About Decipher

Decipher magazine is produced by a team of Clemson University’s undergraduate students to highlight the accomplishments of their peers in Creative Inquiry, Clemson’s unique brand of undergraduate research. Creative Inquiry is Clemson’s way of engaging students in research topics they find interesting, in their own or other cross-disciplinary fields of study.

Each year, more than 3,500 Creative Inquiry students investigate topics ranging from the impact of climate change on lizard behavior to analyzing marketing strategies at music festivals. Their Creative Inquiry projects provide them with the tools they need to explore diverse problems and issues in our community and beyond and to come up with possible solutions. Students value these opportunities to exercise the skills they learned in the classroom and apply them to the real world.

From the more than 404 current Creative Inquiry projects, we selected 38 projects to feature in this magazine. Our Decipher team interviewed the faculty and graduate student mentors and students in each of these projects in order to write these articles and produce illustrations. Decipher is printed and distributed to students, faculty alumni, and friends of Clemson so that they are aware of the many accomplishments of students in the Creative Inquiry program. For example, Creative Inquiry students and faculty have made more than 870 presentations at professional conferences, authored more than 310 professional publications and won more than 71 awards.

Decipher, Creative Inquiry’s magazine, is also available digitally, as a free app through the Apple iTunes store as well as an interactive blog on the Creative Inquiry website.
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Mitchelville photo provided by the South Carolina State Museum

Articles featured on the front cover from top to bottom, left to right: Bionic Arm, Creative Play, Building Healthier Communities in the Dominican Republic, Butterfly Proboscis Structure, Geologic Studies in the Upstate

Articles on the back cover from left to right: Butterfly Proboscis Structure, The Future & Autonomous Cars, Human-Elephant Conflict in Asia, Tiger Gardens, China & US Foreign Relations, Mind Controlled 3D Printing, Breaking the Ice
Since the 1970s, the majority of the world’s crustacean and fish stocks have been in danger due to overfishing. In coastal areas, there are large fisheries targeting species that we know little about, which can harm local ecosystems in unknown ways. In addition, climate change, predators and parasites put more pressure on these marine populations. Baeza’s group studies some of these at-risk species in hopes of collecting relevant data before populations collapse.

The group collects data on the reproductive biology and life history of marine organisms targeted by fisheries to provide information that can help federal and state entities properly manage species. Baeza identified the Florida Keys as a hotspot for his marine research due to several biodiversity issues. Without this research to understand these at-risk populations, many species could die off without us knowing.
suffer further population declines. The result would be negative impacts on the environment and human populations dependent upon these species. The data collected by the Creative Inquiry team also helps aid marine conservation efforts in other biodiversity hotspots such as the Caribbean Sea. Although working with marine species produces a challenge for the team, they manage to generate relevant genetic and morphological information about aquatic life in hopes to improve our understanding of the biodiversity in the Florida Keys and beyond.

Students in Baeza’s project first learn how to distinguish males from females in crab, shrimp and lobster species in the laboratory and to properly measure female fecundity, egg size and reproductive output in these species. For Rami Major, a sophomore genetics major, the work she does in the Creative Inquiry allows her to gain experience in marine biology that she wouldn’t have gained otherwise. “This team has been a cool way to keep something that has been interesting to me in my life, without having to change my major from genetics to environmental science,” Major said. The work of the team extends beyond measuring marine organisms. “In the lab, I want my students to get involved in all the stages of scientific research, all the way from working on the bench, to diving, to analyzing data, to writing and to presenting a poster at a scientific meeting,” Baeza said.

Striving toward the goal to reduce pressures on essential marine species, these Creative Inquiry students are becoming a part of the solution to an ecological crisis. “To me, one way of measuring the success of the Creative Inquiry is to publish a paper with my team that will help to solve, in a minor or major way, a marine conservation problem, either at a local or global scale,” Baeza said.

by Jason Erno

Students analyze marine samples collected from the Florida Keys back in the laboratory.
After age 85, Alzheimer's disease affects 32% of the population. What if there was a way to delay this negative consequence of the aging process? The Aging: A Programmed or Environmental Stress Induced Process? Creative Inquiry team is working to slow the hands of time and hopefully delay age-related conditions.

Led by Dr. Yuqing Dong in the Department of Biological Sciences, seven students are testing possible ways to decrease the speed of aging. Aging is a programmed and universal process associated with the progressive decline of physiological functions. One function that declines as we age is protein homeostasis, or proteostasis, which helps maintain the quality of the proteins in our cells. Due to this decline, as we get older abnormal proteins build up, making us more susceptible to age-related diseases such as cancer, kidney disease and Alzheimer's disease.

Dong’s team is trying to identify which chemicals have the potential to promote proteostasis, in hopes that their discoveries will improve long-term health. The team uses Caenorhabditis elegans, microscopic nematodes, as test subjects. These nematodes are a famous model system and are commonly used to study disease as well as other biological concerns. Human beta proteins are transferred into C. elegans to generate a transgenic animal, allowing the team to gather relevant results without using human subjects. Since the lifespan of C. elegans is 2 - 3 weeks, the team is able to collect a lot of data in a short amount of time.

Currently, the team is investigating the effect of different food supplements on proteostasis. Dong challenges the team to examine a variety of foods and test every hypothesis. The team is focusing on the effectiveness of cranberry and royal jelly supplements. Royal jelly is a byproduct of honeybees that is eaten by the queen bee to prolong her life. Therefore, it came as no real surprise that royal jelly supplements improved protein solubility in aged worms as well, essentially prolonging life. The team also recently discovered that cranberry extract may similarly delay the onset of Alzheimer’s.

Participation in this project prepares students for future endeavors in medical school and other post-graduate programs. Beyond the experience gained in the lab, students also gain the opportunity to have their research published in scientific journals. Six students have co-authored publications in three peer-reviewed research papers. Team members leave this project with quality experience and evidence of their accomplishments. Their findings and publications have laid a solid foundation for future research on the aging process.

by Elise Bell
In 1862, General Ormsby Mitchel of the Union Army created a town for freed slaves on Hilton Head Island, South Carolina. Mitchelville, as the town became known, was the first self-governed community of freed slaves in the country. After visiting the Mitchelville site in 2012, Barbara Hamberg, Department of Philosophy and Religion, knew that students needed to know about this part of their state’s history, so she and Dr. Abel Bartley, Department of History, formed a Creative Inquiry team to research the people of Mitchelville.

As the students began their research on Mitchelville, their project evolved into three different projects: Reconstructing Historic Mitchelville; The Churches of Mitchelville; and Upstate Black Communities Then and Now: Their People and Their Places. The teams have a research niche which has many communities interested in a collaboration. For example, the team has been approached to study the history of Daufuskie Island and the churches in Anderson, South Carolina.

The students in each of the Creative Inquiry projects collect oral histories and conduct genealogical research. This type of research requires work online as well as in-person. One of the methods the teams use to investigate genealogy is through the online software Ancestry.com®. In October 2013, the students had the opportunity to attend a lecture by Kim Harrison, a senior account executive from Ancestry.com® and to present plaques to the descendants of original Mitchelville settlers.

Bartley teaches the teams about the historical aspects of the projects. They analyze tax records, cemetery records, record oral histories and use library resources to find information on their projects. The final products are then presented to the relevant communities. Presentations of the students’ research will be posted on the Daufuskie Island and Hilton Head Island Heritage Library websites.

Students also learn methods for conducting oral history interviews. The team’s trips to Hilton Head Island allow them to utilize their newly learned research methods and collect more background knowledge through dialogues and networking. Twice a year, the students travel to Hilton Head Island to hear lectures, visit sites and collect oral histories. The churches and communities they research welcome the students with open arms, allowing the students the opportunity to meet CEOs, leaders of non-profits and artists in the community. According to Hamberg, these communities have a deep appreciation for the students’ work and make an effort to introduce the students to as many community leaders as possible. The trips are an essential part of each of the Creative Inquiry projects, providing a tangible component to their research. “It’s a place for students to go and learn about their history, and that’s important,” Hamberg said.

Community partners are imperative when conducting this type of historical research. From the beginning, the Heritage Library located on Hilton Head Island has assisted in organizing site visits, locating documents and providing resources to conduct the genealogical research. The Bertha Lee Strickland Cultural Museum in Seneca, South Carolina has also acted as a community partner to the team.

by Polly Goss
Every decade or so, South Carolina experiences a major ice storm. While students across the state rejoice over canceled classes, the forestry industry prepares for a long winter’s night. Timber is South Carolina’s largest industry with an annual economic impact of $18.6 billion and it provides over 90,000 jobs. This means that effectively dealing with the aftermath of an ice storm on a tree stand is a high priority. A tree stand, or group of trees similar in species and age, is the primary way in which commercial forests are organized and maintained.

The latest ice storm in 2014 caused $380 million in damage to trees, highlighting the need for research in this vital industry. Dr. Patrick Hiesl in the Department of Forestry and Environmental Conservation and his Creative Inquiry team are meeting this need through their project: What Should We Do with Ice Storm Damaged Stands?

To accomplish this goal, the team collected data from a commercial site in Georgetown, South Carolina as a basis for computer simulations addressing this question. “We look at different damage levels and age classes to see how these different levels affect the stands over time,” Hiesl said. The research will not only further the understanding of tree stands but will also have immediate and practical applications for interested forestry companies and foresters. “We were able to visit an actual site in Georgetown. The company was eager to see our results,” Mark Boyd, senior forestry major, said.

Through the models, the team will identify various management techniques to assist the forestry industry while making decisions on how to address the negative monetary and environmental effects of ice storms. Eventually, the team aspires to make an app for the forestry industry so that decisions regarding ice storm damage can be made immediately and to address the problems associated with snow in South Carolina.

by Lindsay Bryda
RoomBAS® are round autonomous vacuuming robots that clean houses around the world. The Robot Networks Creative Inquiry team is using these vacuum cleaners for a different purpose. Led by Dr. Yongqiang Wang from the Department of Electrical and Computer Engineering, the team works with six repurposed Roomba® robots in an attempt to enhance communication within a robotic network. It may seem an odd choice but these vacuum cleaners gave the team an already existing robotic platform in which to work. Now, students work to remove the autonomous characteristics of the Roombas® and synchronize them under the same code.

Communication is a paramount feature of well-functioning robots, as they need to communicate with people and other robots in their network. After acquiring a basic understanding of how robotic networks work, the team was able to begin experimenting with robotic cooperation. The primary objective is to have all six robots facing the same heading, and operating in unison. In order to achieve heading synchronization the robots all have to operate under the same code. Several attempts have been made to update and change the code. “I really wanted to learn coding because it teaches you to think about all the possible directions you can take to make the robot perform how you desire it to,” Dhvani Raval, a senior electrical engineering major, said.

Decentralizing communication would ideally lead the robots to collectively work together to increase the efficiency of the network of six robots. “We don’t want one robot to be the leader, we want intercommunication,” Eddie Bear, a senior electrical engineering major, said. Eliminating reliance on one machine to disseminate the message increases the speed at which the robots could pass along communication. Once they finally perfect the coding, the next goal is position detection; this allows a robot to make the others aware of where they are in relation to each other. The team experiments with LED lights and microphones to determine how the communication moves amongst the network.

There are countless benefits to achieving increased cooperation among robotic networks and the team hopes that their project will someday be used on a larger scale application, with a larger group of robots. Recently, the team was selected to present their project findings in China at the Institute of Electrical and Electronics Engineers (IEEE) Conference on Industrial Electronics and Applications. The IEEE is dedicated to advancing technology for the benefit of mankind; that is what this Creative Inquiry team hopes their research will do. Meanwhile, their work is ongoing as they have to frequently update the code to progressively improve robotic synchronization.

by Elise Bell

Dhvani Raval, Eddie Bear and Teddy Maxwell at the IEEE Conference on Industrial Electronics and Applications in Heifei, China. Photo provided by: Teddy Maxwell
How to Start a Startup

Sparking student interest in entrepreneurship

From home-based operations to Silicon Valley giants, owning a business is a dream many people have entertained, attempted or accomplished. In the How to Start a Startup Creative Inquiry, students learn how these dreams can become reality. Dr. John Hannon, College of Business, joins entrepreneur and angel investor Greg Smith to share the responsibility of leading the project, which aims to arm students with the information they need to pursue starting their own businesses. The project includes a wide variety of majors and its participants range from freshmen to seniors. The common factor across this multidisciplinary team is a desire to learn more about owning and operating a business.

“Our job is to fan the flame of their interest,” Hannon said. Many times, this job involves multiple perspectives. Smith’s point of view as an investor is occasionally different from Hannon’s, a relationship that shows students the complexity of entrepreneurship. The group meets weekly to discuss relevant topics and hear from visiting entrepreneurs. Topics include brainstorming ideas, company culture, fundraising, hiring, operations, management and more. Hannon also brings in Clemson alumni entrepreneurs from across the United States for in-person or Skyped talks. Listening to and networking with successful Clemson graduates makes the process of entrepreneurship relatable to the students. These speakers provide invaluable insight and inspiration to the students as they navigate their own entrepreneurial ideas.

The students in the How to Start a Startup project have varying levels of experience with entrepreneurship. Some already run businesses, some want to become entrepreneurs and others are simply looking for knowledge that might prove useful in the future. According to Hannon, the goal of the Creative Inquiry is to inform students about the possibilities and opportunities of entrepreneurship, regardless of their background, major or level of experience.

by Polly Goss
SOUNDING ROCKETS

Taking the understanding of our atmosphere to new heights

World War II brought an international focus to aerospace engineering as rapid technological advancements expanded the realm of possibilities within the industry. This passion for flight continues, especially in the Creative Inquiry project Test and Development of Instrumentation for NASA Sounding Rocket Experiments. Dr. Gerald Lehmacher in the Department of Physics and Astronomy and his team use rockets to study the upper levels of the atmosphere. Specifically, they use sounding rockets, which are equipped with specific instruments to take measurements during a flight over their chosen location. Most recently the rockets used were launched in Alaska. The team investigates the temperature, density and wind structure of the mesosphere and thermosphere — the atmospheric layers 30 miles and above of Earth’s surface.

Through research grants from NASA, the team is able to use NASA’s sounding rockets and attach instrumentation such as accelerometers and vacuum pressure gauges to collect data for their research. By better understanding measurement changes through an analysis of the data collected during the launches, the team will increase knowledge of the mesosphere and thermosphere and how it affects the flight and reentry of private human rocket flights and missiles.

For the students involved, the love of rockets is deeply-rooted. “I’ve been a rocket person since I was a kid so when I saw this project I knew I wanted to do it,” Emily Faber, a physics major, said. Whether or not students go on to pursue a career in aerospace, they walk away with a better understanding of the atmosphere and the equipment needed to reach it.

by Lindsay Bryda
1- Students create an original Palladian style villa adapted for LEGO® bricks

2- Detailed view of a window and cornice

3- Basic Palladian design elements condensed on a smaller scale
Making a house out of bricks is commonplace, but what about LEGO® bricks? LEGO® are a timeless toy that everyone has played with at some point in their life. The Creative Play Creative Inquiry team took this childhood favorite to the next level by making a Palladian-style villa entirely out of LEGO® bricks. Led by Dr. Michael Carlos Barrios Kleiss from the School of Architecture, students Michael King, Michael Hallinan, Phillip Hood and Arthur Southern seek to redefine the function of this classic toy.

Andrea Palladio was a renowned Renaissance architect who is famous for his villas and the shape grammars, or rules of design, that he established. After designing his villas, Palladio wrote a book that set forth rules for how to create a properly designed villa to match his architectural language. For the team, one of the biggest hurdles in constructing their villa was to understand what these rules meant and then agreeing on how to interpret them.

The team uses the rules of Palladio and then adds their own original twist on the villa by creating a miniature one entirely out of LEGO® bricks, an unprecedented undertaking that complicates the design process. Unlike the rules of Palladio, the rules of LEGO® are not explicitly written down so the team had to adapt to the new set of rules that using the blocks presented. It took the team a couple of attempts to match the architectural language to this kind of villa.

LEGO® structures do not have the classic look that is characteristic of Italian villas and this proves to be a significant but exciting challenge for the team. “Having fun is the ultimate goal. Creativity flourishes when you are having fun, are more relaxed, open to new ideas, and playing with toys does that.” Barrios said. Hallinan added that this project gives students the ability to design for themselves, an opportunity that they do not often have in class. Not only does this project bolster the students’ understanding of style and design science, but also gives them an impressive addition to their architectural portfolios.

by Elise Bell

“Having fun is the ultimate goal. Creativity flourishes when you are having fun, are more relaxed, open to new ideas, and playing with toys does that.”
Novel Applications of Photovoltaics: Solar Powered Golfcarts

Motivating students to do great, innovative things, Dr. Rajendra Singh in Electrical and Computer Engineering, mentors Creative Inquiry teams while they make an impact on the Clemson campus and beyond. A team of four students (Ethan Bruce, David Canady, TJ Griffin and Libby Zanin) designed and renovated a golfcart to solely operate on solar power. The team is passionate about decreasing carbon emissions on campus and finding more efficient means to travel.

The team hopes to catch the attention of administration and see a campus effort to adopt this cost effective, efficient means of transportation. Converting a golfcart to solar power increases drive time by 40%, drive distance by 70% and eliminates carbon emissions from the vehicle. Also, this golfcart actually produces energy while it is driving by catching the suns rays on its solar panel roof.

Creating and Delivering Technology Solutions to Seniors in the Clemson Community

According to a recent study by the Pew Research Center, only 59% of the aging population regularly use technology, in comparison to 87% of all adults. This is not only creating a gap between generations, but is also limiting the opportunities in which the aging population can use technology for the betterment of their own lives. Tigers for Multigenerational Technology Implementation (TMTI), led by Dr. Claire Dancz in the Department of Civil Engineering, is devoted to helping solve these social and technological issues. Students and faculty involved in the project represent a variety of majors, reflecting the multidisciplinary scope of the endeavor.

Clemson students have partnered with the Clemson Downs retirement community to address their tech-related needs, including providing smartphone and computer training, developing solutions for mobility improvement, performing feasibility studies for alternative energy installations and addressing other challenges identified by the community. Administrators and Clemson Downs residents joined TMTI students in a focus group to determine how to best understand the challenges and opportunities in this local setting. This collaborative group of students and community members will continue to work to bridge the technology gap in the future.
Elephants have long been regarded as symbols of wisdom and strength. In the Asian country of Myanmar, their symbolism runs much deeper as they are seen as essential in the local cultures and religions. But not every person in Myanmar views these animals with such reverence. Farmers and plantation owners often view them as destructive nuisances capable of destroying entire fields of crops. Finding middle ground between these competing interests isn’t an easy feat but a critical one as elephants are an endangered species.

Christie Sampson, Department of Biological Sciences, and her Creative Inquiry team have set out to extend public awareness in Myanmar of the declining populations of these magnificent creatures. Her team works on public outreach projects in remote villages to explain the biology of elephants and why they are crucial in maintaining the ecosystems in which they inhabit. For example, during the dry season elephants dig for water with their tusks, which consequently allows other animals access to water.

The Creative Inquiry team focuses their public outreach efforts mainly on school-aged children by creating storybooks and educational posters for the schools. The Creative Inquiry team also creates educational videos for adults and encourages parents to read the storybooks to their children so both generations will realize the importance of elephants in their landscape and possible effects of declining populations.

The students involved in this project are mainly in majors relating to the sciences and this project serves as a creative outlet, an introduction to publishing and a challenge to turn complex information on conservation into an engaging story. This project will hopefully lead to more advocacy by the citizens of Myanmar so that more conservation action will occur. According to junior psychology major Alex Scott, “Even if we only directly save one elephant, that’s progress!”

by Lindsay Bryda
In nature, it is said that form follows function. But what happens when two functions for an organism have opposing demands? The Creative Inquiry Comparative Vertebrate Musculoskeletal Biomechanics, led by Dr. Richard Blob and Christopher Mayerl in the Department of Biological Sciences, studies the evolution of animal functions. “The specific systems we pick relate to how animals are able to live in multiple habitats and what specializations are necessary to live there as well as how these adaptations help or hurt animals in each habitat,” Blob said.

Evolution of animal functions related to differences in environment produces diversity among species. The team studies evolutionary biomechanics, or the analysis of structure and function in organisms throughout their evolution. In order to study how these structures perform, the team uses high-speed video cameras to capture footage of animals and measure their movements frame by frame. One project that the Creative Inquiry is currently working on is the waterfall climbing ability of Hawaiian stream gobies. These species of fish swim upstream and climb up waterfalls using their mouths and suckers on their bellies in order to reach predator-free habitats where adults can live and reproduce. However, the ability of gobies to escape predators and their specializations for climbing waterfalls are at odds with one another because tall bodies help fish to avoid predators, but lower, streamlined bodies can help them climb. The team recently traveled to Hawai’i to collect locomotor performance data from goby populations, from which they will determine which mix of physical characteristics are most advantageous for populations living on islands with different habitats.

Another project focuses on the maneuverability and stability of turtles. The rigid shells of turtles make them an interesting model for studying potential designs of small aquatic robots or vehicles. With help from Clemson’s Department of Mechanical Engineering, the team had several designs of keels 3D-printed, and then attached these to the shells of the turtles to test their effect on mobility. For example, a large keel improves
In order to expand their knowledge of evolutionary biology, the team meets weekly to discuss current literature. During these meetings, students rotate choosing an article from an academic journal and leading a discussion. The students in the Creative Inquiry have received attention from NPR and have also presented at scientific conferences like the Society for Integrative and Comparative Biology. “The ability or opportunity to present research you designed, implemented and conducted gives you so much confidence in yourself you wouldn’t get in any other way,” Alex Rubin, a senior biological sciences major, said.

While students in the Creative Inquiry examine specific projects on functional diversity and organism-environment interactions, they also aim to recognize how their work relates to the big picture of evolutionary biology. “There really is a feeling that has evolved over the years to make this Creative Inquiry about the field overall rather than just one specific experiment or project,” Blob said. As the lab continues to conduct research in evolutionary biomechanics, students will continue to be able to provide insight into evolutionary models.

by Jason Erno
Critical Conversions

There are two minutes left on the clock and the Clemson Tigers are driving the ball down the field to win the game. It is third down and six yards to go on their opponents’ 30 yard-line. How does Head Coach Dabo Swinney decide which play is best to call in this situation?

Under the guidance of Dr. John Spinda in the Department of Communication, Kevin Shroat, a junior communication major, and Charles Lillie, a senior sports communication major, are looking for relationships between variables that could help the Tigers and other teams make these decisions. Although the Creative Inquiry is called Sports Fandom, the project focuses on finding connections between different aspects of the game that could be useful for players and coaches in the future. Currently, the team is investigating which variables affect third down conversion success.

Shroat and Lillie gather data from professional football teams and analyze the data to identify trends and correlations. While their goal is to find out which variables have significant effects on third down conversion success, both students and Spinda are learning more about the game itself in the process. The team faces challenges in both data collection and analysis; the data can be difficult to find and the software is new to the students. As for the relationships between the variables and third down conversion success, the correlations are not yet clear. “We don’t know what the answers are going to be. I think it’s going to be a surprise,” Spinda said.

While most college and professional teams hire experts to compute their data, Clemson and other teams could use the analysis that Sports Fandom produces to hone their strategies on the field. If teams can learn more about which factors affect third down conversion success, this information could affect key decisions in big games.

by Polly Goss
**Educating Educators**

*Using interactive case studies to prepare future teachers for the classroom*

Good behavior in a classroom facilitates learning. In behavioral psychology, classical and operant conditioning are two main types of learning that present different solutions to direct behaviors and allow favorable outcomes within a classroom setting.

The behaviorist perspective in psychology is primarily based on observation, making it a difficult concept to thoroughly grasp solely from a textbook. Beyond knowing what to look for, educators must know how to apply this concept in order to effectively manage their own classrooms. Despite behaviorism’s complex nature, the importance of understanding this approach is something all educators agree on.

The Interactive Cases for Learning Educational Psychology Creative Inquiry team recognizes the need for a more comprehensive way to educate future teachers. Led by Drs. Matthew Boyer and Meihua Qian from the School of Education and Dr. Penelope Vargas from the Department of Psychology, five students created an online interactive case study that teachers around the United States can access. “We found people in education who want to be teachers who, as time goes on, forget important things that come up in the classroom,” Leigh Mercer, a senior psychology major, said. This is an especially important concept for new teachers to grasp as they are new to the field.

This simulation presents multiple scenarios on how a student’s behavior could possibly be problematic in a classroom. To remedy a problem, there needs to be an effective feedback response. Teachers need to create the right balance between positive and negative reinforcement, thus determining when to give reward or punishment. “If you want to change a behavior, you need the feedback to occur as soon as possible. Right after you make a choice, we want to let you know if it is an effective response,” Boyer said.

The team creates an extensive decision tree to prepare for all potential outcomes of the simulation. For each step in the simulation, the team provides thorough explanations for why one decision might be more beneficial than another in any given situation. While designing this interactive case study, students have to be mindful of key psychological concepts and core educational theories to better educate educators.

by Elise Bell
Most days every major newspaper or news station mentions China and indeed the importance of US–China relations cannot be overstated. At the local level, South Carolina’s largest international trading partner is China; at the national level, China is in the United States’ top three. Dr. Xiaobo Hu in the Department of Political Science and his Creative Inquiry teams analyze this relationship. Students expand the depth of their knowledge by focusing on three main areas: the dynamics of China’s economic development and its impact on US–China relations, Chinese foreign policy and economic relationships between South Carolina and China.

“Other Creative Inquiry [projects] might be designed in a way to help and support faculty research in areas such as data collection. But in these projects, the student is the focal point,” Hu said. Students stay up-to-date on current events and create a continuous discussion of political and economic news. Each student is expected to contribute a daily article and all students discuss the presented articles. The Creative Inquiry projects serve as an outlet for students to immerse themselves in these topics to better understand the dynamics between these two global powers. The projects are highly regarded by students and most continue to participate for at least two semesters.

Each semester culminates in a trip to Washington D.C. where the team visits Capitol Hill, meets with Congressmen and Congresswomen and tours the Chinese embassy.

Students converse with government officials, senior diplomats and China experts with decades of experience. This political access is the most valuable element for students going on to pursue internships and careers within the foreign affairs field. “The D.C. trip is incredible and the opportunity to visit the embassy is second to none. There were times when we definitely knew more than the experts,” junior political science major Robert Lee Storey said.

Whether students join the Creative Inquiry to advance their career prospects or just to become better global citizens when flipping through the news, all leave the project with a deeper understanding of how foreign relations impact our lives.

by Lindsay Bryda
Geologic Studies in the Upstate

Finding out what the upstate is made of and creating a digital map of the area

The Geologic Mapping in the Upstate of South Carolina and Geologic Properties Creative Inquiry projects give geology students unique opportunities to get their hands dirty. In both projects, the students fine-tune their own research topics and experience field work from a geologist’s perspective. Each of these projects, led by Scott Brame, Department of Geology, allows each sophomore to watch seniors at work and then to begin researching a topic that interests him or her in the spring of the following year. Students can choose research based in the field or in the laboratory, according to their interests.

Senior geology majors Alan Martuch, Geoffrey Ives and Katie Maracci each chose their research topic based not only on the project that most interested them, but also on how they approach geology itself. Martuch made the decision to join Geologic Properties through conversations with friends and with Brame. Much of Martuch’s work for the project involves collecting samples and bringing them back to the lab to prepare for analysis, as well as familiarizing himself with relevant academic literature.

Like Martuch, Katie Maracci is also involved in the Geologic Properties project. Maracci joined the team because she was drawn to the structural aspects of the research and wants to learn more about change as a factor in geology. Maracci studies metamorphic rock and, more specifically, how quartz changes position to indicate shear stress.

Geoffrey Ives was drawn to a different aspect of geology, which led him to become involved in the Geologic Mapping in the Upstate of South Carolina project. “I wanted to work in the field, not in a lab,” Ives said. Ives’s work involves hiking, mapping, gathering samples of outcrops and ultimately using GIS software to develop a digital map of the area. These are the experiences that Brame wants the students to take away from the projects.

“I want them to learn how to do field-based science, which is challenging, but it’s what geologists do. It isn’t about the end result, it’s about how they went about getting the data,” Brame said. As Martuch, Maracci and Ives work to find out what the upstate of South Carolina is made of, this field work is shaping them into geologists.

by Polly Goss
The diversity the United States celebrates is not always reflected in university classrooms. There is a lack of diversity in STEM-related fields and genetics and biochemistry classrooms are not exempt. Dr. Meredith Morris in the Department of Biochemistry and Genetics leads her Creative Inquiry Establishing a Clemson University - K-12 Research Collaboration in an effort to increase interest from diverse populations.

The team works on establishing relationships with high schools around the state of South Carolina. Members of their team visit schools to teach a science class for a day on biochemistry and genetics. In the past, they have worked with Richland Northeast High School in Columbia, SC. The team taught remedial, honors and International Baccalaureate students. Initially, Morris led a hands-on activity, lecture or trivia game like Jeopardy to demonstrate the wide range of topics in genetics or biochemistry. Now, however, the students in the Creative Inquiry have taken the initiative on educating the high school students. “Initially, I would tell them what to do and they would do it. Now, they do it and they tell me what they did. They pretty much handle all of it,” Morris said. Katherine Freeman, a senior genetics major, takes pride in bringing more underserved students into the sciences and finds that she has developed as a teacher because of the project. “If you can teach somebody something, that’s a pretty good indicator that you’ve nailed it down,” Freeman said.

In the future, the Creative Inquiry hopes to become established at multiple local schools near Clemson and visit students once a week instead of once a month in an attempt to start mentoring relationships between more Clemson students and high school students. Hopefully, some of these high school students will soon become majors in the sciences at Clemson.

by Jason Erno
Reaping the Benefits of Agriculture

There is a steady demand for agricultural mechanization and business majors, boasting an estimated 99% job placement rate out of college, but many students do not realize the unique opportunities this field provides. Led by Hunter Massey from the Department of Agricultural Sciences, members of the Development of Course Material for Agricultural Mechanization Undergraduate Curriculum Creative Inquiry work to promote their college and grow the major by informing other undergraduate students of the career prospects within the agricultural sector. The goal is to entice more undergraduate students to join the major by exposing them to the technologically advanced nature of modern agriculture, an evolving field that keeps pace with the latest breakthroughs in science and technology.

Standard agriculture machinery is massive and not easily transportable. As a result, the team redesigned pieces of machinery to make them more compact and conducive to the learning environment. Although located in the lab, the team’s small-scale grain harvester simulation has been calibrated as if it were out in the field. “The whole purpose of it is to be a classroom size combine model — even though it doesn’t look like a combine it has all the sensors that field equipment would include,” Massey said. An exceptionally precise grain table allows the team to monitor hypothetical yields. Yield maps are crucial for surveying fields and determining why certain areas might produce more crops than others. Another project of note within the Creative Inquiry is their one-of-a-kind Mobile Cotton Harvester demonstration unit. The students even put a simulator screen inside the main cabin to give users an authentic cotton-picking experience.

Beyond developing new technologies for their own use, the team has been able to use these machines to inform students about the multidimensional aspects of agriculture. They have participated in exposition shows across South Carolina and throughout neighboring states.

Recently, the team was invited to attend the Sunbelt Ag Expo in Moultrie, Georgia where their Mobile Cotton Harvester was a crowd hit. For added attraction, team members even installed an air-conditioning unit inside the cotton picker’s main cabin to get people to check out the simulator.

Through these exposition shows, the team has successfully generated an increased interest in majoring in agricultural mechanization among prospective students. “The biggest thing for me is getting other people interested in Ag through these projects—especially young kids,” senior agricultural mechanization major Samuel Quinney said. Overall, in their effort to educate others about agriculture, the team has also learned a lot. “This project has not only served the public, but our students as well. They are also learning and growing through these presentations,” Massey said.

by Elise Bell

The team designed a Mobile Cotton Harvester demonstration unit (shown below) to take to exposition shows across the Southeast.
Effective Emergency Response

The EMS Triage Field Reports Creative Inquiry team works to help hospitals avoid incorrect categorizations. Led by Dr. Robert Riggs from the Department of Industrial Engineering, seniors Megan Byham, Kate Watson and Rebecca Albers research methods to make these emergency systems run more smoothly. In an attempt to solve this real-world problem of too many patients with too few resources, they partner with a local hospital, Greenville Health Systems. The team looks for patterns that are not already known so that hospitals can develop a system to better allocate their resources in the face of unexpected circumstances.

In many emergencies, responders do not have the time needed to contemplate which level of urgency to give a patient. Due to the arbitrary nature of trauma activation guidelines, too many people are put into the wrong category. This is a widespread problem facing hospitals across the United States. The team’s main concern is the 9% of cases that are under-triage, or when a patient has been classified as level 2 when they really should have been prioritized as level 1. The main discrepancy arises from the fact that it has been virtually impossible to establish a one-size-fits-all model for emergencies. Cognizant of the difficulties each situation poses, the team is trying to create a reliable, predictive model.

Conventional wisdom tells us that the more information we have the better. Ironically, an abundance of data has actually proven to be one of the team’s biggest challenges as they use data from the National Trauma Databank, providing an extensive spreadsheet to analyze. The massive data set will take the team a while to analyze. “In trying to predict a model it can fall apart really fast. So, we have to tease out what we can,” Riggs said. Their efforts in perfecting this categorical system will hopefully support the nationwide endeavor to improve emergency response.

by Elise Bell
The founding fathers did not anticipate the eventual importance of foreign policy when drafting the Constitution. As a result, the treaty process as enumerated in the Constitution is much simpler than the messy process through which international agreements are now reached. Often these agreements are not sent to the Senate for ratification and instead become law by the authority of the executive branch for the sake of expediency and to avoid a political failure. This trend toward unilateral action has dramatically increased in recent decades and serves as the focal point of the research conducted by Dr. Jeffrey Peake, Department of Political Science, and his Creative Inquiry project The Domestic Politics of US Treaties.

The team studies when and why the President as chief executive chooses to send treaties to Congress, use an executive agreement or use the newly coined term political agreement by analyzing recent international agreements and mapping their path from concept to law. “I think by being involved in research and not just sitting in class, political science students wake up to the shades of gray in the issues,” Peake said.

This project is a continuation of the research co-written by Peake in the 2009 book “Treaty Politics and the Rise of Executive Agreements: International Commitments in a System of Shared Powers.” The team is currently analyzing why President Obama submitted 75% fewer treaties to the Senate than past administrations. This is largely attributed to the political polarization in Washington. The domestic dimensions of international agreements have been considered a niche in the political science field, but recent debate on the Iran Nuclear Accord and Paris Climate Accord have brought the team’s research into the spotlight. Household names such as The Daily Show and the Wall Street Journal have showcased the Creative Inquiry’s data and brought awareness to the sometimes subtle differences in international agreements.

“I’m trying to become as well versed in the topics as I can and we’ve definitely learned more than we realize,” junior political science major Chase Forrester said. This Creative Inquiry project allows students the chance to analyze primary sources instead of just the traditional textbook to understand the complex nature of international agreements with a more holistic approach.

by Lindsay Bryda
I scream, you scream, we all scream for ice cream!
The tasty treat is made so much sweeter knowing that new flavors are being created on Clemson’s campus.
Led by Dr. Johnny McGregor from the Department of Food, Nutrition and Packaging Sciences, the Ice Cream Innovation Creative Inquiry allows students to put their heads together to concoct novel ice cream flavors. For this team, the sky is the limit and creativity is the standard.

The team invents new flavors every year, with some of their products finding their way into the student operated ‘55 Exchange store on campus. “Trial and error is central to this project. Sometimes it takes eight different ice creams until we find one that tastes good,” Kinsey MacDonald, a senior food science major, said. Delicious taste is not the only factor the team members have to take into consideration. As the team gets imaginative, it is imperative for them to consider the practicality of the product and the marketability of the flavor.

In addition to investigating ice cream flavors, the team is using 3D models to design their very own new and improved Ice Cream Innovation Research Lab on campus. After designing, they were able to oversee the renovation process and ensure that they obtained all the equipment they needed. The innovation laboratory is designed to engage people on Clemson’s campus as well as in the surrounding community. This enables the team to provide an “Ice Cream Experience” for visiting groups. While students learn from this project, they simultaneously teach others about food science.

This project collaborates with the food processing industry as well as a regional farm in their research projects. The team places an emphasis on increasing the quantity of products produced in South Carolina in the manufacturing of frozen desserts so they work with South Carolina’s own Titan Farms, the largest peach grower on the east coast. This project received the designation of the Carr Family Endowed Creative Inquiry, which provided additional support to the team. The support allowed them to conduct applied research that concentrated on the use of low-grade peaches that do not have a viable market and would otherwise be wasted. The team works to incorporate these peaches into their desserts and investigates the use of the farm’s peach purees in new products, constantly improving the ice cream experience.

by Elise Bell
According to the National Gardening Association, home food gardens are at the highest levels in more than a decade in the United States. This isn't surprising since they provide cheap, nutritious and organic alternatives to store-bought produce. The Food and Agriculture Organization of the United Nations has utilized food gardens in less developed countries like Rwanda and India to increase nutritional value of diets.

Dr. Dil Thavarajah in the Department of Agricultural and Environmental Sciences recognizes the practicality of these home food gardens and wants to add more nutritious and healthy food options to family diets. "A vegetable garden is a cheap and easy way to provide dietary fiber and protein for a five-member family," Thavarajah said. The Tiger Gardens: Healthy Home Gardens to Combat Malnutrition and Obesity in Rural SC, USA Creative Inquiry team began by building several irrigated wooden garden beds at Clemson to plant vegetables such as broccoli, kale, radishes and brussel sprouts.

The team worked with Clemson Elementary School and Pendleton Elementary School to introduce this garden concept to students. After the Creative Inquiry team set up these beds at the schools, the children continued to plant vegetables and care for the crops. The team also established gardening clubs at each school to educate students about the nutritional value of what they are growing and to introduce recipes using the grown crops.

"We are also planning to start a farm-to-table operation in Greenville, so we'll produce food locally and market it to restaurants and local vegetable stands," Alex Abare, a senior plant and environmental sciences major, said. Each student on the team leads a part of the project: design of the garden, transplanting, education and outreach, fertilizing and harvesting. Without a doubt, the students in this project have shown an exceptional mastery of home garden design as well as the dietary value of owning one.

by Jason Erno

“A vegetable garden is a cheap and easy way to provide dietary fiber and protein for a five-member family.”
Montana
Prairie
Ecology
Montana is known for wide open spaces, rugged terrain and an abundance of wildlife. Students in the Montana Prairie Ecology Creative Inquiry, led by Dr. David Jachowski in the Department of Forestry and Environmental Conservation, want to take a closer look at these features in order to come to a better understanding of the state’s landscape.

This Creative Inquiry team travels to the High Meadows Ranch in Montana to do research in the Great Plains as well as experience life on a ranch. Along the way, the team takes part in unique experiences such as guided nature hikes with Dr. Patrick McMillian from the Department of Forestry and Environmental Conservation, camping in the wilderness areas among free ranging bison and visiting a Native American tribe to gain their perspectives on wildlife and livestock interactions.

There are several ongoing research projects at the ranch. One project investigates if strategic cutting of trees produces more forage or revitalizes nutrients in the soil to create a better environment for cattle grazing. The ranch has a problem with ponderosa pine encroachment, which serves as the focus of the summer research. Students have divided a section of the ranch into square plots where varying amounts of trees are removed, then take clippings of grass and nearby shrubs to bring back for analysis.

To be successful on the trip, students study Montana’s ecology and relevant research methods the semester prior to traveling to Montana. During this time students meet their peers and professors; the project is also led by Drs. Thomas Scott and Gustavo Lascano from the Department of Animal and Veterinary Sciences, who bring cross-disciplinary perspectives to the project. “As wildlife majors, we don’t typically work with livestock,” Sarah Coleman, a junior wildlife and fisheries biology major, said.

Post Montana, students analyze the clippings collected from the ranch to inform decisions on what amount of tree thinnings are ideal for the livestock on the ranch. For the professors leading this Creative Inquiry, their goal is to constantly expand knowledge of Montana’s ecology. This translates into using the research conducted on previous trips as a springboard so that current students can come up with increasingly targeted research goals. The recent addition of Lascano to the project has also allowed the team to analyze the clippings from a nutritional point of view because of his work with microbes and digestion in livestock.

This project provides students a glimpse into the complex issues surrounding livestock raising. Ranchers, conservationists and Native Americans have different views on the proper use of land and animals in Montana. “I enjoyed seeing the relationship between ranchers and wildlife managers so we can understand how decisions affect the other side,” junior wildlife and fisheries biology major Caroline Guerry said.

“This Creative Inquiry is more than just science. It’s about understanding how science fits in and potentially forms a discussion on competing sides on how we should manage public and private land,” Jachowski said. Exposing the complex nature of these issues gives members of the Creative Inquiry lessons in ethical problems and decision making, which not only molds them into better students but also provides them with a more comprehensive understanding to take to their future careers.

by Lindsay Bryda
Historically, only the wealthiest people took advantage of the stock exchange; now, more and more people are buying shares to benefit from a company's success. Working the stock market does not actually require much work at all. In fact, it is a great way to accumulate wealth without ever working. For this reason, many people are attracted to the idea of buying stock but lack a fundamental understanding of how Wall Street works. An increased interest in the stock market has resulted in an increased demand for financial analysts to serve as industry experts.

Every year, the Chartered Financial Analyst (CFA) Program hosts the Global Research Challenge, where teams of aspiring financial analysts come to exhibit their understanding of the complexities of the stock market. In this competition, teams are tasked with analyzing a publicly traded company and giving a convincing recommendation on whether to buy, hold or sell that particular company's stock. There are two main components of this challenge—producing a written report and presenting findings in front of a panel of industry experts.

Led by Dr. Jack Wolf from the Department of Finance, the Global Research Challenge Creative Inquiry team is composed of four senior finance majors: Cooper Burdick, Blake McCall, Jeff Sinkel and Andrew Weber. As participants in this year's CFA competition, the team was assigned to evaluate stock for a particular airline company. “We had to thoroughly analyze not only the domestic economy, but also the broader global economy as well,” Burdick said.

Evaluating the potential success of a particular stock is primarily rooted on the question of how the company makes money and whether they will succeed going forward. The team has to consider all the possible challenges and emerging competitors that the company and the rest of the airline industry could face. They have to determine the bargaining power of customers, intensity of competitive rivalry and even the threat of substitutes. External factors such as the future cost of fuel also play an important part in their assessment.

Consequently, the written report the team produces has considerable breadth and depth. With a panel of industry experts judging them, the team needs detailed supporting information to give a compelling oral defense of their analysis and conclusion. “The students were most anxious about the Q&A session that followed the presentation. However, after all the hard work they had put in, they knew the airline industry inside and out,” Wolf said. After taking finance classes for four years, the team was able to learn first-hand how difficult it can be to predict the future of stock in an intricate and sometimes uncertain market. Significant risk often accompanies remarkable reward potential, and the work this Creative Inquiry team has done serves to navigate this fine line.

Sizing Up the Stock Market

by Elise Bell
A car is driving down the road, surrounded by green hills, blue skies and rolling fields. As it approaches a line of cars on the side of the road, another car suddenly pulls out and almost sideswipes the first car. The driver’s heart pounds with beads of sweat on the forehead and neck and tense shoulders. Before her foot can instinctively press the brake pedal, the car glides to a stop. This is the experience that the Applied Psychophysiology and Performance Creative Inquiry team re-creates as they study the effects of autonomous vehicles on drivers. The team uses the front half of a car designed to simulate a vehicle that can start, stop and navigate itself. The simulator is surrounded by screens that show a realistic environment in order to give participants the feeling that they are in a moving car. With companies like Tesla releasing new autonomous vehicles every year, studying the stress and mistrust related to driving these vehicles could inform companies and customers if autonomous cars are for everyone.

Before allowing a participant to experience the simulated drive, the team gives the participant a questionnaire about his or her normal driving habits. Then, the participant test-drives the simulated car while the team observes how he or she handles the car. When the participant begins the autonomous drive, the screens surrounding the simulator show either a safe or a risky track. The risky track could include a sideswipe, blind turn or a car pulling out in front of the participant. When faced with these dangers, most participants showed physiological signs of stress, including increased heart rate, sweat and tension in the trapezius muscle. After the simulated drive, each participant filled out another questionnaire detailing their trust, or lack of trust, in the autonomous car.

The students on the Applied Psychophysiology and Performance team tackle a wide range of work in order to conduct their trials. They create the environment that appears on the screens, including pedestrians, landscapes and other cars. They also learn about the physiology of the body in order to record and understand the signs of stress and observe and record the results. According to Drew Morris, Department of Psychology, the students adapt their knowledge base to fit the demands of the project. “They are going into something that they have never seen or worked with and troubleshooting. They had to get comfortable with how the human body works and how they interact with technology,” Morris said.

The students’ statistical analysis of questionnaire and physiological data supports the team’s hypothesis that the risky track produces more stress than the safe track. The data also indicates that participants exhibited signs of stress simply by being in an autonomous vehicle. The team intends to broaden its research on autonomous vehicles, possibly by including elderly participants or a nighttime track in order to explore other aspects of the vehicles’ effects on drivers. Small but significant amounts of stress caused by being in an autonomous vehicle could cause health problems in people who are elderly, recovering from surgery or who have heart problems or hypertension. By better understanding the physiological effects of autonomous vehicles, the team hopes that doctors will be able to use their data to make recommendations for these populations.

by Polly Goss
The Scroll of Honor
Preserving the Memory of Clemson’s Fallen Heros
Directly across the entrance from Clemson’s Memorial Stadium stands the Scroll of Honor in Memorial Park, Clemson’s tribute to those that gave the ultimate sacrifice. The Scroll of Honor Creative Inquiry is led by a multidisciplinary team of faculty including Dr. Martin Holland in the Department of Landscape Architecture and Dr. Jan Homevik in the Department of English. The faculty and student team facilitates awareness of this integral part of Clemson’s history and continuing tradition. They work closely with the Clemson Corps, faculty or alumni that are veterans, to manage the grounds and keep records of Clemson’s fallen servicemen and servicewomen.

The Scroll of Honor is a tribute to the 491 students and alumni that gave their lives; their names in stone are a permanent feature of the campus and country they so valiantly defended. Clemson’s military tradition is a proud one that is as old as the university itself. During World War II, Clemson sent more officers to the army than any school other than West Point and Texas A&M. This history translates into the continuing emphasis on military history in the Clemson identity.

The Creative Inquiry team is in the process of designing an interactive kiosk and a mobile app that will highlight the stories of the brave men and women listed on the Scroll of Honor for users while visiting Memorial Park. Respect for these servicemembers is evident on campus, but especially so with the members of this project. “I am honored to know that I am attending a school that produced such brave people who fought to give the freedoms that I enjoy today. This project is my personal way to show my appreciation to those who made the ultimate sacrifice,” Sara Murphy, a junior biological sciences major, said.

Some of the names on the Scroll of Honor are as recent as the conflicts in Iraq and Afghanistan, meaning that students and faculty knew the people the names belonged to before they became memorialized in Memorial Park. The Scroll of Honor sends a clear message to our veterans that they matter to the Clemson family and so do their comrades who did not make it home.

by Lindsay Bryda

“I am honored to know that I am attending a school that produced such brave people who fought to give the freedoms that I enjoy today.”

Above photo by: Craig Mahaffey
Various facial recognition technologies are used on a daily basis—from simple tasks such as tagging someone in a photo on Facebook to more complex undertakings like tracking down a suspect in an FBI investigation. There is an undeniable demand within the intelligence community for a high-speed system that can also deliver accurate results. In most cases, the photos being processed are not straightforward headshots, which significantly slows down facial analysis. Led by Dr. Melissa Smith in the Department of Electrical and Computer Engineering, a group of computer engineering students in the Future Computing Technologies Creative Inquiry uses high performance computing to create a more efficient facial recognition system.

First and foremost, the team must identify troublesome characteristics of the current facial recognition systems. “There are all kinds of variables that you have to account for, such as an unusual angle or dim lighting,” senior Ben Shealy said. Even a beard or a shadow on the face can thwart the system; the team is faced with the challenge of finding techniques that account for those weaknesses.

There are a multitude of algorithms that can be used to process this type of data. “We want to take a current picture of the person, apply several machine learning techniques that each have different strengths and weaknesses and then intelligently interpret the output and make a final classification decision,” Jesse Tetreault, a computer engineering graduate student working with the team, said. To narrow it down, the team opted to use three of the most popular algorithms in facial recognition systems. They found that these three algorithms are very efficient when used in conjunction with one another. Students primarily work on laptops in the lab to try to achieve quicker local computation. As the project progresses, the team begins taking advantage of high performance computing technologies like the Palmetto Cluster supercomputer, which has graphic processing units that can run different algorithms in parallel.

While working carefully to finalize the three algorithms, the team frequently checks the accuracy of their computations. The team uses a public database with 400 photos of 40 different people. Each person was photographed ten times, from different angles in different lighting, enabling the team to determine which algorithms work best in the shortest amount of time. Increasingly, this Creative Inquiry project is getting closer to their central goal of local computation in real time so that facial recognition technologies can become more efficient and accurate.

by Elise Bell
Psychologists have long known that the left and right hemispheres of the brain specialize and perform different functions, yet findings on the physiological effects of this specialization have been inconclusive. Some experiments indicate that the hemisphere engaged by a task experiences a decrease in blood temperature, whereas other studies point to an increase.

Dr. Claudio Cantalupo in the Department of Psychology and his Measuring Functional Brain Asymmetry in Realistic Settings Creative Inquiry team measure the velocity and temperature of the blood in the brain through the use of functional transcranial Doppler sonography and outer ear temperature. Participants in the study wear sensitive instruments similar to earphones while completing mental tasks like rotating an imaginary object or thinking of words that start with a particular letter. During trials, the team records continuous measurements to test their hypothesis that blood flowing to the brain is relatively cooler than the blood in the brain and then gradually increases in temperature because of the amount of energy the brain uses. Also, when participants are doing these mental tasks, the team expects to find that the left hemisphere has faster blood flow because that half of the brain is responsible for linguistic tasks.

“Learning to use the sonography machine and find the right signal on every individual was by far the most challenging aspect of our lab but also the most exciting because it is technology that is unique and fairly new to the field.”

This project differs from its predecessors in that participants are not studied while immobile in an MRI machine. “Learning to use the sonography machine and find the right signal on every individual was by far the most challenging aspect of our lab but also the most exciting because it is technology that is unique and fairly new to the field,” Alison Sansone, a junior biological sciences major, said. This technology allows the participants to be tested in a more natural setting with the hope of more realistic, accurate results.

by Lindsay Bryda
Monkeys, like people, have different personalities and personality traits. The Primate Personalities Creative Inquiry, led by Brett Frye and Dr. Lisa Rapaport in the Department of Biological Sciences, investigates possible connections between different characteristics of monkeys and their behavior. Primate Personalities began with six students helping Frye with research for her dissertation, but evolved beyond Frye’s research as students began to ask their own questions and look into new areas of research. “The students have perspectives that I don’t. It makes for better research when you get everyone’s perspectives,” Frye said.

The Primate Personalities Creative Inquiry is divided into several projects. One group of students studies whether male and female golden lion tamarins react differently to food, while another investigates whether handedness predicts behavior in these monkeys. The students also are investigating possible connections between personality and physiology in common marmoset monkeys. The first step in beginning the research for each group is to design an ethogram, which carefully lists and defines the animals’ behavior. Then the team places food or an object in an enclosure with the monkeys and uses the ethogram to record the time and duration of different behaviors the monkeys exhibit in reaction to the food or object.

In order to closely study the monkeys’ behavior, the students record ten-minute videos that begin when the food or object is introduced. Coding behaviors from the videos can be challenging; the students have to stop and re-watch the videos so often that coding a ten minute trial can take almost five times as long. The projects found that sex is not a factor in tamarin approach to novel foods and that there is only a weak link between handedness and behavior in golden lion tamarins. Although these results contrast the expected outcomes, unanticipated results can be equally informative; students are learning how to navigate the imperfections and surprises that often appear in research. “It’s giving them really nice experience with how you really do a scientific project. From doing a literature search, coming up with predictions, how you test them and actually analyzing the data,” Rapaport said.

The students have had various opportunities to present their work at national and international conferences. In 2016, they presented posters at four different conferences, including the International Primatological Society and American Society of Primatologists in Chicago, Illinois. Tara Brown, a senior biological sciences major who traveled to Chicago, presented a poster on the Creative Inquiry’s research and was able to attend talks from leaders in primate research. This year, students will travel to the annual meetings for the Animal Behavior Society in Toronto, Canada and the American Society of Primatologists in Washington, D.C. Brown has benefited in other ways from her involvement with this Creative Inquiry project. She was one of six students in the country to be offered a summer internship with the Southwest National Primate Research Center. Brown credits the experience and connections she gained from working on the Creative Inquiry with helping her to transition into her internship. “It gives me a lot of really good experience focusing more in-depth on something. You start to read papers and learn the big names in the field and start to admire people who do certain work,” Brown said.

Today, the scientific community knows little about the personalities of golden lion tamarin and marmoset monkeys. Rapaport says that the students’ work, especially the sex-differences project, could be published in a scientific journal. For now, the students will continue to ask questions and conduct research on these animals’ behavior.

by Polly Goss
Mind Controlled 3D Printing

It is not everyday that one can control a motor with just the mind. Led by Dr. Hugo Sanabria in the Department of Physics and Astronomy, the Mind Controlled 3D Printing Creative Inquiry aims to utilize only the electrical signals given off by the brain to design and build whatever can be imagined.

Three-dimensional (3D) printing has become popular with the onset of the Maker Movement— a shift toward open-source software and collaboration among numerous people. Sanabria’s Creative Inquiry encapsulates the movement’s do-it-yourself mentality, according to one of the head students of the project, Perry Bolick, a mechanical engineering senior. After taking one of Sanabria’s classes, Bolick and Sanabria decided to combine their backgrounds in biophysics and mechanical engineering to take on this demanding project. “Neither of us knew what the other specialty had to offer, so until we came together, I don’t think either of us could have made it happen on our own,” Bolick said.

After researching current developments in the field, like mind controlled video games and drones, the team picked up an electroencephalogram (EEG) made to monitor electrical signals produced by the brain. These signals are interpreted by an EMOTIV proprietary algorithm that identifies each signal and maps it to a magnitude and direction. The mapped signals are then turned into keystrokes in a program that the Creative Inquiry developed, which are then converted to a printer’s G-code. So far, the team has been able to 3D print in one dimension and are eventually hoping to write letters by printing in three dimensions with multiple motors.

Sanabria attributes the project’s success to the team’s resourcefulness and diversity. He divided up the groups within the project to have equal numbers of mechanical engineering, electrical engineering and computer science majors. “As a mechanical engineer, it’s imperative for us to be learning electrical and computer engineering at the same time. You need to be fluent in programming. You need to be fluent in electrical. It’s just required now, you don’t have a choice,” Bolick said.

As the onset of the Maker Movement has called upon people to innovate, this Creative Inquiry answers in their own individual style while gaining crucial engineering experience along the way. “From my perspective, it’s a perfect engineering type of project. It’s interdisciplinary and you get to be hands-on and solve problems which are really critical when you go into the job market,” Sanabria said. With 3D printing becoming incorporated into manufacturing and larger industrial processes, the students in this project are sure to advance into the workforce with a unique set of skills.

by Jason Erno
With a mission to change the way engineers learn about their field, Melissa McCullough in the Department of Bioengineering mentors students through her Bionic Arm Creative Inquiry. Inspired by the e-NABLE community, which provides free prosthetic limbs to children, McCullough’s team of twelve students works to create 3D printed prosthetic arms. However, the goal of the project is not a physical product. McCullough wants to provide an environment in which students from any discipline can come into the lab and develop their engineering skills, collaborate and take on leadership roles. This project’s purpose is to inspire students to step out of their comfort zones and to learn about different aspects of engineering. “It helps us become well-rounded engineers,” senior bioengineering major Kylee Denardo said.

As soon as the Bionic Arm Creative Inquiry began, the roster filled almost immediately with bioengineering majors. Now, the team has expanded to other engineering majors. Students from different disciplines are coming to explore, experiment and, most importantly, to interact with each other and learn about different types of engineering.

While many students are drawn to the project to gain practical experience in the lab, McCullough has less tangible goals in mind. She wants to eliminate the fear of failure that sometimes keeps students from trying new things. This is why the Bionic Arm team is not currently fitting an arm to a human.
McCullough does not want her students to feel the pressure of working to fit a specific person or working toward a concrete deadline.

“It encourages people to go outside their comfort zone and not be afraid of learning. A lot of people when they start in the Creative Inquiry want to start with SOLIDWORKS® design because everyone’s taken a class on how to design hands and things, but people are scared to program or to design a circuit because they haven’t done it before. I think showing people that it can be done and that it’s really not that difficult helps grow people’s own individual toolboxes,” Andrew Sedler, a senior bioengineering major, said.

While students like Sedler work toward producing a product, McCullough wants to see them learn to work together and become leaders. According to McCullough, this transformation has been apparent in Sedler. “Andrew came to my group last semester. Amazing technical talent. You could see that immediately. He started breadboarding stuff, throwing stuff in these cool serial programs, and really impressing everybody with his knowledge. What was hard for him was to work as a team, to make sure other people came with him. That was a hurdle he was able to get over.” McCullough said.

For the first few years, the main focus of the Bionic Arm Creative Inquiry has been learning to work as a collaborative group and to experiment without fear of failure.

Looking forward, McCullough hopes to focus more on producing a physical, functional product. For now, she is satisfied with the team learning to combine their experience and skills. As for building a functioning 3D printed prosthetic arm, that is still in the team’s future. For now, the focus on developing the team itself will pay off as the students move into the workforce. “The goal is not to build a product, it’s to build a better engineer,” McCullogh said.

by Polly Goss
Tap water is used in our everyday lives, yet we often don't know exactly what it contains. Dr. David Ladner in the Department of Environmental Engineering and his Evaluating Water Quality and Kidney Stone Correlations in South Carolina Creative Inquiry investigate water systems throughout the state to identify differences in water content.

The team calls 63 water treatment plants around SC for several pieces of information: the calcium and oxalate content, what areas the plants serve and the location of the underground pipes. Calcium and oxalate ions in water produce “hard water,” or water with a high mineral content. When too much oxalate and calcium aggregate together, the formation of kidney stones in the body can occur. Understanding where water from each plant travels can help detect which groups are drinking this water and connect this data to the incidence of kidney stones within these groups. “I’m looking at working at a water treatment plant in the future, and if I can identify water hardness there, I can start making a difference,” Holly Mettlen, a senior environmental engineering major, said. The team also plans on looking at socioeconomic factors for each area and determining if water quality is related to these factors.

In collaboration with Clemson GIS Services, the team has taken to mapping the distribution systems of each treatment plant. “We’ve been able to create a visual representation of where underground water pumps are all around the state, something that’s never been done before,” Ladner said. Not only does the Creative Inquiry project provide the state with vital information about our drinking water, but it also generates an understanding of how South Carolina integrates and distributes resources.

by Jason Erno

“We’ve been able to create a visual representation of where underground water pipes are all around the state, something that’s never been done before.”

Map created by: Dr. David Ladner, Tucker Wood, Mckenna Dove, Ian Atkins and Katelyn Marcacci.
For a child with autism the world can be an intimidating place. A place dominated by overstimulation from common items such as indoor lighting and clothing. Even the way a shirt hangs off the shoulder can be an uncomfortable, emotional experience.

To help regulate this stimuli, compression clothing is widely marketed to children with autism—driven by the belief that conventional clothing could be irritating the body’s natural pressure points, resulting in the child becoming distracted by their uncomfortable state. Compression clothing is advertised to help reduce this effect by creating a blank slate in the same way that white noise is used to minimize audible stimulation.

Dr. Jennifer Bisson in the Department of Psychology and her Compression Clothing and Autism Creative Inquiry team investigates if compression clothing provides benefits.

To test the hypothesis that compression clothing can help calm children with autism, the team remotely monitors Applied Behavioral Analysis sessions between children and their therapists over the course of 10 sessions. An experimental group of children, 4-10 years old, wear compression clothing during these sessions, which are videotaped and sent to the team for analysis. The Creative Inquiry team then monitors the children’s performance, stimulatory behavior and emotional state. To do so, they utilize ELAN, a computer program that is used to record the frequency and duration of certain behaviors the children display.

The Creative Inquiry team is eager to share their findings in hopes that they could be beneficial. “I really like that we are able to include people close to Clemson,” senior psychology major Kelsey Bennett said. Through a partnership with the Early Autism Project in Anderson, South Carolina, participants in this study are from areas geographically close to the university. However, the team is hoping the results will extend beyond this community to help autistic children nationwide and provide insight into a growing market.

by Lindsay Bryda
For many Clemson students and recent alumni, the dormitory called Clemson House was the site of countless freshman year memories. With its iconic neon sign and its location on a hill overlooking campus, the imposing seven-story building was often one of the first landmarks visitors saw as they approached the university. However, anticipating its future demolition, History of the Clemson House Creative Inquiry is uncovering a richer history to the building. Through interviews with alumni, Clemson locals and other individuals who worked or lived in Clemson House, the team intends to record and preserve the building’s unique history.

Built in 1950 to replace a boarding house of the same name, the Clemson House hotel became the center, not only of campus, but of the community. The penthouse hosted visiting faculty and other special guests, dance clubs met in the ballrooms and the restaurant became popular throughout the area. History of the Clemson House team uncovered records of a mural on a wall of the building’s restaurant. Although the mural was covered up over the years, it was once the largest mural in South Carolina. The mural, which was almost as old as Clemson House itself, showed the evolution of the Clemson cadet towards a more global perspective, resonating with Clemson’s military history and the university’s aspirations today.

Like the wall of its restaurant, Clemson House’s residents changed over the years as it housed guests, then secretaries, then finally students in the mid-1980’s. Although its uses varied over the years, the structure of the hotel remained, making the building not only a landmark, but a visual record of the university’s past. The goal of History of the Clemson House project is to take all of these facets of the building’s past into account. According to the project’s faculty advisor, Dr. Alan Grubb, in the History Department, this is a new approach to studying the Clemson House. “It has never been looked at as a historical entity before,” Grubb said. In order to address the building’s full history, the project considers Clemson House’s construction and life as well as its destruction.

“It’s a biography of sorts. It has a very unique, dynamic history,” senior history major Glenn Bertram said.

Tracing the many transitions Clemson House experienced requires not only research into physical changes made to the building, but also collecting memories and stories. In order to capture this broad scope of Clemson House history, the students are using oral history interviews and photography as well as documents from Clemson special collections to piece together the building’s past.

The team plans to publish their research in a book, possibly through Clemson University Press, as a way for students, alumni and the Clemson community to remember and learn more about the historic Clemson House. While the book might serve nostalgic purposes for the students and alumni who remember Clemson House’s presence on campus, it could also teach future generations of incoming students more about the history of their new university.

by Polly Goss
Heart disease is a leading cause of death both in the United States and worldwide, leading to millions of premature deaths each year. As a result, cardiovascular health has become a major concern for people of all ages as problems such as heart attacks and strokes become more prevalent. The Experimental Cardiovascular System and Novel Design for Blood Pump Device Creative Inquiry projects work to find ways to combat this growing international health issue. The students in these Creative Inquiry teams produce prototypes of medical devices and testing equipment for cardiovascular systems. Dr. Ethan Kung, Department of Mechanical Engineering, oversees both projects and says that the students’ work could prove useful in the medical field, improving the study and treatment of cardiovascular disease.

The idea for the projects began in the incoming freshman EUREKA! Program and, under the guidance of Kung, grew into the two Creative Inquiry projects. Many of the students involved are freshmen and sophomores looking for a way to gain hands-on experience and to discover the nuances of their field. Ross Brown, a freshman general engineering major, joined the project to gain this experience. “I was surprised at the level of precision needed for this kind of work,” Brown said.

The students working on the Experimental Cardiovascular System project are designing a prototype that replicates human cardiovascular physiology and anatomy. Currently, these students are creating a device that mimics blood pressure waveforms, an essential part of the simulated cardiovascular system. This system, once completed, could be used in medical device testing and clinical training.

Meanwhile, the Novel Design for Blood Pump Device project is tackling another important aspect of heart patient care. Current models of ventricular assist devices, which help weakened cardiovascular systems pump blood, often cause blood clotting called thrombosis, that can lead to a stroke, heart attack or failure of the ventricular device. The team is attempting to address the problem of thrombosis associated with these devices by working on a new design for a ventricular device that uses a motor to move blood through the blood vessel. This prototype could change the way ventricular devices move blood through systems, diminishing the threat of thrombosis.

Both projects tie together different aspects of engineering to improve heart disease research and treatment options. The prototypes the students produce can potentially help patients as well as students and practitioners who study the cardiovascular system. These devices not only impact the Creative Inquiry students but have the potential to make an impact in heart health.

by Polly Goss

Students Sarah Byrd, Kaleigh Neely and Megan Wander work together to build a waveform device that mimics blood pressure waveforms.
Butterfly Proboscis Structure
Butterflies are fluid feeders with a complex feeding structure. The function of the butterfly’s feeding tube, known as the proboscis, is to suck up fluids. The proboscis has a simple job but it is a complex biological structure that few scientists have examined closely. While the butterfly feeding habits are traditionally researched, little is known about proboscis structures not visible to the naked eye.

As part of the Butterfly Proboscis Structure and Engineering Inspiration Creative Inquiry, biology and engineering students collaborate to investigate the hidden structure and function of the proboscis. The multidisciplinary group operates daily as two teams but they meet monthly to share their findings and observations. Both groups bring new perspectives and different skillsets to the project. The biology team is able to give advice on biological aspects while the engineering team provides a new structural understanding of the proboscis. These brainstorming sessions give rise to thought-provoking discussion that merges the two fields of study.

As a junior environmental engineering major, Alison Arling joined the project to expand her academic interests, which was a common motivation for many of the students involved. To further capitalize on the multidisciplinary effort, the team also acquires an understanding of histology, the study of tissues. A proboscis has both hard and soft tissue and preserving both has proven to be one of the biggest challenges for the group. They have been gradually devising a method with different chemicals that allows them to conserve both types of tissue as working with delicate, live specimens requires considerable care and attention to detail.

Dr. Charles Beard, Dr. Peter Adler and Suellen Pometto from the Department of Plant and Environmental Sciences are collaborating with Dr. Terri Bruce, Director of the Clemson Light Imaging Facility to mentor the biology team of this Creative Inquiry. Meanwhile, the engineering team is led by Dr. Konstantin Kornev from the Department of Materials Science and Engineering. The engineering team uses the biological information to focus on the structural function of the proboscis itself. “The structure has been overlooked, you need an engineer to explain the properties of how it works. That’s where we come in,” Luke Sande, a graduate student, said. He works together with Victoria Galway, a sophomore materials science and engineering major, to measure mechanical properties of the proboscis and relate them to the structure.

Previous studies reported that once a proboscis split, the structure would not be able to repair itself. The students’ research shows that this structure is capable of rejoining the two halves, contrary to these past observations. Moving forward, the students would like to take what they have learned about the butterfly proboscis and examine similar structures on horseflies. In the past, the group developed an artificial proboscis with unprecedented fluid transport properties. Now they want to create a smart fiber modeled after the proboscis that can similarly coil, uncoil and deposit liquids to further understand the structural function of the proboscis.

by Elise Bell

Above: Members of the Engineering group from left to right: Chengqi Zhang, Luke Sande, Bonni McKinney and Pavel Aprelev.
Adjacent: A series of photos of a monarch butterfly using its proboscis.
Contrary to popular belief, the characteristics of human health are not solely based on physical and mental components. Dr. Arelis Moore de Peralta in the Department of Languages and the Department of Youth, Family and Community Studies leads her Building Healthier Communities in the Dominican Republic Creative Inquiry team in taking action to identify and combat communal health problems.

Lower income communities in the Dominican Republic are often faced with high illiteracy rates, lack of higher education opportunities and poor public health systems. The community of Las Malvinas is no stranger to these issues. Moore de Peralta and her team are working to revise the United States’ Centers for Disease Control and Prevention (CDC) healthy communities program Community Health Assessment and Group Evaluation (CHANGE) to operate in less developed countries. The team’s goal is to expand their knowledge of the hazards there in order to identify potential solutions.

The Creative Inquiry group is collaborating with other Clemson groups and agencies from the Dominican Republic to address these issues. Academic, governmental and non-governmental groups in Las Malvinas have partnered with this Creative Inquiry team to combat environmental and health concerns in the community. A local university in Santo Domingo, Universidad Iberoamericana, works with Moore de Peralta’s Creative Inquiry team by helping translate and adapt survey questions to the Las Malvinas community. Clemson GIS Services also helps the team by finding and mapping areas of stagnant water or trash buildup in the community. Representatives from the Dominican Department of Health are contemplating establishing a primary health clinic within the community. “Building healthy communities needs a holistic approach that understands the economic, political and familial factors there. That variety of factors requires a variety of expertise, thus a multidisciplinary approach,” Moore de Peralta said. The CDC is using the team’s adaptation of the CHANGE protocol in other countries like Zambia as the Dominican Republic model is now as a case study in the CDC training manual.

In the future, the team hopes to utilize the ecological area surrounding Las Malvinas as a source of revenue for the community through tourism as well as continue to visit the country every spring break. “After visiting Las Malvinas, I keep myself reminded that what I’m doing in the classroom is for the benefit of people,” Chloe Schockling, a junior health science major, said.

by Jason Erno
Yeast isn’t something that people typically associate with beauty. Yet Dr. Mark Blenner in the Department of Chemical and Biomolecular Engineering works on genetically engineering microorganisms, such as yeasts, to manufacture desirable products for use in the cosmetic and food industries. With modern biotechnology, high-value products and industrial materials are no longer solely produced from petroleum and rendering processes. Masses of microorganisms can be genetically modified and used as small factories to produce desired fuels and chemicals. In the lab, his Creative Inquiry team Engineering Yeast for Sustainable Production of Fuels, Chemicals and Nutraceuticals is constantly developing new “tools” to exploit the yeast’s metabolic processes.

Governmental agencies such as the Department of Defense, NASA and the USDA have expressed an interest in Blenner’s Creative Inquiry because of the potential economic benefits for creating cost-efficient high-value products. Their NASA grant, for example, examines how human waste products can be converted into fuel via microorganisms. But despite the high-profile work, Blenner has other goals in mind for his team. “For me, the primary goal is to make sure students come out of my lab with more critical thinking skills and that they can wrap their heads around answering some of most complex questions that our society will face,” Blenner said.

Lauren Gambill, a senior biochemistry and genetics major, looks at using cheaper sugar substrates like xylose as an energy source for yeast and has presented her research at the Southeast American Chemical Society conference. “I think the biggest thing for me has been learning how to think through things, develop and work through an experiment, troubleshoot and then pass those skills on to others,” Gambill said. With sustainable methods of product development becoming increasingly popular, research into bioprocessing from a renewable energy source could prove to be both environmentally friendly and lucrative.

by Jason Erno
Synthesis and Characterization of Metal and Metal Oxide Nanoparticles

Mentor: Dr. O. Thompson Mefford, Department of Materials Science and Engineering

The Synthesis and Characterization of Metal and Metal Oxide Nanoparticles Creative Inquiry is a team of graduate and undergraduate students. Their goal is to use magnetically mediated energy delivery (MagMED) to convert and deliver the energy of an alternating magnetic field to targeted cells in the form of thermal energy. This process can induce a fever in the cells, which is the body's natural response to an infection.

If this technique is used on cancerous cells, the induced fever could force the body to attack the cells without requiring surgery or chemotherapy. Previously much of the work in this field has focused on iron oxide particles. Unfortunately, iron oxides lack sufficient magnetic saturation and effective magnetic anisotropy. Therefore, the team focused on improving the material properties of these particles by doping them with various transition metals, including copper, manganese, cobalt, nickel and zinc. Combining this knowledge with comparisons of different metals at different concentrations, the team hopes to eventually be able to yield nanoparticles of specific composition and size that will contribute to significant advances in medicine, particularly cancer research.

Low-Cost Microfluidics to Detect Chagas Disease in a Rural Setting

Mentor: Dr. Rodrigo Martinez-Duarte, Department of Mechanical Engineering

This project is currently faced with the challenge of detecting Chagas disease in a rural setting. The goal of the project is to develop an inexpensive and accurate device that will ultimately pave the way for identifying the parasite Trypanosoma cruzi in umbilical cord blood. This parasite causes Chagas disease, which claims up to 14,000 lives a year by causing heart failure. One of the transmission paths
of Chagas disease is congenital (from mother to child). By identifying the parasite, an infant can be cured with antibiotics.

Currently, the multidisciplinary student research team is working to analyze a non-pathogenic strain of Trypanosoma brucei, a parasite similar to T. cruzi, using carbon-electrode and optoelectronic dielectrophoresis techniques. The goal is elucidating how the parasite can be concentrated in specific spots to facilitate its detection. These results will then be applied to concentrating the pathogenic T. cruzi. These techniques, besides progressing the research, equip students with specialized research skills transferable to future endeavors.

**CU and the CDC—Investigations in Legionella**

Mentors: Dr. Tamara McNealy and Dr. Claressa Lucas, Department of Biological Sciences

Through a collaboration with the Centers for Disease Control and Prevention (CDC), the CU and the CDC—Investigations in Legionella Creative Inquiry was able to name a novel strain of the Legionella bacteria, the most common cause of waterborne bacterial outbreaks in the US.

Led by Dr. Claressa Lucas from the Legionella Lab at the CDC, the team named their discovery Legionella clemsonensis after the university that made the collaboration possible. Students are pleased with the contribution they have already made to their field while still studying as undergraduate students.

The CDC sent the Creative Inquiry team a batch of 68 strains of Legionella to analyze. During the research process, the students realized that the delivery did not match with known Legionella strains, which prompted further investigation. This newly discovered strain of Legionella can cause elderly people or those with weak immune systems to develop a treatable version of pneumonia. Furthermore, when under ultraviolet light, this strain fluoresces green instead of the usual blue, red or yellow. The bacteria live in biofilms in all man-made water systems as well as freshwater lakes, streams and rivers.

**Carbides from Epoxy-Nanoparticle Composites**

Mentor: Dr. Rodrigo Martinez-Duarte, Department of Mechanical Engineering

The Carbides from Epoxy-Nanoparticle Composite Composites Creative Inquiry focuses on finding alternative ways to produce metal carbides using a biopolymer as the carbon source. Carbides are extremely useful engineering materials that have a high melting point, hardness factor, abrasion resistance and low density. Consequently, metal carbides have become highly popular materials used in industrial and military applications. These factors make carbides popular options for the manufacture of high quality parts and tools such as wear-resistant cutting tools, abrasive steel bearings and optical ceramics.

Currently, the most common method to produce carbides is through the reduction of metal oxides with carbon black derived from petroleum. In this project, the team is trying to develop a more environmentally friendly process to create carbides by replacing carbon black with carbon from sustainable resources. To do this, the team uses biopolymers such as iota-carrageenan from seaweed, chitin from shrimp shells and cellulose from plants in their search for more environmentally friendly procedures.
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Creative Inquiry Is...

- Collaboration
- Experimentation
- Service Learning
- International
Creative Inquiry is the imaginative combination of engaged learning, cross-disciplinary interactions and undergraduate research that is unique to Clemson University. Team-based investigations are led by faculty mentors and typically span a year or more. Students take on problems that spring from their own curiosity, from a professor’s challenge or from the pressing needs of the world around them. These invaluable experiences produce exceptional graduates.

Since its start in 2005, Creative Inquiry has supported more than 40,160 student experiences in more than 1,200 research projects. Each year, more than 3,500 undergraduate students investigate topics ranging from classroom behavior in K-12 students to modifying microorganisms for petroleum alternatives to studying the biology and ecology of snails.

Creative Inquiry projects, many of which are multidisciplinary, can be found in all disciplines. Students in each project collaborate with their peers to utilize each team member’s expertise to accomplish project goals.

Creative Inquiry offers students real-world and hands-on research experiences, prepares them for graduate school and careers, provides opportunities to work closely with faculty, expands their social network and helps them to develop technical, leadership and communication skills. Many Creative Inquiry projects are cross-disciplinary, providing students with the ability to work with others from diverse backgrounds.

Students believe their Creative Inquiry experience helps them think and learn in new ways, which allows them to be more engaged in higher-order thinking, reflect on what they learn and connect the work done in their Creative Inquiry projects to traditional course work and to their future careers.
by the numbers

40,160 Student Experiences
870 Presentations at professional conferences

38 States
314 Publications

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Phil and Mary Bradley made the first major gift to Creative Inquiry and established an annual award to recognize a faculty member for outstanding work with undergraduate students. The Phil and Mary Bradley Award for Mentoring in Creative Inquiry consists of a plaque and a salary supplement. Creative Inquiry students nominate their faculty mentors for this award.

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