Undergraduate Robert Gilliard has been working in Rhett Smith's chemistry lab for four years. They have been creating a molecule that will change color in the presence of toxic or explosive substances. They envision the molecule being made into a toxin-detecting patch for soldiers to wear on their uniforms.

On the cover: From left to right: Elham Makram, Megan C. Vutsinas, Zachary Welch and John C. Fox. Welch participated in the Eureka Summer Research Program before he began his freshman year in Makram's lab, studying rotating machines with graduate students Vutsinas and Fox.

IDEaS

INQUIRY, DISCOVERY IN ENGINEERING AND SCIENCE

COLLEGE OF ENGINEERING AND SCIENCE SPRING 2009

in this issue:

A Message from the Dean

As I write this message, I'm returning to Clemson from Washington, D.C. Excitement is in the air in our nation's capital with anticipation and expectations running very high as a new administration occupies the White House. There is, though, an undercurrent of concern as the country faces unprecedented economic challenges.

I am just beginning my six-year term on the National Science Board (NSB). This appointment is a great honor, and I'm proud to serve the nation in this capacity. My perspective as an NSB director and as the dean of Clemson's College of Engineering and Science convinces me that we, as a nation, will transform our current challenges into opportunities. When all is said and done, I'm convinced that we will emerge a stronger, more vibrant nation, producing goods and services in environmentally respectful settings. The key to economic recovery will be found in the research universities across the country as we educate creative thinkers, leaders and entrepreneurs.

In this issue of *IDEaS*, you'll find stories about some of the exciting work being done within the college to educate and motivate students. There's a feature that discusses how a re-purposed swimming pool is providing students the opportunity to 'dive in' and experience classroom instruction in a whole new way — all while improving grades and student retention rates. You'll also learn how information technology is revolutionizing sporting events by allowing the fans to have a more interactive experience. iTiger is the start of a campuswide emphasis toward a new generation of wireless technology integration, putting instant replay, game-day statistics, memorabilia, e-concessions and more at the fingertips of fans sitting in the stands. There's also a feature describing how our Creative Inquiry program is opening research doors to undergraduates, promoting the development of reasoning and critical thinking, ethical judgment and communications while providing a deep understanding of the methods of scientific and/or humanities research.

The key to economic recovery will be found in the research universities across the country as we educate creative thinkers, leaders and entrepreneurs.

And finally, there's an article about how South Carolina is using GPS data to improve the safety of the state's road-vehicle-driver system.

It's inspiring to watch the advances we're making, because I know these new technologies and approaches are being produced by the talented, creative members of the student body. Soon they will become the knowledge-rich work force that creates economic development opportunities, not only for Clemson and the state of South Carolina, but also for the world beyond.

Sincerely,

Esin Gulari, Dean
College of Engineering and Science
Clemson University

Thinking INSIDE the Box

By Rebecca Shepherd

When ideas were being tossed around about how best to re-purpose an abandoned swimming pool on the Clemson campus, the College of Engineering and Science (CES) dove right in. They invited a few of their friends to join in the fun.

Take a typical indoor swimming pool. Then add some computer equipment, round tables, visionary professors and interactive students. Mix well, and you have a recipe for successful learning and student retention.

Inspired by successful models already in use at universities such as Stanford, MIT and RIT, Clemson opted to transform the empty pool into a sandbox classroom. Yes, the name bodes visions of kindergarteners enjoying an afternoon outside, but rest assured, a whole lot more is going on in this sandbox than making mud pies and building sand castles.

The classroom is dubbed a sandbox because instructors and their students are exploring the use of technology in teaching and learning with an adventurous and curious spirit — similar to that of children who explore and learn about their world in a sandbox. And, unlike other universities that limited the use of the technology to one type of course, Clemson made it a collaborative effort. So far, a variety of classes are taught there, including engineering, horticulture, computer science, English, nursing, mathematical sciences and experimental statistics.

The room accommodates up to 90 students at 10 round tables equipped with power, Internet and video connections, and Tablet-PCs. The instructor's station is equipped with a Sympodium that allows for writing with digital ink on the computer screen. Web-based software that was developed at Clemson University in 2004 also plays a role, enabling classroom interaction by allowing students to submit their work into a large, online grid. The instructor then scrolls down, enlarges a particular submission and addresses someone's correct or incorrect approach to the problem. Instructors may also display images from individual students' laptop screens via the video connections at each table, facilitating immediate feedback, sharing of information and collaborative learning.

Tablet-PC technology in the room was made possible by a 2007 Hewlett Packard Leadership Grant to the multidisciplinary team of Marilyn Reba in mathematical sciences, Barbara Weaver from Clemson Computing and Information Technology (CCIT) and the English department, Roy Pargas from computer science and Lisa Benson in the engineering and science education department. The team credits having access to the sandbox as one reason for getting the grant.

"HP recognized that we could use the Tablet-PCs in innovative ways in that room, and they were impressed with the space when they came to give us the award," says Benson.

Below: Marilyn Reba was part of the team that received the HP Leadership Grant, making the Tablet-PC technology available in the sandbox classroom.

Instructors using the classroom have noticed a drop in grades of Ds, Fs and withdrawls, especially in freshman engineering and math classes.

Scaling up for student success

The concept of the sandbox classroom was based on the characteristics of a typical SCALE-UP (Student-Centered Activities for Large Enrollment Undergraduate Programs) classroom. SCALE-UP is a program that was initially introduced in the physics department at North Carolina State University as part of the NSF-funded Southeastern University and College Coalition for Engineering Education program, of which Clemson University is a member.

Most faculty are familiar with studies that show the longer the lecture, the less the students retain. In many classes, gone are the days of long rows of students who are passively listening to their instructors and hoping they learn the material when they study outside of class. In fact, given the nature of the material in mathematics and engineering courses, taking a more proactive approach has proven extremely successful in higher grades and student retention rates.

Research shows that the attention span of students allows for a maximum of 12 minutes of lecture time, so it's not surprising that students struggle to interpret their class notes and solve the assigned problems outside of class. In a SCALE-UP learning environment, the lecture is interspersed with various activities that include social interaction among students, instructor and learning assistants. This allows the instructor an opportunity to determine 'who is getting it' so he or she may adjust instruction to suit the learning styles of the students.

An axiom of the SCALE-UP format is that mastery is often better supported by activities other than lecture. Activities that have proven helpful include *think-pair-share*, where students are given a minute or two to think about a problem, then turn to a neighbor to share. Electronic student response systems — such as those used in the sandbox classroom — are also advantageous in that they collect and display student thinking, often anonymously. A one-minute essay may also be used at any time within a class period to measure comprehension rates.

The SCALE-UP format is currently in use at Clemson in general engineering, mathematical sciences (all sections of calculus I and II and a section of calculus III), civil engineering, mechanical engineering, horticulture, nursing, English and computer science.

From top: The classroom has 10 round tables, each able to accommodate up to nine students at a time; the Tablet-PC technology fosters collaboration among students; students are able to work problems and participate more in class thanks to sandbox technology; instructors lecture for about 15 minutes, leaving the rest of the class for students to apply what they have learned.

Weaver, who teaches an English class in the sandbox classroom, describes the unique learning environment. "The instructor is free to walk around the classroom to engage students because of a wireless control system that's used to manage lighting, select computer screens and more. Even the floor of the room is novel. It's a modular construction that 'floats' above what used to be the pool deck. The room could be reconfigured virtually overnight to accommodate new technologies — some of which may not even exist yet."

But this isn't just a creative use of space and technology. Instructors using the classroom have noticed a decrease in Ds, Fs and withdrawls, especially in freshman engineering and mathematics classes. In fact, retention in the general engineering program — one of the most frequent 'players' in the sandbox — is at a 10-year high. Math students have reported feeling more confident about retaining content and participating in class.

When surveyed, students were enthusiastic about the classroom environment. "This technology allows us to share ideas to help each other learn," wrote one student. An engineering student remarked, "It's kind of neat. It's a good benchmark for the instructor to see how the students are doing overall, and it helps them better address the problems."

Of course, these revelations called for an experiment.

Sections of calculus courses held in two lecture halls were selected to help investigate this further. Each group of students was equipped with a Tablet-PC and sat at round tables to facilitate interaction. Instructors were encouraged to lecture on new material for only 15 minutes. The remainder of the class was to be spent on applying the information to problems submitted to the instructor by the students via the Tablet-PC, where the instructor could pinpoint errors or problem areas. Final grades were calculated the same way in all sections, then compared to scores from non-Tablet-PC sections.

The sandbox classroom has enabled instructors to use new technologies seamlessly during classes and leverage that flexibility to attract funding for education research.

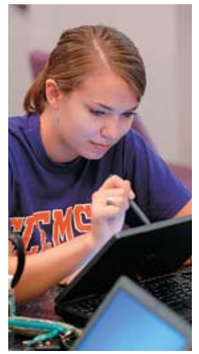
The results? The mean scores in the Tablet-PC classes were consistently 2 to 3 percentage points higher than in the traditional non-Tablet-PC sections.

Many students cited their primary learning source as the pen-based, in-class activity sheets via the Tablet-PC. They valued the abilities to submit answers anonymously to the instructor and pull up corrected activity sheets outside of class. One student says, "Having immediate feedback on my work during class puts the material in my head, really reducing the amount of outside study time."

Reba comments, "We project a variety of mistakes and correct them in front of all the students at a prime learning moment. Pen-based software facilitates showing complicated examples — with graphics and colors — and allows us to monitor student understanding."

The classroom is winning acclaim beyond Clemson students and faculty. In 2008, the Association of Continuing Higher Education bestowed its Use of Technology award upon the sandbox classroom.

"Our goal with the room's design is to explore the use of existing technologies while building in the ability to accommodate future technologies," says Weaver. "We're in a position now to take advantage of the interactive age. We plan to share with other instructors and administrators what we learn in here, what works best for student comprehension and development." *



Interactive Football

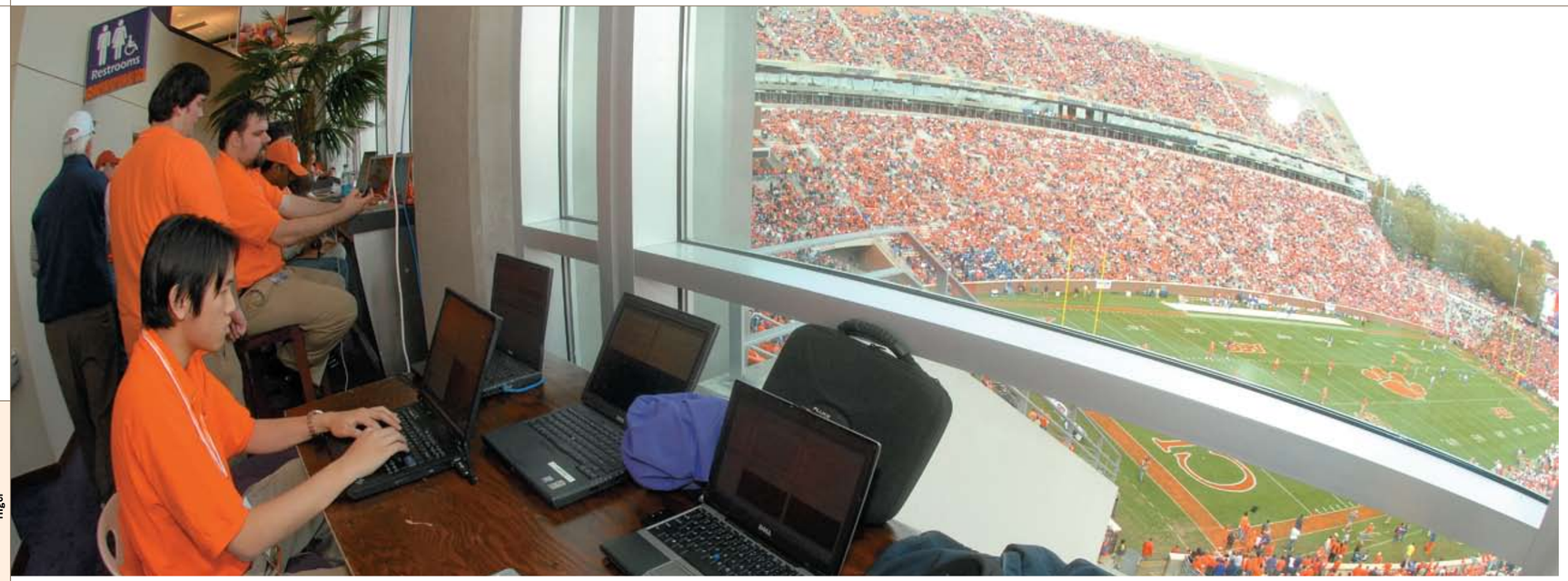
By Susan Polowczuk

Have a question for the coach's show? Ask him.

Hungry at the game? E-mail your order in.

Looking for the shortest lines in the stadium? Go to iTiger.

Clemson's Memorial Stadium and its 80,000 fans are a living laboratory at home games as research, education, technology and athletics come together for more than just football in a joint project known as iTiger (*iTiger.clemson.edu*).



iTiger is a student-driven effort that crosses interdisciplinary lines, involving undergraduates and graduate students from the School of Computing, digital production arts and the College of Business and Behavioral Science, among others. Students are involved in application design and development, infrastructure, project management and game-day logistics.

iTiger brings together the School of Computing in the College of Engineering and Science (CES), Clemson Computing and Information Technology (CCIT) and Clemson athletics. The uncommon collaboration of this trio has brought instant replay, game-day statistics, memorabilia and e-concessions to the fingertips of enthusiasts sitting in the stands using hand-held digital devices. But that's not all; iTiger in the stadium is just the start of a campuswide emphasis toward a new generation of wireless technology integration.

Participation so far has been limited to the West End Zone and a number of suites and outdoor seats near that area of the stadium. This test environment is an experiment in how fans will use devices and in measuring the impact on network connectivity and bandwidth. The goal is to expand iTiger to the entire stadium and to get it into the hands of anyone who wants it, regardless of the wireless device being used.

"We're in the startup, research and development stage, and people are already excited about the possibilities of enhancing the fan experience while discovering new knowledge about wireless communication and engaging students in the process," says Jim Bottum, vice provost for computing and information technology. "We're looking at how the stadium of the future may eventually operate and how other even larger forums in our environment have the potential to operate. We're taking a social networking application and applying it to a sports venue. We hope to eventually use this application on a campuswide scope and, perhaps someday, citywide and beyond."

Participants see iTiger as a launching pad to integrating the entire college campus, a place where learning, research, public safety, social networking and other elements such as retailing, product development and technology transfer all converge in cyberspace.

Other possibilities for iTiger's use within the stadium include instantly accessing public safety officials; interacting with other fans during the game; submitting questions to the coach's show; and in the WestZone Club and suite areas, e-concessions — ordering and paying for food items in advance for pickup at or delivery from the concession stand.

"This may prove to be a great new way for us to provide more service and information to our fans at football games," says athletic director Terry Don Phillips. "We're hoping this may indeed mean they'll be using their cell phones or other mobile devices to get more out of the game, stay in touch with other sports activities, and find out what's going on in the stadium — all in real time. We're happy to provide a setting to help develop these possibilities and more."

The iTiger project utilizes a Cisco Unified Wireless Network with 802.11n Aironet® 1250 Series access points, as well as Cisco routers and switches, designed to eventually provide ubiquitous wireless coverage in the stadium to stream video content to mobile devices.

iTiger is a student-driven effort that crosses interdisciplinary lines, involving undergraduates and graduates from the School of Computing, digital production arts and the College of Business and Behavioral Science, among others. Students are involved in application design and development, infrastructure, project management and game-day logistics. A course is planned to train students working on iTiger projects.

"Memorial Stadium is a natural laboratory for our studies," says Larry Hodges, director of the School of Computing. "On the research side, the challenge is to keep the technology working among so many users in a dense area."

"We are a data-driven culture," adds Ph.D. student Will Pressley, who has helped develop the project with fellow graduate student Abhijit Sribhashyam and School of Computing professor Jim Martin. "We are doing grass-roots development with students and the product at the same time. That is what is unique about doing this at the university level."

"The potential of this project is limitless due to the creativity of the students and the interdisciplinary nature of it," says Martin, technical director of iTiger.

Presently, only hand-held devices with 802.11g specification (which is a standard for wireless local area networks that offer transmission over short distances) are supported by iTiger, although Martin says that will change to include a broader set of cell phone devices.

Currently there is no charge for the service, and Bottum says supporters can make any size gift donation toward the project.

"We are also hoping for individual and corporate sponsors," said Bottum, "and advertising dollars, gifts-in-kind, retail businesses and royalties will help sustain iTiger. For the project to grow, we need the help and support of the entire Clemson community. We are aggressively seeking resources and partners to meet our goals." *

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— Jim Bottum, vice provost for computing and information technology

Shooting for the Moon

Undergraduate students in the College of Engineering and Science are taking research further than you might think.

By Anne McKenzie-Jenkins

From the classroom to the laboratory to professional conferences, students are exploring solutions to the complex problems of today and tomorrow, and everybody plays a role. Creative Inquiry project teams are comprised of undergraduates, graduate student mentors and faculty.

"It's not a typical undergraduate experience," says Christopher Kitchens, assistant professor in the Department of Chemical and Biomolecular Engineering. Along with fellow chemical engineer Scott Husson, he co-manages a Creative Inquiry project team investigating chemical separation methods using advanced membranes. "There's no answer in the back of the book," adds Kitchens. His group of seven undergraduate students (freshmen through seniors) and three graduate student mentors is studying the design of novel membranes for efficient and effective capture of carbon dioxide from power plant flue gas. This groundbreaking work has received funding from the American Chemical Society – Green Chemistry Institute.

Student-powered innovation is a growing tradition at Clemson. For example, if NASA's ATHLETE (All-Terrain Hex-Legged Extra-Terrestrial Explorer) robotic vehicle ever moves across the surface of the moon, it may be thanks to Clemson undergraduate student research. Michelin, a Clemson University partner, is testing its new non-pneumatic lunar wheel on the next generation of moon rovers in Hawaii as part of a NASA Lunar Analogs testing and evaluation event. Some of the elements of that Michelin tire/wheel combination come directly from research conducted by Clemson students.

"It's exciting to know that Clemson student research on treads and wheels could be an integral part of a possible manned mission to the moon," says Clemson mechanical engineer and researcher Joshua Summers. "It's incredible what students can do if they're given the opportunity."

Clemson researchers and Milliken and Co. were challenged by Michelin to measure wear and traction of textile tread leading to the ability to improve tread materials that may someday be used on NASA moon rovers. The Michelin Lunar Wheel is based on the technology of the award-winning Michelin Tweel®, which also includes design features developed by Clemson undergraduate students in fall 2006. Four faculty, two postdoctoral students, eight graduate students, 12 undergraduate students and five high school students are working or have worked on the projects.

Currently, a Creative Inquiry team of 10 freshmen and sophomores is focusing on the next phase of research. Half of the team is designing and building test equipment, while others develop computational models to design tire-sand traction systems that could eventually lead to improved tread material.

Students are lining up to participate in Creative Inquiry projects. According to Husson, that's due to the hands-on nature of the research. Undergraduates are doing team-based research, while developing their lab skills in state-of-the-art facilities. At the same time, graduate students are strengthening their mentoring skills as they guide these dynamic teams. *

From left to right: Joshua Summers and Creative Inquiry team member Samantha Thoe work on the tire/wheel combination for Michelin to be used on the NASA ATHLETE project; Ashley Hart and Gregory White work on an instrument to measure carbon dioxide permeation through new membranes that their Creative Inquiry team has developed; National Scholar Jennifer Moffitt discusses isolating cellulose nanocrystals from Kraft wood pulp and incorporating them as structural additives for polymer nanocomposites with Chris Kitchens.

Taking Technology to the Streets

By Ron Grant

Last year, more than 30,000 people were injured and 1,037 people died in motor vehicle crashes on South Carolina roads. The state is ranked sixth in fatality rates per 100,000 people. Sobering statistics; but they don't even begin to tell the human side of the story.

"A single crash can devastate the lives of family members and friends of the victims, not to mention the staggering economic losses associated with motor vehicle accidents," says Jennifer Ogle of Clemson University's transportation systems group. Ogle, an assistant professor of civil engineering, came to Clemson because the University and the state are positioned to provide a unique environment for furthering her research in vehicle instrumentation, transportation infrastructure design and traffic safety.

"When I came to Clemson, CU-ICAR (Clemson University International Center for Automotive Research) was getting started, and incredibly there was a focus on transportation safety that would support a collaborative research infrastructure," Ogle says. "In addition, the Palmetto State has uniquely positioned itself to gather data critical for this particular focus."

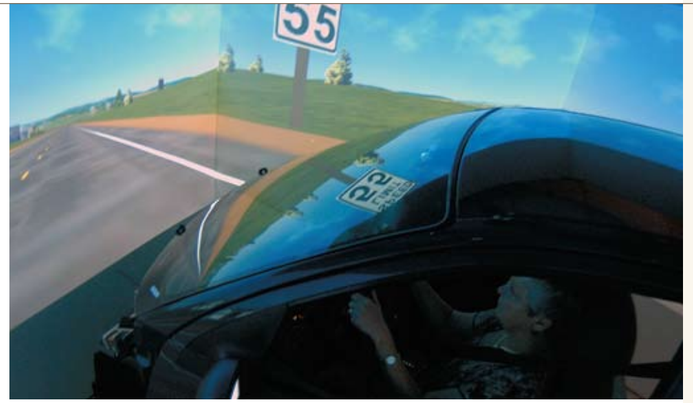
"When I came to Clemson, CU-ICAR (Clemson University International Center for Automotive Research) was getting started, and incredibly there was a focus on transportation safety that would support a collaborative research infrastructure," Ogle says.

South Carolina is one of very few states in the country that have equipped law enforcement vehicles with GPS receivers. When police officers in the state write a ticket or fill out an accident report, they can capture comprehensive location data, providing the Department of Transportation detailed information about where crashes of a specific type are occurring. Engineers and designers can use that data to facilitate development of a user-centered road system that better serves the public good.

What Ogle is discovering about transportation safety issues will make South Carolina a safer place to drive, but her findings can be applied to roadway design anywhere in the country.

In a project funded by the Oregon Department of Transportation (ODOT) and Oregon State University, Ogle teamed with colleague Johnell Brooks from Clemson's psychology department. The two conducted a research project that simulated roadway and roadside design treatments aimed at reducing speeds in transitional areas between rural and urban driving environments. Ogle and Brooks took advantage of their combined expertise in the areas of roadway design and human factors to evaluate proposed countermeasures in the Clemson University DriveSafety driving simulator.

The researchers successfully tested 13 countermeasures in controlled virtual driving scenarios with more than 90 volunteer driver participants (ranging in age from 18 to 60+) to determine which were most effective. In less than a year, and for less than the cost to design and install a single countermeasure, ODOT was able to test numerous treatments and determine which ones had the most potential to produce significant speed reductions. In the end, medians in a series with pedestrian crosswalks were shown to produce the greatest relative speed reductions.



Clemson's Driving Simulator Laboratory has 880 square feet of floor space supporting research on the psychological and scientific aspects of driving. The lab consists of two primary components, a driving simulator and an authoring station for developing simulator scenarios.

zones. An extensive field inventory of roadside terrain and hazardous objects is under way using Clemson's mobile transportation laboratory. Fondly dubbed the "Franken-van," its high top and protruding sensors are reminiscent of Boris Karloff's characterization of Frankenstein's monster in the 1931 film *Frankenstein*.

Using a geographic information system and geo-coded crash locations, Ogle is able to define roadway sections with a high incidence of run-off-the-road, fixed-object crashes. Collisions involving vehicles running off the road and hitting fixed objects account for 40 percent of the fatalities in South Carolina. Trees are the No. 1 type of fixed object, accounting for one-quarter of the fatalities.

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An early pilot study for the Oregon project examined the effects of wireless telephone communication using text and voice modalities. Results indicated that these activities negatively impact driver performance in terms of lane-keeping ability and speed control. Several states have used this study to introduce legislation regulating or eliminating wireless communications while driving a motor vehicle.

Currently, research is being conducted for the S.C. Department of Transportation to evaluate the sufficiency of roadside clear zones and assess the extent of hazardous obstacles and illegal encroachments located in these

Beyond the clear zone study, the data from the rotating laser is being used to generate precision 3-D models of real roadway environments for use in the driving simulator and for development of datasets for crash prediction modeling.

"Whenever a car is involved in a crash, it's not just the car and the road — there's the car, the road and the person driving the car," observes Ogle. "Giving that driver a safe transportation environment is what our work is all about." *

News and notes

Optics researcher elected to prestigious Russian Academy of Sciences

The prestigious Russian Academy of Sciences has elected **Roger Stolen** to its distinguished ranks. A visiting professor in materials science and engineering, Stolen is a pioneer in the field of optics and is a Center for Optical Materials Science and Engineering Technologies (COMSET) faculty member. He studies new materials that interact with light in ways that have critical commercial application in the fields of telecommunications, defense, sensing and displays.

Stolen worked for Bell Labs for 30 years and was part of the team that first observed optical solitons, which are ultra-short pulses that travel great distances without dispersion. Soliton properties of optical pulses play an important role in modern high-capacity optical communication systems. Since 1971, he has been involved in most aspects of fiber optics research, especially fiber nonlinear optics, fiber measurements, novel fibers and fiber components. He is a retired professor of electrical engineering at Virginia Tech and joined COMSET in 2006.

NIH awards Clemson bioengineer $1.5 million to improve durability of tissue heart valves

The National Institutes of Health (NIH) has awarded **Naren Vyavahare**, Hunter Endowed Chair and professor of bioengineering, more than $1.5 million over four years to develop durable bioprosthetic heart valves (BHVs).

Improvements in durability will allow surgeons to implant the valves in younger patients. Vyavahare and his group at Clemson have studied the problem of calcification in arteries and heart valves for nine years. The long-term fatigue damage study funded by NIH is unprecedented in the BHV field. The Clemson group has collaborations with the University of Pittsburgh and the University of Minnesota.

CDC funds Clemson research into black lung prevention

The Centers for Disease Control has awarded **John R. Saylor**, associate professor of mechanical engineering, a three-year, $700,000 grant to investigate methods for reducing harmful particulate levels in coal mines. Saylor's research focuses on a combination of water sprays and ultrasonics to remove dangerous particles from the air. He will work in collaboration with researchers at Boston University.

According to the National Institute for Occupational Safety and Health, coal workers' pneumoconiosis (CWP or black lung disease) is directly or indirectly responsible for the deaths of more than 21,000 miners since the mid-1980s.

Saylor says the high levels of coal-mine dust exposure for miners remains essentially unchanged since that time, even though water sprays have been used for years to reduce dust levels.

"These sprays historically have done a poor job of removing dust particles in the size range that is most damaging to the human lung," says Saylor. "By adding ultrasonic energy to the mix, we'll look at ways to excite the water droplets and more effectively remove dust particles."

School of Materials Science and Engineering director elected to ACerS board

Kathleen Richardson, director of the School of Materials Science and Engineering, has been elected to the board of directors of the American Ceramic Society (ACerS).

Founded in 1898, ACerS serves the informational, educational and professional needs of the international ceramics community. More than 6,000 scientists, engineers, researchers, manufacturers, plant personnel, educators, students, and marketing and sales professionals from more than 60 countries are members of the organization.

Richardson came to Clemson in 2005 and runs the COMSET glass processing and characterization laboratory.

Clemson scientists put a (nano) spring in their step

A team of Clemson researchers, led by **Apparao Rao**, professor of physics, has invented a way to make beds of tiny shock-absorbing carbon springs, which possibly could be used to protect delicate objects from damaging impacts. Similar coiled carbon nanotubes have been made before, but Rao says this method is unique because beds of coiled carbon nanotubes can be grown in a single step using a proprietary hydrocarbon-catalyst mixture. This new approach is cost-effective and can be readily scaled up for industrial applications.

The group also envisions coiled nanotubes in soldiers' body armor, car bumpers and bushings, and even as cushioning elements in shoe soles.

National Science Foundation grants Clemson professors award to develop nanoprobes

The National Science Foundation has granted two Clemson professors $250,000 to research and develop nanofiber-based probes — needles that are 10 times smaller in diameter than a human hair — for medical diagnostics.

The probes may save both money and time compared to more traditional methods of sampling biological fluids. Needles containing tiny fibers will work like sponges to draw up fluids from even the smallest surface.

"This is much like the procedure a butterfly uses to suck up its food," says **Konstantin Kornev**, associate professor in the School of Materials Science and Engineering. He cites one potential application as the ability to draw tiny samples of saliva from the glands of chemotherapy patients who often experience painful dry mouth as a side effect of their treatment.

Kornev and **Igor Luzinov**, associate professor of polymer science, will conduct research over three years with two teams of graduate students. Kornev's group will focus on the development of the fiber probes themselves, while Luzinov's will concentrate on creating smart coatings that will expel fluid upon heating.

Rolls-Royce provides PEER scholarships

The College of Engineering and Science has received a gift of $120,000 for two multiyear engineering scholarships for students who participate in PEER, Programs for Educational Enrichment and Retention. The gift is from Rolls-Royce North America Inc., and the annual scholarship program is designed to support undergraduate scholarships for qualified students majoring in four-year engineering programs.

The award-winning PEER program celebrated 20 years at Clemson in 2007 and has successfully navigated thousands of students

through the college experience. PEER serves all African American and Hispanic/Latino American students in CES, providing a variety of services that include an innovative proactive mentoring program, the Math Excellence Workshop, the PEER/WISE Study Hall, personal and academic counseling, and community service to promote leadership skills.

Clemson scientists create practical silicon optical fiber

Scientists at Clemson University for the first time have been able to make a practical optical fiber with a silicon core, according to a recently published paper in the Optical Society's open-access journal, *Optics Express*.

Led by **John Ballato**, and including fiber pioneer **Roger Stolen**, the team of scientists was able to create this new fiber by employing the same commercial methods that are used to develop all-glass fibers, making silicon fibers viable alternatives to glass fibers for selected specialty applications. This advance ultimately should help increase efficiency and decrease power consumption in computers and other systems that integrate photonic and electronic devices.

Some fibers have been made with a silicon core, but the Clemson version (with collaborators at UCLA, Northrop Grumman and Elmira College) is the first to employ standard mass-production methods, bringing them closer to commercial reality.

Engineering students receive SWE scholarships

Two Clemson students, **Caroline Mason**, a senior in mechanical engineering, and **Kristen Wallis**, a senior in electrical engineering, have received scholarships from the Society of Women Engineers (SWE).

Mason and Wallis both received the GEWN Scholarship for the 2008-2009 academic year in the amount of $2,500. As part of their award, they both also received a yearlong SWE membership.

The SWE Scholarship Program provides financial assistance to women in accredited baccalaureate or graduate programs studying for careers in engineering, engineering technology and computer science.

Clemson hires industry leader as fourth endowed chair for CU-ICAR automotive engineering program

A leader in the complex field of automotive systems integration has joined the faculty as the BMW Endowed Chair in Systems Integration in the automotive engineering graduate program at the Clemson University International Center for Automotive Research (CU-ICAR).

Paul Venhovens came to the University from BMW's research and development headquarters in Munich, Germany, where he has worked in the field of systems integration since 1995. He most recently served as the leader of functional concept design for the 1- and 3-series with responsibility for functional design and integration of vehicle safety, NVH (noise/vibration/harshness), durability, performance, fuel economy and vehicle dynamics.

Clemson turns idle computer time into solutions for world problems

Clemson University is tops in helping to tackle climate change, muscular dystrophy, cancer and a host of other world problems by contributing idle computer time to the World Community Grid (WCG) that lets researchers around the world work on life's toughest issues.

The Clemson team takes the unused power of the Windows computers in instructional labs and gives it to the WCG humanitarian projects where there are a wide variety of computational science problems to solve. The grid is run by IBM.

According to IBM, Clemson's School of Computing has been contributing more than four years of CPU time per day. This means that approximately 1,500 Clemson computers have been working on WCG problems every day. Depending on the day, Clemson has, at times, been first in the nation and as high as fourth in the world for contributions among WCG teams.

WCG's mission is to create the largest public computing grid benefiting humanity. Its not-for-profit work is built on the belief that technological innovation combined with visionary scientific research and large-scale volunteerism can change the world for the better.

Chemistry professor wins Komen funding

Chemistry professor **Ya-Ping Sun** has won a $205,000 grant from Susan G. Komen for the Cure to work on imaging agents that could better detect cancer cells.

Sun's research will look at fluorescent carbon nanomaterials, known as carbon dots, to see whether a combination of light and magnetic resonance imaging can help researchers examine different parts of cells.

"We're enhancing the chemistry and properties of these carbon quantum dots for their potential uses in diagnostics that essentially combine the capabilities of MRIs with those of optical imaging," Sun says. "It may be a more efficient, pinpointed way of detecting where the cancers are."

Research scientist **Li Cao** will also work on the project.

The Komen funding was given to researchers at 81 universities and hospitals in 27 states and five countries.

Mary Lynn Faunda Donovan, executive director of the Upstate affiliate says, "We're especially proud that this is the third research grant that Clemson has received since 2004. It demonstrates that we have researchers right here in the Upstate who may unlock the cure to breast cancer."

Deputy director named for Institute for Biological Interfaces of Engineering

Guigen Zhang, a University of Georgia researcher with a focus on micro/nanoscale bioengineering, has been appointed deputy director of Clemson's Institute for Biological Interfaces of Engineering (IBIOE) at Clemson University.

Zhang, who received his Ph.D. in bioengineering at Clemson in 1994, focuses his research on the development of new devices that combine microscale and nanoscale structures for use in tomorrow's sensors, testing systems and diagnostic devices, as well as a wide range of other applications.

IBIOE is an interdisciplinary research institute focused on cellular engineering for biomedicine and the development of diagnostic tissue test systems for the improvement of health care.

INQUIRY, DISCOVERY IN ENGINEERING AND SCIENCE

IDEaS

SPRING 2009

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

On the cover: A close-up view of iTiger technology that's now available in Memorial Stadium. Fans with hand-held devices may add another vantage point to the game. Find this story on page 6.

Right: Johnatan Dillon drives a van while Vijay Bendigeri oversees a video and laser data collection program. The graduate students are working with Jennifer Ogle and Johnell Brooks to pinpoint areas with the highest rates of traffic incidents. More on page 12.

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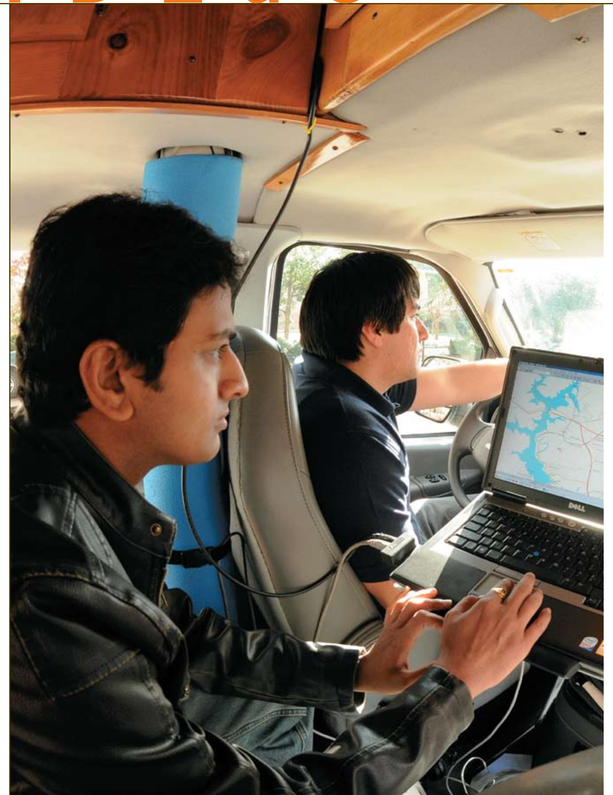
CLEMSON UNIVERSITY



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

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IDEaS

INQUIRY, DISCOVERY IN ENGINEERING AND SCIENCE

COLLEGE OF ENGINEERING AND SCIENCE SPRING 2009

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: 17

Enrollment:	Undergraduate	74
	Master's	17
	Doctoral	61
Degrees awarded:	Undergraduate	n/a
	(First cohort of Bachelor's degrees will be awarded 5/09.)	
	Master's	10
	Doctoral	7

Research expenditures: $4,924,428
Research thrusts: biomaterials, tissue regeneration, emerging technologies for health care, bioimaging

Under the direction of **John DesJardins**, assistant professor and director of study abroad programs for the Department of Bioengineering, four students spent the summer doing research and traveling in London, England. As part of an effort to expand undergraduate opportunities abroad, the department developed a program with Imperial College London in which undergraduates have the opportunity to perform international research for seven full weeks during the second summer session of classes.

Faculty Highlights

The Wallace H. Coulter Foundation awarded a 2008 Early Career Translational Research Award to **Ning Zhang**, assistant professor of bioengineering in the Clemson University-Medical University of South Carolina (CU-MUSC) bioengineering program. Zhang's work on an injectable hydrogel-based system for treatment of stroke was judged by a panel of experts as a highly promising technology that can progress toward commercial development and clinical practice. Her proposed work is to develop an injectable hydrogel-based system to assist stem-cell therapy in treatment of focal ischemic stroke. The Career Awards program supports biomedical engineering research that is translational in nature; it funds two years of research for investigators as they establish themselves in academic research careers.

Bioengineering professor and chair **Martine LaBerge**, past president of the Society for Biomaterials (USA), was inducted as a fellow of Biomaterials Science and Engineering during the 8th World Biomaterials Congress in Amsterdam. The award acknowledges LaBerge's leadership in the field of biomaterials and her research on orthopaedic biomaterials. Her current research includes investigation of total knee-joint design and dynamic contact mechanics, wear performance of total knee-joint replacements, and the mechanisms of friction, lubrication and wear of vascular implants.

Student Achievement

The National Heart, Lung and Blood Institute awarded a predoctoral fellowship this summer to **Carmen Elaine Gacchina**, a student in **Anand Ramamurthi's** lab in the CU-MUSC bioengineering program in Charleston. Her proposed work, "Cues for elastin matrix repair and regeneration in vascular aneurysms," will be funded as a cardiovascular training (T32) grant through MUSC. Gacchina was also named a 2008-2009 Presidential Scholar at MUSC.

Under the direction of **John DesJardins**, assistant professor and director of study abroad programs for the bioengineering department, four students spent the summer traveling and doing research in London, England. The selected students were Calhoun Honors students and included **James McAlpine** (a senior in mechanical engineering), **Kara Rusaw** (a junior in bioengineering), **Courtney Taylor** (a junior in bioengineering) and **Zachary Combs** (a senior in materials science). Three of these students participated in the BioE-Brussels program and traveled directly to begin their new research projects.

Department Overview

Clemson's Department of Bioengineering has a rich tradition of globalization and international outreach. In 1969, Clemson hosted the first in a series of annual symposia (later known as the annual International Biomaterials Symposium) that led to the founding of the Society for Biomaterials (SFB) in 1974. Clemson was considered not only the ultimate location for sharing, learning and discovering the science behind the building blocks of medical devices; its culture exemplified collegiality.

Now the world's premier professional society in promotion of advances in all phases of materials research and development, SFB encourages cooperative educational programs, clinical applications and professional standards in the biomaterials field. Pioneering biomaterials work conducted by Clemson faculty has led to the discovery of medical devices that have revolutionized health care. Over the past 45 years, Clemson's international reputation as the landmark for the field of biomaterials has been sustained.

Annually, SFB recognizes three outstanding researchers in the field through its award for contributions to the literature, basic research and applied research. In overall biomedical engineering education, SFB offers a novel training paradigm that redefines the current research-integrated design model. Course outcomes demonstrate that students do develop new technology when given appropriate training, stimulation of imagination, guidance in strategic and creative thinking, and mentored opportunities for oral and written communication within a team.

One aspect of Clemson's internationalism in biomaterials research is its new bioengineering summer-abroad program, aimed at enhancing students' global awareness of health care and medical-device regulation. To consolidate activities, the department established an office of international programs with the mission to provide high-quality undergraduate and graduate bioengineering education programs that prepare students to apply science and engineering principles to solve problems in biology and medicine, generate and disseminate knowledge to benefit humankind, and apply that knowledge toward health care improvement and scientific and technological development. The 22 bioengineering faculty members are committed to enhancing education and improving preparation of students for the bioengineering profession using a global approach and successfully carrying out this mission through outreach, integration and awareness.

Biosystems Engineering

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Fast Facts

Tenured/tenure-track faculty: 16

Enrollment:	Undergraduate	161
	Master's	17
	Doctoral	4
Degrees awarded:	Undergraduate	45
	Master's	9
	Doctoral	2

Research expenditures: $460,041
Research thrusts: water quality, bioprocessing, non-point-source pollution, instrumentation and control, bioseparations, aquaculture, machine design for biosystems engineering

Justin Montanti conducts research in **Caye Drapcho's** lab on algae to produce high value oils for use in pharmaceuticals or as biodiesel for fuel.

Research Interests

Clemson's biosystems engineering program is focused primarily on three areas of research that when combined:

- create alternative bioproducts and energies (biofuels),
- protect our water and environment, and
- increase the productivity and profitability of agriculture without harming the environment.

Bioprocessing/Applied Biotechnology

Clemson 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 is currently a topic 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.

Natural Resources/Environment

Water management and water quality are major thrusts. Clemson researchers are focused on nearly every aspect of keeping water (surface runoff as well as ground water) safe from chemical or biological pollutants, 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.

Agriculture

Growing healthier, hardier crops and maintaining livestock herds with low environmental impact have become complex science. Research in this department includes:

- precision agriculture technology to increase productivity and profitability of crops while minimizing environmental impacts,
- site-specific control of crop insects and diseases,
- irrigation design and control, especially as implemented for sensor-based agricultural methods, and
- livestock waste management and alternate uses of wastes, such as energy production.

Facilities

Biosystems engineering has several research facilities, including a fiber-quality lab, an agricultural/chemical/biological lab, aquaculture facilities and a biotechnology analytical lab. 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.

New Faculty

The biosystems engineering department has 15 faculty members. **Anand Jayakaran**, from The Ohio State University, recently joined the team. His research includes watershed modeling, low-impact storm-water management and developing broad-based research initiatives that examine the impacts of development on the hydrology of coastal plains watersheds. His research focuses on how hydrologic and sedimentologic regimes are impacted by land development in coastal plain watersheds. With increased demands on the South Carolina coast, the need for low-impact strategies in the development of land is significant. Jayakaran conducted doctoral and postdoctoral research on low gradient modified stream systems in the agricultural Midwest. His graduate research contributed in part to the adoption of alternative stream management techniques in Ohio. Jayakaran has a strong interest in understanding the fluvial geomorphology of coastal streams and incorporating natural channel design in managing storm-water channels.

The latest faculty addition is **Hamid J. Farahani**, who comes from Colorado and Aleppo, Syria, where he was employed by the International Center for Agricultural Research in the Dry Areas. Farahani will conduct research at the Edisto REC where he will bring irrigation expertise to the sensor-based agriculture program that is developing there. One of the leading programs of its type in the world, Edisto REC seeks to develop and utilize cutting-edge engineering technologies to optimize agricultural production and sustainability by maximizing profitability while minimizing negative environmental impacts.

Chemical and Biomolecular Engineering

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Fast Facts

Tenured/tenure-track faculty: 11

Enrollment:	Undergraduate	141
	Master's	2
	Doctoral	36
Degrees awarded:	Undergraduate	27
	Master's	1
	Doctoral	10

Research expenditures: $5,015,083

Research thrusts: chemical and biosensor devices, separation methods to recover products produced biologically by fermentation, thermochemical hydrogen cycles for fuel cells, molecular design of advanced carbon materials, synthesis of alternative fuels

An interaction in research in heterogeneous catalysis has been established and is ongoing between Clemson's **Jim Goodwin** and **Piyasan Praserthdam** of the Department of Chemical Engineering at Chulalongkorn University in Bangkok, Thailand. Currently, **Kanokwan Ngaosuwan**, a Ph.D. student at Chulalongkorn, is spending 18 months in Clemson studying reactions related to finding more efficient ways to synthesizebiodiesel. **Joongjai Panpranot** and **Bunjerd Jongsomjit**, two of Goodwin's former Ph.D. students, are assistant professors of chemical engineering at Chulalongkorn. Panpranot received her Ph.D. from Clemson in 2002. Two years ago, she was designated by the Royal Thai Government as one of the top four young researchers in Thailand.

Departmental Overview

The Department of Chemical and Biomolecular Engineering allows students to specialize in many different research areas such as advanced materials — including polymers, energy, biotechnology and chemical processing. Strong departmental research programs exist in biosensors, polymer processing, rheology, fiber and film formation, supercritical fluids, separation processes, kinetics and catalysis, and membrane applications. The research activities of these groups cover most of the traditional branches of chemical engineering as well as several of the newer areas, including advanced materials, bioseparations, biofuels, hydrogen from water, fuel cells and molecular simulation. Research interests of the faculty range from purely theoretical topics to the analysis and improvement of full-scale industrial processes.

Faculty Highlights

Anthony Guiseppi-Elie, director of the Clemson Center for Bioelectronics, Biosensors and Biochips, delivered a keynote lecture on "An Implantable Biochip for Physiologic Status Monitoring During Hemorrhage and Shock" at the 13th International Conference on Biomedical Engineering (ICBME). The ICBME is a series of biennial international conferences in biomedical engineering held in Singapore. Past conferences have attracted about 800 participants from more than 30 countries.

Facilities

Earle Hall is home to the Department of Chemical and Biomolecular Engineering. A current major renovation to remodel the high-bay wing of this building is adding more than 6,000 square feet of labs, offices and undergraduate research space.

Located in Anderson, S.C., the Advanced Materials Research Laboratory is the headquarters for research by many departments of Clemson's College of Engineering and Science. The 111,000-square-foot facility houses laser and chemistry labs in addition to Clemson's Electron Microscope Facility.

Clemson's Center for Advanced Engineering Fibers and Films (CAEFF) has conducted research at the cutting edge of computational materials design since 1998. With major support from the National Science Foundation, the center has state-of-the-art modeling polymer processes beyond any existing model in the world. CAEFF supports South Carolina's growing knowledge-based economy by promoting a transformation from trial-and-error development to computer-based design of fibers and films.

The Center for Bioelectronics, Biosensors and Biochips located in the Advanced Materials Center of Clemson University focuses on the interface of chemistry, microelectronics, materials science, biology and medical technology to develop sensors that mimic or measure biological functions.

Chemistry

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Fast Facts

Tenured/tenure-track faculty: 22

Enrollment:	Undergraduate	110
	Master's	6
	Doctoral	103
Degrees awarded:	Undergraduate	13
	Master's	3
	Doctoral	12

Research expenditures: $4,860,136

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

Dennis Smith received the 2008 Charles H. Stone Award from the Carolina-Piedmont section of the American Chemical Society. The award is in honor of the local industrialist and recognizes the contributions to the field of chemistry by the most outstanding chemist in the southeastern United States.

Department Overview

The chemistry department is one of the largest and most active academic programs on the Clemson campus. More than 20 faculty members direct the research of approximately 100 graduate students with the assistance of about 15 postdoctoral and visiting scientists. In addition, several faculty members are primarily engaged in undergraduate instruction, including direction of undergraduate research. Faculty 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, bio-organic and medicinal chemistry, computational chemistry, chemical physics, chemical education and other areas.

Faculty Highlights

- Clemson University Department of Chemistry researchers **Ken Christensen**, **Brian Dominy** and **Dev Arya** have teamed up with Harvard Medical School researchers Mike Rogers and Robert D'Amato (Children's Hospital Boston Vascular Biology Program) to identify and develop new inhibitors of angiogenesis or pathological blood vessel growth. These inhibitors may eventually prove useful in the treatment of certain eye diseases that cause blindness and cancer. This project has recently received significant funding by the National Institutes of Health Eye Institute and the Department of Defense Breast Cancer Research Program. With the protein modeling expertise of Dominy and the synthetic chemistry expertise of Arya, this collaborative project will likely yield exciting results in the coming years.
- **Dennis Smith**, professor of chemistry, is the recipient of the 2008 Charles H. Stone Award presented by the Carolina-Piedmont Section of the American Chemical Society. This endowed award is given annually to the most outstanding chemist in the southeastern United States, recognizing contributions to the field of chemistry through activities in the scientific community, public outreach, education and research.
- The chemistry department's newest faculty member is **Jeffrey Anker**. He received his Ph.D. from the University of Michigan, where he worked with Raoul Kopelman on magnetically modulated fluorescence-based sensors. After graduation, he was an NIH Postdoctoral Fellow at Northwestern University with Richard Van Duyne, where he developed plasmonics-based nanosensors to measure chemical concentrations and study binding kinetics.

Facilities

A major renovation is planned for Hunter Hall, the current home of the chemistry department. The renovation will provide space to house high-end instrumentation facilities, including NMR spectroscopy, X-ray crystallography, optical spectroscopy and mass spectrometry.

Civil Engineering

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Fast Facts

Tenured/tenure-track faculty: 20

Enrollment:	Undergraduate	364
	Master's	55
	Doctoral	18
Degrees awarded:	Undergraduate	96
	Master's	34
	Doctoral	8

Research expenditures: $2,143,199

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

Ronnie Chowdhury and his students have been conducting research to support new endeavors in transportation system design by developing intelligent transportation systems (ITS). Improving the mobility, safety and energy efficiency of road-based traffic, ITS technologies also lessen the pollution associated with automobile use. Chowdhury recently completed a project in which an artificial intelligence-based decision system was developed to support evacuations during emergencies, to rapidly respond to highway traffic incidents and to manage incidents and evacuations. In another recently completed project, his team identified cost-effective ITS technologies to support incident management that will save lives and reduce traffic congestion caused by traffic incidents. Recently, Chowdhury published a textbook on transportation infrastructure ITS security. His co-author is one of his former Ph.D. students, Ryan Fries, now a faculty member of civil engineering at the University of Illinois at Edwardsville.

Undergraduate Research

- **Energy Efficiency.** Students are involved in Creative Inquiry with **Leidy Klotz** studying engineers' behavior and energy efficiency. This project will review and apply research on human cognitive and emotional biases to better understand engineering decisions related to energy efficiency. Students will read and analyze books and journal articles plus design and implement a related experiment.
- **Advanced Materials and Energy.** **Bradley Putman** and **Nigel Kaye** are conducting a Creative Inquiry project to find ways to use advanced materials to reduce energy demand. Heating, cooling and ventilating buildings account for 16 percent of total U.S. energy consumption. One approach they are looking at is using pervious concrete to buffer buildings against large temperature changes in extreme climates.
- **Earthquake Hazards.** Students working on a Creative Inquiry project with **Hsein Juang** and **Nadarajah Ravichandran** are studying earthquake hazards reduction. This project focuses on earthquake (seismic)-induced liquefaction hazards and mitigation schemes for the Charleston, S.C., area.
- **Roadways as Sources of Energy.** A team of students working with **Bradley Putman** has been conducting a Creative Inquiry project to study roadways as energy sources. In the past decade, there has been a focus to explore alternative energy sources for many reasons, including improved air quality, global warming and finite natural resources. These efforts are currently gaining more attention due to recent studies that are contributing global climate changes to humankind's reliance on fossil fuels. The main objective of this study is to identify methods to utilize the roadway environment as a renewable energy source. Throughout the duration of this project, the team investigated the feasibility of harnessing energy from vehicular traffic, roadside wind from passing traffic, temperature changes in the pavement, water draining from the roadway and pavement exposure to sunlight. This project could potentially discover a way to use the roadway environment to reduce energy consumption, one of the environmental problems with which it has been associated.
- **Pavement Management.** Students working on a Creative Inquiry project with **Bradley Putman** and **Jennifer Ogle** are studying Clemson University's pavement management system. Pavements are a substantial investment and are key components of the nation's transportation infrastructure. Given the investment necessary for pavements, it is important that they are properly managed to get the most out of the investment over the required service life. The main objective of this project is to develop a pavement management system to be used by Clemson's own parking services and facilities maintenance and operations personnel to assist with selection of pavement preservation methods as well as the design and construction of future pavement facilities.

National Recognition and Honors

Members of the Clemson University chapter of the Institute of Transportation Engineers (ITE) are 2008 Traffic Bowl winners. They competed at the Southern District ITE Annual Meeting in Charleston against nine other university teams in a "Jeopardy" style competition known as the William H. Temple Scholarship Challenge. Graduate students **Sukumar Anekar** and **Swathi Korpu** and Ph.D. student **Priyank Alluri** (all from the Clemson civil engineering department) represented the state of South Carolina in the competition. To bring home first prize and a $3,000 scholarship, the students defeated other teams from North Carolina State, Virginia Tech and the University of Virginia in the preliminary round and Georgia Tech, Southern Polytech and Mississippi State in the final round.

Faculty Highlights

- The civil engineering department welcomes three new faculty members who joined us in August. **Leidy Klotz**, an assistant professor in the construction engineering and management area, earned his Ph.D. in architectural engineering at Pennsylvania State University. He is teaching undergraduate and graduate courses in sustainable construction. **Weichiang Pang**, an assistant professor in the structural engineering area, earned his Ph.D. from Michigan Tech. He is teaching a course on reinforced concrete design. **Melissa Sternhagen** joined the faculty as a lecturer and teaches mechanics courses.

School of Computing

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Fast Facts

Tenured/tenure-track faculty: 24

Enrollment:	Undergraduate	275
	Master's	51
	Doctoral	39
Degrees awarded:	Undergraduate	57
	Master's	26
	Doctoral	7

Research expenditures: $710,684

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

Jason Hallstrom received an NSF CAREER Award this fall for his proposal, *Supporting Patterns for Embedded Network Systems*. The Faculty Early Career Development Program offers the National Science Foundation's most prestigious awards in support of the early career development activities of teacher-scholars.

Department Overview

Clemson's School of Computing was formed from the Department of Computer Science in 2007 with a vision to be a national leader in the definition and advancement of emerging academic fields in computing through the development of successful divisions that integrate computation with the arts, sciences and engineering. The School of Computing is key to the College of Engineering and Science's mission of preparing students for all aspects of computing and as part of a University wide emphasis on information technology and high performance computing. Providing a diverse and rich educational environment in many areas of computing, it also maintains nationally prominent research programs in selected focus areas. The school was reorganized in fall 2008 into three primary academic divisions: computer science, visual computing and human-centered computing.

- Computer science offers students the opportunity for classroom study and research in the underlying theory of computation, algorithms, software engineering, cyberinfrastructure, computer systems and other core areas of traditional computer science.
- Visual computing offers students the opportunity for classroom study and research in computer graphics, visualization, computer vision and image processing, and in various electronic arts such as game design, special effects and animation.
- Human-centered computing (HCC) is the newest division. HCC is an emerging field focused on understanding how to make computational technologies more useable and how computational technologies affect society.

The school currently has 275 undergraduate students and 135 graduate students enrolled in programs leading to the B.A., B.S., M.S. and Ph.D. in computer science; B.S. in computer information systems; and M.F.A. in digital production arts.

Facilities

The School of Computing is housed in McAdams Hall, which recently underwent a $3.9 million renovation and expansion. The project renovated 20,000 square feet of space and added another 24,000 square feet of space. Students have 24-hour access to a diverse set of school facilities that range from workstations, graphics systems, virtual reality systems, networking labs, video production equipment, motion capture and computer clusters.

Faculty Highlights

The School of Computing has 33 faculty members, with the most recent being **Larry F. Hodges** and **Donald H. House**. Hodges is the first hf Flagship Endowed Chair Director of the School of Computing. In 2006, he was awarded an IEEE Career Achievement Award for his work in clinical virtual reality. Prior to coming to Clemson, he served as chair of the Department of Computer Science at UNC-Charlotte. House is the founding chair of the Division of Visual Computing in the School of Computing. Before moving to Clemson this fall, House was a professor at Texas A&M University, where he played a key role in the development of their visualization program.

National Recognition and Honors

- Assistant professor **Brian Dean** served as the team leader of the USA Computing Olympiad Team (comprised of the top four high school computer science students in the country) at the International Olympiad in Informatics in Cairo, Egypt. The USA team earned two of the top 10 spots out of 258 competitors from 83 countries.
- Jerry Tessendorf, principal graphics scientist at Rhythm & Hues Studios in Los Angeles, visited Clemson last fall thanks to a grant from the South Carolina Film Commission. Tessendorf received a 2008 Technical Achievement Award from the Academy of Motion Picture Arts and Sciences for his groundbreaking work in design and implementation of fluid simulation tools. These tools have been used extensively in the production of numerous motion pictures such as *Titanic*, *Superman Returns* and *Happy Feet*.

Electrical and Computer Engineering

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Fast Facts

Tenured/tenure-track faculty: 31

Enrollment:	Undergraduate	355
	Master's	85
	Doctoral	44
Degrees awarded:	Undergraduate	105
	Master's	32
	Doctoral	9

Research expenditures: $2,385,915

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

Xiao-Bang Xu has been awarded a National Science Foundation grant to study the electromagnetic scattering of 3-D objects buried in stratified earth. The grant resulted from a proposal to the Electrical, Communications and Cyber Systems division of NSF.

This research may benefit society through a number of important potential applications, including:

- geophysical exploration of mineral deposit, petroleum and alternative energy resources such as geothermal spots;
- locating buried hazardous waste for environment protection;
- detection of subsurface targets such as land mines for protection of our troops;
- nondestructive testing of underground pipes and other underground facilities;
- microwave imaging of abnormal area embedded in multilayer biological structures for detection of cancers;
- modeling of indoor wave propagation through multilayer walls for wireless Internet planning.

Department Overview

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

ECE has an enrollment of 360 undergraduate students (sophomores and above) and 140 resident graduate students in two separate degree program areas: electrical engineering and computer engineering. As one of the larger departments on campus, ECE plays a major role in degree production, in sponsored research activity and in service to the community.

The graduate programs provide a variety of opportunities for development through research, specialized formal course work and teaching experience. The department offers M.Engr, M.S. and Ph.D. degrees in both electrical engineering and computer engineering. Currently there are about 50 students in the Ph.D. program and about 90 students in the M.S. and M.Engr. programs. Approximately 100 of these students receive financial support in the form of fellowships, industrial grants, teaching assistantships and research assistantships.

Research

ECE research activities center around 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.

Faculty Highlights

The Holcombe Department of Electrical and Computer Engineering welcomes two new faculty who will be working in the area of optoelectronics: **Lin Zhu** from Caltech and **Sung-O Kim** from National Chiao Tung University. Zhu's research interests include semiconductor lasers, periodic photonic structures, optical resonators and the hybrid integration of optical systems with microfluidic systems. Kim's research focus includes flat panel displays, micro-plasma devices, micro-fuel cells, flexible electronics and plasma polymerization.

Guigen Zhang has also joined the college with a joint academic appointment as a professor in ECE and the bioengineering department. Zhang, a University of Georgia researcher with a focus on micro/nanoscale bioengineering, has also been appointed as deputy director of the Institute for Biological Interfaces of Engineering (IBIOE) at Clemson University.

Facilities

Research programs and laboratories include the Center for Semiconductor Device Reliability Research, electromagnetics laboratories, Clemson Electrical Power Research Association, Image Processing and Artificial Intelligence Research Laboratory, Instruction-Level Parallelism Laboratory, Parallel Architecture Research Laboratory, Power Quality and Industrial Applications Laboratory, Radar Systems Laboratory, Robotics and Mechatronics Laboratory, Speech Processing Laboratory and a Wireless Communications Program. 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.

The College of Engineering and Science is well-equipped with networked workstations and personal computers that serve as the foundation for course computing needs as well as the backbone of computing support for the research programs. In addition, a variety of workstations and dedicated computers are maintained in various research laboratories throughout the ECE department.

Engineering and Science Education

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Fast Facts

Tenured/tenure-track faculty: 7

Enrollment:	Undergraduate	1,300
	Master's	n/a
	Doctoral	n/a
Degrees awarded:	Undergraduate	n/a
	Master's	n/a
	Doctoral	n/a

Research expenditures: $234,005
Research thrusts: epistemologies, learning mechanisms and systems, diversity and inclusiveness, assessment

Melanie Cooper and collaborator Mike Klymkowsky (University of Colorado) recently received a grant for $500,000 to develop a new chemistry curriculum, "Chemistry, Life, the Universe, and Everything" (aka, "Chemistry and the Logic of Life"). The curriculum uses the emergence and evolution of life as context for teaching and learning chemistry. The project provides funds for research on student learning and development of interactive materials to help students address misconceptions and to enhance problem-solving abilities.

Faculty Highlights

Julie Trenor will serve 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 more than 600 members from nearly 200 engineering schools, small businesses to 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.

Melanie Cooper received the 2009 Robert S. Campbell Award for Faculty Excellence in Communication Across the Curriculum.

RISE Program

The College of Engineering and Science Living and Learning Community is a unique first-year community for learning and student success. In 2007 RISE was named the No. 1 science, technology, engineering and mathematics (STEM) living-learning program in the nation by the National Study of Living Learning Programs. When asked, one student wrote, "I feel the $150 I spent to be a part of RISE was the best money I spent my freshman year of college. I thank you for all that you have done to make this year so successful for RISE and congratulations on the honor you have achieved."

Student Achievement

Doctoral student **Denise Grant** has been named Southern Regional Education Board (SREB) Doctoral Scholar. SREB seeks to support women and minority students pursuing a Ph.D. with plans to become faculty members in a postsecondary institution. The program offers professional development, mentoring and financial support. Grant received a five-year financial package to pursue a Ph.D. in civil engineering and will conduct her dissertation research under the direction of **Julie Trenor** in the Department of Engineering Science and Education. Grant, a registered professional engineer and Clemson alumna (B.S. 1990, M.S. 1995), is on leave from South Carolina State University, where she was an assistant professor of civil engineering technology.

Department Overview

Vision: The department will be an international leader in engineering and science education through discipline-based education research, preparation of future faculty, and implementation of inclusive, evidence-based curricula.

The Department of Engineering and Science Education, instituted in 2006, is unique in that there is no other department like it in the United States. At present it is home to three distinct units:

- A discipline-based education research group consisting of faculty whose scholarship and research focus on a wide range of issues in teaching and learning in the STEM (Science, Technology, Engineering and Mathematics) disciplines. Current research projects include development and assessment of new curricula, assessment of interactive pedagogies, equity issues, recruitment and retention of scientists and engineers, and the reform of graduate education.
- The General Engineering Program introduces students to the various engineering disciplines at Clemson from both an academic and professional prospective. All engineering students begin their academic journey at Clemson as general engineering majors and are required to complete a first-year curriculum sequence before declaring an intended engineering major.
- The General Engineering Advising Group provides information, support and guidance to assist students in making a successful transition to Clemson. The group also coordinates the transfer students in engineering and the RISE program.

New Graduate Student Program

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

Environmental Engineering and Earth Sciences

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Fast Facts

Tenured/tenure-track faculty: 18

Enrollment:	Undergraduate	27
	Master's	47
	Doctoral	26
Degrees awarded:	Undergraduate	4
	Master's	15
	Doctoral	2

Research expenditures: $1,867,823

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

Cindy Lee received an award from the National Science Foundation to study the use of chiral tracers to determine cycling of POP's in stream ecosystems. Lee has also been selected as an editor of *Environmental Toxicology and Chemistry* for environmental chemistry. The journal is one of the official journals of the Society of Environmental Toxicology and Chemistry.

Department Overview

EEES has a synergistic blend of environmental engineering, environmental science, geology and earth sciences, and nuclear environmental engineering and science. At the undergraduate level, the department is committed to providing the next generation of earth scientists a comprehensive understanding of earth processes through B.A. and B.S. degrees in geology. Specialization tracks in traditional geology, environmental science and hydrogeology allow students to personalize their course work in areas of their particular interests. Unique to Clemson, all undergraduate geology students participate in research with a faculty member from sophomore through senior year.

The department has two distinct graduate 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 graduate programs are nationally recognized; EE&S has been continuously ranked in the top 25 programs by *U.S.News & World Report*. Graduates are sought out by employers across the United States, and today there are more than 1,000 EEES graduates in the nation and around the world.

The teaching and research activities in EEES reflect a comprehensive and highly interdisciplinary approach to studying the environment. Areas of focus include environmental chemistry, environmental fate and transport, hydrogeology, nuclear environmental engineering and science, process engineering, and sustainable systems and environmental assessment.

There are 22 full-time EEES faculty, with more than 20 adjunct faculty, more than 70 graduate students and about 40 undergraduate geology majors. Excellence in environmental engineering has been a tradition at Clemson University for many years. It is the only program in the nation with three faculty members (**Linvil G. Rich, Thomas M. Keinath** and **C.P. Leslie Grady Jr.** — all are emeritus, but are still active with the department) who have been honored with the prestigious Founders Award by the American Association of Environmental Engineering and Science Professors. Currently, six faculty members serve as editors or on the editorial advisory boards of prominent journals. The department houses four National Science Foundation (NSF) CAREER award recipients, the highest honor given to young faculty by NSF. EEES faculty also published five books in the past decade.

The hydrogeology graduate program is one of only a few programs in the country to offer a degree specifically in hydrogeology. Students and faculty associated with this program perform research on a diverse range of topics that have included contaminant transport and remediation, surface and groundwater interactions, enhanced oil recovery and natural gas storage, advanced well testing, constructed wetlands, geophysics and mathematical modeling. The department offers a unique summer hydrogeology field course to graduate and undergraduate students for hands-on experience with field methods for vadose zone and groundwater system characterization, geophysics and contaminated site characterization. This course is based in Clemson with access to a well field and instrumented watersheds in the Clemson Forest.

Faculty Highlights

- **Jim Castle** (with **John Rodgers** of the Department of Forestry and Natural Resources) was awarded funding by the Department of Energy to investigate an "Innovative Water Management Technology to Reduce the Environmental Impacts of Produced Water."
- **Tim DeVol, Brian Powell** and **Robert Fjeld** received a grant from the U.S. Nuclear Regulatory Commission to boost nuclear education and expand the industry's work force.
- **Jim Castle** has been elected to a two-year term as editor-in-chief of *Environmental Geosciences*.
- **Cindy Lee** has been appointed to a three-year term on the Environmental Engineering Committee of the Science Advisory Board of the EPA.
- **Tanju Karanfil** was selected to the editorial advisory board of *Journal of American Water Works Association*.
- A 1989 *Applied and Environmental Microbiology* paper entitled "Biological Reductive Dechlorination of Tetrachloroethylene and Trichloroethylene to Ethylene under Methanogenic Conditions" by **David L. Freedman** (Clemson University) and James M. Gossett (Cornell University) was selected by the Association of Environmental Engineering and Science Professor (AEESP) as the 2008 AEESP Outstanding Publication Award.

Industrial Engineering

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Fast Facts

Tenured/tenure-track faculty: 11

Enrollment:	Undergraduate	125
	Master's	32
	Doctoral	23
Degrees awarded:	Undergraduate	35
	Master's	19
	Doctoral	3

Research expenditures: $777,605

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

Mary Beth Kurz works with **Lindsey Grooms** and **Lisa Slagh** using genetic algorithms to locate a hospital in a city while taking multiple conflicting measures into account. This exercise is part of their Creative Inquiry project.

Clemson University is home to the only industrial engineering (IE) program in the state of South Carolina. Nationally recognized, the department offers teaching, research and outreach that emphasize the discovery and application of knowledge in key information-technology-driven emphasis areas.

A major research and teaching area for the department is production and service systems, focusing on applications of operations research. Related course work includes fundamentals of operations research, production planning and control, supply chain design, quality and reliability, and facility planning and design.

The IE program also includes education and learning systems research, studying the work of faculty and students in the development, application and evaluation of alternative approaches to the delivery of engineering subject material. The research seeks to design educational delivery systems to make more effective and efficient use of faculty and facility resources as well as identify ways to assemble and present engineering materials that will increase the relevance of the educational experience while enabling a greater number of students to successfully complete degree requirements.

Another facet of IE research is the study of human factors, especially within applications of hybrid systems, user-centered design, computer-supported collaborative work, knowledge engineering and industrial ergonomics. Research encompasses aviation inspection systems, computer-supported cooperative work, human/computer interaction, hybrid inspection, industrial ergonomics and the ergonomics of space flight.

Faculty Highlights

The Fluor Corp. has made a $2 million matching commitment to Clemson University to create the Fluor Endowed Chair of Supply Chain and Logistics in the IE department. The $2 million award matches $2 million from the South Carolina Centers of Economic Excellence program for a $4 million total endowment. Establishing this chair allows a world-renowned leader in supply chain research to champion activities in education, research and industry outreach at the Research Center for Economic Excellence in Supply Chain Logistics. The endowment will also support students and associated educational programs.

Scott Shappell's research is focused on the human factors associated with transportation and accidents. Shappell is the co-creator of the Human Factors Analysis and Classification System (HFACS). HFACS is a system-safety model that effectively bridges the gap between human error theory and applied human error analysis. Originally developed for use with U.S. Navy and Marine Corps aviation accidents, HFACS has been used by a number of other aviation organizations in the United States and around the world. Applications have also been made in a variety of other industries including mining, chemicals, oil, manufacturing and medicine. What makes HFACS particularly unique is its ability to identify data-driven interventions.

Facilities

The National Science Foundation has selected Clemson University as a research site for the Center for Engineering Logistics and Distribution, an Industry/University Cooperative Research Center. The selection has the potential to affect the flow of raw materials, scheduling production and distributing finished goods for everything from homeland security and disaster preparedness to automobile production and distribution.

The Clemson Institute for Supply Chain Optimization and Logistics brings together an interdisciplinary group of faculty from four different colleges at Clemson University and provides tangible products and services that support economic development in South Carolina.

School of Materials Science and Engineering

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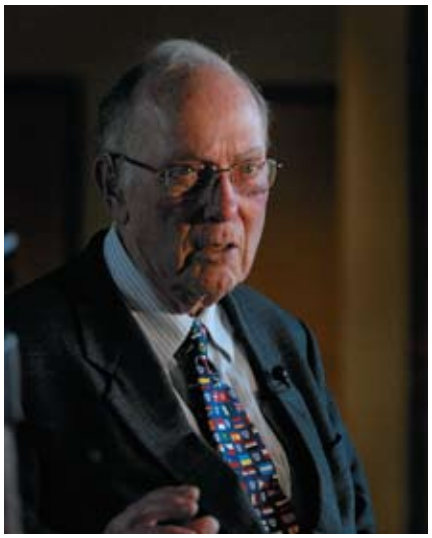
Fast Facts

Tenured/tenure-track faculty: 17

Enrollment:	Undergraduate	109
	Master's	7
	Doctoral	48
Degrees awarded:	Undergraduate	16
	Master's	5
	Doctoral	5

Research expenditures: $6,500,590

Research thrusts: processing and applications of novel inorganic, organic and natural fibers; processing and characterization of interfaces: chemistry, microstructure and failure and fatigue attributes; high-performance metal alloys and metal-, glass- and polymer-based composites; structural and optical ceramics, glasses



Clemson University recently celebrated its long-time connection with Nobel Prize-winner **Charles H. Townes** by naming its state-of-the-art optical science laboratories in his honor. Townes is best known for his research that led to the development of the laser, for which he received the Nobel Prize for physics in 1964.

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

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

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

Faculty Highlights

The MSE school consists of 18 full-time faculty, three research faculty, and 14 administrative and technical support staff. This includes two new hires and one joint hire with the School of Architecture in 2006-07. MSE anticipates the hiring of three new faculty positions, including two of South Carolina's Research Center of Economic Excellence Endowed Chairs: the $8 million J.E. Sirrine Textile Foundation Endowed Chair in Advanced Fiber-Based Materials and the $10 million J.E. Sirrine Textile Foundation Endowed Chair in Optical Fibers.

Facilities

The school and its faculty participate in the following Clemson research centers:

- The Center for Optical Materials Science and Engineering Technologies (COMSET) is headquartered at the Advanced Materials Research Laboratory, a $21 million complex in the Clemson University Advanced Materials Center. The 111,000-square-foot research facility houses laser and chemical labs and the University's Electron Microscope (EM) facility. COMSET is recognized as a global leader for innovation and education in the science and technology of optical materials. Since it began in 2000, it has garnered more than $40 million in research funding.
- The director of the University's EM facility, **JoAn Hudson**, holds a research faculty appointment in MSE. One of the most outstanding EM facilities in the country, this is a critical resource to MSE team members and other researchers.
- Clemson Apparel Research (CAR) was established to revitalize the domestic sewn-products industry through the application of advanced technology and management practices. It is now a premier national resource for high-performance textiles and related materials research and applications. CAR's fast-turn manufacturing and supply chain optimization solutions are being applied to other industries.
- The Clemson Conservation Center focuses on the science of conserving and preserving archeological finds and other historic treasures. One of their current projects is the conservation of the *H.L. Hunley*, a Civil War submarine that sat at the ocean floor for 130 years before it was found and brought up.

Mathematical Sciences

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Fast Facts

Tenured/tenure-track faculty: 41

Enrollment:	Undergraduate	109
	Master's	26
	Doctoral	71
Degrees awarded:	Undergraduate	17
	Master's	26
	Doctoral	6

Research expenditures: $1,202,724
Research thrusts: algebra/discrete mathematics, applied analysis, computing, operations research, probability/statistics

Marilyn Reba received the Clemson University 2008 Award for Innovative Excellence in Teaching, Learning and Technology. She was presented the award at the Fall 2007 Teaching with Technology Symposium and was designated as Clemson's nominee for the Ernest L. Boyer International Award for Excellence in Teaching, Learning and Technology.

The Department of Mathematical Sciences at Clemson 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 courses to cutting-edge research courses at the graduate level. 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 (37 national and international talks in 2007-2008), national and international professional involvement of the faculty, and funded research worth approximately $1 million per year.

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.

Twenty-eight students graduated with bachelor's degrees in the mathematical sciences in 2007-2008. In addition, the department awarded 28 master's degrees and six Ph.D. degrees during the past year.

For the fourth consecutive year, the department hosted the Clemson Calculus Challenge, a calculus-exclusive competition based on the Advanced Placement Calculus AB syllabus. Recognized with $30,000 in funding by the National Science Foundation, the 2008 competition serves the region's brightest high school math students, covering areas of the Southeast, including Atlanta, Ga., and Charlotte, N.C.

Faculty Highlights

The Institute for Operations Research and the Management Sciences presented its 2008 Lanchester Prize 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." This paper was jointly published with Hanif D. Sherali from Virginia Tech. The Lanchester prize is awarded for the best contribution to operations research and the management sciences published in English.

Taufiquar Khan and **Irina Viktrovoa** 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 with mathematical techniques for increasing efficiency and cutting costs for an optimal "smart grid" network.

Clemson currently has 60 smart classrooms interspersed around campus that 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.

Mechanical Engineering

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Fast Facts

Tenured/tenure-track faculty: 33

Enrollment:	Undergraduate	574
	Master's	102
	Doctoral	66
Degrees awarded:	Undergraduate	155
	Master's	41
	Doctoral	6

Research expenditures: $2,993,414

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

Yong Huang received the National Instruments Outstanding Young Investigator Award at the 2008 ASME International Symposium on Flexible Automation.

The Department of Mechanical Engineering has one of the largest academic programs in the state of South Carolina with 520 undergraduate students and 199 graduate students. The department has seen unprecedented growth in the last three years with 13 new faculty joining its ranks, the creation of a graduate program in automotive engineering that focuses on systems integration to meet the challenges of the global automotive marketplace, and the construction of a 90,000-square-foot, unique facility to house the new program.

Funded research activities put this department at the cutting edge in various fields. The research is distributed across nine major disciplines: automotive engineering, bioengineering and biomaterials, design, dynamics and controls, fluid mechanics, materials and materials processing, manufacturing, solid mechanics and thermodynamics, heat transfer and combustion.

Newly developed focus areas include lightweight engineering design for reduced energy consumption in automobiles, development of novel computational and experimental techniques to address fluid flow and combustion problems at different scales, development of new biomaterials and biomanufacturing processes, energy management using control and thermal management techniques, and dynamics, control and measurements in MEMS and NEMS. Computational research makes use of a supercomputing cluster to study microscale phenomena using atomic-level molecular dynamics simulations. These simulations have recently identified novel pathways by which buckyballs and other man-made nanoparticles may be able to enter human cells. The department is also the birthplace of materials formed by chaotic advection.

Faculty Highlights

- **Georges Fadel** was elected by the dean to receive the ExxonMobil Employees Endowed Chair in Engineering for his contributions to the department, the college and the University in addition to his professional achievements in the field of design. He deals primarily with topics in packaging optimization, multi-material design and manufacturing, and design methodology. He has published more than 150 research articles.
- **Paul Venhovens** has joined Clemson as the fourth endowed chair for the CU-ICAR automotive engineering program. He came to the University from BMW's Research and Development headquarters in Munich, Germany, where he worked in the field of systems integration. Venhovens received his Ph.D. in mechanical engineering in 1993 from Delft University of Technology in his home country of the Netherlands.
- **Jim Qiao's** paper titled "Carbon nanomaterials in biological systems" was selected as one of the top papers published in the *Journal of Physics: Condensed Matter* in 2007. The paper, a joint work with Pu-Chun Ke in the physics department, details the physics behind the promise, challenge and emerging concerns of nanotechnology in bioengineering. Qiao's research focuses on computer modeling of transport phenomena at micro- and nano-scales.
- **Lin Ma's** paper entitled "Measurement of aerosol size distribution function using Mie scattering-mathematical consideration" has been ranked No. 9 in the top 25 of the "Hottest Articles" of the *Journal of Aerosol Science*. This journal is one of the most prestigious international journals on aerosol-related topics.

Facilities

The Department of Mechanical Engineering 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 bio-fluids to 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 specialized laboratories for 18 areas.

Our 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 a set of automotive testing resources valued at more than $10 million which includes 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 careers in the automotive sector (OEM and suppliers). The facilities also are used to conduct advanced research and development in automotive engineering in conjunction with our partners.

Physics and Astronomy

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Fast Facts

Tenured/tenure-track faculty: 22

Enrollment:	Undergraduate	75
	Master's	4
	Doctoral	45
Degrees awarded:	Undergraduate	12
	Master's	5
	Doctoral	5

Research expenditures: $2,904,970

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

The research in the lab of **Pu-Chun Ke** focuses on the fundamental questions in single-molecule biophysics, polymer physics and nanoscience. In addition to being committed to graduate research and education, Ke has trained eight undergraduate students over the past five years on research topics ranging from the diffusion of dendrimer-like DNA and DNA damage to gene delivery, supramolecular energy transfer, and cell and aquatic organism responses to carbon nanoparticles.

Physics, the most fundamental of the natural sciences, forms the basis of study upon which the other branches of science are founded. Clemson's physics department focuses on teaching the fundamentals of astrophysics, biophysics, nanomaterials, and surface and interface nanoscience. Additional subjects include atmospheric and space, materials, single molecule, solid state and surface physics.

Biophysics is a discipline that resides at the intersection between chemistry, physics and biology. Currently, three tenure-track faculty members make up the Physics and Astronomy Biophysics Group, with research devoted to such topics as DNA damage and repair mechanisms, effects of nanoparticles and biological systems interactions, *in situ* modeling and prediction of protein-protein interactions, and RNA structure-function relationships. Efforts are currently being made to expand research in this interdisciplinary field, and much work has been carried out in recent years by talented undergraduate students. Former and current undergraduate biophysics research students work in the laboratories of professors **Emil Alexov, Pu-Chun Ke** and **Meredith Newby Spano**.

The research in the Alexov lab utilizes the methods of computational biophysics and bioinformatics to predict 3-D structures of proteins and protein-protein complexes. They use either experimentally determined or predicted structures to calculate biochemical properties, pKa's and the effect of the environment (pH and salt concentration) on proteins stability, function and interactions. The Alexov lab actively collaborates with experimentalists and medical doctors to better understand biological characteristics of proteins and protein-protein complexes. One talented undergraduate student in particular, **Kemper Talley**, has done an enormous amount of work on modeling protein-protein interactions. In just a short time, Kemper has already co-authored three papers, including one in the high-profile *Biophysical Journal*.

Among the current and former undergraduate trainees, **Jessica Moore**, now in her third year at the Medical College of Georgia, published a journal paper in 2004 which has now been cited 57 times and regarded as the earliest work on RNA delivery using a nanotube transporter. **Katherine Freedman**, now finishing medical school at the University of Kentucky, published four journal papers during her three years of research in the Ke lab. Other notable undergraduate trainees from the Ke lab include **Aaron Jones** (currently in graduate school at UNC-Chapel Hill) and William Floyd (currently at UC-Berkeley graduate school). Among the current undergraduate students, **Michelle Reid** conducted research at the Helsinki University of Technology in Finland this past summer and co-authored a paper on cell contraction in the high-impact journal *Small*.

The long-term goal of the Newby Spano lab focuses on understanding the natural "tools" RNA employs to expand its structure/function capabilities within the cell. Students employ biophysical methods such as fluorescence and NMR spectroscopies. Research commenced in the laboratory two years ago with a group of four undergraduates including **David DeWitt, Robert Clarke, Justin Moody** and **Aaron Allen**. In the fall of 2007, DeWitt presented a talk on his research at the Southeastern Regional Meeting of the American Chemical Society, and Allen, Moody and Clarke presented posters. DeWitt, who worked on an HIV-1 RNA project, now has a paper in preparation. He presented a poster on his work at the RNA Society Meeting in Berlin, Germany, in July 2008, and is now a graduate student in the biophysics and biochemistry graduate program at Yale. Clarke is a graduate student studying theoretical physics at UC-Berkeley, and Moody is enrolled at the Medical University of South Carolina in Charleston.

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* This degree program includes courses in the College of Agriculture, Forestry and Life Sciences, as well as the College of Engineering and Science.

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