julie Trenor** and graduate student **Denise Grant**. Fleming coded more than 80 interview transcripts for family roles related to students selecting and persisting in engineering as their major and analyzed the data based on parental educational attainment. The research team is currently working on a manuscript for publication in an engineering education journal.

Environmental Engineering and Earth Sciences

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Fast Facts

Tenured/tenure-track faculty: 15

Enrollment:	Undergraduate	41
	Master's	54
	Doctoral	28
Degrees awarded:	Undergraduate	7
	Master's	10
	Doctoral	4

Research expenditures: $2,082,003

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

Ten Clemson engineering students traveled to El Salvador for their second Engineers Without Borders (EWB-USA) site assessment and work trip. Led by EEES grad student **Jim Chamberlain**, the student group surveyed field elevations for a future water line, evaluated a home wood stove design, repaired a Hydram water pump, collected GPS points for a comprehensive agricultural map, analyzed water quality samples and built foundations for block village houses. The group continues to help design a new water distribution system with the help of **Sam Sarkar**, an EEES master's student. **Mark Schlautman** is a co-adviser of the EWB-USA chapter, and **Jose Alfaro** will be working with the group in the coming year on this and other international sustainability projects.

Department Overview

The Department of Environmental Engineering and Earth Science (EEES) has a synergistic blend of environmental engineering and science, geology and earth science, and nuclear environmental engineering and science. We offer several academic options to our students.

At the undergraduate level, the department is committed to providing the next generation of earth scientists a comprehensive understanding of earth processes through our B.A. and B.S. degrees in geology. Specialization tracks in traditional geology, environmental science and hydrogeology allow students to focus their course work in areas of their particular interest. Unique to Clemson, all of our undergraduate geology students participate in research with a faculty member from sophomore through senior years.

At the graduate level, the department has two distinct programs: environmental engineering and science (EE&S) and hydrogeology. The EE&S program offers M.S., M.Engr. and Ph.D. degrees, while the hydrogeology program offers an M.S. degree. Both programs are nationally recognized and have been continuously ranked in the top 25 programs by *U.S.News & World Report*.

Faculty Highlights

Ron Falta and **Larry Murdoch** were recently awarded an EPA Science to Achieve Results grant to pursue research related to geologic sequestration of carbon dioxide (CO_2). Geologic storage of CO_2 is considered to be one of the most promising alternatives for reducing global CO_2 emissions to the atmosphere. The three-year, $891,000 project, titled "Understanding and Managing Risks Posed by Brines Containing Dissolved Carbon Dioxide," involves laboratory experiments and numerical modeling to better understand the injected CO_2 behavior. This project focuses on the unique properties of CO_2 dissolved in brines at high pressures (>1000 psi). Under these conditions, the aqueous solubility of CO_2 can be 50 g/l or more. The project is a collaborative effort between Clemson and Stanford universities. The work at Stanford will be directed by **Sally Benson**, an adjunct faculty member in the EEES department. Benson is currently director of Stanford's Global Climate and Energy Project.

Brian Powell will collaborate on a proposal ($6 million over five years) funded by the Department of Energy's (DOE) Office of Science, Biological and Environmental Research. The project will be led by Annie Kersting and Mavrik Zavarin at the Lawrence Livermore National Laboratory and will focus on understanding the dominant geochemical processes that control plutonium transport in the environment. Plutonium geochemical behavior is influenced by complex chemical, physical and biological processes.

The Department of Defense (DOD) selected the proposal entitled "Subsurface Thermal Energy Storage for Improved Heating and Air Conditioning Efficiency" – submitted by **Ron Falta** (PI) and **Fred Molz**, along with Chuck Newell from GSI Environmental Inc. in Houston, Texas – for funding. This four-year project is funded at $971,000 and will build a new generation of a geothermal heat pump system that is assisted by subsurface thermal energy storage. The project team will build this system to heat and cool a 10,000- to 20,000-square-foot building at a DOD facility somewhere in the U.S. (location to be determined).

Leslie Grady and **Bill Hiatt** (EE&S Ph.D. '06) were selected to receive the 2009 Rudolf Industrial Waste Management Medal from the Water Environment Federation for their publications in the journal *Water Environment Research*.

Tom Overcamp was presented with the Outstanding Associate Editor Award from the *Journal of the Air & Waste Management Association*.

Student Achievement

Hari Shankar Peethambaram, a current EE&S graduate student, was selected as a recipient of the Ivanhoe Foundation Fellowship ($5,000). **David Freedman** serves as Peethambaram's adviser.

Jia Hu attended American Water Works Association Annual Conference in San Diego in June. She represented South Carolina at the poster session with her poster "Formation and Speciation of Halonitromethanes: the Effects of pH, Bromide and Nitrite." Hu won second place for the Fresh Ideas Award of the poster session. **Tanju Karanfil** serves as Hu's adviser.

Ting Shao's paper entitled "Factors Influencing the Adsorption of Synthetic Organic Compounds by Carbon Nanotubes in Aquatic Environments" won the 2009 Water Environment Federation (WEF) Student Paper Competition in the master's division. As the winner, she received a $500 award and presented her paper at the annual meeting of the WEF. **Tanju Karanfil** serves as Shao's adviser.

Sixteen students from across the country have come to participate in the Clemson University Hydrogeology Field Camp. The camp lasts five weeks and provides hands-on activities for graduate and undergraduate students. **Larry Murdoch, Stephen Moysey** and **Scott Brame** coordinate and teach the field camp.

Industrial Engineering

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Fast Facts

Tenured/tenure-track faculty: 9

Enrollment:	Undergraduate	172
	Master's	116
	Doctoral	37
Degrees awarded:	Undergraduate	42
	Master's	20
	Doctoral	2

Research expenditures: $767,398

Research thrusts: supply chain optimization and logistics; human factors and safety in health care and other complex systems; education and learning systems

Professor **Sandra Garrett** and her students work with a local hospital to improve workflow.

Department Overview

The Department of Industrial Engineering offers three separate degrees: B.S., M.S. and Ph.D. In addition, in the beginning of 2009, the industrial engineering program unveiled an online M. Engr. in industrial engineering focused on capital projects supply chain.

Faculty Highlights

The department takes great pride in the work faculty have done to promote excellence in scholarship, research and industrial engineering education. In the last four years, the department has recruited faculty from top industrial engineering programs, bringing a wealth of new ideas and talent to the department. This synergy is exemplified by several initiatives currently under way.

Byung Rae Cho is leading a department-wide six-sigma quality research and educational effort.

The department has been selected as an NSF site for the Center for Engineering Logistics and Distribution. As part of this center, **William G. Ferrell**, **Mary Elizabeth Kurz**, **Scott A. Shappell** and **Kevin M. Taaffe** are pursuing systems integration-, hurricane evacuation-, logistics- and optimization-related research with federal and state agencies and several regional and upstate companies.

In the human factors area, **Joel S. Greenstein**, **Sandra K. Garrett, Scott A. Shappell** and **Paris F. Stringfellow** are actively pursuing funded research in systems safety, human error, human computer interaction, learning technologies and job aiding.

To engage undergraduate students in research, **Maria E. Mayorga** and **Brian J. Melloy** have proposed a new Creative Inquiry paradigm to enrich the student experience at Clemson University.

Sandra Garrett is working with Barrett Caldwell of Purdue University to propose a new system that warns of an impending pandemic by monitoring signals in human behavior. The system could result in using a simple icon on a television screen to warn of future phases of an outbreak of an illness such as the flu. Researchers agree it is extremely difficult to identify a pandemic event before it is under way and spreading from person to person, yet the timeliness of this early detection is critical for an effective response and disaster-mitigation strategy. History and computer-generated simulations show that the speed in which a response strategy is initiated – even more than the specific strategy itself – will have the largest influence in reducing the overall impact of a pandemic. Given the importance of rapid response, identifying the specific event phases and the triggers that indicate a need for action is essential.

Student Achievement

At the Summit on the NAE Grand Challenges held at Duke University last spring, **Thashika D. Rupasinghe** and **Deepak Vembar** (Advanced Technology Systems Laboratory) won first place in the Learning/Computation Poster competition. They received this award for their research poster entitled "Virtual Reality in Aircraft Maintenance Technology." The Grand Challenges are a critical grouping of problems that must be addressed and solved in order to maintain our national security, quality of life and sustainable future.

School of Materials Science and Engineering

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Fast Facts

Tenured/tenure-track faculty: 15

Enrollment:	Undergraduate	122
	Master's	23
	Doctoral	52
Degrees awarded:	Undergraduate	32
	Master's	2
	Doctoral	6

Research expenditures: $7,342,705
Research thrusts: advanced fibers, smart materials for sensors, conservation of materials

John Ballato, associate vice president for research and economic development and director of COMSET, has been elected a Fellow of the American Ceramic Society.

Department Overview

The School of Materials Science and Engineering (MSE) prepares students to apply science and engineering principles to problems related to the understanding, characterization and development of new technology necessary for the processing and manufacturing of different materials and related products. MSE has various research and teaching interests, but its primary concentrations include polymer fiber chemistry, polymer sciences and ceramic materials engineering. It offers degree programs in each of these specializations. MSE also maintains collaborative partnerships with several research groups at Clemson outside of the school, including the chemistry, physics, mechanical engineering, electrical engineering, chemical engineering and bioengineering departments.

MSE has a diverse range of classes and research efforts, which span all of inorganic and organic materials science and engineering.

Faculty Highlights

The American Ceramic Society's (ACerS) Ceramic Education Council has selected **Kathleen Richardson** as the recipient of its 2009 Outstanding Educator Award. This award recognizes outstanding work and creativity in teaching, in directing student research or in the general educational process (lectures, publications, etc.) of ceramic educators.

Richardson is currently a member of the ACerS Board of Directors and achieved the rank of Fellow in the society in 2006. She is a past chair of the Glass and Optical Materials Division of the society and is currently president of the National Institute of Ceramic Engineers. Richardson has recently been appointed to the editorial committee of the newly established *International Journal of Applied Glass Science* and will author a review article in the inaugural issue of *Glasses in Photonics*.

John Ballato, associate vice president for research and economic development at Clemson University and a professor in the School of Materials Science and Engineering, has been elected a Fellow of ACerS.

Ballato is director of the Center for Optical Materials Science and Engineering Technologies at Clemson, and his research interests include the optical properties of materials and fiber fabrication. He has published more than 160 archival scientific papers, holds 25 U.S. and foreign patents, has given more than 125 lectures and colloquia, and has co-organized 25 national and international conferences.

Student achievement

Graduate student **Jimmy Xi** received the Diamond Award from the National Consortium for Graduate Degrees for Minorities in Engineering and Science.

Graduate student **Vijoya Sa** received the Fiber Society's 2009 Outstanding Paper Award.

The Clemson chapter of Materials Advantage received the organization's 2009 Outstanding Student Section Award.

Undergraduate student **Jamie Hodges** received the Goldwater Scholarship Award.

Mathematical Sciences

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Fast Facts

Tenured/tenure-track faculty: 43

Enrollment:	Undergraduate	144
	Master's	27
	Doctoral	66
Degrees awarded:	Undergraduate	17
	Master's	36
	Doctoral	13

Research expenditures: $840,883
Research thrusts: algebra/discrete mathematics, applied analysis, computing, operations research, probability/statistics

Mathematical science classes are held in 60 of Clemson's 250 smart classrooms interspersed around campus. These smart spaces enable the sharing of work to solve problems and foster collaboration. They also facilitate online quizzes — either in or out of class — and accommodate mathematical modeling.

Department Overview

The Department of Mathematical Sciences provides major contributions to the instructional and research mission of the University. Enrollments average 5,000 to 6,000 students per semester in more than 300 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 80 faculty members and 100 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 worth approximately $1 million per year. Computational modeling, biomathematics and stochastic modeling have garnered recognition for the department.

Degree programs are organized by discipline into five areas in the mathematical sciences: algebra and discrete mathematics, applied analysis, computational mathematics, operations research, and probability and statistics.

Faculty Highlights

The INFORMS Lanchester Prize for 2008 was awarded to **Warren P. Adams** for a series of papers, including "A hierarchy of relaxations leading to the convex hull representation for general discrete optimization problems," which was jointly published with Hanif D. Sherali.

Taufiquar Khan and **Irina Viktorova** lead an interdisciplinary research team in a joint effort with ITRON Inc., a leading technology provider and critical source of knowledge to the global energy and water industries. The team will be developing information theory and noise models for complex power system networks using mathematical techniques to increase efficiency and cut costs for an optimal "smart grid" network.

For the fifth consecutive year, the Department of Mathematical Sciences hosted the Clemson Calculus Challenge, a competition based on the advanced placement calculus AB syllabus. Recognized with $30,000 in NSF funding, the 2009 competition involved 227 of the region's brightest high school math students, covering areas of the Southeast with most students coming from Georgia, North Carolina and South Carolina. The department is eager to encourage the study of calculus in high school; prizes of this annual competition include partial Clemson University scholarships.

Student Achievement

Steven Goodson, Mira Narayan and **Josh McGinnis** — students from mathematical sciences' Creative Inquiry courses — presented research talks at the Undergraduate Research Conference at Francis Marion University in March 2009 and exhibited research posters during the research days at Clemson University in April 2009.

Mechanical Engineering

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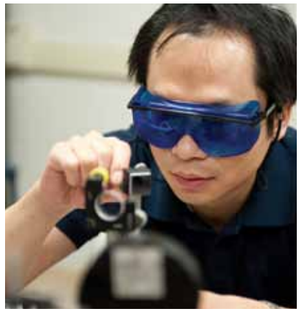
Fast Facts

Tenured/tenure-track faculty: 32

Enrollment:	Undergraduate	566
	Master's	161
	Doctoral	90
Degrees awarded:	Undergraduate	130
	Master's	34
	Doctoral	6

Research expenditures: $4,299,297

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



Assistant professor of mechanical engineering **Lin Ma** has been awarded an NSF CAREER Award to study the science of turbulent combustion — the mode of combustion in many practical energy-generating devices. The project focuses on the study of turbulence-chemistry interactions using advanced laser-imaging techniques.

The grant, totaling $400,000, will fund the project "CAREER: Resolving Turbulence-Chemistry Interaction Using Novel Laser Diagnostics." The project aims to understand the complicated physics of turbulent combustion, which will contribute to the solution of pressing global issues of energy security and environmental sustainability.

The devices — according to Ma — can range from the simple, such as barbecue grills, to the complicated, such as industry boilers and aircraft engines.

Department Overview

The department includes 32 tenure-track faculty, seven ASME Fellows, one SME Fellow, two Presidential Faculty Fellows, five NSF CAREER awardees, one NSF PECASE awardee and one member of the European national/international journals. The department holds three of the largest endowed chairs in the country — each valued at $10 million.

Facilities

The department is housed in the state-of-the-art, 100,000-square-foot Fluor Daniel Engineering Innovation Building and the newly completed Campbell Graduate Engineering Center. Excellent machine shop facilities, a high bay and a wind tunnel are included in the Fluor Daniel Building, and the department also has advanced computational research facilities to support high-performance computing applications. From raindrop formation to biofluids, and chaotic mixing for polymeric materials to complex automotive systems, faculty and students are working together to do what engineers do best — solve problems through the use of analytical and physical methods.

Facilities include the following specialized laboratories:

- Aerodynamics
- Advanced computational research
- Automotive research
- Chemical materials processing
- Computational engineering mechanics
- Flow visualization
- Fluidization
- Gas turbine
- Interfacial hydromechanics
- Liquids separation
- Machine design and development
- Materials processing, mixing and environmental studies
- Mechanical characterization of advanced materials
- Photomechanics
- Product realization
- Robotics and mechatronics
- Smart structures and nanotechnology
- Two-phase heat transfer

The newest facility is the Campbell Graduate Engineering Center, which houses the automotive engineering program. This 90,000-square-foot state-of-the-art facility provides faculty and students with a set of automotive testing resources valued at more than $10 million, including a 7-post shaker in a climactic chamber, a 500-horsepower chassis dynamometer, a 500-horsepower engine dynamometer and a full-scale coordinate measuring machine. These facilities provide graduate students with the best possible educational experience as they prepare for international internships and, ultimately, careers in the automotive sector (OEM and suppliers). The facilities are also used to conduct advanced research and development in automotive engineering in conjunction with our corporate partners.

Faculty Highlights

John C. Ziegert has received the Arnold O. Beckman Founder Award in recognition for conception and implementation of the laser ball bar — an instrument for measuring the spatial positioning accuracy of multi-axis machine tools. The award recognizes a significant technological contribution to the conception and implementation of a new principle of instrument design, development or application. Ziegert is Timken Chair in Design at Clemson and has been inducted into the College of Fellows of the Society of Manufacturing Engineers. This highly prestigious honor has been awarded since 1986 and can be earned only through years of dedication and service.

Student Achievement

Clemson University's first motorsports innovation partner, the Dale Earnhardt Foundation, awarded its annual undergraduate scholarship to **Michelle Phillips**, a rising junior from Ellisville, Mo., majoring in mechanical engineering. She is the first woman to receive the scholarship, which was created in Dale Earnhardt's memory.

"We're honored to be able to award this scholarship to a deserving student each year and help them pursue their education and career in motorsports engineering," says Teresa Earnhardt, CEO of Dale Earnhardt Inc. "To be able to recognize a young woman who is excelling in this field is even more special to me. We're proud of her accomplishments and look forward to her representing the Dale Earnhardt Foundation as our Clemson Motorsports Scholar. And we hope to see Michelle in NASCAR in the coming years."

Don Beasley, chairman of Clemson's mechanical engineering department, says the Dale Earnhardt Foundation partnership offers students a rare entrée into the motorsports industry.

"The Dale Earnhardt Foundation displays its commitment to excellence year after year," he says. "We're grateful for their support of our students who have a passion for this field. Michelle is very deserving with her leadership on the Clemson Formula SAE team, her outstanding grades and her winning attitude."

Physics and Astronomy

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Fast Facts

Tenured/tenure-track faculty: 22

Enrollment:	Undergraduate	92
	Master's	4
	Doctoral	45
Degrees awarded:	Undergraduate	13
	Master's	8
	Doctoral	5

Research expenditures: $3,118,364

Research thrusts: astrophysics, atmospheric and space, biophysics, materials, nanomaterials, surface and interface, nanoscience, single-molecule, biophysics

Professor **Gerald Lehmacher** makes final preparations before payload assembly at Poker Flat Research Range, north of Fairbanks, Alaska.

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 and 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. degrees 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

NASA has awarded funding to Clemson astronomers led by **Mark Leising** to study a mysterious emission coming from the central regions of the Milky Way galaxy.

Gamma rays, the light of energy a thousand times more powerful than X-rays created by the convergence of antimatter and normal matter, are seen coming from the disk of our galaxy — roughly from where we see the glow of the Milky Way under a dark sky — but mostly from the direction of the center of the galaxy in the Southern Hemisphere.

"We're not surprised to see this emission from the Milky Way's disk," says Leising. "What is surprising is how bright this emission is from the center of the galaxy. It's not coming just from the very center — where a black hole lurks that is two million times the Sun's mass — but from a region a few thousand light-years across surrounding the center."

One explanation involves black holes — collapsed stars of five to 10 solar masses — pulling matter from close companion stars. Another involves the decay of exotic "dark matter" particles. Dark matter is the name given to something out there that is detected so far only by its gravitational pull on normal matter.

Leising and his students are working in collaboration with colleagues from Germany, France and NASA's Goddard Space Flight Center. They hope to unravel this mystery by combining information from a number of NASA and European Space Agency satellites.

Clemson space physicists led by **Gerald Lehmacher** have traveled around the world to launch rockets to test atmospheric conditions. Most recently, the scientists launched a salvo of four rockets over Alaska to study turbulence in the upper atmosphere. The launches took place at Poker Flat Research Range north of Fairbanks as part of a NASA sounding rocket campaign.

Lehmacher was assisted by graduate students **Shelton Simmons** and **Liyu Guo**.

The rockets were 35-foot, two-stage Terrier Orions, and they released trimethyl aluminum that created a glowing vapor trail nearly 87 miles up. Sensitive cameras on the ground tracked the trails. From that data, Lehmacher and his team were able to analyze upper-atmospheric winds by tracking how the vapor trails formed, billowed, dispersed and diffused. Two of the rockets had additional deployable payload with instrumentation to measure electron density and neutral temperature and turbulence.

In January, **Miguel Larsen** was assisted by three undergraduate students, **Lucas Hurd, Matt Jenkins** and **Matt Henderson**, in Norway to carry out a joint experiment with Japanese scientists to study atmospheric winds and circulation from heating created by electrical currents associated with the Northern Lights. The measurements were made with instruments flown on a Japanese S-310 rocket launched from the Andoya Rocket Range in northern Norway and a suite of sensitive radar and camera instruments on the ground.

Larsen was responsible for the wind measurement aboard the instrumented rocket.

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