Dr. Shiou-Jyh Hwu and Wendy Queen go over vacuum line techniques in a physics lab. Hwu has been studying low-dimensional magnetic compounds for potential device applications in quantum computing and information storage. This is just one example of inter-departmental collaboration within CES, namely the chemistry and physics departments.

On the cover: A photograph of molten carbon won second place in Clemson's 2006 Science as Art competition. The material, mesophase pitch, is a liquid-crystalline material used to manufacture carbon fibers and composites for high-strength structures such as aircraft, spacecraft and high-performance sports equipment.

IDEaS

COLLEGE OF ENGINEERING AND SCIENCE SPRING 2008

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Creative Inquiry gives students a taste of research.

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One of Clemson's best discoveries is a program about discovery.

8 Broadening Our Horizons
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Clemson's chapter of Engineers Without Borders uses skills to help others.

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Minority retention program reaches a milestone.

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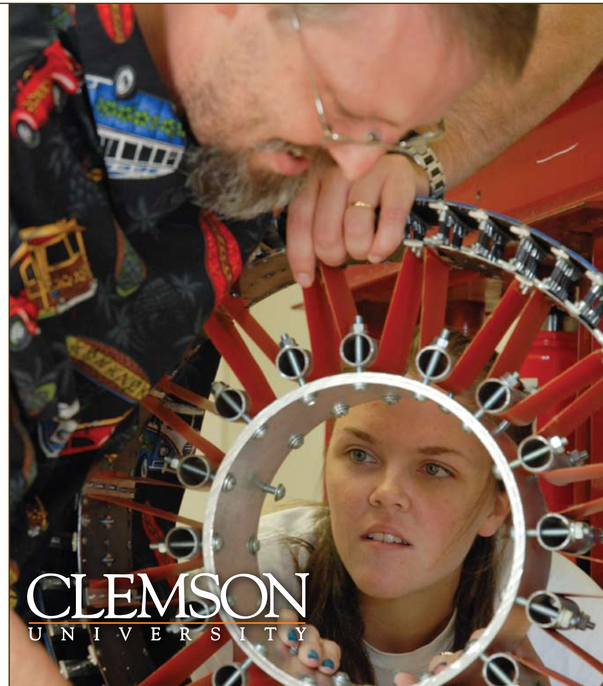


A Message from the Dean

Welcome to the second issue of *IDEaS*, a publication of the College of Engineering and Science (CES) at Clemson University!

The heart of a university is in the ideas that inspire it, as well as the inquiry and new discoveries that follow. It's often a cyclical process, resulting in new ideas to pursue. In CES, we've developed an acronym that embodies the true spirit of research. With that, *Inquiry, Discovery in Engineering and Science*, or *IDEaS*, is the perfect moniker for our publication.

In the first issue, we concentrated on telling the general story of CES, identifying our partnerships with industry and research teams and leaders in the college. We also highlighted our unique collaborative environment. This issue focuses on our students, celebrating their aspirations and achievements. **One of the things that sets Clemson apart from other research universities is that we encourage the entire campus to engage in discovery from undergraduates on up to the most accomplished professors.** This issue offers a deeper understanding of a few of the advantageous programs that are available to our students.

Each of Clemson's colleges participates in subject-appropriate research that facilitates intensive, discovery-oriented approaches to learning as part of our Creative Inquiry (CI) program. At this time, there are more than 30 CI projects in CES — some in collaboration with other colleges on campus. Each project combines a meaningful experience with deep understanding and appreciation of scientific and/or humanities research.

Another Clemson program invites incoming freshmen to begin their college-level research early. The EUREKA! program takes place for a month in the summer to introduce the Clemson experience to students in the Calhoun Honors College. Students who take advantage of this opportunity often find it helps them build rapport with their future professors and fellow honors students, paving the way to a successful college career.

Studying abroad continues to be a popular program at Clemson. **As more and more employers discover the value of hiring personnel with an understanding of the global economy, Clemson is seeing record numbers of students packing their bags to experience more of what the world has to offer.** Currently, more than 15 percent of CES graduates have some sort of study abroad experience. While that's three times the national average, I look forward to seeing even more students benefit from international study.

Clemson's chapter of Engineers Without Borders is just one of the outlets available to CES students who wish to pursue service-learning opportunities. Our students have already traveled to New Orleans to help rebuild areas affected by Hurricane Katrina and plan to visit El Salvador and Tanzania in the near future.

And while I'm telling you about our extraordinary students, I'd be amiss if I didn't mention PEER, Programs for Educational Enrichment and Retention, which has just celebrated 20 years on the Clemson campus. This program offers support to African-American, Hispanic and Latino CES students in the form of mentoring, academic counseling and tutoring. And the results speak for themselves. **Clemson is in the top 10 in the nation, among predominantly white schools, in numbers of African-American students graduating in technical fields.**

The following pages offer more information about each of the programs I've described, along with some updates about the latest happenings around the college. We've also added a back section that describes our 14 schools and departments in-depth.

We're a research university that's invested in student success. I'm sure once you've flipped through this issue of *IDEaS*, you'll have a few ideas of your own as to why some of the nation's best and brightest students are choosing Clemson.

Sincerely,

Esin Gulari, Dean
College of Engineering and Science
Clemson University

Redefining the Undergraduate Experience

By Anne McKenzie-Jenkins

What do green stinkbugs and hospital evacuation have in common?

They are both the subjects of unique research projects in the College of Engineering and Science.

Clemson University students have a universe of challenges to study. One increasingly popular approach is the Creative Inquiry program.

Creative Inquiry includes all intensive, discovery-oriented approaches to learning. Emphasis is placed on providing an experience that will be meaningful to undergraduate students, while promoting reasoning, critical thinking, ethical judgment and communication skills as well as a deep understanding of the methods of scientific and/or humanities research. Project teams are led by one or more professors who direct the team's research efforts across multiple semesters.

Let's take a closer look at two projects.

In the industrial engineering department, professor Kevin Taaffe and his team are exploring health-care facility emergency evacuation planning. His team includes industrial and chemical engineering students, plus a nursing student. The work also provides an opportunity for a graduate student in industrial engineering to improve mentoring skills.

While many researchers have studied and proposed emergency response plans for natural disasters, most focus on the ability of a

College of Engineering and Science Creative Inquiry 2007-08

Unmanned Aerial Vehicle Research
Timothy Burg, Ph.D., Department of Electrical & Computer Engineering

Integrating Mathematical and Computational Science into Bioengineering Modeling and Design Problems
James Brannan, Ph.D., Department of Mathematical Sciences, and John DesJardins, Ph.D., Department of Bioengineering

Developing Clemson University's Solar Decathlon Team
Elizabeth Carraway, Ph.D., Department of Environmental Engineering & Earth Sciences

Design Experiences in Human-Computer Interaction
Joel S. Greenstein, Ph.D., Department of Industrial Engineering

Sensor-Enabled Game Design
Jason Hallstrom, Ph.D., School of Computing

Renewable Resource Polymers for Biomedical Applications
Douglas Hirt, Ph.D., and Graham Harrison, Ph.D., Department of Chemical & Biomolecular Engineering, and Lisa Benson, Ph.D., Center for Advanced Engineering Fibers & Films

Enhancing CO_2 Absorption in Cellulose Membranes
Scott Husson, Ph.D., and Chris Kitchens, Ph.D., Department of Chemical & Biomolecular Engineering, and Lisa Benson, Ph.D., Center for Advanced Engineering Fibers & Films

Enhancing Chemistry Education Through Service Learning
John Kaup, Ph.D., Department of Chemistry

Project GADGET: Genetic Algorithms Designed by underGraduate Engineering Team
Mary Kurz, Ph.D., Department of Industrial Engineering

Nanoconstruction and Nanomanipulation Using a Scanning Tunneling Microscope
Russell Lake, Ph.D., and Chad Sosolik, Ph.D., Department of Physics & Astronomy

SPIRIT: Student Projects in Rocket Investigation Techniques
Miguel Larsen, Ph.D., Department of Physics & Astronomy

Synthesis and Plymorphic Control of TiO_2 Nanoparticles for Visible Light Active Antimicrobial
Burtrand I. Lee, Ph.D., School of Materials Science & Engineering

Developing and Deploying Intelligent Wireless Cyber-Services for the Clemson University Campus
Krishna P.C. Madhavan, Ph.D., Department of Engineering & Science Education, School of Computing

Game Engine Design and Construction
Brian Malloy, Ph.D., School of Computing

Codes and Cryptography
Gretchen Matthews, Ph.D., Shuhong Gao and Hiren Maharaj, Department of Mathematical Sciences

Applying Operations Research to Real-world Problems in the Service Industry
Maria Mayorga, Ph.D., Department of Industrial Engineering

A Framework for Creative Inquiry in the Industrial Engineering Curriculum
Brian Melloy, Ph.D., and Delbert Kimbler, Ph.D., Department of Industrial Engineering

Water, People and Environment: An Exploration of Resource Sustainability at Clemson and Abroad
Stephen Moysey, Ph.D., Department of Environmental Engineering & Earth Sciences

The Groundwater Project
Larry Murdoch, Ph.D., Department of Environmental Engineering & Earth Sciences

Continued on page 4

Facing page: Dr. Kevin Taaffe discusses research with his Creative Inquiry (CI) team.

Left: Dr. Steve Stevenson and Ian Wood, a member of his CI team, explore Skunk Works Software.

Right: Members of the unmanned aerial vehicle research team pose with their invention.

Continued from page 3

Interdisciplinary Development of Geoscience Research Tools
Larry Murdoch, Ph.D., Department of Environmental Engineering & Earth Sciences, Richard Brooks, Ph.D., Department of Electrical & Computer Engineering, and Cecil Huey, Ph.D., Department of Mechanical Engineering

Functional Tissue Engineering of Heart Valves
Jiro Nagatomi, Ph.D., and Dan Simionescu, Ph.D., Department of Bioengineering

Clemson University Pedestrian Facility Safety Study
Jennifer Ogle, Ph.D., Department of Civil Engineering, and Johnell Brooks, Ph.D., Department of Psychology

Exploring New Technologies for Living and Learning
Roy Pargas, Ph.D., School of Computing

Renovation and Augmentation of a Four Manual Electronic Organ
William Park, Ph.D., Department of Engineering & Science Education

Incorporating Pipes into an Electric Organ
William Park, Ph.D., and Ben Sill, Ph.D., Department of Engineering & Science Education

Roadways as an Energy Source
Brad Putman, Ph.D., Department of Civil Engineering

ASCE Steel Bridge Team
Scott Schiff, Ph.D., Department of Civil Engineering

Skunk Works Software
Steve Stevenson, Ph.D., and Ken Weaver, Ph.D., School of Computing

Journey Inside the Cell
Alexey Vertegel, Ph.D., Department of Bioengineering

Health-Care Emergency Evacuation Planning and Airport Operations Modeling
Kevin Taaffe, Ph.D., Department of Industrial Engineering

Institutionalizing Creative Inquiry in the Undergraduate Research Component of the Geology Curriculum Using the Clemson Forest and the Clemson Campus
John Wagner, Ph.D., Department of Environmental Engineering & Earth Sciences

host hospital or triage unit to accommodate the influx of patients resulting from the disaster. Few formal studies specifically address the issues these facilities face when their occupants must be evacuated.

"Hurricane Katrina revealed the need for this critical area of research," says Taaffe. "Everyone was able to see the obstacles that were presented in those evacuation efforts." He believes the students value this opportunity to make an impact on real-world practices. "It's an area of research that's very real. We don't know when events will occur that put us in the position of turning our theories and simulations into real actions."

The team is working to create a simulation model for North Greenville Hospital. The next step will be an optimization model.

Students on this Creative Inquiry team are also benefitting from the less structured interactions that occur in the project environment. "It's a discovery process that's being driven by the students," says Taaffe.

At the same time, a cross-disciplinary team is looking for ways to protect soybean and cotton crops using unmanned aerial vehicles (UAVs).

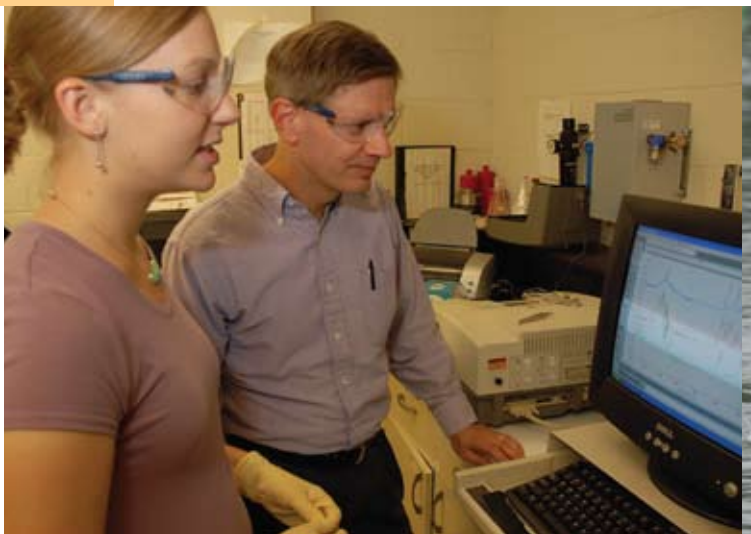
Using four unmanned state-of-the-art medium scale research helicopters, the team will track the movements of adult green stink bugs. These insects, also known as *nezara viridula*, pose a tremendous negative economic threat to the soybean and cotton farming industries, causing yield reduction, diminished seed quality and delayed maturity.

Students on this Creative Inquiry team are also benefitting from the less structured interactions that occur in the project environment. "It's a discovery process that's being driven by the students," says Taaffe.

By attaching a tracking device to individual bugs, the team hopes to gain a better understanding of the behavior and life cycle of the bugs. This understanding will lead to new areas of research designed to better protect these vital crops.

The team consists of students and professors of electrical, computer, agricultural and biological engineering, as well as entomology.

For more information about Clemson's Creative Inquiry program, visit *www.clemson.edu/ugs/creative_inquiry.* *



Left: Dr. Douglas Hirt works with Courtney Taylor to identify renewable resource polymers for biomedical use.

Right: Clemson's Concrete Canoe team tests their latest design.

ONE OF CLEMSON'S BEST DISCOVERIES IS A PROGRAM ABOUT DISCOVERY.

EUREKA!

By Rebecca Shepherd

Many are familiar with the story of the mathematician Archimedes who, upon discovering fluid displacement while in a bathtub, ran naked through the streets shouting "Eureka!" (Greek for "I found it!"). In the same spirit of discovery, many Calhoun Honors College students have the opportunity to experience "aha! moments" (sans the streaking, of course) by taking part in Clemson's Experiences in Undergraduate Research, Exploration and Knowledge Advancement! — also aptly dubbed EUREKA!.

EUREKA! is a unique endeavor that immerses incoming students into the academic world of Clemson University and enriches the rising sophomore academic experience. For a month in the summer,

> While EUREKA! opens academic doors, it also helps students acclimate to the social side of college life.

participants perform research, explore the campus and its many facilities, become acquainted with some of the University's best faculty and administrators, and experience the diverse culture and natural beauty of Upstate South Carolina.

Raymond Smith, a junior from Birmingham, Ala., remembers his first exposure to university-level research. "I think the combination of my background and my professor's understanding of my educational level enabled me to comprehend my project and effectively apply myself to the research." He was paired with bioengineering professor Sarah Harcum and studied how *E. coli* bacteria produce proteins for medicinal purposes. "She was very understanding whenever I asked her about something I had not been exposed to before."

Chemistry professor Julia Brumaghim thinks the EUREKA! program helps students lose their fear of

approaching and asking questions of faculty members. "The students are more likely to approach faculty about doing additional undergraduate research. They definitely gain an advantage by interacting with faculty early on." She adds, "I've hosted two EUREKA! students in my labs, and both are now co-authors on manuscripts submitted for publication. Not bad for a few weeks' work!"

Chris Briere, a sophomore from Seymour, Tenn., was paired with chemical engineering professor Anthony Guiseppi-Elie and studied how polymer films could be assembled to emulate the senses of smell and taste. He says, "EUREKA! made me realize how fulfilling doing research can be."

"The students are more likely to approach faculty about doing additional undergraduate research. They definitely gain an advantage by interacting with faculty early on," says chemistry professor Julia Brumaghim.

Briere and Guiseppi-Elie are continuing their research at the Center for Bioelectronics, Biosensors and Biochips. Briere adds, "If you work hard in your lab, the connections you build will be invaluable whether you're working on a project in your field or not."

While EUREKA! opens academic doors for students, it also helps them acclimate to the social side of college life. Briere recalls, "The first semester is often a daunting time for incoming freshmen (I know it was for me), but I felt the process went more smoothly because we were entering with 30 close friends — who all lived in the same residence hall."

Rachel Bedosky, a sophomore engineering student from Bluffton, S.C., agrees with Briere about

Clockwise from upper left: Ashley Lawhon and Dr. Julia Brumaghim study the role metal ions play in preventing damage to DNA with antioxidants.

Rachael Bedosky, Mitchel Plyer and Dr. Pam Mack examine a world with depleted resources in the Lifeboat Project.

Chris Briere, Meena Mirdamadi and Dr. Anthony Guiseppi-Elie test to see if an artificial tongue can detect sour substances.

Lauren Miller, Elizabeth Steele and Dr. Ken Webb discuss the characterization of biodegradable hydrogel.

Scott Winston and Christopher Pollock work with biphasic liposomes with Dr. Bill Pennington in his lab.

Reid Sanders, Caroline Yount and Dr. Miguel Larsen compare the wind measurements in their *in situ* rocket with incoherent scatter radar readings.

Ray Smith investigates recombinant protein production in highly reduced genome *E. coli*.

the advantages of having a network of peers before classes even started. "EUREKA! definitely prepared me for my transition to college life. We were able to become familiar with the campus long before classes began, and we learned how to manage our time between working on our projects and socializing. We also met many of our future professors and identified the opportunities that awaited us on campus."

Bedosky's best friend, Ashley Lawhon, was her roommate during the program. Lawhon, a sophomore from Knoxville, Tenn., says they frequently hang out with the friends they made through EUREKA!. "The best part is that the whole experience is completely free. I loved EUREKA! so much that I'm going back next year as head counselor."

For more information about Clemson's EUREKA! program, visit *www.clemson.edu/cuhonors/eureka*. ✻

By Ron Grant

Broadening

Last year, the College of Engineering and Science's (CES) study abroad program reached a special milestone. Eighty-eight students packed their bags and went overseas for international studies — the highest number to date!

"We've been promoting study abroad for a long time, for a number of reasons," observes Steve Melsheimer, associate dean for undergraduate studies. "Aside from the intrinsic educational value, it's a lot of fun — but, most importantly, it prepares graduates to flourish in the global economy. Employers recognize that, and students seem to be getting the message. A few years ago, the number of Clemson engineering and science students annually studying abroad was more like 30 to 40."

It's important to note that the South Carolina economy is heavily committed to internationalization, with companies such as Michelin, BMW and Bosch. But, globalization is also a fact of life for U.S. companies, notably including such Palmetto State companies as GE and Fluor. Clemson students who study abroad find that this experience gives them an invaluable edge in the job market.

Currently 15 percent of Clemson's engineering and science graduates have some sort of study abroad experience. While that is three times the national average, CES would like even more students to benefit from international study.

Clemson is a member of Global E^3, a consortium of top engineering schools that offer American students the opportunity to spend a semester or a year in any of 17 countries. In turn, it also allows students of foreign member schools to study in the United States. Participants maintain progress toward graduation while studying abroad. In addition, Clemson has individual exchange agreements with schools in France, Germany, India and other countries.

Summer programs, on the other hand, are primarily Clemson-led student groups. The 2006-07 program in Trier, Germany, had a record 24 students, the largest number of CES students that Clemson has had in any one place, reflecting a program growth of more than 100 percent. The focus of the program was "Sustainable Energy and the Environment," with an emphasis on alternative energy. With gasoline prices on the rise, coupled with widespread discussion of global warming, Clemson students were drawn by the opportunity to learn from Germany's vast experience in energy conservation and sustainable energy systems while also learning about German culture.

"The Trier program offers a lot of neat opportunities for our students," states Randy Collins, associate professor of electrical and computer engineering and the instructor of record for the 2007 Trier summer program. "It's a 'get your feet wet' global experience that inspires many of our students to explore longer, deeper programs."

The college is continuing to establish new opportunities. This summer, two new programs will be offered in Belgium (see sidebar) that focus on timely topics in bioengineering and nuclear energy. And, responding to the growing importance of Asia in the global economy, a new exchange program has been established at Ansal Institute of Technology in Delhi, India. ✻

UCL Université catholique de Louvain

ICHEC BRUSSELS MANAGEMENT SCHOOL

Clemson's connection with Brussels and Belgium began with its founder, Thomas Green Clemson, who was a senior U.S. diplomat in Brussels from 1844 to 1850. Those connections were revived with the founding of the Thomas Green Clemson University Brussels Center (CUBC) in 2005. CUBC is a partnership among Clemson University, ICHEC (Institut Catholique des Hautes Études Commerciales) Management School and UCL (Université Catholique de Louvain).

Our Horizons

Clockwise from upper left: Tyler Dyre, a Clemson senior studying physics in Paderno, Italy, visits St. Peter's Basilica.

Students tour the Morbach Energy Landscape, a renewable energy park in Morbach, Germany.

Dr. Randy Collins (back row, second from right) and his students sit in front of the medieval Eltz Castle in Germany.

Students test a fuel cell at the Environmental Campus of the Fachhochschule Trier in Birkenfeld, Germany.

Students visit the city museum in Trier.

Students tour the Electoral Palace in Trier, a building that dates back to 1615.

Limitless Pos

With the help of encouraging faculty and community support, Clemson engineering students are taking what they learn in McAdams Hall outside of the classroom. *Way* outside of the classroom.

Engineers Without Borders (EWB) is an international organization that facilitates collaboration toward improving the quality of life for disadvantaged communities. It was a biosystems engineering student, then-junior Kim Walton, who first researched the organization and brought the idea to professor Caye Drapcho in 2005. What started as a discussion between student and professor gained momentum as other students got involved, resulting in Clemson's student chapter of EWB with 40 dues-paying members and five active faculty advisers.

"Many of our Clemson students have a strong altruistic streak in them," Drapcho says, "so it's easy to get them interested. I introduce EWB to my students in class, in the hopes of sparking interest in those who may not have thought about helping others with their education and skills."

EWB participants first used their know-how to help New Orleans residents after Hurricane Katrina. So far, the group has traveled to the region three times to work with Catholic Charities on Operation Helping Hands, using travel funds donated by Fluor Corp. Drapcho points out the added bonus for the students — beyond helping others and learning through action — of opening their eyes to a less-fortunate side of America.

"The first home we did was for a middle-class family," she says, "one that many of our students could relate to as being very much like their own. They (the family) had insurance and arranged for their home to be gutted, but the workers took the money and never returned. During that first trip in May 2006, I was very impressed with how hard they worked and how dedicated they were. I have been extremely proud of them!"

sibilities

by Carrie DuPre

The next project for Clemson's EWB is to help improve the water supply in El Salvador requiring a detailed application process and about $150,000. Jim Chamberlain, a graduate student, brought the El Salvador project to Clemson from his previous institution, Central Texas College. It was a natural fit for Drapcho and Clemson's chapter. With the assistance of Jim and other students like current chapter president, Mary Katherine Watson, much of the project application has been completed, and a portion of the needed funds has been solicited from the Clemson Rotary and Clemson University Student Government.

The immediate need in El Salvador is for clean drinking water; the secondary need is for ecotourism, which will in turn strengthen the economy. Students will also examine solutions to power office buildings, including solar energy and wind power. For their first trip to the region, slated for summer 2008, most of the EWB students will have worked throughout the year on some aspect of the project planning.

Plans continue for designing and installing solar water heaters for homes in New Orleans and starting a new project in Tanzania. To stay up-to-date on the chapter's work, visit *people.clemson.edu/~ewb*. ✻

"Many of our Clemson students have a strong altruistic streak in them," Drapcho says, "so it's easy to get them interested."

Top photos: Clemson EWB students lend a hand to rebuild structures and lives after Hurricane Katrina.

Above: EWB students take a break for a group photo during their trip to rebuild parts of post-Katrina New Orleans.

PEERS AMONGST YOUR

By Susan Polowczuk

Electrical engineer (EE '91) Donna Poindexter Smalls still recalls the feeling she had stepping onto Clemson University's campus as a freshman. "I was a fish out of water," she says.

Now a product manager for Schneider Electric, Donna grew up in Columbus, Ga. She was the first in her family to enter college, and familiar faces were few. But that didn't last long.

"PEER was an oasis in a big sea," she says. "From day one, the program and the people were there to support me."

PEER, the Programs for Educational Enrichment and Retention, recently celebrated 20 years on the Clemson campus. Donna says the program helped her navigate the college system from what courses to take to how to talk to professors. It also introduced her to lifelong friends and her future husband.

"Without PEER, I would have felt alone, lost in the system," says Mordecai "Corey" Smalls (EE '92), Donna's other half and a lead electrical engineer with 3 Phoenix in Raleigh, N.C. He adds that the program grounded him. "PEER was definitely a catalyst to set me up for where I am now in a technical leadership position. It also planted seeds and gave us tools to pursue graduate degrees in technical fields."

PEER serves all African-American and Hispanic students in the College of Engineering and Science (CES), providing a variety of services that include an innovative proactive mentoring program, the Math Excellence Workshop, the PEER/WISE Study Hall and personal and academic counseling.

Among predominantly white schools, Clemson is in the top 10 in the nation for numbers of African-American students graduating in technical fields each year.

Corey and Donna Poindexter Smalls pose for a family portrait with their children. Both Corey and Donna attribute successful college careers to their involvement with Clemson's PEER program.

PEER helps students form close-knit social networks within the College of Engineering and Science, creating supportive social and learning environments.

Many PEER students say that participating in the program has helped them to find their place on campus and make connections that serve them later in their careers.

In addition to **proactive mentoring**, other highlights of the PEER program include:

Math Excellence Workshop (MEW) — MEW students outperform other students in their summer mathematics classes and graduate in STEM (science, technology, engineering and mathematics) majors at a significantly increased rate. MEW earned national recognition with a Noel-Levitz Corporation Retention Excellence Award. The program is NSF-sponsored through the Louis Stokes–South Carolina Alliance for Minority Participation. It is also sponsored by Duke Energy and CES.

Sneak Preview — This is the primary recruiting event for PEER. High school students get a "sneak peek" at university life when they stay on campus and attend classes. Eighty percent of participants go on to attend Clemson.

WISE — Originally an outgrowth of PEER, WISE (Women In Science and Engineering) encourages girls and women to consider technical majors.

Community Service — "PEER got me involved in community service, doing a program to recruit high school students. That instilled leadership and confidence in me to this day," says Andre Loyd (ME '02), who is currently a Ph.D. bioengineering student at Duke. "Later when I decided to go to grad school, the PEER office was very instrumental in helping me get through the application process," he says.

"PEER connects minority engineering and science students to one another," says director Sue Lasser. "Each group of students instructs and inspires the next. Expertise is handed down from year to year."

According to the Engineering Workforce Commission, among predominantly white schools, Clemson is seventh in the nation in numbers of African-American students graduating in technical fields each year. Black Clemson students graduate in these fields at the same rate as their white counterparts — about 48 percent of each entering class. The national average for black engineering students is 21 percent.

PEER's proactive mentoring approach has been duplicated at other institutions around the country and has attracted interest from as far away as South Africa. Lasser was awarded one of the first national Presidential Awards for Excellence in Science, Engineering and Mathematics Mentoring. Both Lasser and Robert W. Snelsire, professor of electrical engineering and co-founder of PEER, have also received Clemson's Martin Luther King Award for Excellence in Service.

PEER director Sue Lasser poses with some of her students at graduation.

"The true measure of success is seeing these students not only graduate, but thrive in their lives. It is truly rewarding," says Lasser.

To stay up to date on PEER, visit *www.ces.clemson.edu/peer/links.htm*. ✻

News and notes

Office of Nuclear Energy awards grant to Clemson program

Clemson's Nuclear Environmental Engineering and Science (NEES) program gets an upgrade in research equipment with a Global Nuclear Energy Partnership (GNEP) University Readiness grant from the Department of Energy at the Office of Nuclear Energy.

Clemson's NEES program focuses on environmental aspects of nuclear technologies, including classroom instruction and laboratory research about radioactive waste processing, environmental health physics, environmental radiochemistry, environmental remediation radiation detection and measurement, and environmental risk assessment.

The GNEP University Readiness awards aim to upgrade laboratories, improve reactor facilities, purchase state-of-the-art equipment, provide increased faculty support and further enhance nuclear-related curricula at the nation's universities. Clemson's award will purchase a liquid scintillation counter, an automated titrator, and materials and supplies for potentiometric titrations.

Clemson students conduct bone-loss research on shuttle *Endeavour*

Members of the Clemson bioengineering department were at the Kennedy Space Center in August, conducting research on mice that were aboard the 13-day *Endeavour* shuttle mission. The team was studying bone loss as part of a larger study of effects of microgravity on the body.

Currently, crewmembers lose up to 2 percent of their skeletal mass each month during International Space Station missions, and bone strength declines with each month in space. Ted Bateman, assistant professor of bioengineering, says, "Earlier research showed that astronauts experience bone loss on extended missions, even when they exercise, due to microgravity. These studies may one day help space travelers retain bone mass and strength during long-duration flights, and the results have the potential to help bone-loss patients here on Earth."

This marks the second time Clemson University bioengineering faculty and students have participated in shuttle flight research. Clemson is a co-investigator in this study, sponsored by Amgen Inc. in partnership with BioServe Space Technologies, a NASA-sponsored Research Partnership Center at the University of Colorado, Boulder.

NIH recognizes Clemson nanotechnology for molecule tracking

The National Institutes of Health (NIH) has awarded two Clemson chemistry faculty members a grant to detect, track and image the interior of cells. Jason McNeill and Ken Christensen will develop polymer dot nanoparticles for tracking single molecules in live cells.

The development of techniques for following individual molecules within cells is important because scientists could use this technology to determine the body's defenses against invading viruses and bacteria and how proteins operate within the cell. The technology could also help doctors identify the exact location of cancer cells in order to improve treatment and minimize damage to healthy tissue. Other possible targets of investigation include plaques and fibrils in the brain associated with Alzheimer's disease and mad cow disease.

Details of the nanoparticle technology were presented at the 2007 national meeting of the American Chemical Society in Boston and have been published in the *Journal of the American Chemical Society*, in *Langmuir* and in the *Journal of Physical Chemistry*.

Breast cancer research and inkjet-tissue printing get NSF boost

The National Science Foundation (NSF) has awarded $2 million to the Center for Biological Interfaces of Engineering (CBIOE) at Clemson University for the development of engineered tissues that will help study the causes, progression and treatment of breast cancer.

The tissue engineering technology, which was pioneered at Clemson, is based on inkjet printing and will allow the creation of identical tissue samples that can be used to build cause-and-effect models.

"Our research team includes breast cancer surgeons, engineers and scientists — the breadth of expertise is tremendous and absolutely crucial for this very complex problem," says CBIOE director Karen Burg, who will lead the multidisciplinary research team.

Other collaborating investigators include Steve Ellis and Susan Duckett in animal and veterinary sciences, Thomas Boland in bioengineering, Amy Moran in biological sciences, Jason McNeill in chemistry, and Rick Groff and Timothy Burg in electrical and computer engineering. Partnering institutions include the Carolinas Medical Center, the University of North Carolina at Chapel Hill and the University of North Carolina at Charlotte.

Chemists discover new antioxidant marvels

A team of Clemson University chemists has found a new mechanism for antioxidant activity: The antioxidants bind to naturally present iron and copper in the body to prevent formation of reactive oxygen compounds that damage DNA.

Cardiovascular, Parkinson's and Alzheimer's diseases, in addition to cancer, are often linked to DNA damage that occurs when metal ions in the body such as iron and copper produce reactive oxygen compounds that damage human cells. Studies have shown antioxidants that neutralize this activity and that occur naturally in fruits, vegetables, green tea, garlic and onions can be effective at preventing DNA damage.

"Our studies have shown that antioxidants even at low concentrations found in these foods bind to iron and copper and prevent DNA damage," says lead investigator and chemist Julia Brumaghim. "This goes a long way in understanding how antioxidant supplements might help treat or even prevent these debilitating illnesses."

The group is now testing its findings in bacterial cells and will test human cells next. Research is funded through a grant from the American Heart Association.

Implantable biochip could mean the difference between life and death

The Department of Defense has awarded $1.6 million to the Center for Bioelectronics, Biosensors and Biochips (C3B) at Clemson University for the development of an implantable biochip that could relay vital health information if a soldier is wounded in battle or a civilian is hurt in an accident.

Anthony Guiseppi-Elie, C3B director and Dow Chemical Professor of Chemical and Biomolecular

Engineering and professor of bioengineering, says first responders to the trauma scene could inject the biochip into the wounded victim and gather data almost immediately. He adds that the biochip also may be injected as a precaution to future traumas.

Clemson scientists have formulated a gel that mimics human tissue and reduces the chances of the body rejecting the biochip, which has been a problem in the past. The award funds a joint study with the department of molecular pathology at the University of Alabama at Birmingham and Telesensors Inc. in Knoxville, Tenn.

NSF funding brings CAEFF and Tetramer Technologies together

The National Science Foundation (NSF) has provided funding that will allow the Center for Advanced Engineering Fibers and Films (CAEFF) to partner with Tetramer Technologies to further develop the Clemson University spinoff company's quantum dot technology. The NSF grant is intended to stimulate the transfer of innovative, leading-edge research performed at university engineering research centers to small businesses, which then move research results into the marketplace.

The project is based on patented Clemson optical fluoropolymer technology licensed by Tetramer and originally developed in Clemson's Center for Optical Materials Science and Engineering Technologies (COMSET) laboratories for optical applications.

This collaboration has the potential to impact the solid-state lighting, solar-energy harvesting and polymer optical fibers markets, as well as benefit national security through scintillator development.

Cooler, faster, cheaper: Clemson researchers advance silicon chip production

The next generation of laptops, desk computers, cell phones and other semiconductor devices may get faster and more cost-effective with research from Clemson University.

"We've developed a new process and equipment that will lead to a significant reduction in heat generated by silicon chips or microprocessors, while speeding up the rate at which information is sent," says Rajendra Singh, D. Houser Banks Professor and director for the Center for Silicon Nanoelectronics.

The heart of many high-tech devices is the microprocessor that performs the logic functions. These devices produce heat depending on the speed at which the microprocessor operates. Presently, dual-core or quad-core microprocessors are packaged as a single product in laptops to reduce the heat without compromising overall speed of the computing system.

The researchers say the patented technique has the potential to improve the performance and lower the cost of next-generation computer chips and a number of semiconductor devices, which include green energy conversion devices such as solar cells.

Clemson professor recognized by American Ceramic Society

Denis A. Brosnan, a professor of materials science and engineering at Clemson University, received the John Jeppson Award from the American Ceramic Society (ACerS). The award recognizes distinguished scientific, technical or engineering achievements in ceramics.

Brosnan is director of the National Brick Research Center, an ACerS Fellow and a member of the Structural Clay Products and Refractory Ceramics Division. He holds 11 U.S. patents, including one that dramatically changed the field of restorative dental materials. He is currently researching manufacturing and environmental concerns in clay bricks and restoration of historic masonry buildings.

LaBerge elected to head Society for Biomaterials

Clemson bioengineering professor and department chairwoman Martine LaBerge has been elected president of the leading professional society in the biomaterials/bioengineering field, the Society for Biomaterials (SFB), including more than 1,000 members from academics, industry, government and clinics.

As SFB president, LaBerge supervises and controls the business and affairs of the corporation and chairs the meeting committee and the board of directors.

Smith receives Outstanding Young Alumni Award

Dennis W. Smith, Clemson professor of organic chemistry, has been recognized with the 2007 Outstanding Young Alumni award by his alma mater, Missouri State University. This honor recognizes graduates for extraordinary achievement in their personal and professional endeavors. Since the inception of the award in 1985, only 25 individuals have received this recognition.

Smith is a founding member and associate director of Clemson's Center for Optical Materials Science and Engineering Technologies (COMSET).

Yang named DuPont Young Professor

Yanru Yang, assistant professor of environmental engineering and science at Clemson University, was named a DuPont Young Professor by the DuPont Fellows Forum. Yang is now a member of the 40th class of DuPont Young Professors and will receive a grant of $25,000 per year for three years. She is also invited to meet with members of the DuPont Fellows Forum to present her work in a seminar.

Yang is focused on environmental biotechnology with a particular interest in microorganisms relevant to the degradation of hazardous substances and treatment of water and waste.

Foulger group nails cover

The cover of the November 5, 2007, issue of *Advanced Materials* displays work done by Clemson's Foulger Group on the preparation of hydrogel-encapsulated crystalline colloidal arrays. The cover of *Advanced Materials* is instantly recognizable and associated worldwide with the highest quality research from the top researchers in the field.

Since its inception in the School of Materials Science and Engineering in 1999, the Foulger Group has been developing the materials and methods to synthesize and fabricate complex structures for use in optics-oriented applications. ✻

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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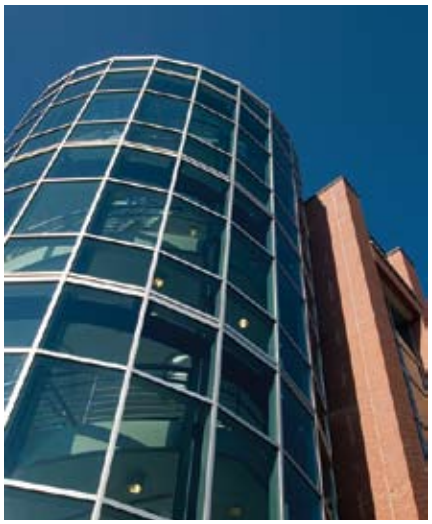

Clemson University is known as the international birthplace of the field of biomaterials — the building blocks of medical devices. The Society for Biomaterials (SFB), the premier professional society in the field of bioengineering, began at Clemson in 1974. In 2008, department chair and professor Martine LaBerge is serving as president of SFB, which has become the leading professional society in the biomaterials/bioengineering field and has more than 1,000 members from academics, industry, government and medical clinics.

Bioengineering's major research efforts focus on:

- Biomaterials
- Tissue Engineering
- Biointerfaces
- Biomechanics
- Biomolecular Engineering
- Biophotonics

Exciting, meaningful research is coming out of each area. For example, one team recently received $2 million in total grants to study radiation-induced bone loss. Both the National Institutes of Health and a branch of the National Aeronautics and Space Administration contributed the funds to study bone loss that occurs both clinically, as a result of radiation cancer treatment, and aeronautically, as a result of weightlessness in space flight.

The National Science Foundation awarded another Clemson team $2 million to develop engineered treatment for the study of breast cancer, particularly causes and characteristics during progression and treatment. The study will use tissue engineering technology based on inkjet printing — developed at Clemson — to create identical tissue samples that can be used to build cause-and-effect models.

Faculty

The bioengineering faculty has more than doubled over the past five years to 19 full-time faculty members. The latest additions include:

- Richard Swaja, former senior science adviser at NIBIB, as professor of bioengineering and director of the Bioengineering Alliance of South Carolina,
- Delphine Dean, assistant professor of bioengineering, who conducted her graduate work in the laboratory of Professor Alan Grodzinsky at MIT, and
- Ning Zhang, assistant professor of bioengineering, who obtained a doctoral degree in bioengineering from the University of Utah under Professor Patrick Tresco.

A search is on for the new $4 million Hansjörg Wyss Regenerative Medicine Endowed Chair in Orthopaedics, which was funded equally by the state of South Carolina and the Wyss Medical Foundation. Searches are also under way for two junior-level, tenure-track faculty members in the field of biomaterials science and engineering.

Facilities

Clemson's strong commitment to bioengineering has resulted in a $12 million allocation for a 29,000-square-foot addition to Rhodes Engineering Research Center. The three-story building will provide state-of-the-art undergraduate laboratories for tissue engineering, bioinstrumentaton and biomechanics. Classrooms will be equipped with the latest long-distance learning capabilities and research laboratories where undergraduate and graduate education will be integrated.

Building is also under way for the Clemson Translational Bioengineering Research Center, a 30,000-square-foot space located on the Greenville Hospital System's Patewood Campus. The center, a partnership between Clemson University and the Greenville Hospital System, will focus on bioengineering research and delivering new medical and surgical products to the market more quickly.

Biosystems Engineering

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David Brune, professor and holder of the Charles Carter Newman Endowed Chair of Natural Resources, recently received a patent for his controlled eutrophication process, which has been licensed for restoration of the Salton Sea in California.

Research Interests

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

- help people stay healthy,
- 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 and creating biomaterials and biofuels using natural and modified microorganisms. Biofuels, particularly biodiesel, from biomass and aquatic organisms is currently a topic of significant research. Ongoing research also includes hydrogen from biomass via fermentation pathways as well as 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 groundwater) 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 14 faculty members. Anand Jayakaran, from Ohio State University, recently joined the team. His research will include watershed modeling, low impact development and best management practices relative to storm water runoff from changing land use including commercial development of agricultural and/or forested lands.

Chemical and Biomolecular Engineering

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Anthony Guiseppi-Elie, Dow Chemical Professor and director of the Center for Bioelectronics, Biosensors and Biochips

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, 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

- The article "Synthesis of Biodiesel via Acid Catalysis," written by Edgar Lotero, Jim Goodwin, David Bruce, Dora Lopez, Yijun Liu and Kaewta Suwannakarn, was published in *Industrial & Engineering Chemistry Research*. It has been named three times in the past year as a "hot paper" as defined by Thomson Scientific (ISI) Essential Science Indicators. The term "hot paper" refers to the top scientific articles published worldwide within the past two years that receive the most citations over a two-month period. Only 200 papers in chemistry are so named. Goodwin's activities in this area have been recognized by researchers in the industry and have established his group in the forefront of biodiesel synthesis research. He is also editor of the Elsevier international journal *Catalysis Communications*.
- Anthony Guiseppi-Elie, Dow Chemical Professor and director of the Center for Bioelectronics, Biosensors and Biochips, has been named guest editor for *NanoBiotechnology*, a journal dedicated to science and engineering at the intersection of nanotechnology, molecular biology and biomedical sciences. Guiseppi-Elie will serve as guest editor for the special issue "Frontiers in BioCompatibility." This special issue will explore the emerging roles of bioactive, responsive and biologically inspired materials by design, plus biomimicry and nanotopography in addressing long-term implant biocompatibility.

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.

Chemistry

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Jennifer Kauffman, a doctoral student in materials science and engineering, extrudes alginate fibers in Dr. Bill Pennington's lab.

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

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

Faculty Highlights

- Jason McNeill and Ken Christensen have developed a method to dramatically improve the longevity of fluorescent nanoparticles containing materials called conjugated polymers that may someday help researchers track the motion of a single molecule as it travels through a living cell. Through a grant from the National Institutes of Health (NIH), the chemists are exploiting a process called resonance energy transfer, which occurs when fluorescent dye molecules are added to the nanoparticles. The team reported their findings at the 234th annual American Chemical Society (ACS) meeting in Boston.
- Dev Arya received the Horace S. Isbell Award for outstanding contribution to the field of carbohydrate chemistry during the August 2007 ACS meeting. Recognizing carbohydrate scientists under the age of 41, the award goes to those who have demonstrated excellence in the field and show promise of making high-quality contributions. Arya's research involves the chemistry and biochemistry of amino sugars and new pathways for molecular recognition of nucleic acids. His work opens up genetic targets for the development of new antibiotics that will be greatly needed in this century.
- Stephen Creager was recently named to the post of chemistry department chairman. He has been a member of the Clemson faculty since 1995 and served as associate dean of the graduate school from 2005 to 2007. He was an NIH postdoctoral fellow at the University of Texas and taught at Indiana University for six years before coming to Clemson. His research interests focus on electrochemical science and technology.
- Luis Echegoyen was awarded the 2007 Charles H. Herty Medal. This award, presented annually by the Georgia section of the ACS, recognizes the work and service of outstanding chemists. Echegoyen, former department chair and professor of chemistry at Clemson, is currently serving a two-year appointment as chemistry division director with the National Science Foundation.

Facilities

A major renovation is planned for Hunter Hall, where the chemistry department is located. 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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Civil engineering professor Prasada Rangaraju is a EUREKA! adviser and has many areas of interest, including: cement, concrete, aggregate and supplementary materials; microscopy and petrography of cement-based composites; aggregates; durability of cementitious systems; and the design, construction and rehabilitation of concrete pavements.

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

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

- The Clemson University civil engineering department was ranked No. 14 among civil engineering departments in public universities that offer a doctoral program, according to *U.S.News & World Report.* This ranking is based on the opinion of engineering deans and senior faculty in engineering colleges throughout the country.
- About 90 percent of seniors take the FE exam. Their pass rate in October 2006 was 86 percent compared to the national pass rate of 71 percent. Their pass rate in April 2007 was also 86 percent compared to the national average pass rate of 76 percent.

Faculty Highlights

Two new faculty members joined the civil engineering department in August 2007.

- Nigel Berkeley Kaye obtained his Ph.D. from Cambridge University and worked as a post-doctoral research associate at Imperial College in London. Last year, he was a lecturer in the civil engineering department at Clemson University. Kaye's teaching and research interests are in fluid mechanics.
- N. (Ravi) Ravichandran obtained his Ph.D. from the University of Oklahoma and continued to work there as a postdoctoral research associate. His teaching and research interests are in computational geotechnical engineering.

Robert Nowack will officially retire in May 2008 after 60 years of teaching. "PB," as he is known to many, started teaching at Clemson in 1947 and has taught multiple generations of the same family. In 1999, he was awarded an honorary doctorate in recognition for his service to his students and the University. Nowack holds the distinction of being an alumni professor, a title held by only a few.

Facilities

Lowry Hall is the home of the civil engineering department. It houses faculty and staff offices, undergraduate laboratories and graduate research labs. Additional specialized research laboratories are located just a short distance from campus. The Wind and Structural Engineering Research Facility, for instance, is a state-of-the-art facility supporting experimental research on the performance of buildings, bridges and other structures.

School of Computing

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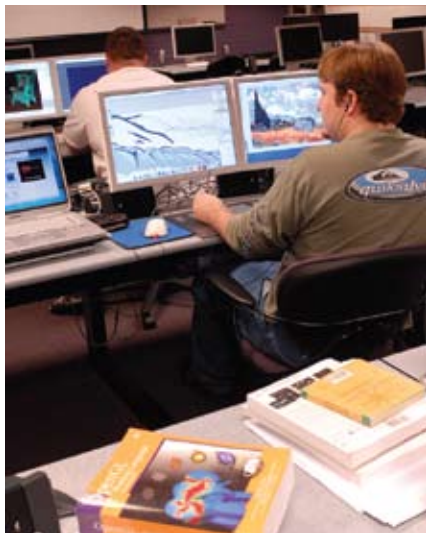

Clemson is in the midst of substantially upgrading its data center by investing $46.5 million over the next five years to build a totally new IT infrastructure that promises increased storage, bandwidth and CPU resources.

Clemson's School of Computing was created from the existing computer science department to enable the University to respond more effectively to emerging areas within the broad field of computing and to develop academic programs that will prepare students for a society in which computing has become so essential.

Students who seek careers in computing require core knowledge of the fundamentals of hardware and software system design, but they must also understand the application domain and its culture to solve problems. They find that what they learned in computer science must be complemented by knowledge of other domains (finance, architecture, insurance, civil engineering, construction). The School of Computing expands the conceptual framework for teaching and research to encompass these complementary domains.

The school is organized by focus areas:

- Computational Arts
- Foundational Computer Science
- Informatics (IT and High-Performance Computing)
- Computational Science
- Computing in Education

The school also offers an interdisciplinary program, the Master of Fine Arts degree in Digital Production Arts (DPA). There are very few programs like this in the country. DPA is a professional degree program aimed at producing technically savvy, artistically talented graduates who are sought after by the growing electronic arts industry, particularly by those companies engaged in special effects within the entertainment and commercial video, film and gaming industries. The recent advent of dramatic special effects in film, television and games has created an unprecedented demand for educational programs leading to careers in the field. To fill this need, the DPA program offers a blend of instruction from art, computer science, computer engineering, graphic communications, performing arts, philosophy and psychology, together with newly designed courses targeted at production techniques specific to the animation effects industry. Graduates now hold positions at Pixar, DreamWorks Animation, Industrial Light & Magic (Lucasfilms) and Rhythm & Hues, among others.

Faculty

The school has 31 full-time faculty members with plans to hire 15 more, including a permanent director. Both faculty and students have recently received several prestigious awards. Jay Steele, a doctoral student, received an NVIDIA Fellowship for the second year in a row. Only 12 of these are awarded worldwide. Doctoral student Michael Murphy has been awarded a three-year Graduate Research Fellowship by the National Science Foundation. Professor Jason Hallstrom and doctoral student Andy Dalton received the Best Testbed Award at the third IEEE CREATE-NET International Conference on Testbeds. Professors Sebastien Goasguen and James Martin have received an IBM Faculty Award for their project, Autonomic Virtualized Infrastructure, and Professors Robert Geist and James Westall have received an IBM Faculty Award for their project, VCL Supercomputing.

Facilities

The school supports numerous state-of-the-art instructional labs with more than 600 CPUs. Research labs hold specialized equipment including blade-servers, eye-tracking workstations, a large display wall, a high-performance (16.5 TFLOP) computing system built from graphical processing units (GPUs) and a motion-capture system for building animations and analyzing human motions. High-speed wireless access to the Internet is available throughout campus. The University has a 10 Gbps Internet connection, and school researchers are deploying an experimental, 4.9GHz WiMAX campus network to support both academic research and joint projects with public safety and law enforcement agencies.

Electrical and Computer Engineering

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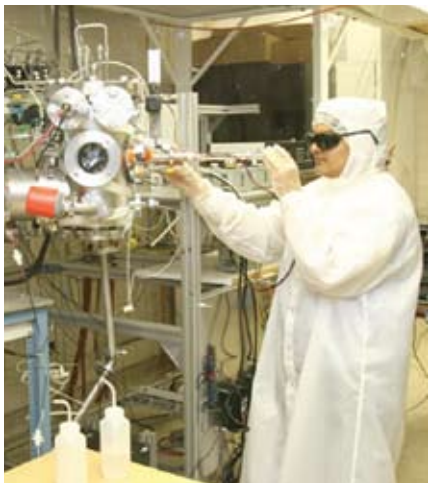

The next generation of laptops, desk computers, cell phones and other semiconductor devices may get faster and more cost-effective with research from Clemson's Rajendra Singh, D. Houser Banks Professor of Electrical and Computer Engineering and director of the Center for Silicon Nanoelectronics at Clemson University. Singh and his team have developed a new process and equipment that will lead to a significant reduction in heat generated by silicon chips or microprocessors while speeding up the rate at which information is sent. The researchers say the patented technique has the potential to improve the performance and lower the cost of next-generation computer chips and a number of semiconductor devices, which include green energy conversion devices such as solar cells.

Milton W. and Betty M. Holcombe have given a total of $6 million to support the Milton W. Holcombe Electrical and Computer Engineering Department (ECE). Their latest gift establishes the Milton W. and Betty M. Holcombe Fund for Excellence to sponsor programs such as undergraduate research for seniors, improved graduate education, visiting lecturers and faculty, and student enrichment.

An airborne communications systems pioneer, Milt Holcombe is a 1953 graduate of Clemson. His career included development of the airborne command post systems for the Air Force to keep the president of the United States in touch with key officials during an international crisis. He co-founded Electrospace Systems Inc., a multimillion-dollar telecommunications and navigation systems firm, later sold to the Chrysler Corp.

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

ECE graduate studies and research programs include a spectrum of activity reflecting the interests and expertise of the faculty. Particularly noteworthy across the faculty are the breadth of education, the balance between experience and youth, the record of recent publications and the research funding obtained in recent years. More than 30 faculty members teach and perform research in a broad range of topics in electrical and computer engineering, and many are known nationally and internationally. Among them are IEEE Fellows, two endowed chairs and seven named professors. Additionally, several young faculty members have won prestigious national and international awards and grants.

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 over 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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What was originally an indoor swimming pool is now a state-of-the-art instruction facility that inspires experimental learning on a massive scale.

The College of Engineering and Science broke new ground with the establishment of the Department of Engineering and Science Education (E&SE). The new department focuses on improving educational methods and curriculum at the university level and also assists in improving K-12 education in math, science and engineering. K-12 outreach activities will recruit students into engineering and science at Clemson and elsewhere.

There are only two other departments like this in the country: one at Purdue University and another at Virginia Tech. But Clemson's program is unique in that it combines math, science and engineering.

E&SE has begun offering graduate-level courses for Clemson engineering and science students preparing for academic careers. It will ultimately grant M.S. and Ph.D. degrees in engineering and science education.

One of the new teaching innovations introduced to Clemson by E&SE and designed to improve the educational methods of the college is the adaptation of the SCALE-UP (Student-Centered Activities for Large Enrollment University Programs) approach to engineering and science classes. With this approach, a professor is more of a facilitator and coach than a lecturer. Students work in groups where learning occurs by guided inquiry instead of passive instruction. Initial data on student success in SCALE-UP classes shows real promise.

The foundation for this new department is Clemson's general engineering program, where all engineering students spend their freshman year. This program provides the opportunity to learn about different engineering disciplines and academically prepare for declaring a major beginning with the sophomore year.

Engineering at Clemson has a strong track record of external funding for engineering education research and publications in peer-reviewed journals in the field.

Faculty

Full-time E&SE faculty conduct research in one or more of the following areas: active learning environments, the integration of technical research and undergraduate education, development of future engineering and science educators, and building curriculum-based K-12 outreach programs. They also teach in the general engineering program for first-year students.

Facilities

The latest addition to the department's facilities is the Holtzendorff Teaching with Technology Experimental Classroom, also known as the "sandbox classroom." Originally an indoor swimming pool, this unique facility opened its doors in December 2007.

The classroom is called a sandbox because instructors and students explore 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. Interactivity, spontaneity and collaboration are encouraged in this unique environment.

Accommodating 90 students at 10 round tables equipped with power, Internet and video connections, the classroom also features a Sympodium™ that enables the instructor to write with digital ink on the computer screen. A wireless control system manages lighting and projects computer screens, allowing the instructor to walk freely around the classroom to engage students.

Environmental Engineering and Earth Sciences

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A gift of nearly 200 acres on the Commonwealth of Dominica from John D. Archbold serves as an outdoor laboratory where Clemson students and scientists work with island citizens to address pressing land-use concerns. One of Dr. Shelie Miller's projects involves recycling waste tires and other trash to build new playgrounds.

Research efforts in environmental engineering and earth sciences (EEES) reflect a comprehensive and highly interdisciplinary approach to environmental issues. Areas of focus include process engineering (targeted at water, wastewater and air treatment, and soil and groundwater remediation), environmental health physics (ABET/ASAC accredited), environmental chemistry, environmental fate and transport, sustainable systems and environmental assessment, environmental radiochemistry and hydrogeology. A snapshot of current research projects includes sustainable methods for waste tire processing, development of novel carbonaceous sorbents for enhanced removal of dissolved organic matter from natural waters, numerical modeling of contaminant mass transfer during thermal treatment of solvents in fractured geologic media, biostimulation and bioaugmentation to treat chlorinated solvents in groundwater, the role of microbial activity in lead corrosion of drinking water, development of an *in situ* method for detection of tritium, assessing the toxicity of metal oxide nanoparticles to wildlife and modeling the biogeochemical processes responsible for the enhanced transport of plutonium in groundwater.

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 who have been honored with the prestigious Founders Award by the Association of Environmental Engineering and Science Professors.

Faculty

The department has 20 full-time faculty members, several active emeritus faculty members, more than 20 adjunct faculty and more than 70 graduate students. The latest additions include:

- Yanru Yang, assistant professor, who was recently selected as a DuPont Young Professor. This highly competitive and prestigious award is given annually to only 16 young professors worldwide.
- Shelie Miller, assistant professor, who received her Ph.D. from the University of Illinois-Chicago where she also served as a doctoral resident with Alcoa Inc., conducting life cycle assessments of petroleum lubricants and soybean oil.
- Brian Powell, assistant professor, who recently completed postdoctoral studies in the chemical sciences division at Lawrence Livermore National Laboratory.
- Treavor Kendall, assistant professor, who completed postdoctoral studies at Harvard University and is currently investigating the chemical dynamic of mineral surfaces in contact with aqueous solutions, organics and biological materials.
- Stephen Moysey, assistant professor, who received his Ph.D. in geophysics from Stanford University and is currently developing advanced quantitative tools to predict groundwater flow and transport processes.

Facilities

The environmental engineering and science program is housed in the Linvil G. Rich Environmental Research Laboratory, which contains 42,000 square feet of laboratories, offices, classrooms and meeting space. Specialized laboratories are available for radiation detection, organic separations, molecular biology, adsorption and chemical oxidation, and bench-scale continuous flow bioreactors. Analytical instrumentation includes gas chromatography/mass spectrometry, atomic absorption spectrometry, ICP/MS, atomic force microscopy, organic carbon analyzers and ion chromatography. The geological sciences program also has excellent laboratory space on the main campus.

Industrial Engineering

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Graduate students Priyantha Devapriya and Mark McElreath discuss a logistics modeling project for Michelin® in the new CELDi lab.

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, available at undergraduate and graduate levels, 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.

Mary Beth Kurz has been the first to harness the new Condor® grid at Clemson, using the equivalent of 17 years of computer time in just one week. Kurz studies genetic algorithms for large-scale optimization in manufacturing and scheduling applications. The Condor application has enabled her to run hundreds of algorithmic processing jobs to increase the throughput of manufacturers. In the early hours of the morning, Condor is hard at work, harnessing the power of about 1,700 idle desktop computers in various labs and offices across the Clemson campus and creating a supercomputing grid that can rapidly process high volumes of data.

Facilities

The National Science Foundation has selected Clemson University as a research site for the Center for Engineering Logistics and Distribution (CELDi), an Industry/University Cooperative Research Center (IUCRC). 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.

CISCOL (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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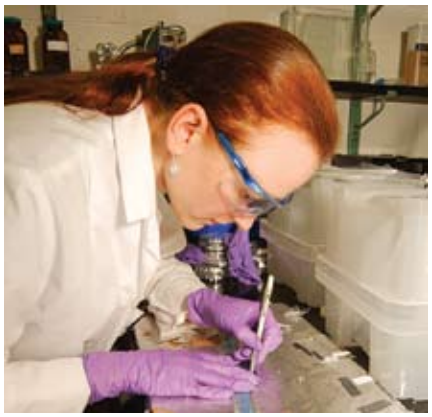

The school's on-campus presence for teaching and research is primarily housed in Sirrine and Olin halls. Laboratories in the advanced fiber, metal, ceramic and polymer research areas include:

- Weaving Laboratories
- Nonwoven Laboratories
- Dyeing, Finishing and Printing Laboratory
- Clemson Apparel Research Facility
- Composites Fabrication
- Physical Testing Laboratory
- Fiber Physics Laboratory
- Electrical/Electronic Fiber and Fabric Properties Laboratory
- Extrusion and Rheology
- Analytical Laboratories
- Advanced Metallic and Composites Group

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. As a result, this school's expenditure per faculty member was $459,000 in 2006, resulting from a blend of public and private research support.

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 to class and lab focus is a key part of the Clemson MSE curriculum.

Faculty

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 Technology (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 over $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.
- The National Brick Research Center is an industry-funded organization providing research, education and service to producers and users of clay bricks and other ceramic materials (tile, mortar and ceramics).

Mathematical Sciences

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Teams of high-school students work together at the Clemson Calculus Challenge. The Department of Mathematical Sciences is eager to encourage the study of calculus in high school; prizes of this annual competition include $500 scholarships to Clemson University.

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 2006-2007), national and international professional involvement of the faculty, and funded research ($1.5 million in 2006-2007).

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 students graduated with bachelor's degrees in the mathematical sciences in 2006-2007. In addition, the department awarded 28 master's degrees and eight Ph.D. degrees during the past year.

Faculty Highlights

The American Statistical Association named Robert Lund a 2007 Fellow. The nation's pre-eminent professional statistical society recognizes outstanding contributions such as innovative research in applied probability, statistical climatology and time series analysis as well as stellar leadership in the field of statistical science. Individuals are nominated for the honor by other members and must have an established reputation. Lund becomes the fourth Clemson faculty member to receive this award, joining professor emeritus Ted Wallenius, department chair Robert Taylor and visiting professor W.J. Padgett.

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.

For the fourth consecutive year, the Department of Mathematical Sciences will host 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.

Mechanical Engineering

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The Carroll A. Campbell Jr. Graduate Engineering Center is a 90,000-square-foot, state-of-the-art facility housing automotive testing equipment valued at over $10 million. Located on the CU-ICAR campus in Greenville, S.C., the center offers graduate-level classes and research opportunities.

The Department of Mechanical Engineering has one of the largest academic programs in the state of South Carolina with 574 undergraduate students and 175 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
- 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

The department includes 33 tenure-track faculty, seven ASME Fellows, one SME Fellow, two Presidential Faculty Fellows, five NSF CAREER awardees, one NSF PECASE awardee, one member of the European Academy of Engineering and 10 associate editors/members of the editorial boards of national/international journals. The department holds three of the largest endowed chairs in the country — each valued at $10 million.

Facilities

This year saw the opening of the Campbell Graduate Engineering Center, built on the new 250-acre Clemson University International Center for Automotive Research campus in Greenville, S.C. This center houses state-of-the-art facilities for automotive research that include 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. Students work with industry partners, including BMW, Michelin, Timken and the Society of Automotive Engineers, all with facilities located on the same campus.

On the main Clemson campus, 23 state-of-the-art labs support the department's research interests. They include experimental, computational, design and material processing labs.

Physics and Astronomy

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She has dined with astronauts and generals. At the age of 20, she has traveled the likes of Taiwan, Norway, Italy and the Marshall Islands to study physics. And at the beginning of the spring term, Clemson senior and physics major Caroline Yount of Conover, N.C., was in Alaska to launch rockets in total darkness.

"The rockets are useful in figuring out the layers of the atmosphere," said Yount when asked about her experience with the SPIRIT 3 (Student Projects Involving Rocket Investigation Techniques). "The ionosphere is the link between space and earth. It's a natural communications tool. So we send communication signals into this level with the rockets to see how the sun is affecting the earth."

Yount was in Alaska with Clemson physics professor Miguel Larsen and 12 undergraduate and two graduate students. She has presented previous findings at national and international conferences. "I felt inspired by the company I was in," recalls Yount. She adds that NASA is interested in the research.

Yount was awarded the Robert H. Goddard Space Research Scholarship for 2006-2007. The award honors one undergraduate a year in the United States for outstanding contribution to the field of space research.

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.

Clemson has reached an agreement with the National Science Foundation-funded National Optical Astronomy Observatory, providing guaranteed access to 10 percent of the observing time per year on the Kitt Peak National Observatory 4-m Mayall telescope. Since the mid-1970s, the Mayall 4-m has been a groundbreaking workhorse of the U.S. national observatory system, which includes the new giant twin Gemini 8-m telescopes in Hawaii and Chile. This three-year agreement allows Clemson graduate students and faculty abundant access to world-class telescopes in the Northern and Southern hemispheres and allows astronomers the opportunity to exchange half of their 4-m time for nights on nearly every other optical telescope in the U.S. national system. The agreement was made possible by a $100,000 grant from the Charles Curry Foundation based in Seneca, S.C.

Faculty Highlights

- Don Clayton, professor emeritus of physics and astronomy, joined the Clemson faculty in 1989 and is a leading scientist in nuclear astrophysics, gamma ray astronomy and nuclear isotopic clues to the origin of the solar system. The American Astronomical Society credited him as generating one of the most important astrophysics research papers of the 20th century. He also brought international recognition to Clemson as an inductee of the American Academy of Arts and Sciences, which honors leading intellectuals from around the world in every field and profession. He graduated from Southern Methodist University in 1956 and received his Ph.D. in physics from California Institute of Technology in 1962.
- Terry Tritt delivered an address at the Alan MacDairmid Memorial Nano Energy Summit in Dallas at the world-renowned NanoTX '07 Conference. Tritt focused on the challenges in alternative energy, specifically how billions of dollars could be saved every year if energy lost from hot engines could be captured and converted into electricity via thermoelectric devices. Most recently, Tritt received the 2008 Governor's Award for Exellence in Science, honoring his achievements and contributions to science in South Carolina.

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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.

CLEMSON UNIVERSITY

INQUIRY, DISCOVERY IN ENGINEERING AND SCIENCE

IDEaS

SPRING 2008

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On the cover: Samantha Thoe and Dr. Joshua Summers explore tire technology innovations during the summer EUREKA! program. For more information on EUREKA!, see page 5.

Right: Dr. Timothy Burg's students work on a Creative Inquiry project that involved tracking stinkbugs with remote-control helicopters. For more information on Creative Inquiry, see page 2.

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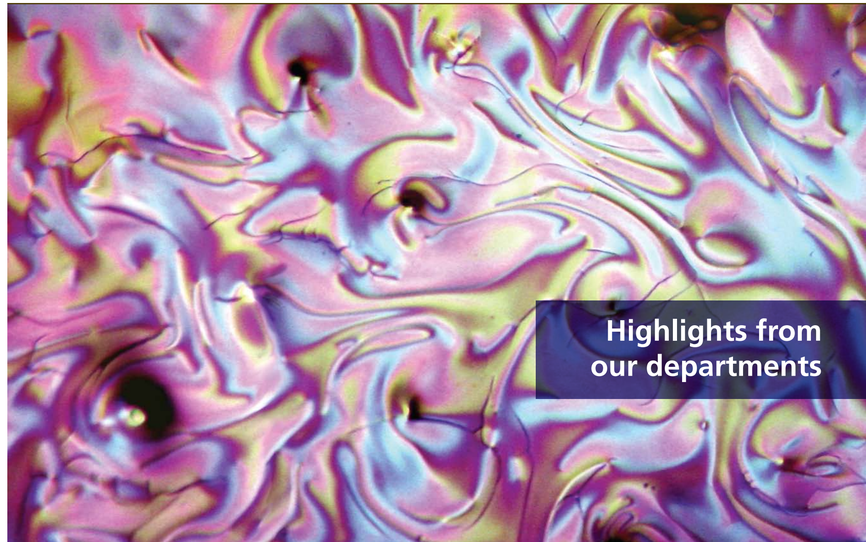

Highlights from our departments