IDEaS

CLEMSON UNIVERSITY
COLLEGE OF ENGINEERING
AND SCIENCE

INQUIRY, DISCOVERY IN ENGINEERING AND SCIENCE

SPRING 2013

Tetramer Technologies, one of Clemson's most successful startup companies, is bringing research to market.

Building the Force

"Contributing to a workforce that can be productive in a global economy continues to be one of Clemson's core missions."

As South Carolina's land-grant institution, Clemson University proudly continues the historic tradition of promoting "the liberal and practical education of the industrial classes in the several pursuits and professions of life." Sounds a little like workforce and economic development, doesn't it?

Contributing to a workforce that can be productive in a global economy continues to be one of Clemson's core missions. This issue highlights the college's efforts in several key areas.

The disparity between the available jobs in advanced manufacturing and the number of qualified workers has been significant, and it reflects a national trend. At the height of the recession, 32 percent of manufacturing jobs went unfulfilled nationwide due to an underskilled labor pool. Leadership in Clemson's College of Engineering and Science observed those trends and recognized the need for an improved workforce — one with highly specialized knowledge and strong math and science skills. Our feature on the Clemson University Center for Workforce Development builds on the premise that every advanced manufacturing job in South Carolina should be — and can be — filled locally.

Workforce development, though, means more than turning out a skilled labor pool. There is also an entrepreneurial aspect to building a modern labor pool, and Clemson is fostering this economic development spirit as part of its technology transfer program. Our feature "Getting Started" introduces technology transfer initiatives that are creating new products and services along with the young entrepreneurs who are moving research to the marketplace.

The "Computing for Real Life" story introduces Clemson's Human-Centered Computing Division, a relatively young discipline that is producing graduates who are filling voids in both academic and corporate workforces. And "Body Builders" shares news about Clemson's Biocompatibility and Tissue Regeneration Laboratory. Bioengineering students working in this lab are gaining immeasurable experience in the cutting-edge field of regenerative medicine. These talented, hard-working graduate students not only pursue their own research, they also mentor ambitious undergraduates.

From manufacturing to medicine, Clemson University is building tomorrow's economy and workforce today — one graduate at a time.

On the cover: Tetramer Technologies, one of Clemson's most successful startups, has developed advanced polymeric materials, including some that encapsulate luminescent nanoparticles. These have applications in LED lighting, fiber sensing and radiation detection.

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

CONTRIBUTORS

EXECUTIVE EDITORS
Martine LaBerge
Ron Grant
Rebecca Shepherd

DESIGNERS
Dave Dryden
Christine U. Prado

PHOTOGRAPHERS
Craig Mahaffey
Patrick Wright

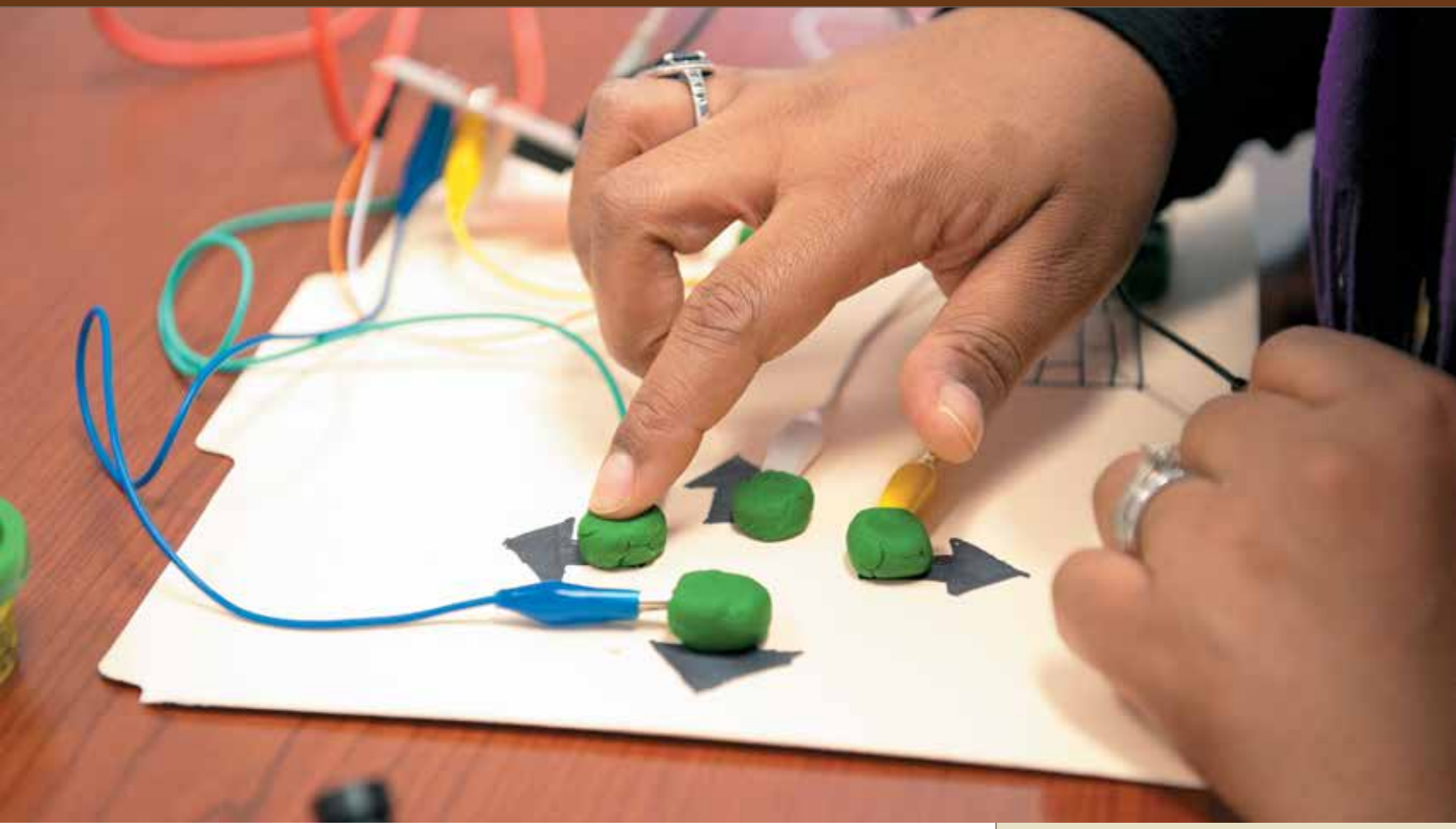
WRITERS
Ron Grant
Peter Hull
Ross Norton
Heidi Coryell Williams
Alexa Woodward

INQUIRY, DISCOVERY IN ENGINEERING AND SCIENCE

CLEMSON
College of ENGINEERING AND SCIENCE

IN THIS ISSUE

SPRING 2013



FEATURES

DEPARTMENTS

Above: Christina Gardner-McClure, a researcher in Clemson's Human-Centered Computing Division, conducts research on how students learn STEM and computing content. She's studying what kinds of learning environments support the students as they learn.

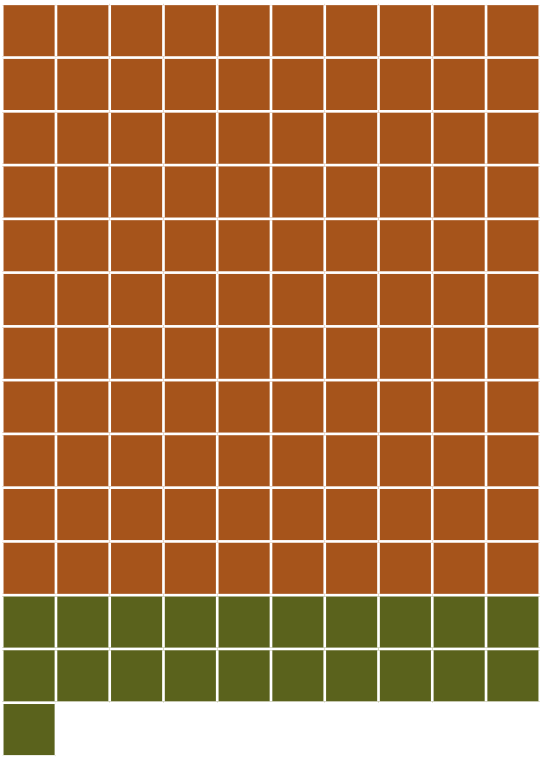
Metal Origami

This is a close-up view of a folded metal sheet that was created at the Clemson University International Center for Automotive Research in Greenville. It was made by IOI lances that folded very thick plate with better precision than that achieved by press brakes. This image is ¾ inch mild steel folded to 90 degrees.

The Numbers

These graphics represent information about CES enrollment, student involvement within the college and how the college has grown over the past eight years.

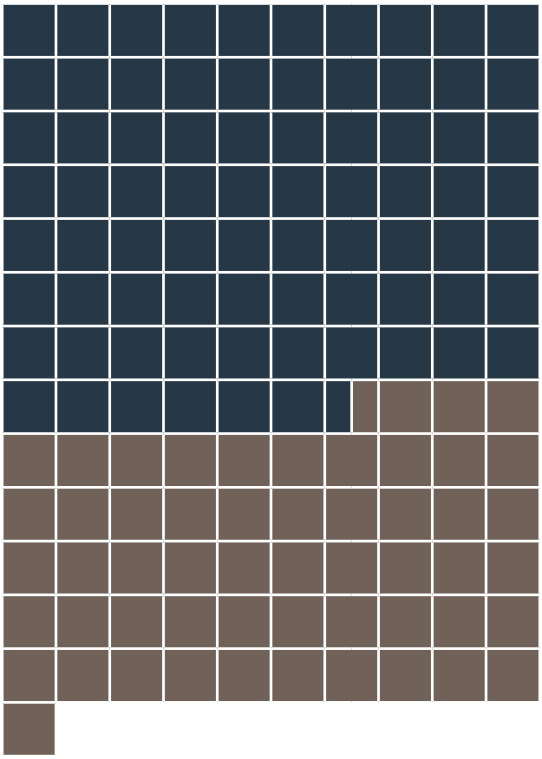
Freshman Enrollment by Discipline



1,104 General engineering students

208 Science students

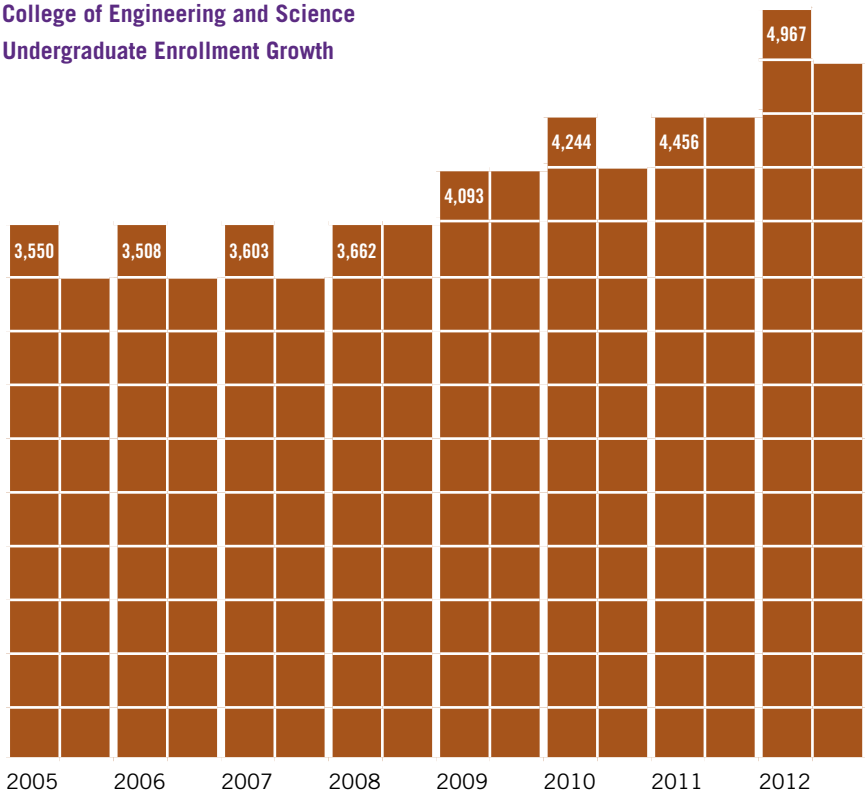
Freshman Enrollment by Residence



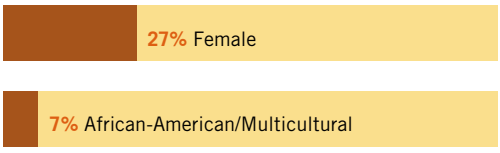
865 South Carolina residents

447 Nonresidents

College of Engineering and Science Undergraduate Enrollment Growth



Freshman Enrollment



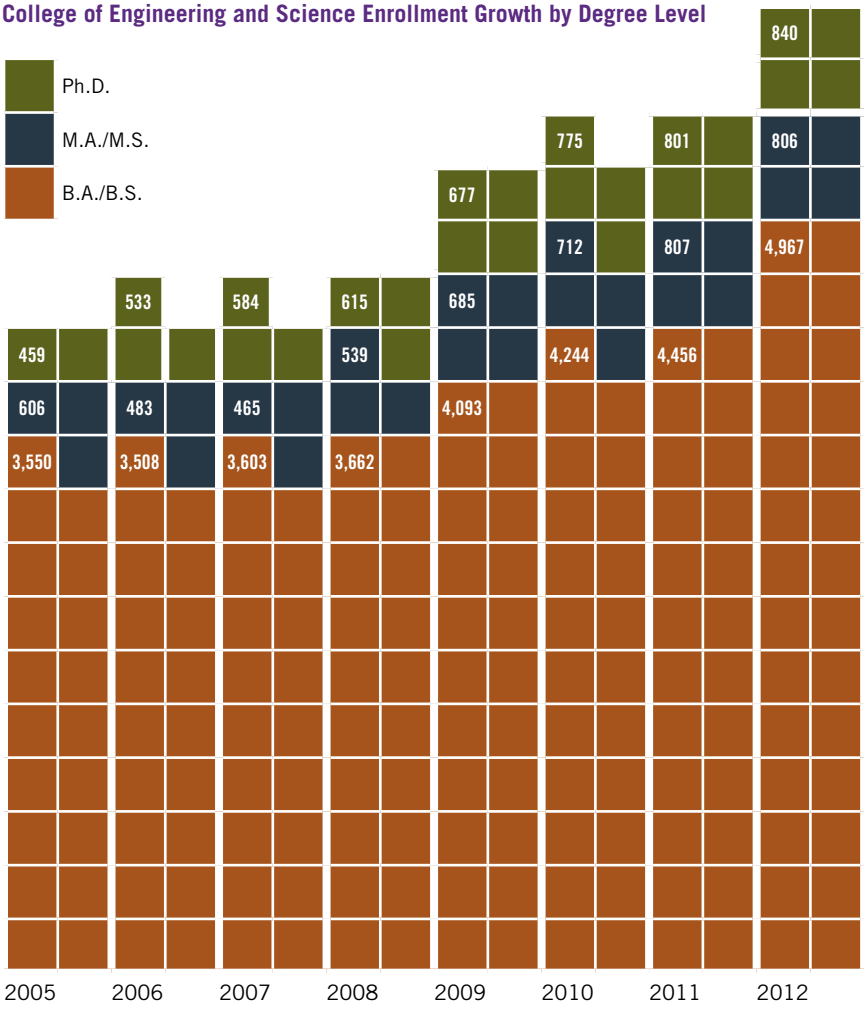
27% Female

7% African-American/Multicultural

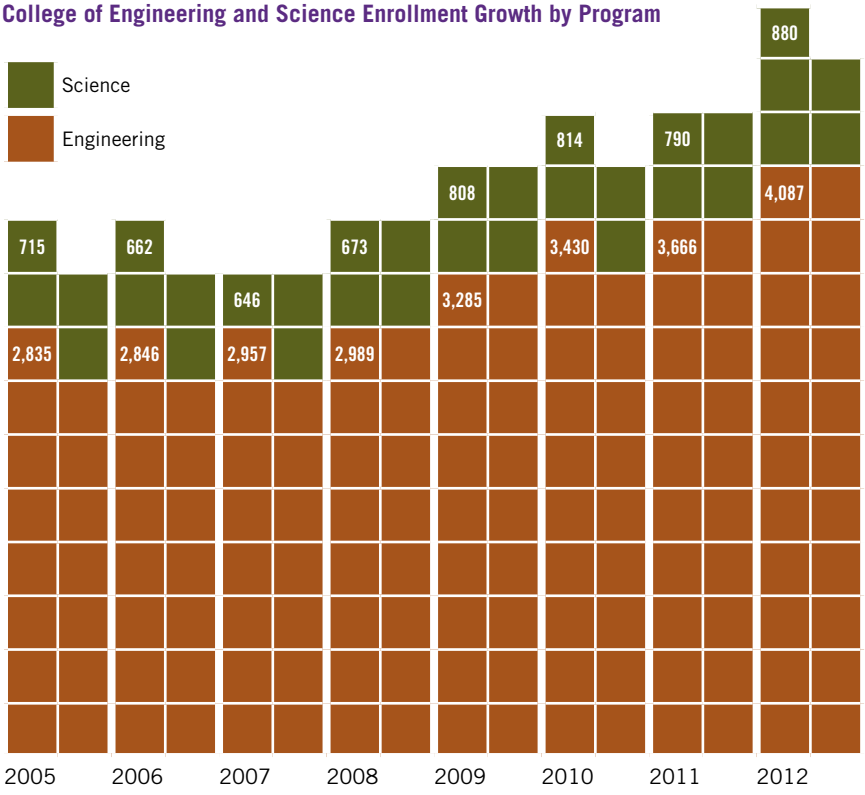
Freshman Enrollment Average SAT Score

1286

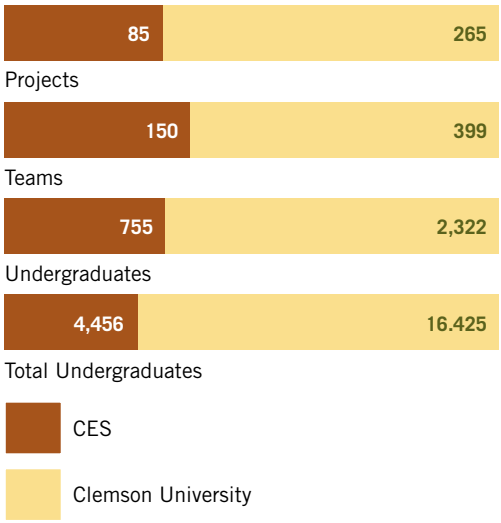
College of Engineering and Science Enrollment Growth by Degree Level



College of Engineering and Science Enrollment Growth by Program



Creative Inquiry (Undergraduate Research) Participation



67
Percent of seniors who reported having field experience, clinical assignments, an internship or practicum

38
Percent of seniors who have worked on a research project with a faculty member outside of class

24
Percent of CES students who have studied abroad

91
Percent of first-year students who reported that Clemson has a substantial commitment to their academic success

Getting

Above: An assortment of fibers developed by Tetramer Technologies, a spinoff company created by research conducted at Clemson University.

In their 1981 hit, "Start Me Up," The Rolling Stones weren't making reference to technology startup companies, but never stopping seems to aptly describe what's been going on through the Clemson University Research Foundation (CURF). It's also a sentiment shared by young Clemson University entrepreneurs as they endeavor to transfer technology from the laboratory to the marketplace.

Clemson entrepreneurs are bringing technology and research findings to market.

By Ron Grant

Started

Clemson is a land-grant university. The mission of land-grant universities has historically been devoted to teaching, research and extension. These three functions represent a dynamic continuum of knowledge that connects land-grant universities with the people of the state and to the needs of society.

Traditionally, land-grant universities have shared research findings and new knowledge through a series of regional extension offices. In recent years, however, market forces — combined with an entrepreneurial emphasis on the part of research universities — has led to small-business startups that have become another avenue for sharing knowledge.

As the largest academic research entity at Clemson University, the College of Engineering and Science (CES) has become an incubator for startups that are developing international reputations. Over the past two decades, more than 18 spinoff companies have either been established or are in various stages of development. CURF has been facilitating this growth since 1982, providing leadership and expertise to maximize the societal impact of University research and innovation. Simply put, CURF provides resources for developing high-growth, high-impact technology-based startups.

"Over the past 20 years, Clemson University has out-licensed more than 45 technologies to startup companies, generating more than $400,000 in license revenue to date," says Vincie Albritton, CURF's deputy director. "In addition, Clemson startup companies have created more than 100 jobs in the advanced-material, biomedical-device and information-technology sectors — with many requiring at least a bachelor's degree and offering salaries well above the per capita income of the state."

Tetramer has worked in collaboration with Clemson professors to obtain federal grants. So far, five proposals have been submitted through the Tetramer and Clemson partnership.

Clemson Startups

Company	State/Prov.	Faculty/Student Inventor
Bite Technologies LLC	South Carolina	Eric Muth and Adam Hoover
KIYATEC LLC	South Carolina	Former graduate students: Matt Gevaert and David Orr
Earth Renewable Technologies Inc.	South Carolina	Former faculty: Danny Roberts and David Gangemi
Advanced Photonic Crystals LLC	South Carolina	Joe Kolis Former graduate students: Henry Giesber and Matt Mann Current graduate student: Colin McMillen
SensorTech LLC	South Carolina	Martine LaBerge and Andrew Clark
Medusim Solutions LLC	South Carolina	Delphine Dean, George Fercana and Jiro Nagatomi
Luminescent MD LLC	Maryland	Former faculty: Elizabeth Carraway, Mark Schlautman and Ji Hoon Lee
Tetramer LLC	South Carolina	John Ballato, Jeff Dimaio and Steve Foulger
Omnibond LLC	South Carolina	Stan Birchfield
Lab21 Inc.	South Carolina	Ya-Ping Sun
Vatrix Medical Inc.	Minnesota	Dan Simionescu, Naren Vyavahare and Jason Isenburg
Tiger Bioanalytics Ltd. Co.	South Carolina	Guigen Zhang
Universal Biotech LLC	South Carolina	Alexey Vertegel, Igor Luzinov, Konstantin Kornev, Viktor Klep and Killugudi Iyer
Specialty and Custom Fibers LLC	South Carolina	Ken Marcus, Phil Brown, Chris Cole, Igor Luzinov, Yonnie Wu, Bogdan Zdyrko, Killugudi Iyer and Viktor Klep

CURF manages Clemson's intellectual property and typically transfers rights to third parties through licensing – either to a company with the appropriate resources to fully develop and commercialize the intellectual property or to a startup venture specifically designed to develop the new technology.

Licensing to a Startup Venture

A startup venture is typically created to develop a particular technology for commercialization. Such an endeavor carries substantial risk and calls for a high degree of innovation and aggressive, practical leadership. The focus is commonly a particular technology; therefore, resources can be directed specifically to the development of that technology alone. CURF has access to facilities and resources for startup ventures that are interested in developing and commercializing the University's intellectual property.

One of the most successful startups with Clemson origins is Tetramer Technologies, which was formed in 2001 as a faculty-driven startup company commercializing high-value research activities. Tetramer's strength is advanced polymeric materials, which have applications in next-generation technologies such as telecommunications and fuel cells.

Tetramer Impacts

Over the last eight years, Tetramer has grown from two full-time employees to 22 full-time and seven part-time employees. Tetramer has had a total of 60 employees – 88 percent of whom are Clemson University graduates or students. The majority of the employees who have left Tetramer moved on to graduate or medical school. Tetramer has had 18 students work in part-time positions or as part of the National Science Foundation's (NSF) Research Experience for Undergraduates program. Nine more students have come to Tetramer through Clemson's cooperative education program over a total of 21 semesters. The company has also trained five students from Daniel High School through the NSF Research Assistantship for High School Students program over nine summer employment periods. All of the students have since gone on to pursue careers in science and engineering.

A high-impact shoulder stabilization device designed by a team of senior biomedical engineering students placed third in the Collegiate Inventors Competition.

The AssureFit chest-tube stabilization device won the annual National Collegiate Inventors and Innovators Alliance BMEStart undergraduate design competition.

In addition, Tetramer leadership has taught more than 225 Clemson students the CES 403/603 course, "Career Success in Science and Engineering." Designed to help technical students make the transition from academia to research and development in industry, the course has been very well-received and continually garners high ratings by students.

Additionally, one semester of the materials science and engineering course, "Solid State Materials," was taught. Tetramer researchers have also co-taught six semesters of entrepreneurship courses at Clemson and have given more than 20 invited lectures to various student groups around campus about career and entrepreneur topics.

Tetramer has donated a large volume of its PFCB (perfluorocyclobutyl) material to Clemson for use in research. This material typically sells for $60,000/kg in the marketplace. Tetramer has also worked in collaboration with Clemson professors to obtain federal grants. So far, five proposals have been submitted through the Tetramer and Clemson partnership.

In terms of direct financial benefit to CURF or to the University, Tetramer has provided nearly $1,800,000 in royalties, equipment leasing, rents and grants since January of 2004. What's more is that vendors in Oconee, Pickens and Anderson counties have received nearly $300,000 in direct purchases from Tetramer.

"Translating" Engineering into Startups

From advanced materials to bioengineering, recent academic innovations have given rise to commercially applicable medical advancements.

These advancements are fueled by the 20-year partnership between CES and the Greenville Hospital System (GHS), and more recently, the opening of the Clemson University Biomedical Engineering Innovation Campus (CUBEInC) on the Patewood medical campus. This facility includes translational research laboratories that focus on cardiovascular and orthopaedic engineering. CUBEInC enables the translation of high-impact medical technology and devices from the laboratory to bedside, providing numerous opportunities for entrepreneurial pursuits.

"GHS is a wonderful partner for Clemson," observes Martine LaBerge, bioengineering department chair. "Where Clemson has a comprehensive understanding of biomaterials, the hospital system is the go-to organization in Upstate South Carolina for medicine and surgery."

"When these areas of expertise are combined, there exists a real opportunity to make a difference in the quality of life of the people of our state," she adds. "Plus, the Patewood facility is an important economic development driver for South Carolina."

Using CUBEInC as a springboard for innovation, assistant professor John DesJardins and colleagues have mentored two recent senior biomedical engineering design projects that have recently developed technologies destined for the marketplace.

One team won the annual National Collegiate Inventors and Innovators Alliance (NCIIA) BMEStart undergraduate design

Bioengineering professor John DesJardins has worked with undergraduate and graduate students on research that has developed technology destined for the marketplace.

Clemson's pediatric arm stabilizer was designed to facilitate blood draws from young patients.

competition, and a second team placed third in the Collegiate Inventors Competition (CIC).

NCIIA team leader Breanne T. Przestrzelski of Swannanoa, N.C., and teammates Carlyn M. Atwood of Greenville, Lauren E. Eskew of Mount Pleasant and Brennen C. Jenkins of Liberty partnered with GHS pediatric surgeons John Chandler and Robert Gates to develop the innovative AssureFit chest-tube stabilization device. AssureFit prevents surgical drains from dislodging following procedures, allowing for greater patient mobility and comfort while saving time and medical expense.

"The device solves a costly and critical health care issue that can currently lead to serious surgical complications," says DesJardins. "We're very impressed with what the students have produced in their design work and are excited to see that the device has substantive clinical applications combined with considerable market potential." Przestrzelski's team, mentored by Hunter Professor of Bioengineering Naren Vyavhare and graduate assistant Eric Lucas, recently showcased their technology at the Southeastern Medical Device Association in Atlanta, Ga., and the 2013 NCIIA Open Minds Meeting in Washington, D.C.

The CIC team developed a high-impact shoulder stabilization device that targets patients who have experienced an anterior shoulder dislocation. Team members Riley Csernica of Mount Pleasant, Meredith Donaldson of Hickory, N.C., Chelsea Ex-Lubeskie of Goose Creek and Kaitlin Grove of Roanoke, Va., partnered with Proaxis Therapy clinicians Chuck Thigpen and Ellen Shanley to create a device that is low-profile and intended for use as a functional brace, meaning it is to be worn while active. The brace has a dynamic stabilization system at the glenohumeral joint to provide compressive support at the site of injury. The team, advised by assistant professor David Kwartowitz and graduate assistant Xin Xie, initially will target athletes who have shoulder injuries, but they'll also find applications for the elderly and the military. DesJardins, Csernica and David Orr — the chief operating officer of KIYATEC Inc. in Greenville — recently received a $50,000 NSF I-CORPS award to develop a business model around this exciting technology. Team members Csernica and Ex-Lubeskie are now forming an LLC to bring the shoulder brace to market.

Another source of startups

Several startups are also being contemplated as a result of Clemson's Creative Inquiry (CI) program. CI is a unique concept that gives undergraduate students the opportunity to pursue research. Students work in teams with faculty mentors, take ownership of their projects and assume the intellectual risks necessary to solve problems and get answers. Team-based investigations are led by a faculty mentor and typically span two to four semesters. Participants develop critical thinking skills, learn to solve problems and hone their communication and presentation skills.

Creative Inquiry gives undergraduate students the opportunity to work in teams with faculty mentors, take ownership of their projects and assume the risks necessary to solve problems and get answers.

One recent medical device that has entrepreneurial potential was developed over the course of the last two years. This CI project team was made up of 12 students majoring in mechanical engineering, nursing, bioengineering, business and general engineering who worked with faculty advisers Todd Schweisinger (mechanical engineering) and Arlene Johnson (nursing). The GHS Children's Hospital expressed the need for a pediatric arm stabilizer that could be used to facilitate blood draws from young patients. The invention was first disclosed to Clemson in March 2012, and the University filed a provisional patent for the invention. Orange Rock Medical Technology LLC is currently negotiating licensing rights with CURF.

Clemson's CI program is providing research opportunities that are leading to a multitude of technology transfer prospects. It is economic development that, in the immortal song lyrics for "Start Me Up," "never stops, never stops, never stops." *

BODY BUILDERS

Dan and Agneta Simionescu have built a foundation for the future of medicine through their research with Clemson University's Biocompatibility and Tissue Regeneration Laboratory.

By Heidi Coryell Williams

Some day in the not-so-distant future, everything from heart valves to rotator cuffs could be surgically repaired with less risk of rejection, a longer life and much-improved odds for healing thanks to some cutting-edge work that's happening in the Clemson University Biocompatibility and Tissue Regeneration Laboratory (BTRL).

The professors behind this research, married couple Dan and Agneta "Aggie" Simionescu, have patented several parts of the process that could lay the foundation for these types of medical advances. Along with many others in the biomedical field, the Simionescus strongly believe that the future of medicine relies largely on our ability to translate research and lab work on tissue engineering into an actual clinical scenario.

"If we can regenerate tissues, we can change medicine forever," Dan explains.

And that's exactly what he and Aggie are doing – both on campus and in a newly opened collaborative clinical facility at Greenville's Patewood Medical Complex.

Where the Science Happens

The body already has the miraculous ability to heal itself.

When we get a minor cut, the wound scabs over and disappears. When a muscle, or the tendons around it tear lightly, they usually grow back together and repair. But if an injury is severe or traumatic enough, the body loses its ability to regenerate tissue – whether it's an arthritic knee that stiffens and swells or heart valves that no longer maintain blood flow.

Artificial replacement surgery was developed to help our bodies move and bend and beat again. But such replacements – particularly when they are synthetic – are almost always temporary. A piece of stainless steel, a plastic casing or a titanium body part all have limited life spans after they are implanted in the human body.

That's where Clemson's BTRL comes in. Formed in 2006, the lab sits in the Rhodes Research Center, home of Clemson's bioengineering department. The facility occupies about 900 square feet split into two labs. One is focused on basic research, cell biology and biochemistry. The other is focused on bioreactor development and biomechanical testing.

The Simionescus laid the foundation for many of their theories in that on-campus facility,

developing patents for a variety of medical advances that could one day do everything from curing aneurysms to building new heart valves out of tissue components and stem cells.

But taking that research and applying it to the clinical field — making it available to doctors who could then offer it to patients — has become the next step. That's why they created the Laboratory for Regenerative Medicine at Clemson's translational facility, recently coined CUBEInC (short for Clemson University Biomedical Engineering Innovation Campus).

The facility has been designed to take regenerative technologies research from labs located on the Clemson campus and move it one step closer to a bedside application.

Today, three years after the translational facility first opened, the Greenville-based center is well equipped for sterile work with human stem cells and scaffolds, filled with a variety of specific bioreactors, high-powered microscopes and other devices. Better still, the Laboratory for Regenerative Medicine has built relationships with surgeons and clinicians around the state who are eager to understand and use translational regenerative medicine on their patients.

It's a unique relationship, one in which autologous adult stem cells are used for tissue regeneration, thereby "bridging the gap" between bench and bedside. The Simionescus and their students are working with professionals in the field to understand patient needs, while developing proposals for grant applications and performing preclinical studies so that the research might continue to develop and improve.

"This is not a field where competition is that important," Aggie explains. "It's about how to collaborate and bring everybody together."

"The Miracle Molecule"

Dan's childhood was spent in the Romanian capital of Bucharest. His father was a clinician and cell biologist in the 1960s and 1970s — a time when biochemistry and cell biology were in their infancy. Dan helped his father in the lab by preparing samples for observation under the microscope with a particular stain.

It was a simple tannin — a staining agent used to stabilize the degradation of connective tissue. We know today that this matrix-binding polyphenol contains the same antioxidant tannin found in red wine, and it binds collagen and elastin molecules together, reducing the tendency for tissue deterioration and degradation by other enzymes after implantation.

When Dan came of age to pursue his own career as a biochemist, he remembered those early lessons. And as stem cell research began to advance and Dan pursued his own study of it, something occurred to him: If the tannin — the matrix-binding polyphenol — had the ability to stain, dye and bind tissue, it could have the same effect on tissue scaffolds and stem cells.

He wrote a grant to the National Institutes of Health (NIH) to study the theory, and it was readily accepted and funded. It turns out, his hypothesis was right, and since then, the polyphenol agent has paved the way for several important medical advances.

"Almost everywhere we go with this molecule, it is doing good," Dan says. "The Miracle Molecule" — as it was dubbed by one of the Simionescus' students — does bring stability to stem cells so that, when it's placed on a tissue scaffold, it creates an environment for healthy, newly regenerated tissue to grow.

The research has since appeared in some of the field's most significant journals, including *Circulation* and the *American Journal of Pathology*. More telling, their work is hitting the mainstream. On the morning of their interview for this publication, Aggie caught a television segment on stem cells and heart valve replacement surgery while watching the NBC morning news.

See for yourself

Check out some live demonstrations involving the Simionescus' work online by visiting *youtube.com/watch?v=VltFX6q8hB4* or *youtube.com/watch?v=M3PlAvrfIUw*.

For more information, the BTRL maintains an interactive and informative website. Check it out at: *clemsonbtrl.com*.

The Engineering of Medicine

Stem cell research like what Dan and Aggie are doing not only takes extraordinary amounts of knowledge and effort, it requires substantial funding, as well. Because, while ample research has been done in the lab and on animals, there are very few examples where regenerative medicine has been clinically implemented.

The Simionescus develop heart implants capable of "self-repair and growth."

Much like building an office complex, building tissue requires a significant investment in the foundation and support systems that strengthen and stabilize new growth. The lexicon of a biomedical engineer is not that different from the jargon used by traditional engineers. Before a new building can be constructed, a scaffold — or temporary platform — is required.

What the Simionescus are doing works the same way. For tissue engineering, a blank piece of tissue is necessary to act as a temporary platform for regenerated (or new) tissue to build up. Once all of the cells have been removed from a tissue sample, it becomes scaffold-like — something akin to a piece of cloth — where new, healthy stem cells can begin to grow. Eventually the tissue scaffold — much like a traditional scaffold — is rendered unnecessary.

Construction is complete.

Heart of the Matter

Even at the earliest stage of their careers, the Simionescus were interested in more natural replacement therapies, particularly as they applied to heart valve replacement. Valvular heart disease results in about 275,000 valve replacement procedures around the world each year, according to the NIH. The complications that might contribute to the failure of native heart valves include structural deterioration, calcification, tissue overgrowth and thromboembolism.

Although existing heart valve replacements provide major improvements in cardiac function and life expectancy, they also have significant limitations, including degeneration and rapid calcification — eventually requiring surgical replacement within 15 to 20 years. These risks are particularly prominent in pediatric patients when they outgrow their mechanical implants. These limitations, among others, are what prompted the Simionescus to develop implants capable of "self-repair and growth."

So far, the heart valve project is the most advanced that the couple has worked with. Part of this goes back to where their research began. In Romania, where Dan and Aggie were working with a cutting-edge surgeon at Targu Mures Medical Center to replace damaged heart valves, many patients required the heart valve surgery. Aggie explains that many could not afford the surgery.

"Heart valves are very expensive," Dan says. "Our boss couldn't afford to replace them, so he would send these patients home and they would never come back again."

Collaborating with that surgeon, Radu Deac, Aggie and Dan were charged with making affordable replacement heart valves out of cow pericardium or "heart sacs," giving Romanian patients another chance at life. The couple worked for about five years, preparing pericardial valves, and about 1,000 were successfully implanted.

Funding for such projects and research was limited in Romania, and the Simionescus knew there was more that could be done. So they came to the United States to do just that. "We really believe in what we are doing," Aggie explains.

This is especially true for the work she's pursuing now on behalf of diabetic patients. The rate of diabetes has more than doubled in the last two decades, according to the Centers for Disease Control and Prevention. Diabetes significantly increases the rates of heart disease, stroke, hypertension and amputation.

"Everybody with diabetes will develop a cardiovascular disease," Aggie says.

Much work has been done on the tissue engineering of heart valves and arteries in otherwise healthy individuals, but there was no research or testing for the diabetic population. Diabetic patients form advanced glycation end products, which contribute to inflammation and fibrosis, making wounds difficult to heal. Anytime surgery is done on a diabetic patient, it's more problematic.

"We know how traumatic it is in the diabetic environment," Aggie says. She applied for an NIH grant to perform tissue engineering testing and research on diabetic rats — it was also quickly accepted and funded. Now she is working to see if regenerated tissue holds up better for an animal battling the deteriorating effects of diabetes.

The Future of Medicine

For a couple of biomedical researchers, Dan and Aggie Simionescu are able to make the work they're doing downright easy to understand.

"I had lunch with a donor the other day," Dan explains. "We talked for 30 minutes. By the end of lunch, he'd changed his mind about gifting from his estate to donating right now."

Contributions like these make a huge difference for the department's studies — which cost hundreds of thousands of dollars — not only for the equipment and facilities required to carry them out, but also the use of test animals, the processing of stem cells and the technology required to isolate them for rebuilding purposes.

And Clemson's bioengineering students are gaining immeasurable experience in the cutting-edge field of regenerative medicine. The Simionescus' "very talented, hard-working graduate students" not only pursue their own research projects but also mentor ambitious undergraduates. "Graduate students are making an excellent fit for pharmaceutical and medical device companies, where they have small biologics divisions," Dan says. Many undergraduates trained in the Simionescus' group also go on to pursue graduate and medical degrees.

Dan says, "I think we have the smartest graduate and undergraduate students in the whole world." ✻

Build Anew

Collaborations are ongoing with the Greenville Hospital System, as well as with the Medical University of South Carolina, but the BTRL group is continually seeking clinical collaborators interested in this endeavor. For more information, contact the Department of Bioengineering at *bioe@ces.clemson.edu* or call 864-656-7276.

A young discipline brings a diverse group of scholars to Clemson University.

By Ross Norton

Making it matter. It is the mission of a young discipline that harnesses the power of computers and the expertise of computer scientists, and blends in the ingredients to create a better world.

In Clemson University's School of Computing, the Human-Centered Computing Division (HCC) has attracted more than its fair share of young researchers from a very small national pool of African-American talent. Assistant professor Kyla McMullen is one of these researchers, and she explores how to use sounds to help people gain spatial information.

McMullen creates virtual environments that use sound cues to represent locations by playing the sounds in a special way through headphones so that they appear to come from a specific location in space.

"One motivation for this area of work is that humans can only pay visual attention to so many things until visual modality gets overloaded," she says.

This is the essence of the HCC – taking science that many of us don't understand and transforming it into something we can use.

Take a pilot, for example. A pilot has to keep her eyes on a lot of things. What if some of that visual stress could be relieved by using sound to let her know the locations of the other planes? What if sound could indicate the status of instrument measurement tools?

"We can help people divide their attention in useful ways. Pilots could use our sort of interface to listen to information that would normally require visual attention," McMullen says. "That would keep their eyes free to deal with all of the other important information going on in the cockpit."

McMullen joined HCC after earning her master's and Ph.D. in computer science from the University of Michigan. She is rare in her field.

According to the Computing Research Association's Taulbee Survey, of 1,400 Americans receiving a computer science Ph.D. in 2010-2011, less than a quarter were female and 1.2 percent – that's 16 people – were African-American. About 10 percent of the African-American computer science faculty and Ph.D. students at national research universities are at Clemson University.

They're drawn by the promise and the atmosphere of HCC, the School of Computing and the University.

"When I came to visit, I saw that I would be a good fit within the virtual environments group, and I felt it was a collaborative and welcoming environment that would foster my growth," McMullen says. "I felt I'd have access to the resources and mentoring that I'll need to be successful, and that the University would be committed to my success as a researcher."

At the heart of that mentoring is HCC chair, Juan Gilbert, who tirelessly seeks to develop solutions to real-world problems and to understand how computer technologies affect society.

Juan Gilbert, the mentor for the HCC group

Computing for REAL LIFE

The inaugural Presidential Endowed Chair in Computing, an IDEaS professor in the School of Computing and a professor in the automotive engineering department, Gilbert is also the recipient of a Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring from President Obama. He leads a team that researches applications such as electronic voting, workforce development and instructional technologies. In addition, he researches voice-texting – aka "voiceing" – an application that allows drivers to speak, rather than type, text messages.

Last year, Gilbert was selected to direct a three-year, $4.5 million project funded by the U.S. Election Assistance Commission to increase the accessibility of new, existing and emerging technological solutions in the design of voting systems.

"HCC is a relatively young discipline that deals with people," Gilbert says. "Our motto is 'Change the World,' and we will. Our graduates will address societal issues, and they'll look at problems, design solutions, build prototypes and evaluate the results."

Those four steps are traditionally performed by three different teams in the working world today, and Gilbert explains that's why HCC graduates are being warmly welcomed in the workforce.

"Our graduates are filling a void in both academia and the corporate world," he says. "They'll impact policy and how the world exists."

The world as it existed at the end of September 2001 determined the future of associate professor Damon Woodard.

With the nation still reeling from the Sept. 11 attacks, Woodard was drawn to the James-Bond-like technology found in biometrics and a wider field called identity science. In addition to the use of traditional biometric traits such as face and iris patterns for establishing identity, he also explores the use of cultural traits, behavioral interaction, emotional cues and the policies and ethical issues surrounding the use of identity.

"Especially after Sept. 11, security became important, and I found myself interested in biometrics because it draws from so many areas,"

Woodard says. "You have to know a lot about various disciplines, and I found that to be very interesting."

He wasn't the only one. After he earned his doctorate from Notre Dame, the intelligence community awarded him a postdoctoral fellowship to continue his biometric work. Funding for his research continues to come from law enforcement agencies and the intelligence community.

"We're working to achieve higher accuracy in increasingly challenging situations. Facial recognition technology is more difficult, for example, when people are walking, when their face is partially covered or when they age," he says.

Shaundra Daily joined the division because it's a place that offers a single home to someone who likes to wear a lot of hats, academically speaking.

"It's a place where I can continue to have my identity crisis," she jokes.

"HCC is a relatively young discipline that deals with people," Gilbert says. "Our motto is 'Change the World,' and we will."

Daily's research crosses so many disciplinary borders that it's difficult to put her in any one category. It takes a place like HCC to provide a good home for someone with two degrees in electrical engineering and two more in media arts and sciences, not to mention her Ph.D. from the Massachusetts Institute of Technology.

Her research interests combine things generally associated with hard science with things that usually are not — such as empathy, emotions, feelings and how those feelings affect youth and their learning.

Daily's goal is to use the power of computers to enhance learning for children. One project, for example, explores a way to measure teacher-student engagement. The assistant professor uses sensors to detect endocrine secretions — or indicators of emotion — to collect physiological data on emotional responses. Another application allows students to program digital stories about themselves to help them better understand their emotions. Yet another sees children programming computer characters to dance with them. The children are so taken with the project that they don't even think of it as formal learning.

"I like the idea that I can build something with a computer that allows students to learn more effectively or to deal with their emotions," Daily says. "I wear a lot of hats, but, in the end, I'm trying to empower students and broaden their participation in the STEM fields."

Daily is not the only part of the team working to improve young thinkers through the power of computing science.

Assistant professor Christina Gardner-McCune believes a populace with more than just a user's knowledge of computers will build a stronger society.

"My goal is to get them started early," Gardner-McCune says of the young people she intends to introduce not just to computers, but also computing.

"My work focuses on the intersection of education and computer science. I design technology, learning environments and curriculum to help youth become designers and innovators of technology — not just passive consumers." Participants in her after-school and summer-camp

Left: Gilbert, Daily and Woodard

Right: Reme, Gardner-McCune and McMullen

Left: Woodard

Right: McMullen and Remy

computing programs are encouraged to envision the future of technology by proposing computing-based solutions to real-world problems. They are then taught how to program and given the resources and tools to design prototypes of these technologies. These individuals are empowered by their ability to bring their ideas to life.

Gardner-McCune's goal is to improve K-12 education through the integration of computing and technology throughout the curriculum. She imagines a world where learners are driven by their interests and use computing and technology to leverage those interests to learn and excel. She designed a cooking curriculum that integrated science, cooking and technology, for example, so when kids got excited about a cooking project, they strengthened their scientific reasoning skills as they explored the science behind the cooking.

"It's all about getting kids excited about learning and exploring the role that computers play," says Gardner-McCune, who considers herself a "learning scientist."

Her interest in the area emerged while she was a graduate student and postdoctoral researcher at Georgia Tech, where she designed after-school programs to encourage middle- and high-school students to explore science and computing through contexts that naturally interest them. Her driving idea was to create better scientific and computational thinkers for the future.

"I'm not a teacher," she says. "I'm a learning scientist who wants to improve STEM and computer science education," she says. "Human-centered computing allows me to apply my computer science training to better understand how people learn with technology and to design educational environments that foster learning."

Sekou Remy is working to create access to robotics and intelligent systems everywhere from K-12 classrooms to the population at large. He evaluates robotics and intelligent systems made for the general public and looks for ways to make them better for the end user.

Remy knows everyone can't write a program for robots, but he believes we could simply show some robots what to do. "Robots built for entertainment and service outside of industrial use could be trainable so that users could show them how to perform tasks through demonstration and feedback," he says.

The average person may not have the time or inclination to program a computer to clean the floor, for example, but anyone can demonstrate.

Remy is also interested in giving people who do not have ready access to a robot the ability to use one via cloud computing. For instance, a class of middle-school students could program a robot in the cloud using simulation and then be ready to try it on the real thing when they get their turn with a robot shared with other schools.

The assistant professor was drawn to Clemson when he saw some exciting HCC research going on around the Upstate of South Carolina.

"It's a really beautiful part of the country, and I see opportunities for growth and development here," says Remy, who grew up in Trinidad and Tobago. "My motivation is to improve quality of life and give this state a competitive advantage. My job is to make sure I'm doing things that have impact on the state, the nation and the world." ✻

Answering the Call

The Clemson University Center for Workforce Development is helping to create a new breed of skilled worker in S.C.

By Alexa Woodward and Peter Hull

South Carolina is currently a hub of next-generation advanced manufacturing, and a center at Clemson University is working to ensure this new breed of employer can call on a labor pool rich with a skilled and qualified workforce.

For almost 100 years, South Carolina's manufacturing sector was largely tied to textile and other factory work that provided little room for professional growth, employing workers at young ages with minimal education. This climate drastically changed in the 1990s, when South Carolina's traditional manufacturing jobs were largely outsourced to lower-wage regions around the world. Many of these factory workers were left jobless, as they lacked the skills and education to transition into other occupations.

During the textile exodus, a few notable advanced manufacturers were locating to South Carolina, including transportation, energy and aviation companies. These employers required advanced technical skills and paid higher wages for them.

The disparity between the available jobs in advanced manufacturing and the number of qualified workers has been significant and reflects a national trend. At the height of the recession, 32 percent of manufacturing jobs went unfilled nationwide due to an underskilled labor pool.[1]

Clemson took this as a cue to act.

When the state's advanced manufacturing growth was in its early stages, leadership in Clemson's College of Engineering and Science (CES) observed these statewide growth trends and recognized the need for an improved workforce — one with highly specialized knowledge and strong math and science skills. CES realized that as industry clusters grew, they would require better-skilled workers in order to thrive in the region.

One of those advanced manufacturing companies is BMW Manufacturing Co. When it produced the first car in its Spartanburg plant in 1994, a new era had begun. The future looked bright, as more international companies followed suit, and soon Clemson built a foundation of successful partnerships in areas where the needs for skilled workers have been greatest.

Whether through certificate, continuing education or advanced degree programs, South Carolina has benefited greatly by keeping its labor force homegrown. Such an ethos is a mainstay of Clemson University President James F. Barker. "The surest path to prosperity is education, and economic and workforce development continues to be Clemson's highest priority as an institution," he says.

In 2007 AdvanceSC was established by Duke Energy to support the S.C. communities it serves. It provided Clemson with initial funds to explore the usefulness of visualization and simulation tools to support "e-learning" in manufacturing education and new technologies in aviation fields. This initiative indicated that a key element in workforce development is the creation of educational tools for next-generation engineers and technicians to support the aviation and automotive industry clusters across the state.

This success fed into a multiyear process of fine-tuning a statewide vision for collaborative workforce development that would include Clemson University, South Carolina's technical colleges, key industry partners and support from federal agencies.

The center addresses foundational skills gaps in science, technology, engineering and math (STEM).

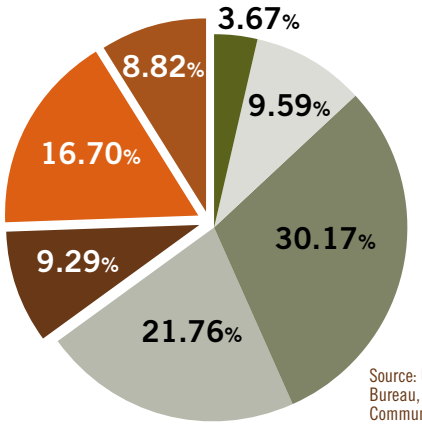
The result of these combined efforts is the Clemson University Center for Workforce Development (CUCWD), an initiative created upon the premise that every advanced manufacturing job in South Carolina should be — and can be — filled locally.

"Our goal is to develop next-generation engineers, scientists and technicians to work in industries that drive the nation's economy," says Anand K. Gramopadhye, director of the center and Clemson University's associate vice president for workforce development.

The center addresses foundational skills gaps in science, technology, engineering and math (STEM). Traditional K-12 math and science teaching efforts in South Carolina are not producing graduates with an ability to master the basics. In fact, 37 percent of S.C. students who enter technical college programs require remediation in basic math courses — costing the state nearly $13 million a year. Of those students who enter technical college programs, only 14 percent graduate. Among all states, South Carolina ranks 37th for the number of work-eligible adults who have obtained at least an associate degree.

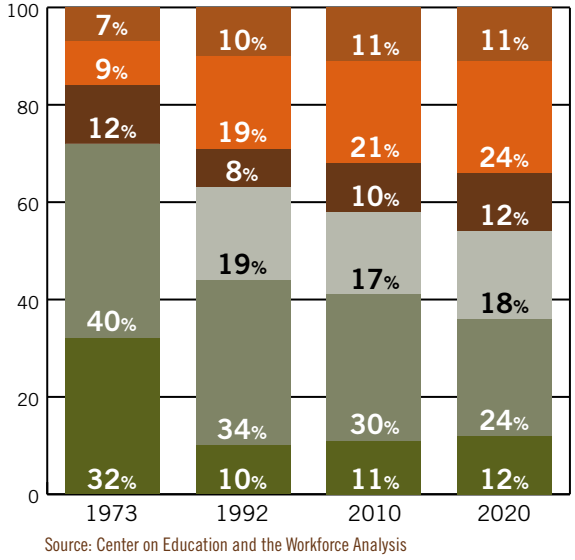
[1] *Source: Roadmap to Education Reform for Manufacturing sponsored by Deloitte and Manufacturing Institute*

2010 Levels of Education for South Carolina Residents



Source: U.S. Census Bureau, 2010 American Community Survey

Education Level Job Requirements



Source: Center on Education and the Workforce Analysis

Less than 35 percent of South Carolina's workforce has more than a high school education, at a time when 59 percent of all jobs nationwide will require postsecondary education and training.

When such educational challenges are compared with industry growth and the availability of high-skilled, STEM-oriented jobs, the solution is clear: South Carolina needs comprehensive workforce development for economic growth.

"For workforce development to be effective, it must engage the full spectrum of education, addressing the science and math competency gaps prevalent at every level," says Gramopadhye.

CUCWD is built upon the idea that a permanent advanced manufacturing workforce will only exist when STEM skills are developed at the elementary-, middle- and high-school education levels. Further, technical colleges should target specific advanced manufacturing skills and offer professional development for adults seeking to transition into higher-wage jobs.

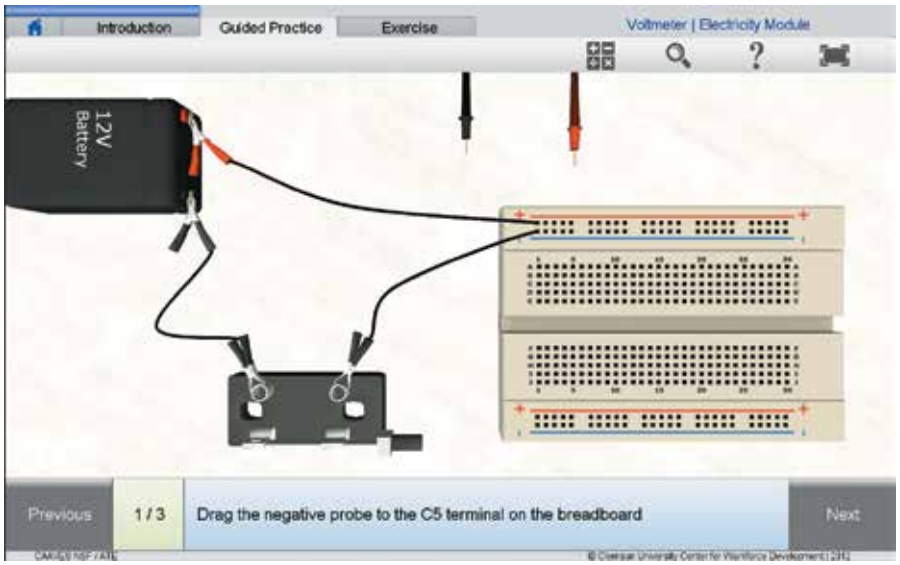
The goals of this initiative run the gamut of skills gaps at every stage because it is designed to serve South Carolina's advanced manufacturing sector over the long haul. Focusing on e-learning initiatives, career pathways, P-20 outreach and industry cluster networking, CUCWD takes a multifaceted, comprehensive approach that is effective through collaboration.

"The key element of workforce development is education," Gramopadhye says. "To produce results, we must engage industry in the educational process to identify their specific needs."

"The key element of workforce development is education," Gramopadhye says. "To produce results, we must engage industry in the educational process to identify their specific needs."

A full-spectrum approach must be taken to increase capacity, he adds. To be successful in this new economy, job seekers must

At a recent STEM forum introducing the CUCWD to the P-12 and technical college communities, center director Anand Gramopadhye (right) exchanges ideas with S.C. Rep. Garry Smith.



Clemson's Center for Workforce Development utilizes visualization and simulation tools to support "e-learning," or distance education — both are key capabilities for developing next-generation engineers and technicians.

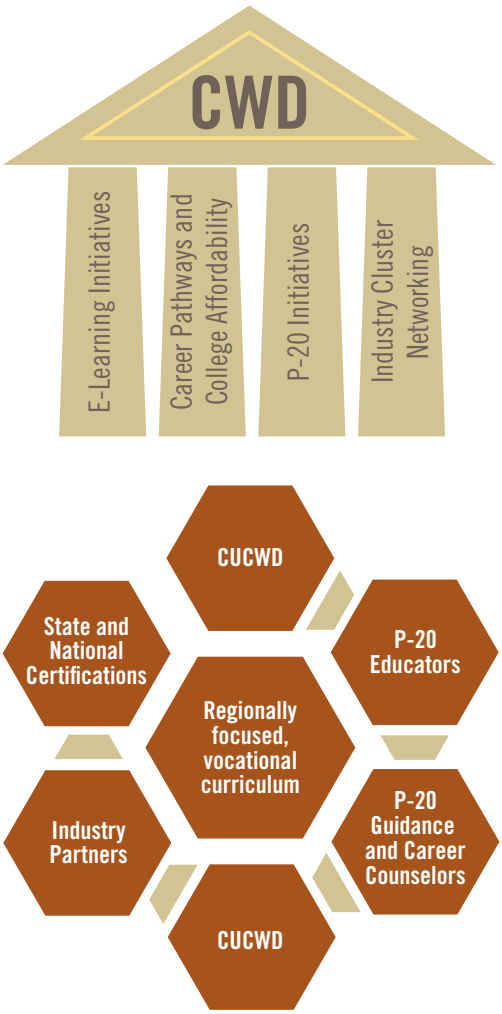
be educated about employment opportunities and receive the necessary tools to build the precise skills that are required.

One example of CUCWD's work is the creation of e-learning modules designed to address skill needs articulated by industry partners. A number of advanced manufacturers have expressed that workers should have a more comprehensive foundation in quality control skills and measurement. In response, CUCWD is currently developing courses focused on metrology, quality control and tolerance. Because of the modular nature of the e-learning courses, they can be implemented in a variety of settings at no cost to the user.

Another example of CUCWD's comprehensive STEM efforts is a recent forum on P-20 (preschool through higher education) STEM education held at the Clemson University International Center for Automotive Research, where industry leaders from Michelin, Milliken, GE, BMW and Fluor engaged in dialogue with K-12 and technical college educators and administrators, as well as state representatives about their workforce needs.

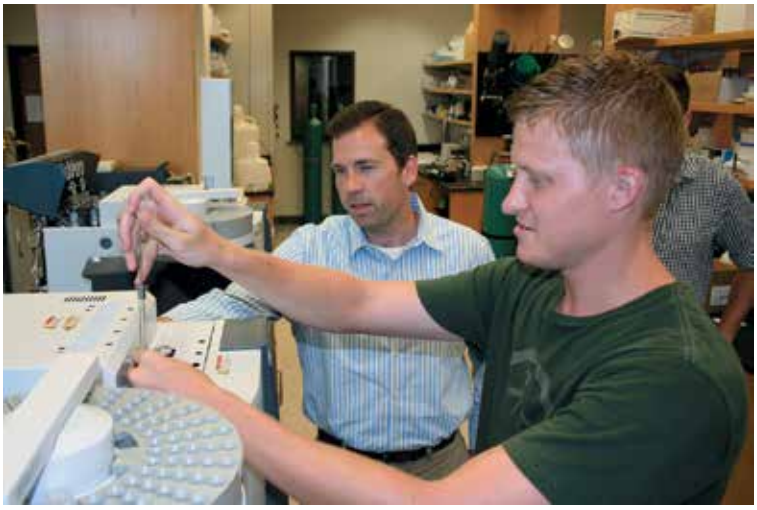
CUCWD is a Commission on Higher Education-approved center, supported by the National Science Foundation, the U.S. Department of Labor, the U.S. Department of Education and private sector partners. Federal funding associated with the center totals more than $35 million, dispersed throughout the state among 16 technical college partners and CUCWD activities in the Greenville, Columbia and Charleston areas. Through consortium grants with essential technical college partners, the center has played a key role in bringing significant federal funding to South Carolina to improve workforce development initiatives statewide.

Today, the state's technical colleges and industry partners associated with CUCWD are partnering with Clemson University to create a sustainable environment for higher-wage, higher-skilled jobs that can feed the state's growing economy. This is vital to a sustainable economic development model for South Carolina. *



Clemson's workforce development initiative builds on four key components: e-learning, career pathways and college affordability, P-20 STEM initiatives and industry partnerships.

The News from Around the



Clemson scientist named Kavli Fellow of the National Academy of Sciences

Environmental engineering and earth sciences associate professor Kevin Finneran has been named a Kavli Fellow of the National Academy of Sciences.

The Kavli program recognizes young scientists who are leaders in their fields and brings them together in the Frontiers of Science program, which is a collaborative symposium between the academy and the leading scientific academy of a foreign country.

Finneran was invited to speak and become a Kavli Fellow at the German-American Frontiers of Science conference in Potsdam, Germany. The Alexander Von Humboldt Foundation is the participating organization in Germany.

Finneran's presentation, "Bioremediation: Basic Science Meeting Applied Goals," can be viewed at *vimeo.com/44772026*.

Clemson introduces first medical device reprocessing certificate program

Clemson University has established the first program to train engineers to recycle and reprocess medical devices. The Medical Device Recycling and Reprocessing Certificate Program offered by the Clemson University Biomedical Engineering Innovation Campus (CUBEInC) was developed in response to the dramatic market adoption of reprocessing in recent years.

Medical device reprocessing has been identified as a core component of green technology and is predicted to be one of the top 20 fastest-growing industries in the next five years.

Medical devices considered suitable for reprocessing are diverse and impact nearly all hospital departments. A few examples of reprocessed devices include electrophysiology catheters for cardiac irregularities; numerous devices used during endoscopic surgery; and noninvasive products, such as pulse oximetry sensors and various disposable compression therapy devices.

CUBEInC is located at the Greenville Hospital System University Medical Center Patewood campus. Clemson's program is made possible, in part, by contributions from third-party reprocessors, including market leader Stryker Sustainability Solutions.

Team AssureFit and design mentors: (left to right) Jenkins, Eskew, Atwood, Przestrzelski, Gates and DesJardins.

Bioengineering team wins undergraduate design competition

Clemson University's bioengineering senior design team won the annual National Collegiate Inventors and Innovators Alliance BMEStart undergraduate design competition for AssureFit, a novel chest-tube anchoring device.

Under the direction of professor John DesJardins, the biomedical device was developed by a team of undergraduate bioengineering students as part of their senior design project. Team leader Breanne T. Przestrzelski and teammates Carlyn M. Atwood, Lauren E. Eskew and Brennen C. Jenkins partnered with Greenville Hospital System pediatric surgeons John Chandler and Robert Gates to develop the innovative device.

The AssureFit chest-tube stabilization device is used to prevent surgical drains from dislodging following procedures, saving time and medical expense. The device also allows for greater patient mobility and comfort.

I-Corps teams march to the head of the pack

Clemson University Innovation Corps (I-Corps) teams took the top two spots in a presentation competition in Atlanta.

The National Science Foundation (NSF) I-Corps program fosters entrepreneurship that could lead to the commercialization of technology that has been supported by NSF-funded research.

Timothy Burg, associate professor in the Holcombe Department of Electrical and Computer Engineering, led the first-place team. Douglas Hirt, chairman of chemical and biomolecular engineering, captained the second-place team.

I-Corps teams are composed of three primary members: the principal investigator (in these cases, Burg and Hirt), an entrepreneurial lead and a mentor.

The entrepreneurial lead for Burg's team was Ravi Singapogu, a postdoctoral student. The team mentor was Lisa Perpall, the technology commercialization officer from the Clemson University Research Foundation.

Burg and Singapogu have developed a new method to train surgery residents via a novel surgical simulator for force-based (or haptic) laparoscopic skills.

The entrepreneurial lead of Hirt's team was Cody Reynolds, a postdoctoral fellow; the mentor was Matt Gevaert, the CEO of KIYATEC of Greenville. The team's project focused on drug-eluting fiber applications. There are many instances where drug-eluting – or drug-delivery – sutures can prevent infection and ultimately save lives.

Clemson's award-winning I-Corps teams include, (from left), Burg, principal investigator; Singapogu, entrepreneurial lead; Perpall, team mentor; Reynolds, entrepreneurial lead; Hirt, principal investigator; and Gevaert, team mentor.

image by: Kinect Fun Labs Challenge

Clemson's Dukes (left) and Hayes (center) receive their second-place award in the Kinect Fun Labs Challenge.

'Pirates' raid second place at international Microsoft competition

A student team from Clemson University's School of Computing took second place in the Kinect Fun Labs Challenge, one of eight competitions held as part of the 10th annual Microsoft Imagine Cup.

The theme for the 2012 Cup, held in Sydney, Australia, was: *Imagine a world where technology helps solve the toughest problems.*

Graduate students Patrick Dukes and Austen Hayes, known competitively as the "Whiteboard Pirates," developed a stroke rehabilitation application using Microsoft's Kinect tracking system. Kinect, a motion-sensing input device, enables users to control and interact with an Xbox 360 or a desktop computer without having to touch a game controller. The interface is accomplished with gestures and spoken commands.

Dukes and Hayes saw shortcomings with current stroke therapy so they came up with "Duck Duck Punch," a cost-effective system for upper-arm therapy that can be used at home. The result: a system that interjects a little fun into what can be a challenging rehabilitation regimen.

Read more about this system in *Popular Science* by visiting *popsci.com/technology/article/2012-07/kicking-2012-imagine-cup.*

Clemson student recognized by Society of Hispanic Professional Engineers

Clemson University graduate student Daniel Lind has received a STAR award from the Society of Hispanic Professional Engineers. The awards recognize key contributors in the Hispanic community in the fields of science, technology, engineering and math (STEM).

Lind attended the University of Miami, where he received his B.S. in mechanical engineering. He studied at the Clemson University International Center for Automotive Research (CU-ICAR) in Greenville and received his master's degree in automotive engineering in August. He is now a STEM Fellow in the Congressional Hispanic Caucus Institute Graduate Fellowship program.

During his two years as a graduate student at CU-ICAR, Lind started a Society of Hispanic Professional Engineers chapter at Clemson.

Clemson students unveil Deep Orange 3 at SEMA 2012

Deep Orange 3, the third-generation Deep Orange vehicle prototype designed and engineered by Clemson University automotive engineering students, is a whole new vehicle – inside and out.

Deep Orange 3 made its debut at the 2012 Specialty Equipment Market Association (SEMA) show. The annual gathering attracts more than 120,000 attendees and some 2,000 exhibitors to the Las Vegas Convention Center.

Working at the Clemson University International Center for Automotive Research (CU-ICAR), the students have free rein to push the boundaries of conventional design and engineering. They designed the vehicle in partnership with Mazda North American Operations and the Art Center College of Design in Pasadena, Calif.

Deep Orange 3 features a unique TwinEngine hybrid powertrain that automatically chooses front-, rear- or all-wheel-drive; a load-bearing structure based on innovative sheet-folding technology patented by Industrial Origami; and a groundbreaking 3+3 seating configuration in sports car architecture – all packaged in an exterior design created by students at the Art Center College of Design.

Paul Venhovens, BMW Endowed Chair in Automotive Systems Integration, leads the Deep Orange program. He says the latest design not only provides solutions to the efficiency-vs.-sportiness debate, but also delivers driving pleasure, practicality and flexibility in a setting where everyone enjoys the ride.

The vehicle accelerates from zero to 60 mph in 7.5 seconds with a top speed of 125 mph, achieving 42 city and 49 highway miles per gallon.
Read more about Deep Orange 3 at *clemson.edu/media-relations/4219/clemsons-deep-orange-program-an-innovative-approach-to-education* and *wheels.blogs.nytimes.com/2012/11/05/engineering-students-give-a-sneak-peek-at-car-project*.

Technology institute awards CU-ICAR economic development excellence award

The Clemson University International Center for Automotive Research (CU-ICAR) has been honored by the State Science and Technology Institute (SSTI) with the Excellence in Tech-Based Economic Development award for its role in regional economic development.

SSTI president and chief executive officer, Dan Berglund, said CU-ICAR exemplifies a comprehensive strategic initiative that connects a research university, key industry partners and government at all levels to increase the competitiveness of a key regional industry and develop the necessary workforce to support it.

SSTI is a national nonprofit organization that leads, supports and strengthens efforts to improve state and regional economies through science, technology and innovation.

Associate dean selected for ACE Fellows program

E.R. "Randy" Collins, associate dean for undergraduate and international studies in the College of Engineering and Science, has been named to the American Council on Education (ACE) Fellows Program.

Established in 1965, the Fellows Program strengthens institutions and leadership in American higher education by identifying and preparing promising senior faculty and administrators for more responsible positions in university administration. Fellows are nominated by the presidents or chancellors of their institutions and selected in a national competition.

The program combines retreats, interactive learning opportunities, campus visits and placement at another higher education institution to condense years of on-the-job experience and skills development into a single year. Fellows also conduct projects that contribute to their home institutions.

Collins has been placed in the provost's office at Virginia Tech, working with Mark McNamee, senior vice president and provost.

NSF awards $1.2 million grant to Clemson professor for energy storage research

Rao, left, and Podila are researching the use of carbon nanomaterials for energy storage.

Clemson University physics professor Apparao Rao has received a $1.2 million NSF grant to explore the use of carbon nanomaterials for energy storage.

Rao will lead a team of researchers from Clemson and the University of California-San Diego in developing novel types of electrochemical capacitors with blueprints for their scalability. He is regarded as a leader in developing nanomaterials and discovering how the laws of physics operate in a world of indescribable minuteness. At one-billionth of a meter, these materials have a much greater surface-to-volume ratio than other substances, which can lead to unusual and often very useful properties.

This project will build on previous research by Rao and his research associate, professor Ramakrishna Podila, which provided insight on engineering and characterizing defects in carbon nanomaterials.

The researchers now aim to use carbon nanomaterials with chains of molecules that allow electric current to flow in high-energy storage devices superior to those available today.

CES Honors Donors and Scholarship Recipients

CES recently held a luncheon honoring donors and the students their gifts have inspired. Alumni and friends of the college who've established scholarships were able to spend some time with their scholarship recipients to hear about some of the amazing aspects of these students' Clemson Experiences.

Susie and Ann Adams spend some time with William Duncan, an industrial engineering senior.

Helen and Bill Arthur talk bioengineering with senior Chelsea Koch.

The Clemson-Fluor Connection

A recent after-hours gathering at the Fluor campus in Greenville brought together Clemson alumni with CES administrators, faculty and students. Fluor employees heard firsthand how their support is critical for research and scholarship.

Annette Allen '87, vice president and general manager of Fluor's Greenville offices, and Larry Dooley, Clemson's interim vice president for research, discuss the Clemson-Fluor partnership.

Scott Mason (third from left), professor and Fluor Endowed Chair in Supply Chain Optimization and Logistics, and Larry Dooley (far right) discuss the new online master's degree in supply chain and logistics with Fluor employees.

Steve DeVita (left) exchanges thoughts with Ron Andrus, interim chair of civil engineering.

Alumni Spotlight

The Meaning of T³

The *IDEaS* roving camera caught up with **Ken '81 and Layne '81 Smith** at the Cumulative Giving and Legacy Societies Induction Ceremony. Both are the type of active alumni who are referred to as T³, meaning their support for Clemson involves time, talent and treasure. In addition to financial gifts, which are critical, they also share their most precious gifts — their time and their talent.

Ken is deeply invested in CES and Clemson. A member of the College Advisory Board, he served as its chair from 2007 to 2009. He also led the college's Will to Lead campaign committee.

At the University level, Ken serves on the Clemson University Foundation Board and is a member of the national campaign committee. He is also active in the greater Greenville area, having provided leadership to the S.C. Chamber of Commerce and the S.C. Governor's School. As the senior vice president of Fluor's government group, Ken led the corporate effort to establish the Fluor Endowed Chair in Supply Chain and Logistics. The $2 million Fluor gift generated an equal S.C. state match to make the chair possible. Under Ken's leadership, since 2000, the Fluor Foundation has contributed gifts of $300,000 to numerous Clemson entities.

On a personal level, Ken and Layne established a scholarship endowment to assist CES students, and they have supported the West End Zone expansion. Their association with the University is generational. All three of their daughters have gone to Clemson, including Kelly '08, graphic communications; Haley '11, travel and tourism; and Cameron expects to graduate in 2013.

In 2009, the Clemson University Alumni Association recognized Ken with its Distinguished Service Award (DSA), the University's highest alumni honor.

DSA honorees demonstrate a dedication to enhancing the value of the University for future generations; service to church, community, profession and public service; and personal accomplishments that serve as a model for present and future Clemson students. Ken meets and exceeds all of those parameters.

The Departments

Automotive Engineering

Imtiaz Haque, Ph.D.
Department Chair

6 Research Drive
Greenville, SC 29607
864-283-7217

sih@clemson.edu

clemson.edu/centers-institutes/cu-icar

Fast Facts

Tenured/tenure-track faculty: 10

Enrollment (Fall 2012):

Undergraduate	-
Master's	116
Doctoral	44

Degrees awarded (Aug. and Dec. 2012 only):

Undergraduate	-
Master's	34
Doctoral	5

Research expenditures: $2 million

Research thrusts: systems integration, vehicle manufacturing, vehicle design and development, vehicular electronics

Bioengineering

Martine LaBerge, Ph.D.
Department Chair

301 Rhodes Research Center
Clemson University
Clemson, SC 29634-0905
864-656-5556

laberge@clemson.edu

clemson.edu/ces/bio

Fast Facts

Tenured/tenure-track faculty: 22

Enrollment (Fall 2012):

Undergraduate	269
Master's	35
Doctoral	83

Degrees awarded (Aug. and Dec. 2012 only):

Undergraduate	6
Master's	17
Doctoral	5

Research expenditures: $7 million

Research thrusts: biomaterials engineering, bioelectrical engineering

Chemical and Biomolecular Engineering

Douglas Hirt, Ph.D.
Department Chair

127 Earle Hall
Clemson University
Clemson, SC 29634-0909
864-656-0822

hirtd@clemson.edu

clemson.edu/ces/chbe

Fast Facts

Tenured/tenure-track faculty: 11

Enrollment (Fall 2012):

Undergraduate	184
Master's	-
Doctoral	35

Degrees awarded (Aug. and Dec. 2012 only):

Undergraduate	1
Master's	2
Doctoral	2

Research expenditures: $2 million

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

Chemistry

Stephen Creager, Ph.D.
Department Chair

219 Hunter Laboratories
Clemson University
Clemson, SC 29634-0973
864-656-4995

screage@clemson.edu

chemistry.clemson.edu

Fast Facts

Tenured/tenure-track faculty: 23

Enrollment (Fall 2012):

Undergraduate	144
Master's	2
Doctoral	86

Degrees awarded (Aug. and Dec. 2012 only):

Undergraduate	6
Master's	4
Doctoral	4

Research expenditures: $3.6 million

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

Glenn Department of Civil Engineering

Ronald D. Andrus, Ph.D.
Interim Department Chair

Lowry Hall
Clemson University
Clemson, SC 29634-0911
864-656-3002

randrus@clemson.edu

clemson.edu/ce

Fast Facts

Tenured/tenure-track faculty: 20

Enrollment (Fall 2012):

Undergraduate	435
Master's	69
Doctoral	56

Degrees awarded (Aug. and Dec. 2012 only):

Undergraduate	57
Master's	24
Doctoral	6

Research expenditures: $3 million

Research thrusts: sustainable and resilient infrastructure

School of Computing

Larry F. Hodges, Ph.D.
Director

100 McAdams Hall
Clemson University
Clemson, SC 29634-0974
864-656-7552

lfh@clemson.edu

clemson.edu/ces/computing

Fast Facts

Tenured/tenure-track faculty: 28

Enrollment (Fall 2012):

Undergraduate	412
Master's	134
Doctoral	68

Degrees awarded (Aug. and Dec. 2012 only):

Undergraduate	22
Master's	44
Doctoral	2

Research expenditures: $1.7 million

Research thrusts: computing foundations, data analytics, software engineering, cyberinfrastructure, networking, bioinformatics, computer graphics and animation, eye tracking, visualization, digital arts, intelligent and interactive systems, identity science and affective computing, virtual environments, human/computer interaction, pedagogical tools using tablet PCs and handheld devices

Holcombe Department of Electrical and Computer Engineering

Darren Dawson, Ph.D.
Department Chair

105 Riggs Hall
Clemson University
Clemson, SC 29634-0915
864-656-5924

ddarren@clemson.edu

clemson.edu/ces/ece

Fast Facts

Tenured/tenure-track faculty: 32

Enrollment (Fall 2012):

Undergraduate	452
Master's	76
Doctoral	85

Degrees awarded (Aug. and Dec. 2012 only):

Undergraduate	45
Master's	22
Doctoral	8

Research expenditures: $2.8 million

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

Environmental Engineering and Earth Sciences

Tanju Karanfil, Ph.D.
Department Chair

L.G. Rich Environmental Laboratory
342 Computer Court
Anderson, SC 29625
864-656-1005

tkaranf@clemson.edu

clemson.edu/ces/eees

Fast Facts

Tenured/tenure-track faculty: 20

Enrollment (Fall 2012):

Undergraduate	167
Master's	72
Doctoral	36

Degrees awarded (Aug. and Dec. 2012 only):

Undergraduate	9
Master's	25
Doctoral	3

Research expenditures: $2.6 million

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

Industrial Engineering

Anand K. Gramopadhye, Ph.D.
Department Chair

110 Freeman Hall
Clemson University
Clemson, SC 29634-0920
864-656-4716

agramop@clemson.edu

clemson.edu/ces/ie

Fast Facts

Tenured/tenure-track faculty: 12

Enrollment (Fall 2012):

Undergraduate	262
Master's	141
Doctoral	31

Degrees awarded (Aug. and Dec. 2012 only):

Undergraduate	8
Master's	32
Doctoral	5

Research expenditures: $1.5 million

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

Materials Science and Engineering

Igor Luzinov
Interim Chair

161 Sirrine Hall
Clemson University
Clemson, SC 29634-0922
864-656-5958

luzinov@clemson.edu

clemson.edu/mse

Fast Facts

Tenured/tenure-track faculty: 16

Enrollment (Fall 2012):

Undergraduate	98
Master's	9
Doctoral	46

Degrees awarded (Aug. and Dec. 2012 only):

Undergraduate	3
Master's	8
Doctoral	8

Research expenditures: $5.3 million

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

Mathematical Sciences

Robert L. Taylor
Department Chair

O-110 Martin Hall
Clemson University
Clemson, SC 29634-0975
864-656-3434

rtaylo2@clemson.edu

clemson.edu/math

Fast Facts

Tenured/tenure-track faculty: 44

Enrollment (Fall 2012):

Undergraduate	163
Master's	29
Doctoral	95

Degrees awarded (Aug. and Dec. 2012 only):

Undergraduate	12
Master's	13
Doctoral	6

Research expenditures: $827,320

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

Mechanical Engineering

M.K. "Ram" Ramasubramanian, Ph.D.
Department Chair

100 Fluor Daniel EIB
Clemson University
Clemson, SC 29634-0921

864-656-5640

rammk@clemson.edu

clemson.edu/ces/me

Fast Facts

Tenured/tenure-track faculty: 23

Enrollment (Fall 2012):

Undergraduate	619
Master's	84
Doctoral	63

Degrees awarded (Aug. and Dec. 2012 only):

Undergraduate	62
Master's	23
Doctoral	2

Research expenditures: $1.6 million

Research thrusts: transportation, energy, design, materials, manufacturing, fluids, complexity, multi-scale modeling

Physics and Astronomy

Mark Leising, Ph.D.
Interim Department Chair

118 Kinard Laboratory
Clemson University
Clemson, SC 29634-0978
864-656-5304

lmark@clemson.edu

clemson.edu/ces/physics-astro

Fast Facts

Tenured/tenure-track faculty: 21

Enrollment (Fall 2012):

Undergraduate	83
Master's	7
Doctoral	54

Degrees awarded (Aug. and Dec. 2012 only):

Undergraduate	-
Master's	8
Doctoral	6

Research expenditures: $2 million

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

CLEMSON
College of ENGINEERING AND SCIENCE

CLEMSON
College of ENGINEERING AND SCIENCE

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

Nonprofit
Organization
U.S. Postage
PAID
Clemson, SC
Permit No. 10

New Freeman Hall

Strategically planned to promote collaboration and connectivity, the new Freeman Hall will provide plenty of open and informal space to inspire teamwork and cooperative thinking inside. The building, home to Clemson's industrial engineering department, opens up to the outside with a transparent façade to encourage an inviting flow from the front of the building. Construction is planned to begin this summer.