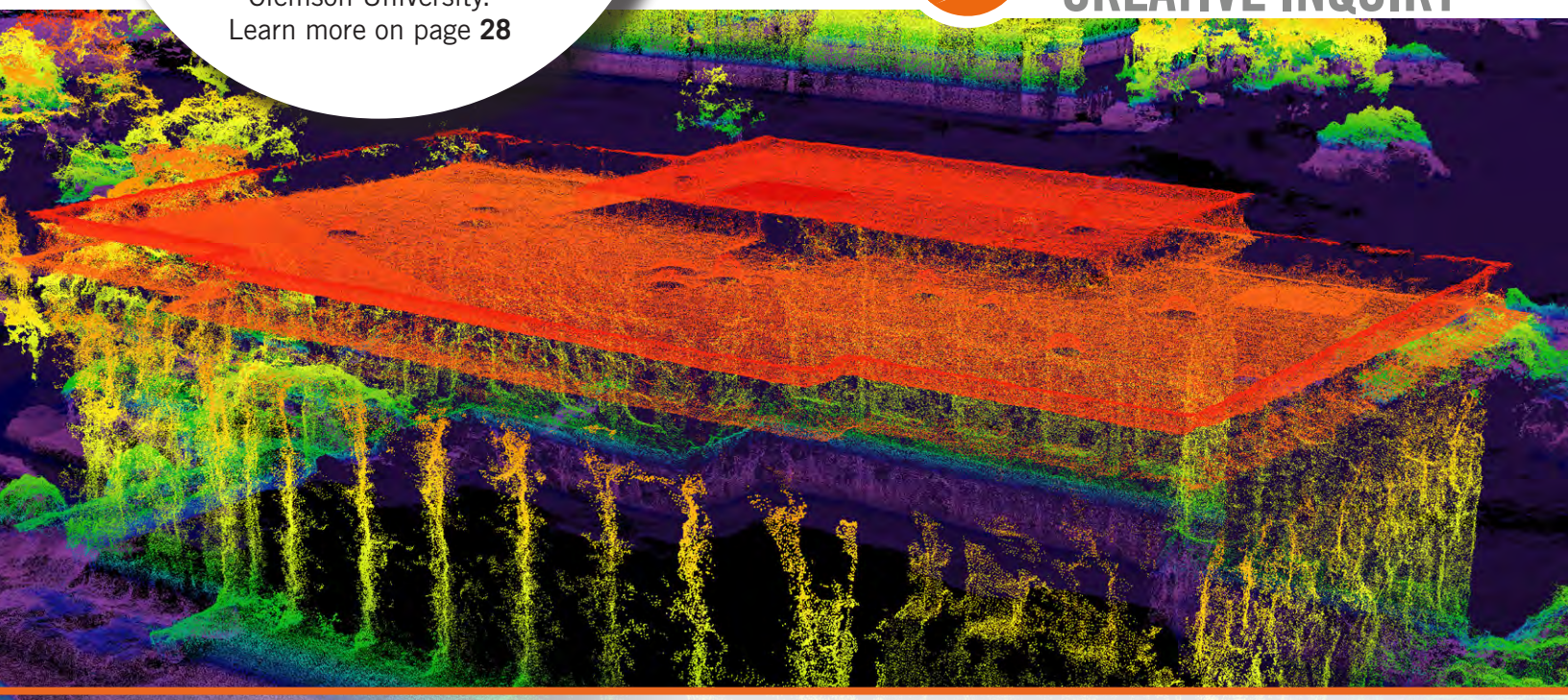
2019 decipher magazine

Creative Inquiry Magazine | Volume 8

Cover and Below
Creative Inquiry is buzzing around campus more than ever, now with flying drones and the latest mapping technology. The Light Detection and Ranging (LIDAR) data pictured is being used to 3D print a map of Clemson University.
Learn more on page **28**

CLEMSON®
CREATIVE INQUIRY



FOLLOW US

@ciclemson

ciclemson

@ciclemson

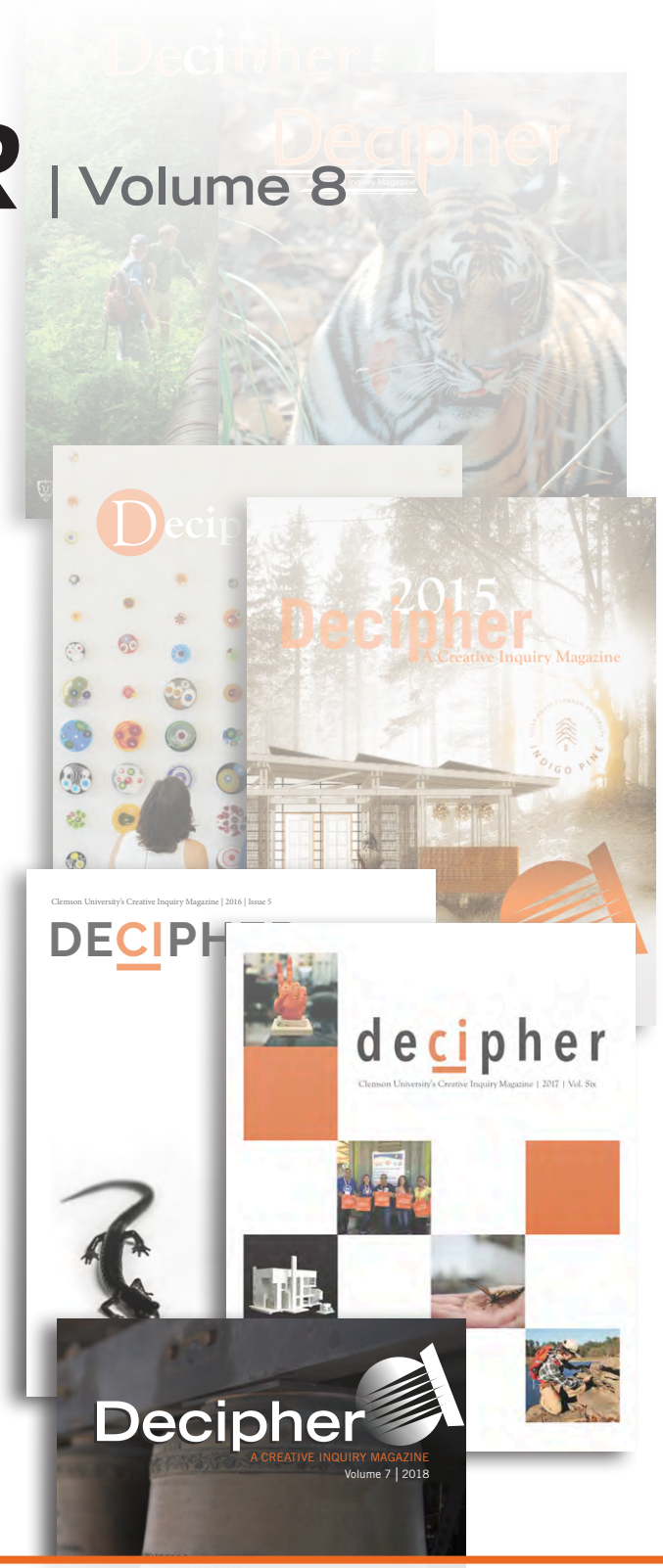
CONTACT CREATIVE INQUIRY

Cora Allard-Keese
Associate Director
phone: 864–656–0721
email: callara@clemson.edu

Barbara Speziale
Director
phone: 864–656–1550
email: bjspz@clemson.edu

CLEMSON.EDU/CI

ABOUT DECIPHER | Volume 8



Decipher magazine is produced by a team of Clemson University's undergraduate students to highlight the accomplishments of their peers in Creative Inquiry (CI), 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, other or cross-disciplinary fields of study.

Each year, more than 4,000 Creative Inquiry students investigate topics ranging from exploring bacterial genomes in search of new drugs to creating technologies that address food insecurity. Creative Inquiry projects provide students with the tools they need to explore diverse problems and issues in our community and beyond, and to propose possible solutions. Students value these opportunities to apply the skills they learn in the classroom to solve real-world problems.

From the 400 current Creative Inquiry projects, we selected 26 projects to feature in this magazine. The team interviewed faculty, graduate students and undergraduate students involved with each of these projects in order to write these articles and produce photographs and 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. Though this magazine can feature only a few projects, CI accomplishments are considerable, including more than 1,725 presentations at professional conferences, more than 452 professional publications and over 478 awards.

Decipher is also available digitally as an interactive blog on the Creative Inquiry website (clemson.edu/ci). Visit our blog for more information and to see more interactive project highlights.

ACKNOWLEDGMENTS

CREATIVE INQUIRY STAFF

Barbara J. Speziale, Director
Cora Allard-Keese, Associate Director
Tullen Burns, Project Coordinator
Julie DuBose, Fiscal Analyst
Lindsay Hobbs, Administrative Assistant
Sagar Thakur, Database/Web Manager
John Morgan, Graduate Assistant
Joseph Whitt, Graduate Assistant

DECIPHER STUDENT STAFF

Stone Washington, Writer and Editor
Sarah Dorsey, Writer and Editor
Niko Hajimihalis, Assistant Editor
Kevin Crumley, Chief Graphic Designer
Emily Pilot, Assistant Graphic Designer
Sarah Stewart, Photographer
Colleen Blaine, Writer
Tessa Schwarze, Writer

INTRODUCING CORPORATE CI

There is no 'typical' Creative Inquiry project (CI). From the start of the CI program, projects have originated from many diverse sources—including from a professor's research, students' ideas or observations of community or campus needs.

A founding tenet of CI is the intent to help Clemson students become thinkers, leaders and entrepreneurs, to be able to approach a task or problem and figure out how to solve it—and to do so in a wide range of disciplines.

In recent years, businesses have discovered the power of CI to develop talent, to attract interns and employees and to familiarize college students with the workings of their industries. The new Corporate CI program allows industries to engage Clemson's creative, talented undergraduates in industry-relevant research projects.

The results benefit all. Students gain understanding of real-world work topics and opportunities to network with potential future employers. Companies gain visibility on campus, insights into selected project topics and relationships that help recruit interns and employees.

The ideal Corporate CI project involves open-ended topics that can be addressed over two or more semesters of iterative exploration, design, implementation and evaluation cycles.

Projects can be within or across disciplines. Current projects include qualitative marketing research, applications of artificial intelligence and developing a disaster relief supply chain.

CI and industry—a natural expansion for the inquisitive minds of Clemson students and a contribution to building the workforce of the future.

CLEMSON CREATIVE INQUIRY
CORPORATE

Corporations seeking more information may contact,
Barbara Speziale:
864–656–1550
bjspz@clemson.edu

THANK YOU TO OUR CORPORATE PARTNERS

IBM Watson
SIEMENS Ingenuity for life
Ulbrich
WEYERHAEUSER FAMILY FOUNDATION
PERKINS + WILL
vf
U.S. Endowment for Forestry and Communities

Beginning Fall 2019

ally do it right.
SONOCO FRESH
Trulite GLASS & ALUMINUM SOLUTIONS

Table of Contents

Decipher (verb)
to succeed in understanding, interpreting or identifying

Photo by Marion Clement

Who Gives a HOOT?

The Evolving Habitat of Barred Owls

by **Niko Hajimihalis**

Photo by Charles Aurich

Photo by Marion Clement

As I walk through downtown Clemson after a long night in the library, I hear eight distinctive hoots from the tree above that harmonize into what almost sounds like the phrase, "who cooks for you, who cooks for you all." Puzzled at first, I look up into the trees and catch a glimpse of the bird who is making the unique noise. This mottled brown-gray bird with horizontal streaks running up and down its body looks out of place in an area that is better known for its lively student nightlife than wildlife resources. Yet here I stand, making eye contact with this beautiful barred owl.

Marion Clement, a graduate student in the Department of Forestry and Environmental Conservation, is leading the Barred Owls in an Urban to Forest Landscape Gradient Creative Inquiry project to determine why these forest-dwelling birds now inhabit our neighborhoods. The undergraduates participating in this project are learning important skills in the field of wildlife ecology. "We have been collecting data from urban and rural populations in order to check owl densities," Kirsten Brown, an environmental and natural resources major, says.

In the first phase of the project team members spent long nights in the field conducting audio surveys to find where owls were located. They started by playing owl calls and listening for responses. Once owls were found, the team used mice to bait the owls in order to catch them and fit them with tracking devices. Global Positioning System (GPS) telemetry devices were placed on the backs of the owls in order to track their movement. Determining the locations of the owls allowed the team to identify each owl's home range as well as compare the foraging patterns of urban, suburban and forest dwelling owls.

The willingness of homeowners to assist the owl research team is key to this project's success. To study barred owls in urban environments, the team must access private property with the cooperation and permission of the homeowners. Many Clemson families are excited to support the project and want to know how they can help create habitats to encourage barred owls in their backyards. The anthropomorphic nature of these creatures allows families across the Piedmont region of South Carolina to find a new sense of connection with the ecosystems in their backyards.

While the primary goal of this Creative Inquiry project is to understand why barred owls are living in developed landscapes, the study may also identify necessary characteristics for supporting wildlife diversity in developed areas. Due to their specific habitat requirements, barred owls are typically found in pristine, mature forests. The presence of a barred owl in a neighborhood might be a clue that the urban forest is healthy, with plenty of prey and large trees. Promoting the types of habitats that the barred owl prefers is likely to promote other wildlife species, such as birds, mammals, amphibians and reptiles. The close relationship between students, homeowners and owls provides students with valuable skills in wildlife research and public outreach. Before we know it, seeing one of these creatures downtown may become the norm.

Photo by Charles Aurich

Photo by Eric Rodgers

Students take body measurements of a barred owl.

Photo by Marion Clement

Assessing the EU's Influence

by **Stone Washington**

Whether fluent in European politics or not, many people are aware of Great Britain's dramatic decision, in June 2016, to exit from the European Union (EU), commonly referred to as Brexit. Although familiar with the term Brexit, few people are aware of the significant impact that it holds for other countries in the European Union.

The EU was founded in 1993 as a global organization working to unite its countries economically, politically and socially. The EU, comprised of 28 European nations, is primarily tasked with monitoring an interconnected system of trade while seeking to ease the burdens of commerce. Despite this, many people, even in Europe, remain confused regarding the purpose of the EU. At Clemson, students in the Assessing the EU's Influence Creative Inquiry project, led by Dr. Amber Curtis in the Department of Political Science, strive to understand the significance of the EU and investigate its influence on global affairs.

This year under Curtis' guidance the students conducted two main studies. One examined how European citizens interact with the EU on a daily basis to determine whether or not the average citizen is aware of the institutional resources available to member nations. The students analyzed survey data from citizens from Germany, Poland and the United Kingdom (UK)—three countries known to have different opinions of the EU. The team primarily focused on the UK due to the Brexit controversy. Curtis emphasizes how invaluable it is to gain first-hand information from citizens in the UK regarding the ramifications of exiting the EU and feelings toward whether or not the decision made was beneficial for the country. "Its actions, its policies, its daily operations into the realm of the citizens' lives and their perceptions of why the EU is a good or bad thing," Curtis said.

"Its actions, its policies, its daily operations into the realm of the citizens' lives and their perceptions of why the EU is a good or bad thing."

The second study arose organically. "Dr. Curtis has given us a lot of opportunity to do what we want with the project," Sarah Reynolds, a junior political science major, said. While collecting healthcare data from the Center for Disease Control and the World Health Organization in the fall, the team discovered what would frame their second study. Using these health records, the team began investigating how perceived health threats affected natives' willingness to accept immigrants.

Curtis views this Creative Inquiry project as an excellent learning opportunity. The students in the project get a unique, in-depth experience in the world of academic research at a much deeper level than in their general course work. Students contribute to the existing scholarship on the EU by developing surveys, running the surveys through an international polling firm and collecting the results. Students then analyze the data using tools such as Excel or Stata. The team presents their results at various events in hopes of an eventual publication.

"I think a lot of students, even in the Department of Political Science, don't know much about the EU. Our research will help them understand not only the EU, but European attitudes in comparison to American attitudes," Meghan Walling, a junior political science major, said. This team's research is helping to clear up confusion regarding the EU and to bring a global perspective to Clemson students.

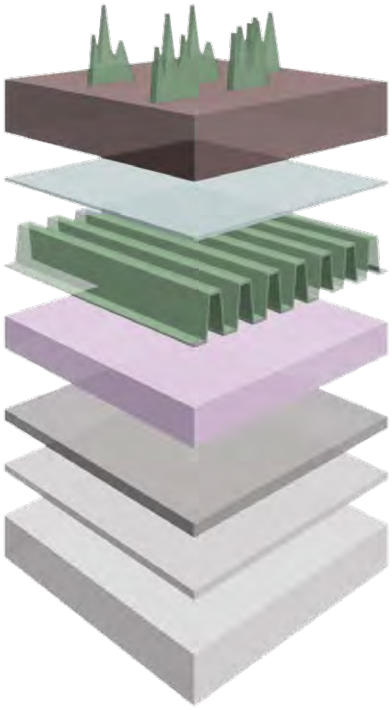
My Roof has a Green Thumb

by **Sarah Dorsey**

When looking for flora and fauna in a city, it may be a good idea to look up. In urban landscapes, placing gardens on rooftops is a growing trend. Even Clemson University's campus hosts two green roofs, on Lee III and the Watt Family Innovation Center. A green roof is one covered with soil and plants that are watered with rainwater and controlled irrigation systems. Succulents are often used to regulate the roof's temperature and provide an aesthetically pleasing, variegated landscape. The Coupling Green Roofs, Rainwater Cisterns and Urban Agriculture Creative Inquiry project, mentored by Dr. William Martin in the General Engineering Program, is working to design a self-sufficient garden system for rooftops.

Donovan Rice, a sophomore computer engineering major, enjoys the practical applications of this project such as the coding skills he learns in Python

Layers in a Green Roof System



Above: Patrick Fuller, Donovan Rice and Dr. Martin working on the table-top green roof model.

and Ubuntu operating systems. Rice hopes their work is laying a foundation for systems that can eventually be implemented world-wide. "After completing our first prototype garden plot, I'd like to see this CI design a consumer-friendly, mass-producible garden plot that can be used worldwide to grow environmentally-friendly gardens in urban areas," Rice says.

Currently, the team is addressing water usage in the green roof system. Cisterns (large water barrels) and green roofs are both ineffective systems when used individually. On a green roof similar to Lee III only 10% of rainwater is absorbed by the soil. The rest is diverted to storm water drains. The Creative Inquiry team thinks they can improve the system by combining it with cistern systems. Both systems come with a large installation cost. "The measurable benefits are not always worth the cost," Martin says. Capturing all excess roof water will reduce or eliminate the need for storm water drains entirely which will make having a green roof more feasible.

For testing purposes, the team designed and built a four-foot-square tabletop roof model with dirt but no plants. They are investigating water accumulation in the system by continuously recording the weight of the model using electronic load cells under the legs of the table. This weight changes with water saturation. Analyzing this data allows the team to understand the kinetics and water demands in the system over time.

Students can choose to work on the construction or software side of the project, but they all work together to attach the cistern to the model system. The software team writes code to program the system to irrigate the green roof after a specific number of rainless days or when the weight of the system is at a minimum, indicating there is not enough water. When relying solely on cistern water, the system will be a completely closed loop. Once the model system works properly, the team will start growing plants. The next big leap will then be scaling up to a roof-sized system.

Green roof systems are a testament to the engineers' ability to create a fully functioning ecosystem on top of a building. Improving the current systems in use for water retention and storage can decrease runoff and reduce flooding and related impacts. This new system will increase sustainability and decrease the costs of a green roof system. Eventually, the team hopes to see students maintaining closed loop green roofs on campus to give them a greater sense of ownership and pride in their buildings, school and community.

A microscopic VIEW of OYSTERS

by **Niko Hajimihalis**

Students collecting oysters at Baruch Marine Field Laboratory in Georgetown, S.C.

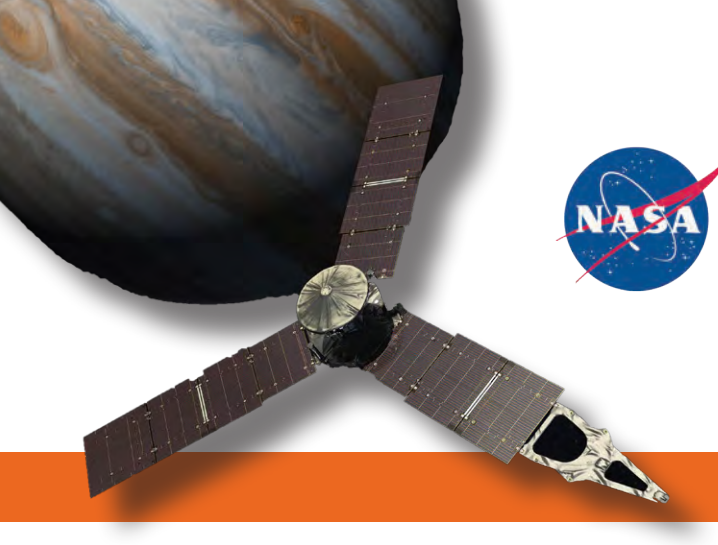
Oysters are famous for their unique taste, but Clemson University's Ocean Under the Magnifying Glass—Using Microscopy to Understand the Impacts of Climate Change Creative Inquiry project is here to show that these small creatures have much more to offer. Oysters are a key component in the coastal ecosystem: they serve as natural buffers to protect beaches from rising sea levels; act as natural filters in the ocean; and they provide a home for other underwater creatures. Unfortunately, climate change may be affecting the shell formation of these creatures in ways that marine biologists never expected.

The project, led by Dr. Vera Chan and Dr. Andrew Mount in the Department of Biological Sciences, approaches the study of oyster shell formation through microscopy. By examining the formation of oyster shells through a microscope, students are able to investigate how climate change potentially affects the development of oysters. The team cultivates wild Atlantic oysters, *Crassostrea virginica*, in an artificial, recirculating seawater system. "We have created a mini ocean and hatchery in Clemson," Chan said. By replicating the ocean's ecosystem, the team is able to monitor spawning in the oysters and track abnormalities in shell formation caused by higher carbon dioxide (CO_2) levels in the water.

By increasing CO_2 levels in the system, the team is replicating potential levels of CO_2 in the ocean caused by global warming. The team closely monitors how increasing CO_2 levels impact the oyster population by noting changes in the oyster shells' growth, development and calcification. Jonathan Stewart, a senior biological sciences major, thinks the team's research may impact other areas of research. "You may find other applications from researching how the shell develops that are unrelated to this project. Whether that be industrial applications or using microscopy in other fields, it could benefit research in different fields," Stewart said.

Time will tell how climate change affects oysters on a microscopic level. By creating and studying oysters in an artificial, miniature ocean in Clemson, this team is helping to discover the impacts of rising CO_2 levels on oysters. Similar to how oyster lovers crack open their favorite seafood, this Creative Inquiry team is cracking open the study of oyster shell formation.

By increasing carbon dioxide (CO_2) in the system, the team increases the acidity which decreases carbonate (CO_3^{2-}) and affects oyster shell growth.



Drops of Jupiter

by Sarah Dorsey

After 10 years of running her own graphic design business, Brantley Kerns returned to college to study astrophysics. Majoring in physics with an astronomy concentration as well as working towards minors in mathematics and English, she found a perfect fit for her interests in the Ground Based Support of the NASA Juno Mission Creative Inquiry project, led by Dr. Máté Ádámkovics in the Department of Physics and Astronomy. The project is acting as ground support for the ongoing mission to Jupiter.

The National Aeronautics and Space Administration (NASA) decided to send the Juno spacecraft to Jupiter because the mid-1990's Galileo Mission was the last full Jupiter mission and NASA recognized that regular planetary monitoring is key to understanding how the solar system is changing. Juno launched in 2011 and arrived at Jupiter in 2016. Since then, it has been sending back stunning pictures of Jupiter and its Great Red Spot, a 300-year-old giant hurricane raging on Jupiter's surface. Juno measures Jupiter's composition, internal structure and water content. NASA uses this data to test planet formation theory and to hopefully make some conclusions on how Jupiter may have formed.

Juno is not the only machine capable of taking measurements of Jupiter. Telescopes and teams of scientists on earth (ground support) can take measurements. These teams perform observations for data validation of NASA spacecraft measurements. The Keck Observatory in Hawaii houses two such telescopes and they record complementary data to Juno. The Creative Inquiry team gets spectroscopic data from Keck, analyzes it with their computer model and compares their results to results generated from Juno's data.

The Creative Inquiry team is responsible for making the Python code that reduces and rectifies the data to clean and process the data. This assists NASA scientists in analyzing the data, furthering their mission to decode the secrets of Jupiter's formation. The data can tell how much water is in Jupiter and the Red Spot. "It can also tell the composition and fluid dynamics that are constantly changing," Kerns said. While initially confusing, when team members understand what the numbers mean, it is a beautiful system. "When you are actually in the data, things just click," Kerns said.

Space interest is not required to be a team member. While Kerns and Rachel Conway, a senior physics major, had previous interests in space, Andrew Wetzel, a sophomore computer engineering and physics double-major, joined for the coding and began to like space after working on the project. This Creative Inquiry project has a powerful ability to bring together people who are like-minded in relish for academic research. "There are in-depth things I know from the Creative Inquiry that aren't taught in regular classes," Kerns said. All agreed having a relationship with a professor like Ádámkovics was important when they were curious about school or space subjects. "Their energy for learning and doing things is great to be around," Ádámkovics said.

The students marveled at how far they had come, from barely knowing what Python was to now writing complicated code.

The team will continue to get data from Keck and Juno allowing the students to use their gained knowledge to perfect the data. Kerns will continue to discover her favorite areas of space research and hopefully go on to a career with NASA or another space research company. By the end of Juno's mission in 2021, NASA and the Clemson team want to know what Jupiter is made of and how it formed. They can then take steps to understand how other planets formed and even hypothesize about the presence of life outside of Earth.

Human Factors Forensics

by **Stone Washington**

Human factors is a term that defines the way in which humans interact with their environment. It encompasses a person's perceptual, cognitive and physiological relationship to others and one's own existence. It also comprises an important element of the legal arena, providing the basis for fault and accountability behind one's decision-making. Dr. Benjamin Stephens in the Department of Psychology, mentors the Human Factors Forensics Creative Inquiry project which applies the scientific method to decipher how human decision-making factors into the law. Students examine the basic principles behind perception and cognition while applying these principles to certain incidents where individuals were hurt in order to better understand the scenarios and to help understand the causes of injuries.

The Creative Inquiry team uses case studies to reexamine previously documented cases to determine causality. "So, in order to help a jury understand the situation, sometimes a scientist needs to explain how we perceive the world, how we can think about what we're doing and how that might have influence in a given incident in which someone was hurt," Stephens says.

The Human Factors Forensics team

One case the team is investigating is a common accident at Clemson University—students tripping. To investigate, the team asks the person where they tripped and if they saw the trip hazard coming. The team then decides what type of measurements to take to assess whether the person was reasonably careful or distracted (e.g., looking at a cell phone).

Stephens sees the project as an invaluable experience for students—a combination of scientific experimentation and the application of human factors theory to real-world incidents. "There's a nice synergy between doing experimental research in a laboratory and having a better understanding of why accidents happen and what can be done to make a situation safer," Stephens says. The team's next research study involves situations where people working on or around skylights have fallen through the skylight into the room below. Morgan Kilver, a senior psychology major, says they want to figure out if people do not see it. By applying a set of human factors, the team hopes to prevent similar accidents from occurring in the future.

Students dissect pig ligaments and tendons to use in testing their stretching device testing.

Soft Tissue + Sports Injuries

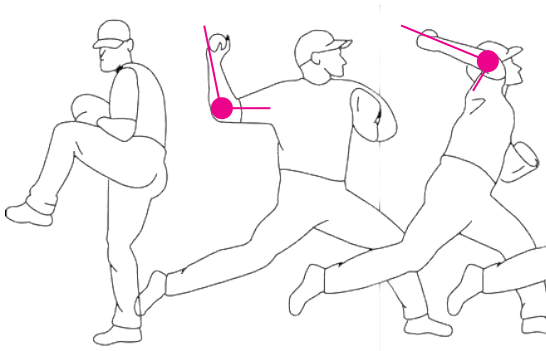
by **Niko Hajimihalis**

Division I athletes are among the most athletic people in the world. For college baseball players, the ability to throw and hit baseballs that are traveling more than 90 miles per hour is one of the most difficult feats in the sport. Unfortunately, baseball injuries are a part of the sport. Countless pitchers across the United States suffer from injuries in the elbow region. These ligament and tendon injuries are attributed to the stress and torque of repetitively throwing a baseball. The Exploration into Soft Tissue Sports Injuries: Diagnosis and Prevention Creative Inquiry project hopes to create new tools to accurately assess injuries. They want to assess ligament and tendon injuries, while also studying the forces and stresses that repetitive pitching motions cause on these tissues and muscles.

Led by Dr. Delphine Dean in the Department of Bioengineering, this Creative Inquiry team is approaching the project from multiple directions. In the laboratory, students dissect and preserve pig tendons for use in their research. The tendons and ligaments of pigs are remarkably similar to those of humans, giving the team the opportunity to investigate how stretching pig tendons may correlate with how a human's tendon stretches.

When both pig and human ligaments are stretched, microtearing occurs. Microtears only happen when consistent, repetitive motion takes place and it increases the likelihood of a complete tear. By studying stretching in pig tendons and ligaments, the Creative Inquiry team is able to gain a better understanding of the relationship between microtearing and more serious injuries.

On the other side of the project, students are engineering a device to help stretch pig tendons. "This device will cyclically lift and stretch the tendons based off of inputted variables

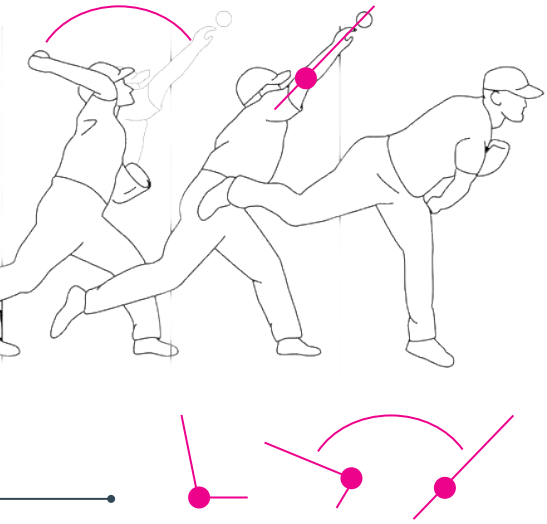


Everyday, countless pitchers across the country suffer from injuries, especially in the elbow region, due to the stress and torque of repetitively throwing a baseball.

to try and recreate the repetitive motions made in pitching," Melissa Judge, a senior bioengineering major, said. The device's blueprints are done, and students are waiting to finish making the final product in the Watt Center's Student Makerspace. The team plans on comparing previously collected data with the data that they collect using this device.

Going forward, the team hopes to include the Clemson baseball team in their research. After they validate their results from the laboratory and the use of the mechanical stretching device, the team will submit an Institutional Review Board protocol to use ultrasound technology on the baseball players. Using an ultrasound will enable the students to take images of the joints in athletes and compare density data found in ligaments with and without microtearing.

Sports fans understand that it is incredibly difficult to be a Division I baseball player. What many do not know is how taxing this sport can be on the body. It is this Creative Inquiry team's hope to educate sports fans, researchers, doctors and others about how we can help prevent injuries in those who put their bodies on the line for the game that they love and that the fans love to watch.



The different phases of alignment in the pitching motion.

Tessa Schwarze | Writer

Tessa is a senior psychology major from Atlanta, Georgia. She hopes to one day work in public health as a neuroepidemiologist. In her free time, she enjoys reading, writing and traveling abroad.

Combating Oceanic Threats with Theater

by **Tessa Schwarze**

There is something very fishy happening to the oceans but it has almost nothing to do with the fish. Approximately one quarter of ocean ecosystems depend on coral reefs, yet as global warming becomes an increasing issue, corals are dying worldwide. At least half of the world's coral reefs have died in the past 30 years. This decline negatively impacts marine species that depend on the reefs for survival.

The Something Very Fishy Creative Inquiry project led by Dr. Michael Childress, Kara Noonan and Kylie Smith in the Department of Biological Sciences aims to educate children about the dangers of ocean degradation. To encourage people to do their part in protecting oceanic ecosystems, the team has created a family-friendly musical theater production.

The team partnered with award-winning children's songwriter Kathy Prosser and the Pickens County Performing Arts Center (PCPAC) to create a musical that takes its audience on a journey to understand the importance of marine conservation. The musical includes a dialogue between Sandy Carson, a marine

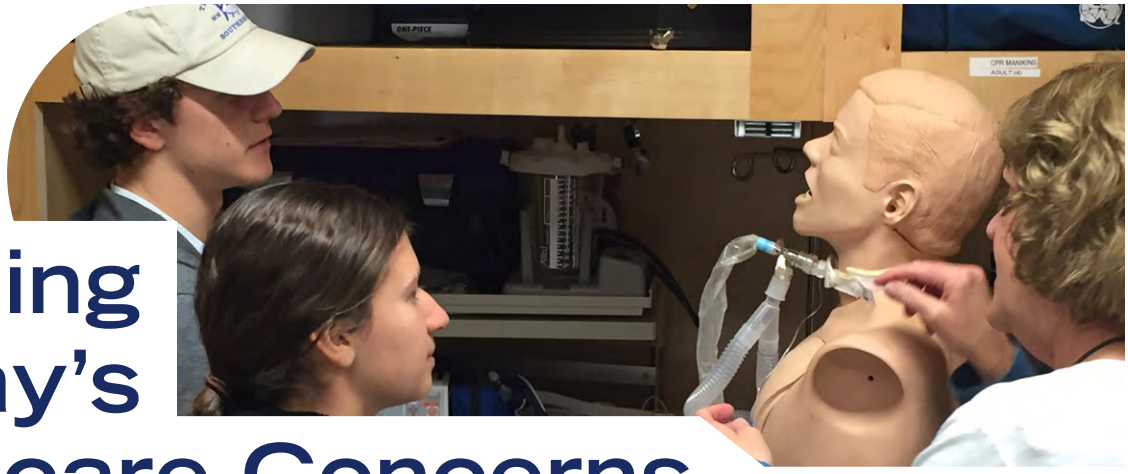
scientist, and Stu Pidder, a local fisherman, who considers the ocean his personal waste bin. The audience learns about human impact on our oceans from the perspective of several marine animal puppets including: Boss the Great White Shark; Octavia the Octopus; and Sunny the Seal. In spring 2019, more than 2,700 public and homeschool elementary students were able to enjoy the performance and accompanying educational activities at the PCPAC.

After the performance, the audience was led through an interactive journey to further explore marine ecosystems. Students visited the little fishing town, complete with a marine animal hospital where they explored the diversity of marine species. Students learned to identify invertebrate marine animals in touch tanks. The audience also experienced a display on the Florida Keys National Marine Sanctuary, where a national park ranger described the importance of clean beaches and mangrove trees. The children even got to see a sea turtle nest.

The journey continued with an interactive exploration of coral destruction and regeneration. A marine biologist led students through a coral nursery research laboratory to demonstrate how corals are grown and transplanted. A scuba instructor showed examples of healthy, bleached, diseased and dead corals on a wall mural. After learning about the importance of corals, students transplanted their own corals at the base of a reef mural. Riley Garvey, a senior biosystems engineering major, said this was his favorite part about the event. "Just getting to interact with the students was great," Garvey says, "seeing them actually transplant the coral onto this [shelf], that was really cool."

The Creative Inquiry team consists of 30 students from various majors. They work together as a dynamic unit, similar to the communities in a coral reef. Alexandria Cousart, a senior language and international health major, says the diverse array of students adds to the success of the project. "This research group's collaborative effort is working towards a common goal to educate future generations about the importance of conservation," Cousart says.

Cousart is looking forward to the next event, not just because the kids have a great time but because the take away message is important. Children left the event with different emotions: some kids were enamored with a new ocean-orientated career path and others were eager to start recycling with their families. "These little things, they can start piling up to make big differences," Cousart says.



Tackling Today's Healthcare Concerns

by **Stone Washington**

The world faces many complicated healthcare problems that modern medicine has not been able to solve. One team of Clemson students is seeking to make a difference. Led by Dr. Nancy Meehan in the School of Nursing, students in the Nursing/Engineering Collaboration to Solve Current Healthcare Problems Creative Inquiry project use cutting-edge technology to create solutions to address healthcare issues. To do so, students take advantage of technology, such as computer-aided design (CAD) and additive manufacturing, to construct and test prototype solutions.

After the team uses CAD to conceptualize their ideas, they go to The Watt Family Innovation Center's Student Makerspace to render three-dimensional (3D) prints, making their ideas into objects. To test their prototypes, the nursing students use the Clinical Learning and Research Center, a modern healthcare clinic setting that allows students and practitioners to test potential solutions in a realistic, clinical environment.

Sarah Clopeck, a junior nursing major, loves the ability to be creative. "It's a way to make nursing students innovative. That way, when they go out into the field, they can use their skills and overcome problems when they face them," Clopeck says. Some nursing students really enjoy the exposure to 3D printing. The regular use of the Makerspace by nursing students builds what might once have been unlikely collaborations between engineering and nursing students. The collaboration with engineering majors helps the team take a more interdisciplinary approach to addressing real-world problems.

The team is creating healthcare solutions for real people. For example, an assisted palliative care patient was suffering from tubes pulling on her skin. To relieve the patient's discomfort, the Creative Inquiry team created a specialty vest to keep the tubing confined and from irritating her. The team also created trunk holders in the Makerspace to safely and securely transport oxygen tanks.

The inventions made in this Creative Inquiry project can assist doctors in overcoming complicated health issues, but these students are also providing a positive experience to patients by their heartfelt contributions. "The fact that Clemson University students wanted to help make their [patients'] lives better was phenomenal. It improved their healthcare just because somebody tried to do something for them," Meehan said.

ENERGY AUDITS

by **Stone Washington**

Electrical energy is one of the most important commodities in the world. In a sense, electricity fuels the modern progression of our lives, powering household lights, electronics, cooling, heating and general appliances. Beyond everyday home uses, manufacturing companies rely heavily upon electrical energy. Even with such a dependency, many companies find it difficult to maximize their energy efficiency. As a result, many businesses expend more money and resources than necessary. The Industrial Assessments: Energy and Resource Efficiency Audits Creative Inquiry project, led by Dr. Michael Dale in the Department of Environmental Engineering and Earth Sciences, is working with Clemson University's Industrial Assessment Center to conduct energy audits around the upstate.

The team serves as a conduit by providing energy assessments to local South Carolina manufacturers. To qualify they must be small or medium-sized companies within a 150-mile radius of Clemson's campus.

The typical energy assessment begins with a comprehensive tour of the manufacturing facility. Then the students examine energy systems, collect data, run calculations and provide the company with a report including useful recommendations for maximizing energy efficiency and saving money. "From the day of the assessment we then have 60 days to turn in our report to DOE [Department of Energy]," Dale explains, "and we've crunched the numbers on all of the data we've collected to calculate how much energy they could save annually on each of these different systems, how much it's going to cost to implement and then calculate a simple payback time."

Clemson University Facilities is an important collaborator. Facilities provides an introduction to the various energy systems. This familiarizes students with the systems they will encounter while conducting assessments. For example, students accompanied facilities while they evaluated the new and recently retrofitted lights in the Cooper Library and Fike Recreation Center.

This Creative Inquiry project serves as an excellent professional development experience. Engineering students in this field are able to interface with clients which enhances their interpersonal skills as well as professional branding. Ben Snelson, a junior environmental engineering major, praises the experiences with the team. "It's invaluable. Learning about production and facility in class is way different than actually going and seeing it. It puts everything into real perspective," Snelson says. This Creative Inquiry project is successfully improving energy efficiency at industries across the upstate.

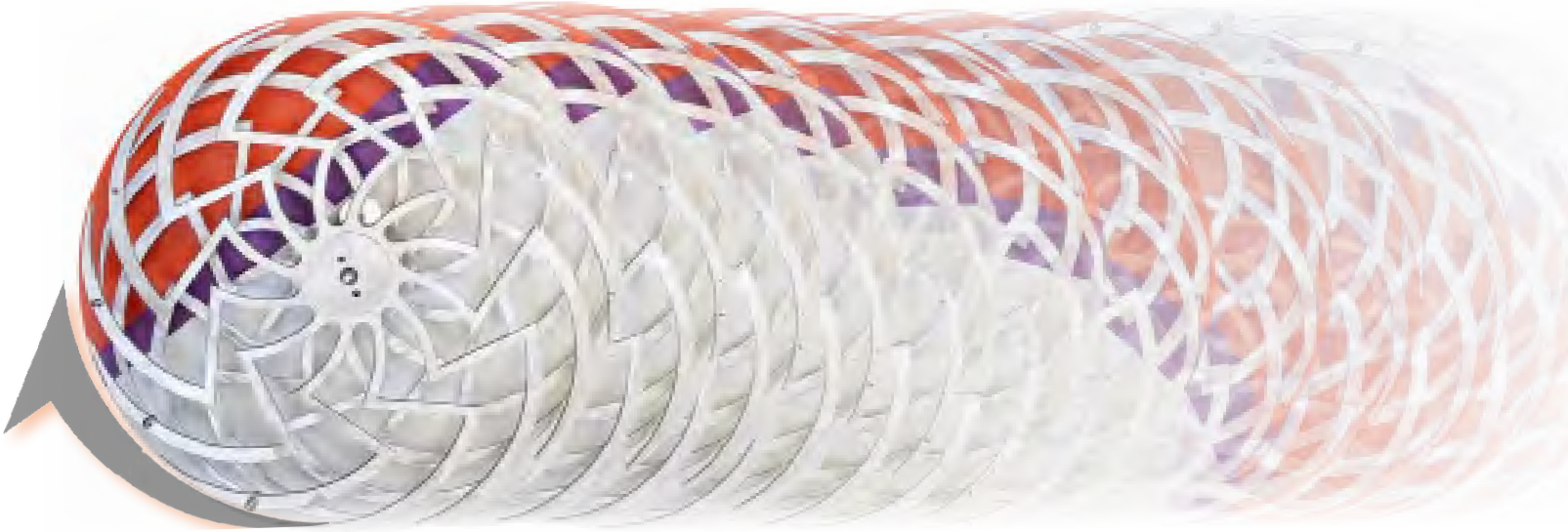
ART IN Motion

by **Stone Washington**

A common perception of art is that of motionless paintings and sculptures, which inspire a sense of quality and beauty from their timeless appearance. At Clemson University, the Kinetic Sculpture Creative Inquiry project provides a different perspective, harnessing kinetic energy to bring still sculptures to life. Kinetic sculptures are art pieces capable of moving through the distribution of kinetic energy. There are multiple types of kinetic energy that can move sculptures, including wind power, motors, coiled springs and even magnetism.

Dr. Christopher Norfolk in the Department of Chemical and Biomolecular Engineering mentors the project. The team creates many sculptures propelled by winding gears—similar to the movement that governs an automatic wristwatch. Other sculptures are people-powered, driven by gravity as someone picks the object up and drops it to power the kinetic motion. "We had one last year that was a ferrofluid, which means it had a power source but the movement was in response to changes in the magnetic field," Norfolk said, "The magnetic field was generated by the movement of electrons; electricity."

Students use the Watt Family Innovation Center's Student Makerspace to print three-dimensional prototypes of sculptures in plastic,



and if the team wants a more refined sculpture, they seek assistance from Machining and Technical Services (MTS) at Clemson. Using MTS gives the team the ability to use a computer-controlled plasma cutter to cut from large sheets of aluminum which allows the project to showcase an aluminum spring-powered sculpture.

Katie Mruz, a senior mechanical engineering major, loves being involved with the project because of the new dimensions broken through combining art and engineering. The team is working to create sculptures with optical illusions to mesmerize their viewers. Students are at the helm of deciding what kind of direction each sculpture will take and have the potential to create truly revolutionary pieces of art.

Each year, the Creative Inquiry team members work in hopes to showcase their sculptures at the annual Artisphere event in downtown Greenville, SC. This exciting event allows Creative Inquiry students to engage with their creative side and present unique artistic creations to the public eye. The students also use the opportunity to provide activities to the public to introduce science, technology, engineering, art and mathematics (STEAM) concepts.

When designing art pieces, Norfolk has confidence in the artistic abilities of some of his students. "If there is a real artist, someone who has that real artistic bent, who chooses to participate in the class, then there's no telling what they might create," Norfolk said, "We're ready to support crazy new ideas that lead us in bold new directions." The spirit of this Creative Inquiry project is driven by student leadership, allowing both Norfolk and the students to embark on a learning journey where everyone experiments on new ideas and discoveries together.

Clemson STEAM exhibit at Artisphere in downtown Greenville.

"We're ready to support crazy new ideas that lead us in bold new directions."

Taking a SHOT at Better BIOPSY NEEDLES

by **Sarah Dorsey**

3D Printed Grip Prototype

Needles are no fun. No patient enjoys a shot—even less, a biopsy procedure. In animal and veterinary sciences, biopsy needles look similar to large, borer tools which pose several issues when needing to collect tissue samples from a precise area of an animal. With that in mind, Dr. Heather Dunn in the Department of Animal and Veterinary Sciences patented her method of collecting animal biopsy samples with a small needle rather than the more common, large borer tool.

Dunn and Dr. Jeremy Mercuri, in the Department of Bioengineering, launched the Animal Model Tissue Biopsy Device Design Creative Inquiry project seeking to improve the device. The team worked to understand the needs for the device and its users and designed a potentially marketable solution.

To begin, the team thoroughly assessed the old device and identified unappealing characteristics. The issues included: lack of a tactile/grip mechanism; the existing grip was uncomfortable and made taking biopsies difficult; and the needles used were too long. After watching the device in action and interviewing Dunn for a customer's perspective, the team set design goals based on feedback regarding desirable device characteristics and existing problems.

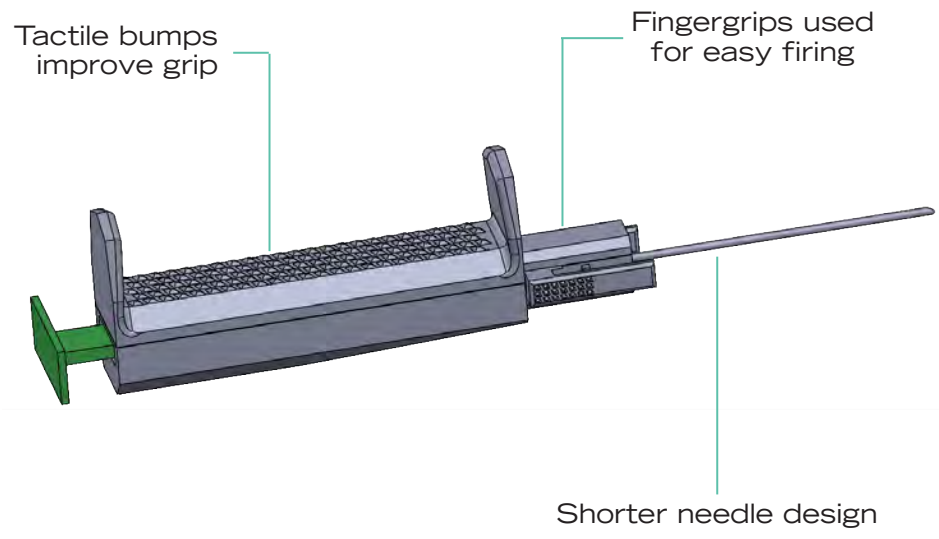
After discussions, the team decided to completely revolutionize the new needle's shape, creating a reusable hand grip for better comfort and control. The team designed each

component and printed prototypes in the Watt Family Innovation Center's Student Makerspace. Creating prototypes using three-dimensional printing technology was essential for the team's ability to touch the device parts and iteratively design them at a low cost.

Over the course of the project, the team has run the gamut of problems. "The biggest engineering challenges faced by the team were the design of the internal mechanical components and getting them to fit together and function properly and repeatably," Mercuri said. The team must ensure that everything is perfect since a medical device and human or animal life is involved. The team conducted mechanical tests to ensure durability which is essential for technical and safety documentation needed by the Food and Drug Administration. Evaluation of cost-effective manufacturing processes for mass production is the next step for the team.

This interdisciplinary project offers a glimpse at engineering education of the future. "I am excited that undergraduate students are solving this problem. It is great to have one team give another team problems to solve. This just doesn't happen in a traditional classroom," Dunn said. This Creative Inquiry project is not only making scientific strides but helping the students make personal strides. "This is my first undergraduate experience that I joined my freshman year. This CI has pretty much been the basis of all of the R&D skills I've used since then," Jacob Garland, a junior bioengineering major, said.

Once veterinary professionals are comfortable with the design and can use it safely, the project will remodel the device for human cancer biopsy applications. Mercuri thinks that the team's design provides better ergonomics than other devices on the market, and that the new device may aid in the accuracy of the biopsy placement and help obtain more reliable tissue samples.



Soildworks 3D Render

They work hard to make this device a manufactured reality, committed to lowering costs, reducing pain and getting better tissue samples one shot at a time.

Colleen Blaine | Writer

Colleen is a junior marketing major with a minor in writing from Boulder, Colorado. She loves to travel and is currently studying abroad in Florence, Italy. She hopes to work as an editor in the publishing industry after graduation.

Stone Washington | Writer and Editor

Stone is a senior history major with a political science minor from Atlanta, Georgia. In his spare time, he enjoys free-lance writing, weight-lifting, reading the Bible and spending time with family.

Sarah Stewart | Photographer

Sarah is a senior wildlife and fisheries biology major from Charleston, South Carolina. In her free time, she enjoys reading, hiking, practicing yoga, cooking vegetarian food and petting every dog she sees.

BREAKING BUD

Counting blossoms on peach trees.

by **Stone Washington**

The cultivation of fruit is a complex process. The timing of bud break is critical for fruit trees—especially peach trees, South Carolina's number one fruit crop. It must occur at just the right time in order to avoid late frosts which can kill unprotected buds. During development and before blooming and developing into fruit, the buds are capable of surviving vast fluctuations in chilling and warming temperatures.

The Breaking Bud: Investigating the Environmental Control of Spring Bloom Timing in Peaches Creative Inquiry project's goal is to determine if different peach varieties have different temperature requirements for development. The peach tree is the perfect fruit tree to investigate because it is one of the best genetically characterized flowering trees. The genome of a peach tree is almost half that of a rice plant, and as a result much simpler to analyze.

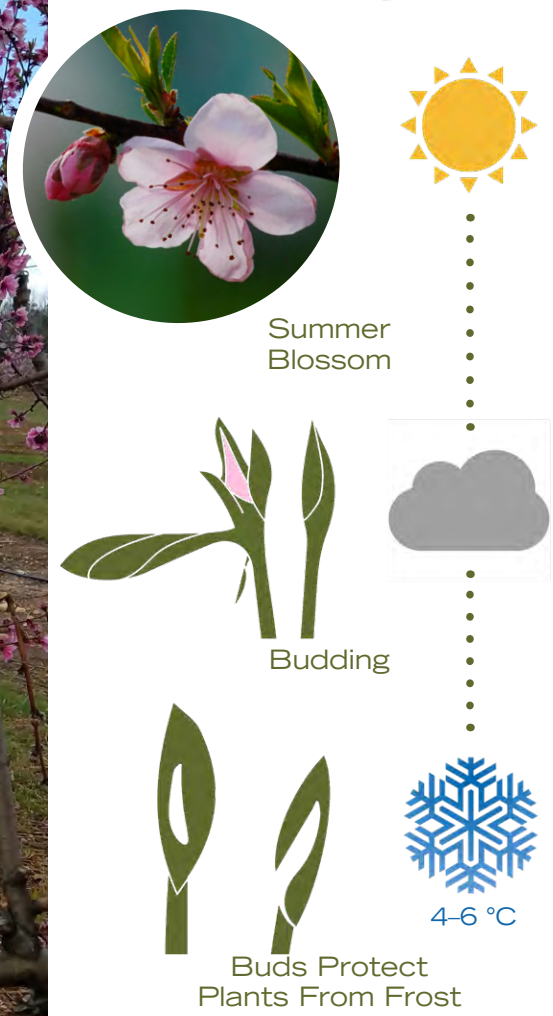
To investigate the budding and blooming cycle, Dr. Douglas Bielenberg in the Department of Biological Sciences and his Creative Inquiry team are tracking the specific time of bud break in different varieties of peaches. In their initial study, they made observations on bud break on more than 30,000 individual buds from 54 varieties of peaches. The students were surprised to find that the base temperature and thermal times for bud break varied greatly among the varieties.

Temperature and temperature fluctuations are important factors affecting bloom timing in peaches, it

> “If you’re a peach grower, you lose your flowers in the spring; that’s your one opportunity to make money all year...so that’s it. You’re done.”

is important to maintain proper balance between cooling and warming for crop survival. The buds must develop at the right time between the end of winter and the beginning of spring, avoiding opening prematurely which could end in subsequently dying from a late frost. Second, it is essential to have slow and steady warming by spring weather to allow the bud to mature.

Peach losses from frost can be devastating. Several years ago, growers lost their peach crop due to a late frost in the season. “If you’re a peach grower, you lose your flowers in the spring; that’s your one opportunity to make money all year,” Bielenberg said. “So that’s it. You’re done. Your annual income is gone. So, if we can do anything to help make that occurrence less frequent, then that’s a really big help to growers in that industry.” The team is continuing to work one bud at a time to identify the precise environmental mechanisms governing bud and bloom in different peach varieties in hopes of eventually providing fruit growers with a way to avoid unexpected crop failures.



Invasive, Toxic Lionfish

When Predator Turns Prey

by **Stone Washington**

Biological Magnification

Harmful substances such as pesticides accumulate in higher concentrations in higher trophic levels

The voracious lionfish met their match when consumed by the insatiable appetite of Hurricane Irma. During the destructive September 2017 category 4 storm that ravaged much of the United States' eastern coast, the Florida Keys became the center of immense devastation. As the hurricane barreled up the east coast, Irma's destructive impact left hundreds of sunken boats in the Gulf of Mexico, creating significant oil and sewage spills.

The storm affected many sea creatures by exposing them to released fuel. One creature in particular, the lionfish, has become a central interest to Dr. Peter van den Hurk in the Department of Biological Sciences. He mentors the Ecotoxicological Effects in Aquatic Species: Lionfish as Indicators for Oil Pollution in the Caribbean Creative Inquiry project. The team is examining whether lionfish are adversely affected by oil contamination. "The lionfish are voracious feeders and they grow fast. They eat an enormous amount of small fish," van den Hurk explains. This voracious appetite contributes to the bioaccumulation of toxins or pollutants from the oil spill—as lionfish eat, they accumulate the toxins that are in their prey. Since lionfish are an invasive species

and are negatively impacting native fish species, there are no restrictions on catching them.

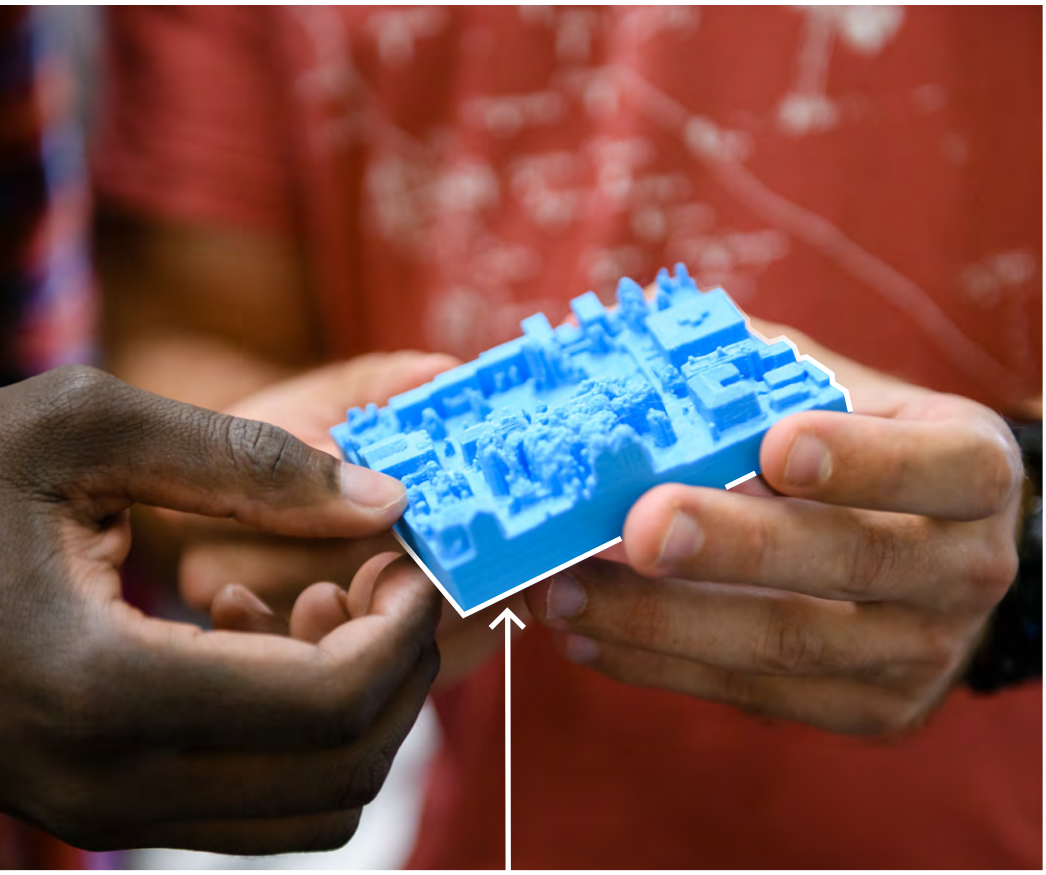
The primary goal for this project is to determine if lionfish can be a monitoring species for assessing the effects of oil on marine life. Students are closely examining lionfish exposed to oil contamination and conducting biochemical analyses to see if ingested oil compounds are impacting protein and enzyme activity. The team hopes their work will serve as the baseline for assessing the health of marine organisms after an oil spill by measuring their toxicological response. "That's the whole point of this Creative Inquiry project," van den Hurk states, "is to find out when the lionfish are exposed to oil compounds, what is their response? What can we measure in the fish as a response to the oil compound?"

To completely understand the toxicological response seen in lionfish collected post spill, the team needed to conduct more controlled experiments. To do so, they collaborated with the National Oceanic and Atmospheric Association (NOAA) Ecotoxicology Branch in Charleston, SC. They used the NOAA facilities to conduct a controlled exposure experiment in which an experimental group of lionfish were exposed to three different concentrations of oil extracts. After the trials, the team extracted the liver and gallbladder from each fish and returned to Clemson to conduct a biochemical analysis. The results from this analysis will shed light on the previous lab results obtained from lionfish collected in the Florida Keys.

The project is largely student-driven, allowing for students to freely experiment while van den Hurk is available to answer questions. Shelly McComb, a senior biological sciences major, enjoys her role in monitoring captured lionfish. "Lionfish could be an indicator that the entire coral reef system and all of the fish are being harmed and polluted. It could have a big impact, or we could find that nothing is happening and that lionfish are really resilient, which is why they are taking over," McComb says.

Shelly McComb, '19
Biological Sciences

GAME of Drones



3D Print of Cooper Library Bridge Created from Photos Captured by a Drone

by **Sarah Dorsey**

As freshmen at Clemson University, Hannah Sarver, a sophomore environmental engineering major, and Joe Green, a senior biosystems engineering major, were both interested in three-dimensional (3D) technologies. Little did they know their interests would allow them to 3D-print a topographically accurate, scaled miniature model of Clemson's campus. The From Drones to 3D Printing Terrain Models Creative Inquiry project is mentored by Blake Lytle and Patricia Carbajales-Dale from the Clemson Computing and Information Technology Research Support as well as Dr. Michael Dale from the Department of Environmental Engineering and Earth Sciences. The Creative Inquiry project analyzes drone images of campus and turns them into miniature 3D-printed models. The ultimate goal is to create a manual of standard operating procedures for drone image processing.

The team explores the process by documenting their methodology—from drone to 3D printing models. After taking drone images of campus, they process the set of images into a digital, 3D model, assess its accuracy and use a 3D printer to print the final product. To test and document the process, Sarver used the football stadium and scaled the 3D prototype to the size of a quarter. Green processed parts of Bowman Field, Brackett Hall and

Tillman Hall, each reduced to the size of a Skittle.

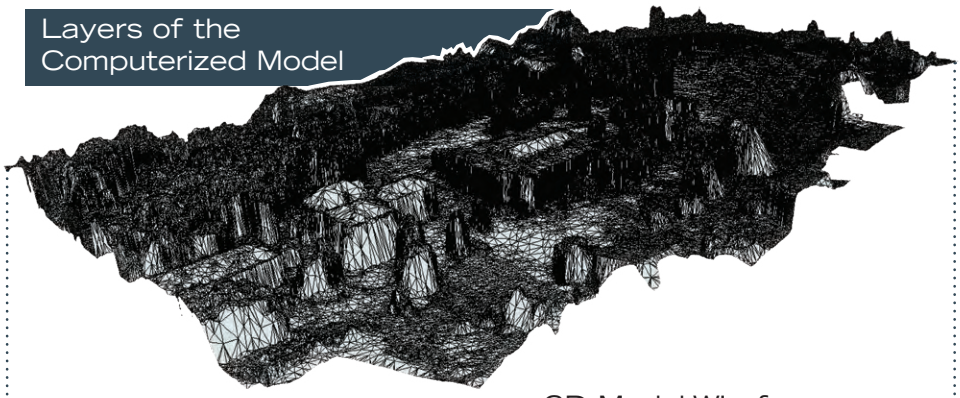
Each student documents their workflow and the team collectively decides on the best processes to include in the manual. This work is important because the use of drone technology is exploding and will potentially have huge economic impacts in the agriculture, military, business, trade and communications sectors. For example, this research may assist the drone powered package delivery services, as well as in the effective integration of drones into crop management systems in agricultural communities.

As the team showcases their miniature campus models, they provide proof of the procedures they are developing. Their creativity and problem-solving skills are apparent. "My role as mentor is rewarding because students get to use their creativity and problem solving on cutting-edge technology," Lytle said.

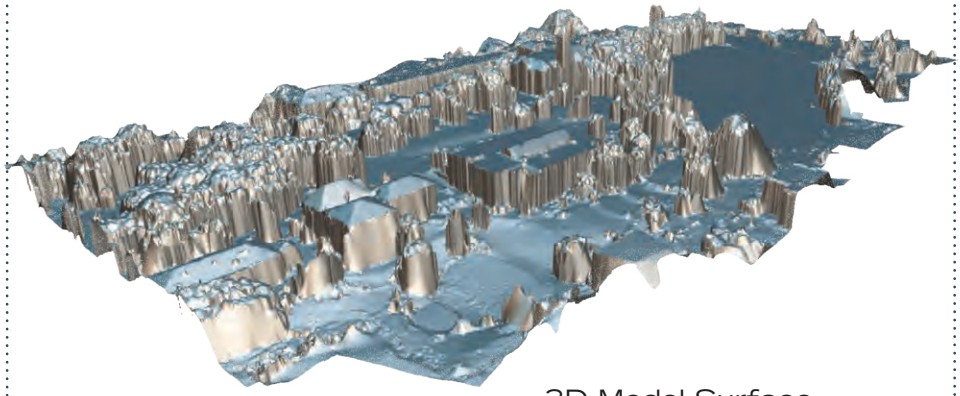
This Creative Inquiry project gives students practical experiences with up-and-coming drone and manufacturing technologies, key skills in today's job market. Green and Sarver hope the knowledge and skills gained in this project will give them a competitive advantage over other applicants when they enter of the workforce. For many students, enjoying a project and excelling are just as rewarding as good grades, and Sarver and Green seem to have found that in the From Drones to 3D Printing Terrain Models Creative Inquiry project.

> "Students get to use their creativity and problem solving on cutting-edge technology."

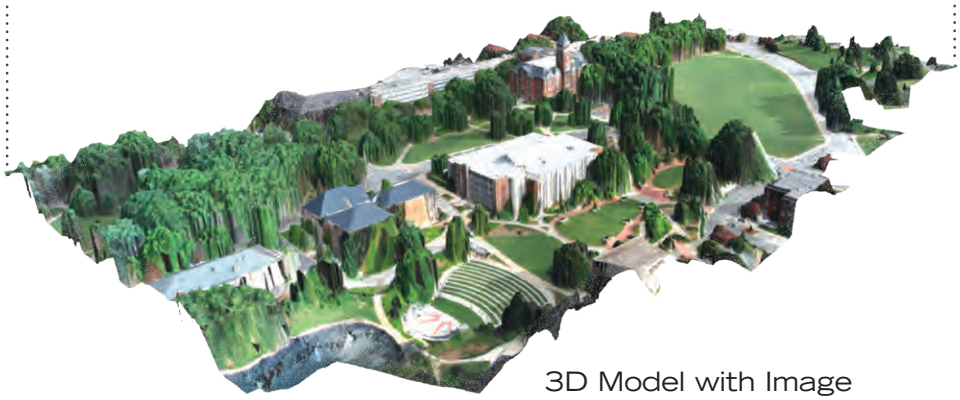
Layers of the Computerized Model



3D Model Wireframe



3D Model Surface



3D Model with Image Overlay

3D Print of Clemson's Memorial Stadium

Life After the BURN

Appalachian Fire Ecology

by **Niko Hajimihalis**

Strong winds, fuel and a particularly dry season can produce flames from uncontrolled wildfires that consume acres of forest in minutes. In 2016, the combination of these factors spurred unprecedented wildfires that raged across tens of thousands of forested acres in the southern Appalachian region. These fires seared across five states leaving forests and towns burned to the ground.

When the fires ceased, a unique ecological study opportunity arose. Led by Dr. Donald Hagan in the Department of Forestry and Environmental Conservation and in collaboration with the US Forest Service, the Appalachian Fire Ecology Creative Inquiry project is conducting research to assess the ecological impact of these fires. When the Creative Inquiry project began in 2017, students set up 90, 10 x 10 meter plots in Rock Mountain, Georgia. Half of these plots were located on burn sites while the other half were not. Since then, students travel to and from Rock Mountain to measure the effects of the wildfires on the area.

Once the students arrive at the plots, they monitor soil changes and vegetation in the designated areas. They also document patterns in soil erosion, overstory mortality and ecological succession within the plots. "We want to see what a wildfire kills and what is growing back. Are you having the same species return or different species? Looking at these factors you can predict what the forest is going to look like in the future," Hannah Bailey, a senior forest resource management major, said.

One of the most important aspects of this Creative Inquiry project has been the focus on the long-term effects of wildfires on trees. "Last year we identified every tree in the plot. Students noted the species and dimensions of the trees and then transcribed a long list of variables regarding the tree's health," Hagan said. Students return to these trees at regular intervals and record any health changes.

Students surveying transects after wildfires.

The team's research is receiving national attention. They had the opportunity to present their findings at the 2019 Society of American Foresters Annual Meeting in Portland, Oregon. Their research was well received and had the distinction of being only one of two undergraduate research projects to present. The presentation by the Creative Inquiry undergraduates was praised as being graduate level research.

Each trip to collect data produces new findings. They continue to see tree mortality. Some trees that were alive after the fire have since died. Vegetation that is not common in the area is beginning to grow inside of burn site plots. Hagan hopes that this project will continue for several more years in order to properly document the long-term impacts that wildfires have on forest ecology.

Going Whole Hog with Bioinformatics

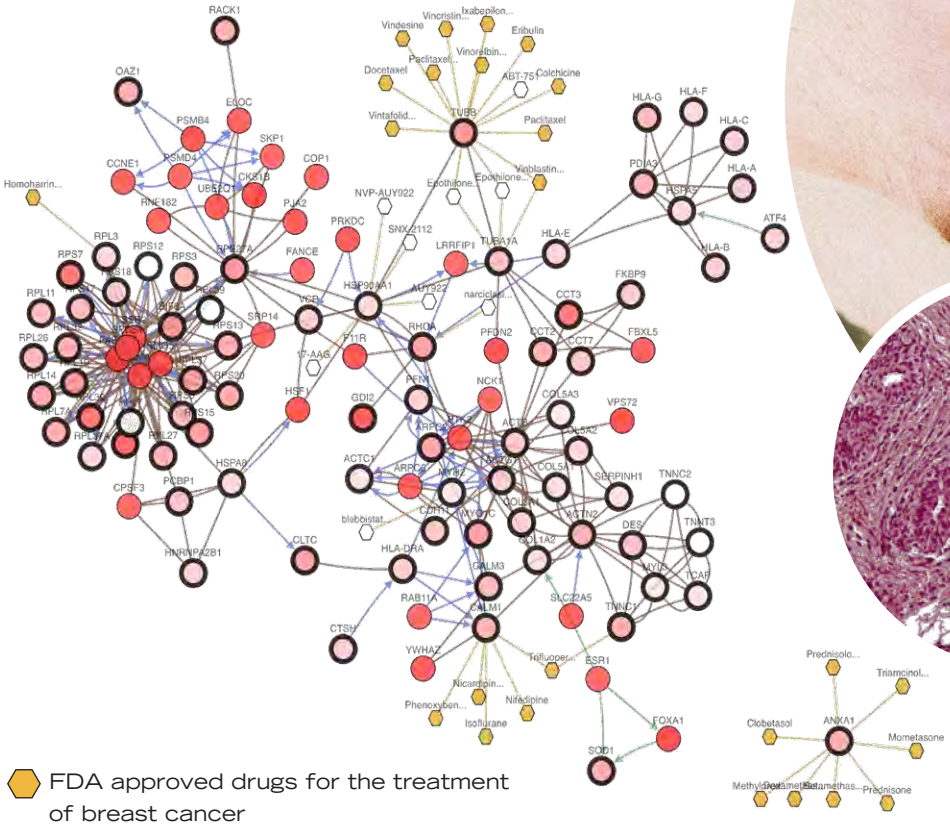
Students and Dr. Dunn engaged in lab research.

by **Colleen Blaine & Sarah Dorsey**

One in eight women develop breast cancer in their lifetime. Of those women, 15–20% are diagnosed with triple negative breast cancer (TNBC), an aggressive form of breast cancer. The incidence rate of TNBC in African-American women is close to double other ethnic groups. Dr. Heather Dunn, in the Department of Animal and Veterinary Sciences, mentors the Bioinformatics for Cancer Genomics Creative Inquiry project. The project's goal is to investigate early mammary gland development because certain types of aggressive human breast cancers including TNBC potentially reactivate the developmental cellular processes. In addition, these aggressive types of breast cancer lack Food and Drug Administration approved drugs so patients diagnosed with TNBC are prescribed a treatment regime for other cancer profiles. Sometimes the patients respond to these treatments, but it is far from ideal.

The Creative Inquiry team is investigating TNBC by evaluating signaling events in the early developmental stages of mammary cells. However, instead of working with human cells, they are using mammary tissue and cells from pigs. Current literature of mammary gland development has been extrapolated from rodent models with distinctly different profiles compared to humans. Ideally human tissue would be examined, however there are fewer than 72 human donors of postmortem prepubertal mammary gland tissue. Most tissue banks lack the acquisition of samples from young individuals, particularly those who are prepubertal.

Network created with circles representing overactive genes found in cancer tissue and hexagons representing drugs targeting cancerous tissue using these over active genes



Morphological changes in mammary tissue of young swine.

FDA approved drugs for the treatment of breast cancer

Drugs in different phases of clinical trials for potential treatment of breast cancer

Based upon data generated by the The Cancer Genome Atlas Research Network

Therefore, investigation of mammary development using the neonatal pig model that closely resembles the cellular events in humans is ideal.

The team investigates cellular signaling events by comparing gene expression from fine-needle biopsy samples as the pig matures. By mapping out the results using bioinformatics analysis, the team has started to notice expression patterns that may otherwise be overlooked. By comparing genetic maps of swine mammary gland development to early stages of metastatic TNBC, the team found that gene expression is similar. It is possible the team has not only identified signaling events that occur during development but also the early events in metastatic breast cancer.

The Creative Inquiry project's work is creating excitement in the cancer research world. Dunn also sees her students' excitement and passion through their personal connections to the subject. Most of the young researchers have a personal link to breast cancer: one lost her mother to the disease; another student's mother is a survivor; and others have loved ones suffering from multiple cancers. "I have had the chance to meet new people and work with some amazing students who share something in common and that is a passion for finding a cure for cancer one step at a time," Amber Stone, a junior animal and veterinary sciences major, says.

The Bioinformatics for Cancer Genomics Creative Inquiry project is in its infancy, but these students are making substantial progress. This team is paving the way for other cancer researchers to understand how human cell development can be analyzed in search of potential cancer cells. The team looks to do much more, an attitude encouraged by Dunn. "I always tell them the world is their oyster," Dunn says. There is certainly no stopping them on their path to understanding cancer and potentially finding a cure.

DATA FROM THE DEAD

by Tessa Schwarze

When there was a grave robbery at a Pickens County cemetery, the coroner called Dr. Katherine Weisensee in the Department of Sociology, Anthropology and Criminal Justice to come and investigate. Weisensee, who specializes in forensic anthropology, said that the coroner had another favor to ask in addition to the investigation. The county had a room full of death records dating back to 1970 and the coroner wanted to know if students wanted to organize them. Weisensee accepted and the Death in Pickens County Creative Inquiry project began.

The goals of the project are more than basic organizational tasks. They use Geographic Information System (GIS) software in their record keeping, which allows them to digitally store the records and look at it spatially. Every death has a geolocation which allows the students to overlay other information with the same geolocation, including data about socioeconomic status and population density. Using GIS allows them to look at relationships between the deaths and other data to better understand patterns of deaths occurring in Pickens County. The database is a goldmine: a data treasure trove, uncommon in rural areas.

Only a few such databases exist, and all of them are from urban centers outside of the Southeast. However, instead of merging the database with the rest of the United States, the project isolates Pickens County as a singular research population. The team is almost exclusively looking at what is unique about death here.

Their analyses are uncovering some interesting discoveries, particularly regarding cases of suicide. It is commonly reported in the literature that females frequently choose non-violent means of suicide, such as drug overdose. However, in Pickens County, the vast majority of female suicides are gun related. Although suicide is currently a focus of the team, many of the death records list heart failure or car accidents as the cause of death. These numbers can be extremely helpful for health intervention and population education. "Because these data are down to the census block, we can really make specific inferences about Pickens, not just [general] health and violence. By examining patterns of death across space and over time you can understand the living population," Weisensee says.

The team has entered more than 1,000 records in the database, but there are thousands remaining. Christina Martinson, a senior anthropology major, notes that data entry can be a draining process, but the benefits are worth it. Skills in database development and management as well as GIS software are highly marketable skills giving these students a competitive advantage after graduation. "Our research database asks about the person in detail and most of these details are missing from the original records, so we work as a team to systematically input," Martinson says.

The data does not die in Pickens County. The students are able to attend the annual American Academy of Forensic Sciences Conference to disseminate their findings and to learn more about the discipline. "This project is what anthropology is all about—the community. This benefits the students, it benefits the county, and benefits the sciences by building this database about [a population] we can learn more about life and death in our area," Weisensee says.

I Think, Therefore I AGE

by **Stone Washington**

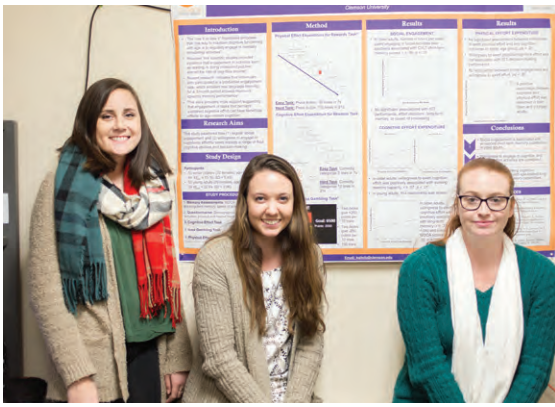
Decision-making defines the many unique choices that people make each day. People rely on complex cognitive movements to direct the many choices they are able to make; choices capable of significant consequences across all stages of life. Though many people are well aware of the complex decisions they make, not many understand the underlying processes that lead them to make a specific decision.

Dr. Kaileigh Byrne in the Department of Psychology at Clemson University leads the Aging and Decision-Making Creative Inquiry project to examine the complexities behind the decision-making process. This Creative Inquiry team examines adaptive and maladaptive decision-making strategies linked to individuals with healthy aging, processes that allow for individuals to maintain functional activities and their quality of life independent of outside assistance. "Decision-making depends on personal motivation and past experiences," Byrne said, "if we've had a lot of past experiences—positive past experiences—in a certain area, then we might be more risk-seeking in that context. If they're more negative in a certain context, then we might be more guarded or more risk averse."

The team recruits study participants from the Clemson area. Participants are split into two groups: senior citizens (65 or older) and young adults (20 to 35). Participants from both groups answer questions regarding their everyday decisions in order for the team to determine how they make individual decisions and what experiences from their past inform their decisions.

The students collaborate with Erin Newell, a former undergraduate who serves as the lab manager. Newell and Savannah Busto, a junior psychology major, spent last summer examining and analyzing participant data. "It's just eye-opening to see we are part of this new, interesting, cutting-edge research, finding answers to these problems along the way," Busto said. Busto's work uncovered the relationship between social engagement and memory. Part of the team's research involves direct interaction with the subjects to understand if they are experiencing healthy aging or cognitive deterioration.

The Creative Inquiry team hopes this research will identify and eventually counteract the cognitive trends in those affected by Alzheimer's disease. Currently, this disease occurs more in senior citizens in isolated rural areas. The team is interested in investigating if social interactions, or lack thereof, can affect incidence of Alzheimer's disease and if so, does it change the person's decision-making. The team is excited to see what will develop and hopes that their principle findings will go toward alleviating related complex psychological issues that many older adults face. Because of the lack of research in this area, this Creative Inquiry project has the potential to contribute to revolutionary findings in the field of psychology, while establishing new ways to enhance cognitive development in aging adults.



GEOLOGICAL STUDIES IN DOMINICA

by **Tessa Schwarze**

Dominica is the youngest island in the Lesser Antilles, but being young does not mean it lacks in diversity. The island is home to myriads of species ranging from rainforest inhabitants to coral reefs. This island paradise formed around 26 million years ago in an event that many typically associate with catastrophe—a shift of the two tectonic plates and consequential volcanic action.

Home to nine volcanoes, Dominica might seem like a hazardous visit, but to the Geological Investigations in Dominica Creative Inquiry project led by Scott Brame, in the Department of Environmental Engineering and Earth Sciences, it is the destination. In fact, during their spring break the team travels to study Dominica's geology and how it affects the living systems around it. The students are excited to have the opportunity to study in Dominica

during spring break. “I’ve never been out of the country before but all of this cool volcanic activity, like the boiling lake and ocean deposits, it’s all stuff I’ve really wanted to see,” Hailey Mundell, a senior geology major, said.

Brame spends a year preparing the students for this trip. While in country, the teams’ research activities range from hiking up volcanoes to exploring the boiling lake to snorkeling in the ocean to examine geological deposits. It may seem like a vacation, but the trip also includes plenty of hard work. The team collects data on sand deposits both in the ocean and on land. These deposits tell a story of how the island arose over 26 million years ago, all the volcanic eruptions since and the activity of the tectonic plates. Volcanic eruptions are important events, they release carbon dioxide and methane gases into the atmosphere potentially compromising air quality. “Volcanoes can impact life on the whole island. We want to understand every type of implication the eruption had and if it does erupt again what could happen,” Ryan Monico, a junior geology major, said.

There has not been a large volcanic eruption in Dominica for more than 500 years and there is a general feeling that Dominica is long overdue. Although it is difficult to pinpoint exactly when an eruption will occur, the team’s analyses will help characterize the behavior of the tectonic plates, helping to predict future eruptions. “There’s always a future implication when talking about active volcanoes,” Daulton Geyer, a senior geology major, said. “All of these details can help us predict when it may erupt again and the damage it could cause. The more information we know, the more likely we can help the island avoid unanticipated disaster.”

The team’s research is defined by the past but their findings are informing the future. For example, the team is studying the impact of gases released from the volcanic thermal springs into Champagne Reef (named for the bubbles formed by the release of gases). They are analyzing the biological response of microorganisms to the acidity of the water and how it changes over the years. This work will potentially show how these organisms will respond to the effects of climate change.

CUTE AGGRESSION

by Colleen Blaine & Tessa Schwarze

On January 7, 2019 the Clemson University football team defeated Alabama to win their third national championship in school history. Emotions were running high for the Tiger fans: smiles, cheers, hugs. But amid all the ear to ear grins in the stadium were tears. Christian Wilkins, football player and senior communications major, later apologized to the Clemson fans for his display of emotions. "I'm not sorry that I cried, I'm just sorry that I'm an ugly crier," Wilkins said.

Happy crying, ugly or not, is a display of emotion that psychologist Dr. Oriana Aragon in the Department of Marketing refers to as a dimorphous expression. Dimorphous expressions are two contrasting physical displays that manifest from a single, intense emotional experience. Yet, they are not just seen in trophy winning athletes. The urge to pinch a cute child's cheek, or an awkward laugh when experiencing fear at a haunted house are also dimorphous emotions. "We see them all the time, but we never stop to ask why we do it or even what it communicates," Aragon said.

Research has shown that emotions influence a costumer's decision to purchase a product. The Dimorphous Expressions Creative Inquiry project, led by Aragon, wants to further the research by asking why this occurs and how intense emotions like dimorphous expressions can inform consumers about product experiences. A good example of dimorphous expression marketing is the car industry. One model drives a car, screaming with fists pumping while speeding down the highway. Another model smiles while driving with tears streaming down their face. The intensity of these emotions can elicit varying reactions among the consumers, but what companies are looking for is the flavor of experience appropriate for the product. In this example, the aggressive driver presents an adventurous edge such as a sports car while the flavor of the crying driver is savory, reflecting the sentiment behind driving a luxury car.

The team works together to effectively observe and analyze the psychological aspects of expressions. To evaluate expression, they design experiments using acting majors to display expressions in several videos which are shown to a sample of viewers. The viewers are monitored with an electroencephalogram while they watch the videos.

Using marketing strategies that involve dimorphous expressions allows companies to make a more personal connection with their consumers by making the commercials a more intimate experience. Beyond that, the research has an impact on other areas of society such as sports. Wilkin's ugly cry is just an example of the possible areas this could apply. "Emotions are so important to understand...and apply to so many different contexts. We're just beginning to skim the surface of possibilities," Aragon said.

ANGER

Eyebrows down and together

Eyes glare

Narrowing of the lips

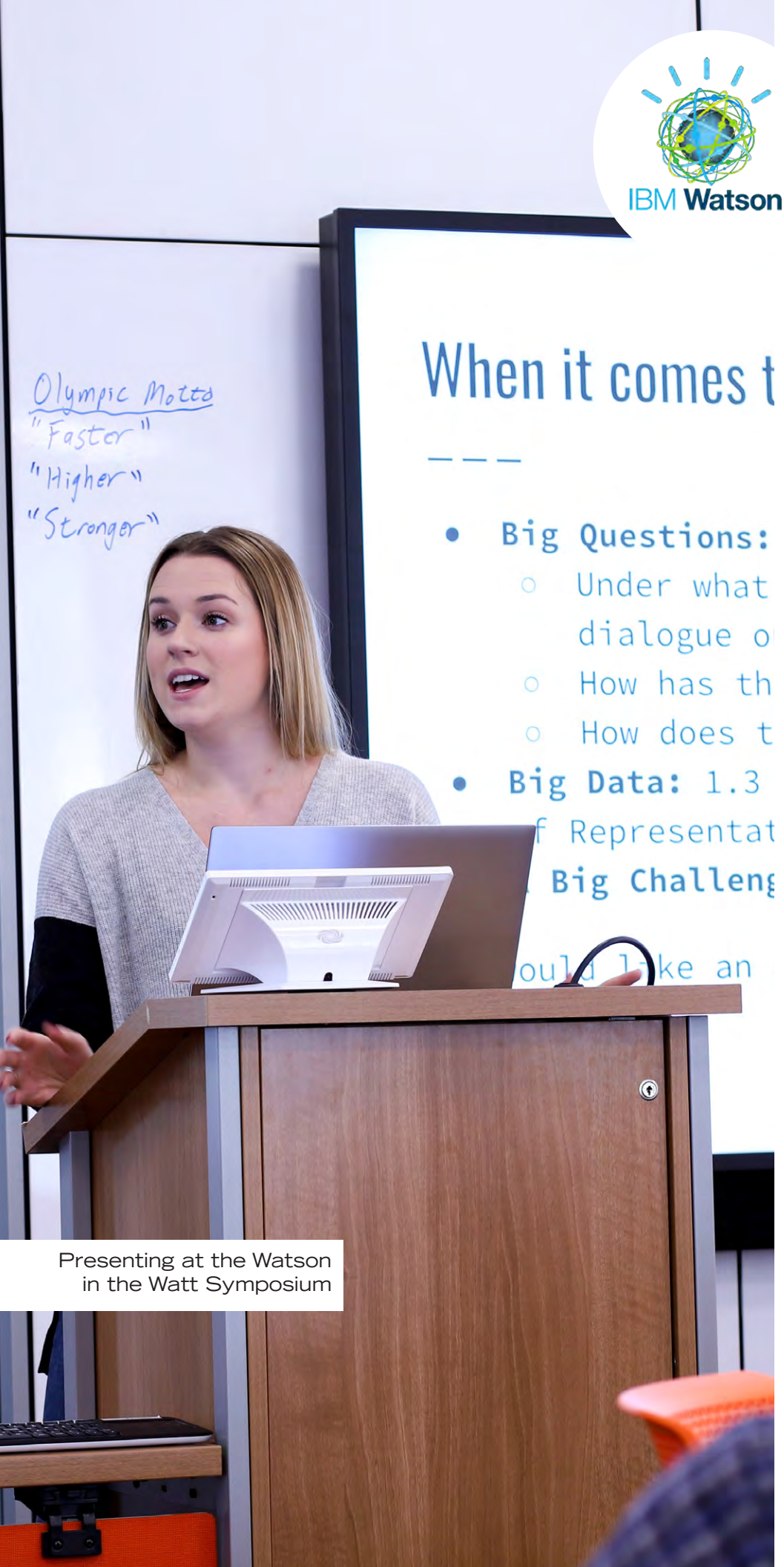
HAPPINESS

Crow's feet wrinkles

Movement from muscles that orbit eyes

Raised cheeks

The team records expressions that are later examined frame by frame.



Presenting at the Watson in the Watt Symposium

WATSON IN THE WATT

by **Niko Hajimihalis**

Artificial intelligence (AI) has the potential to revolutionize the world as we know it. For many, the term AI evokes imagery of science fiction, yet in reality, this new form of technology has wide ranging applications that are incredibly beneficial to society. Whether it is through improving efficiency, accuracy or intelligent decision making across industries, this innovative new technology has improved rapidly over the last two decades. The Watt Family Innovation Center partnered with IBM in order to bring IBM's artificial intelligence computer system named Watson to campus to explore AI use cases.

The partnership resulted in the IBM Watson in the Watt Corporate Creative Inquiry project led by Dr. Hudson Smith in the Watt Family Innovation Center and Dr. Kuang-Ching Wang from the Department of Electrical and Computer Engineering. The project recruits some of the brightest and most creative students from majors across campus. Currently, the students are working with nine research teams to help faculty incorporate IBM Watson's technology into their research or research analyses. These studies vary from using AI to understand political discourse on social media to combing through millions of Reddit comments to understand trends on the Internet to predicting the sex of chicken eggs.

Thus far, the largest research study the Creative Inquiry project has collaborated with is the Analysis of Agricultural Drone Images with the Watson Visual Recognition research

team led by Dr. Joe Maja, a research scientist at Clemson's Edisto Research and Education Center. The purpose of the study was to, "analyze drone recordings of ornamental plants in order to try and figure out which ones were healthy and which plants needed water," Smith said. The Creative Inquiry team assisted in this research by training Watson to analyze the drone images in order to differentiate between healthy and unhealthy plants. Watson was able to take the images, convert them to numerical data and then analyze the data to identify healthy and unhealthy plants. This eliminated the risk of human error and alleviated the research team's workload by automating repetitive tasks.

When the Creative Inquiry project is not assisting with other teams' research, they meet to learn more about using IBM Watson, research AI in general and discuss the future of AI in society. Some of the students in the project hope to gain an internship with IBM. The hands-on experience with Watson, including the application of Watson to research challenges gives these students an advantage over other potential candidates.

This Corporate Creative Inquiry project is supported by gifts from IBM. This support plus presentations at three research conferences this year is evidence of the team's excellent work. A recent increase in funds from IBM will allow the Creative Inquiry team to assist in even more projects by implementing Watson in their research. Therefore, Smith plans to recruit more students in order to take on new AI projects. Through this Creative Inquiry team's work, they hope to show how to both implement and understand AI more completely.

CLEMSON CREATIVE INQUIRY CORPORATE

Images of ornamental plants

↓

10010110
1100010110
1100010110
1100010110
1100010110
1100010110
1100010110

Converted into numerical data

↓

Determines plant health

Niko Hajimihalis | Writer and Assistant Editor

Niko is a senior political science major from Baltimore, Maryland. In his free time he enjoys watching sports, hiking and traveling.

UP AND COMING

A glimpse at new Creative Inquiry projects that *Decipher* will feature in the future

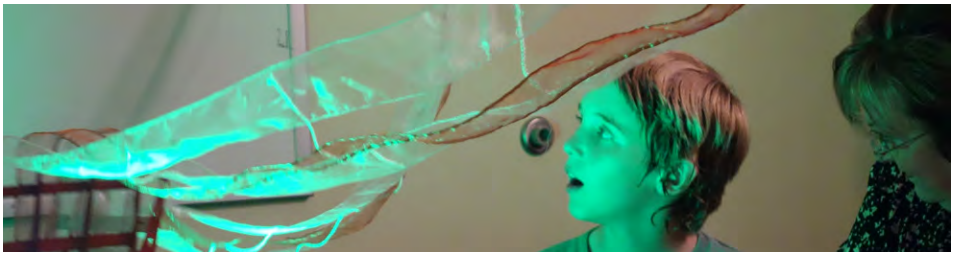
LIT KIT

In an increasingly technological world, it can often be hard to engage people outside of the realm of their personal devices. Children especially are often distracted by the lure of the latest phone upgrade or video game. As a result, many younger children are more engaged in their recreational electronics, paying less attention to their school storybook readings and class exercises. To better enhance learning environments for elementary school children, Clemson students in the Lit Kit Creative Inquiry project, led by Dr. George Schafer in the Department of Architecture, have introduced an ingenious device, fusing the allures of technology with the necessities of learning. The LIT KIT transfers written text and images from picture books and displays its contents onto the surrounding environment.

LIT KIT is a portable robotics and multimedia system capable of being programmed by children to provide a sensory-enhanced interactive experience for picture book reading. The LIT KIT system is controlled by a tablet which generates scenes that relate to elements in picture books. The project is a collaboration between architecture and literary students working to combine electronics and reading to augment early childhood reading comprehension.

The LIT KIT uses a touch-screen tablet interface, running the device through a website. People can program scenes using the website communicating with the functionality of the device. The ideal target is children between 7 and 8, when children begin reading aloud in classrooms. Children in this age group provide essential feedback regarding their experiences with LIT KIT.

Assisting childhood learning in creative new ways forms the basis for this Creative Inquiry's future endeavors.



Face mask Performance

Football helmets have evolved rapidly since their inception. Advances in technology have allowed for safer helmets to be produced, effectively helping prevent injuries within the sport. The Football Face mask Performance Creative Inquiry project, led by Dr. Gregory Batt from the Department of Packaging Sciences and graduate student Andrea Fisher, is working to continue these advancements by studying the effects that a season of head impacts has on the effectiveness of football face masks.

The project partnered with a local high school's football program in order to collect data on their face masks. The team collected data by analyzing videos of football games, recording the number of hits to the face masks throughout the season. "We compared the stiffness change between the control face masks and used face masks to see the deviation of stiffness between the two," Andrea Longacre, senior packaging sciences major, said.

The Creative Inquiry team hopes their research will make playing football safer one piece of equipment at a time.

WHERE ARE THEY NOW?

A visit with previously featured Creative Inquiry projects

Democracy Building in Post-Conflict Societies

Led by Dr. Vladimir Matic in the Department of Political Science, this Creative Inquiry project works for four semesters to prepare for, complete and evaluate the study abroad experience. The group's five-week trip travels to five countries: Serbia; Kosovo; Montenegro; Croatia; Bosnia and Herzegovina. While preparing, students research the countries they will visit and present their findings to help prepare the rest of the group. They also travel to Washington DC and meet with representatives from the respective embassies. The project also organizes fundraisers to collect school supplies for Balkan students.

Clemson students receive a briefing at the U.S. Embassy in Belgrade, Serbia

Community Supported Art

The Community Supported Art (CSArt) Creative Inquiry project, led by Dr. Valery Zimany in the Department of Art, continues to send art out into the community. "It seemed to fill in a gap of small business practices for artists. There is a really great movement of makers today interested in entrepreneurship often not included in studio art discipline specific courses," Zimany said.

Over the years, shares have steadily increased up to this year's fifteen. Half of shareholders return from previous years, including President Clements and College of Arts, Architecture and Humanities Dean Richard Goodstein. Shares usually sell out in less than a week. "It is a way to work with other artists as a collective and gives you experience if you want to own your own company," Daniella Espinoza, a junior visual arts major, said.

The team now utilizes The Watt Center Family Innovation Center's Student Makerspace for innovative materials and art production techniques. Students from different backgrounds, such as biological sciences majors and Katie Francis, a mathematics major with a visual arts minor, use this project to combine science and art. One student even designed and laser cut geometric bowls to be used as promotional items for CSArt. Integration of new technologies is just the tip of the iceberg as the CSArt team looks towards another year of beautiful art and new shareholders.

Horse Play

by **Colleen Blaine & Sarah Dorsey**

Riding a horse can make anyone feel like they are on top of the world. A sense of power transcends from the horse to the rider, allowing the rider to feel in control. However, for individuals with cerebral palsy or spinal cord injuries, horseback riding is much more than an exciting, enjoyable or invigorating activity. It is physical therapy. Riding provides incredible physical benefits, including spine, hip and shoulder alignment that assists with balance and other motor functions.

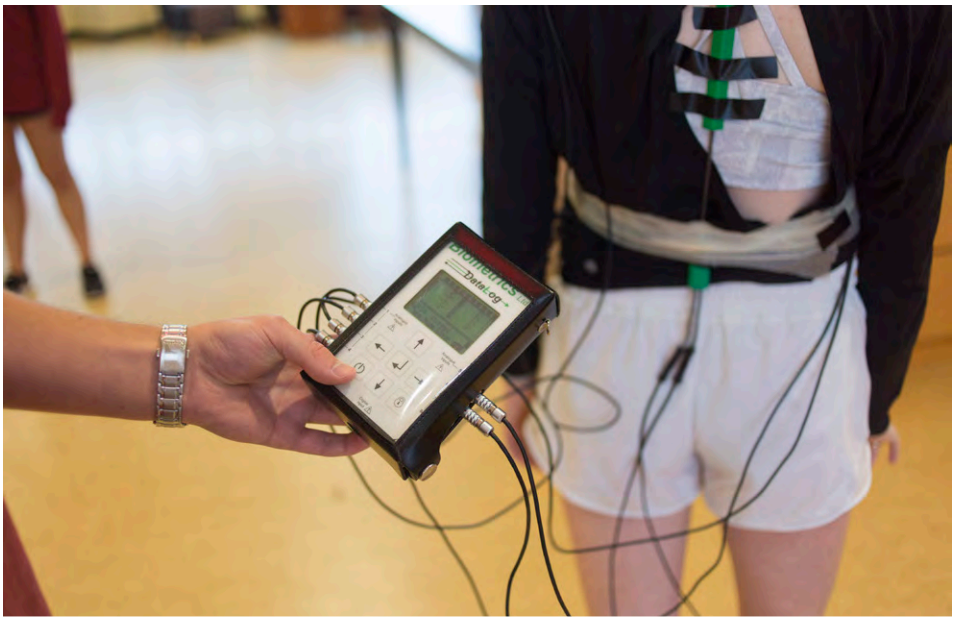
Hippotherapy, also known as equine-assisted therapy, is a developing treatment for people with spinal cord injuries, cerebral palsy and multiple sclerosis. This type of therapy enables those with motor disabilities to feel in control of their movements while being on a horse. Graduate student, Anne Marie Holter, and Dr. John DesJardins, both from the Department of Bioengineering, are investigating the benefits of hippotherapy with the Horse Play Creative Inquiry project.

The team is trying to quantify the positive, physical benefits hippotherapy patients experience. "It is very important to quantitatively prove that this method of rehabilitation is useful in order for it to eventually be implemented by practicing physical therapists," Nathan Luzum, a senior bioengineering major, said. In order to do this, the students attach angle sensors to a rider's hips or spine to monitor angular displacement, and electromyography (EMG) sensors to the leg and back muscles. The angle and EMG sensors measure joint movement and muscle responses of the person during the ride, which provides data on how the movement of a horse affects the movement of a rider. The team collects data from experienced and novice riders to determine how the movement of the horse can stimulate different muscle movements in different riders. Although the project is in the exploratory phases, analysis of the movements will be instrumental in quantifying the effects of hippotherapy.

However, it is not all data and analysis for this Creative Inquiry project. When they are not analyzing sensor data, they can be found at the Clemson Equine Center with students in the ClemsonLIFE program, a program

that provides students with intellectual disabilities with a postsecondary experience. The team helps the ClemsonLIFE students groom, tack and mount horses during riding sessions. For Holter and the Creative Inquiry students, getting out of the quantitative mindset and into the stables is an important part of their research. It makes the work relevant—seeing the benefits of horseback riding in person. This approach is helpful in such a new field. "We can take this research wherever we want to go because there are not any standards out there. We would be creating the standards," Holter said.

The results of the team's research will hopefully assist in clarifying any misunderstanding regarding the benefits of hippotherapy. The team ultimately wants their work to break the barriers and make hippotherapy a more accessible therapy. Treatment misconceptions are not the only obstacle. Stables equipped with the proper facilities for therapy and with horses that are trained are hard to find. "There is always room for improvement, room to quantify things and give [this therapy] that scientific merit that it deserves as so many other forms of rehabilitation therapy have," Holter said. The Horse Play Creative Inquiry project is paving the way for more widespread use of hippotherapy by gathering evidence to support the validity of the treatment.



Students use EMG to record areas of the body affected while riding.

Kevin Crumley | Chief Graphic Designer

Kevin is a senior architecture major with a business administration minor. He is from Greenville, South Carolina. In his free time, Kevin enjoys biking and playing golf.

Emily Pilot | Assistant Graphic Designer

Emily is a senior psychology major with a minor in education. She is from Gilbert, South Carolina.

OUT OF THE DARKNESS

by Niko Hajimihalis

Suicide and mental health issues are topics often swept under the rug due to the stigma associated with them. These issues are especially prevalent in a college setting due to the increased risk of mental health issues among men and women aged 18–24. Fortunately, the Campus Suicide Prevention Creative Inquiry project, led by Drs. Heidi Zinzow and Martie Thompson in the Department of Psychology and Kristi Bussell, Assistant Director for Suicide Prevention and Mental Health Initiatives at Clemson, is conducting research and providing outreach activities to help support those fighting mental health issues and educate the campus at large.

The Creative Inquiry team is collaborating with many organizations across campus, including Clemson's Healthy Campus, Redfern Student Health, Counseling and Psychological Services, University Housing, the Student Veterans Association, Psychology Club and Clemson University Sexuality and Gender Alliance. Partnering with others to educate students about mental health issues enables the Creative Inquiry team to be more intentional in their mission to reach at-risk populations. "We have become more synergistic and collaborative across campus so that our at-risk groups are not in their individual silos, but working together. I credit that a lot to our Creative Inquiry team over the years," Zinzow says.

The Creative Inquiry project's research addresses the effectiveness of their advocacy training program. The program trains faculty, staff and students on how to recognize risk factors and warning signs as well as how to refer students to the appropriate resources for help. "We are able to take part in both research and events that are impactful to our students now. Because we train people about suicide prevention, we get to both contribute to mental health scientific literature and impact students on our campus immediately," Rebecca Roth, a junior psychology major, says. The gratification of being able to help those who are struggling with mental health issues has been one of the key motivators for students in this project.

The annual Out of the Darkness Walk, which supports the American Foundation for Suicide Prevention, is one of the team's main outreach events. This fundraising event helps raise money for research and education on suicide and depression as well as provides a safe outlet for survivors of attempted suicide or those that lost a loved one to suicide to share their story.

Students on the team also engage in other education and outreach activities around campus such as hosting educational seminars and speaker panels, developing website content, social marketing and co-facilitating advocacy trainings and campaigns related to suicide prevention. These activities give those struggling with mental health issues a hand to reach out to. It is the Creative Inquiry team's hope that their work will continue to break the stigma and foster a safe environment on campus for discussions in order to help those in need.

Tackling Social Issues

by **Stone Washington**

Ethical issues appear frequently in multiple sectors of society such as law, technology, prison reform and medicine. In universities across the country, ethics commonly takes root in college philosophy studies. Clemson University helps facilitate the study of ethics through a unique Creative Inquiry project that educates students first-hand on how to handle ethical issues and engage in reasoned debate about them.

Dr. David Antonini in the Department of Philosophy and Religion heads the Applied Ethics and Ethical Debate Creative Inquiry project. The team learns about complex philosophical concepts and uses them in the examination of contemporary ethical issues. They then apply these concepts to solve real-life cases varying from determining whether felons should be able to vote to the definition of death to sociological issues surrounding transracialism.

In one of the case studies, for example, students use ethical theories to try and discern what people's motivations are when they decide to identify with a race different than their own. "I would say the cases dealing with race have been the ones that have been the hardest. Sorting out the cultural norms and the cultural stereotypes surrounding discussions of race and trying to take ethical theories and make sense of those. It's been really difficult," Antonini says.

Antonini thinks that this Creative Inquiry project has a significant influence on students—to better their understanding of how ethics can positively impact real world dilemmas. "Philosophy can seem like something that is a little bit abstract and doesn't find its way into every day culture and society," Antonini says, "This has been really eye-opening for me, to see students take seemingly abstract ethical theories and use them to make sense of cultural and racial issues that are confronting us every day."

Sarah Dorsey | Writer and Editor

Sarah Dorsey is a senior bioengineering major from Columbia, South Carolina. In her free time, she plays billiards or goes birdwatching. She also has a pet rabbit and loves dogs.

SPOTLIGHTS

Project Spotlight | Veteran's History

Since Fall 2012, the Veteran's History Project has digitally archived over 70 video interviews of veterans in a joint effort with the Library of Congress to preserve and honor the stories of American combat veterans from all conflicts throughout our country's history. The project provides digital, firsthand accounts of the sacrifices those that serve in the armed forces make on our behalf. This summer, the CI team, led by Dr. Vernon Burton in the Department of History, was invited to the Library of Congress in celebration of this accomplishment.

Project Spotlight | Solar Stations

In the fall of 2018, three solar stations were installed outside of the Watt Family Innovation Center. These stations were a result of more than four years of dedication by Victor Liao, a 2018 graduate with a degree in biosystems engineering, and his fellow team members. Liao worked under the guidance of Dr. Rajendra Singh from the Department of Electrical and Computer Engineering. Singh's CI project focuses on the development of novel applications for photovoltaics, i.e., solar power.

Student Spotlight | Allison Kaczmarek

Allison Kaczmarek's experience with the Butterfly Proboscis Structure and Engineering Inspiration Creative Inquiry project gave her an advantage over other applicants for an undergraduate research internship at the Adolphe Merkle Institute in Fribourg, Switzerland in Summer 2018. During the internship she furthered her research experience with bioinspired materials at the National Center of Competence in Research. She is a junior materials science and engineering major.

AWARDS

Researcher of the Year | Dr. Mark Blenner

Dr. Mark Blenner, from the Department of Chemical and Biomolecular Engineering, was named the Junior Researcher of the Year in May 2019. Blenner is know for his research productivity—supported by several agencies such as the National Science Foundation, National Aeronautics and Space Administration, US Department of Defense and the US Department of Agriculture. He is equally know for student engagement. Blenner mentors six Creative Inquiry projects involving 20–30 undergraduates each year. His students are constantly recognized nationally for their accomplishments; they include recipients of the Barry Goldwater Scholarship.

Beckman Scholars Program
Shaoni Dasgupta + Nate Matzko

This year, Clemson was selected to participate in the Beckman Scholars program—a prestigious recognition of our commitment to undergraduate research. Over the next three years, six exceptional undergraduates will be supported for extended intense laboratory research under the direction of a select group of mentors drawn from the College of Science and the College of Engineering, Computing and Applied Sciences. This year's Beckman Scholars are Shaoni Dasgupta (left), a junior biological sciences major, and Nathan Matzko (right), a junior biochemistry major, working under the guidance of Dr. Kerry Smith and Dr. Michael Sehorn (respectively), both in the Department of Genetics and Biochemistry.

Project Spotlight | Design Morphology

Once a small Creative Inquiry (CI) team from the School of Architecture, the Design Morphology CI evolved into a collaboration between Dr. Brandon Ross from the Department of Civil Engineering and Dr. Michael Carlos Barrios Kleiss from the School of Architecture. This unlikely collaboration has resulted in an award from the National Science Foundation (NSF). The CI project studies natural structures and processes to find applications in the building environment.

This award from the NSF gives civil engineering and architecture students the opportunity to engage in research regarding the use of patterns in the building process.

Stars & Stripes

Sports for Service by Niko Hajimihalis

The men and women of the United States military make the ultimate sacrifice by putting their country before themselves. Unfortunately, military veterans often have a difficult time acclimating back into civilian life, especially when their service results in injury. The Injured Military Veteran Adaptive Sport Program Development Creative Inquiry project aims to help support these veterans. The team, led by Dr. Skye Arthur-Banning in the Department of Parks, Recreation and Tourism Management, offers programs for injured veterans that in turn provides coaching certification to participants so they can offer adaptive sports programs in their own communities.

The Creative Inquiry students work with graduate students to collect and analyze data related to the impact of these programs. The team evaluates past camp experiences and assesses how veterans integrate information from the Clemson program into their community programs. Collecting data for evaluating past and present camps is a key to their success. "They assist in collecting data, organizing the event, planning the camp's curriculum, facilitating travel, and researching community reintegration for injured military veterans," Arthur-Banning says.

Recruiting military veterans is the greatest obstacle for the team. Currently, the majority of recruitment is done through word of mouth; although some students have been able to travel to military bases and other cities to talk to members of the military community. These trips also allow students to evaluate community implemented programs, as well as offer those programs additional support and resources.

One of the programs the Creative Inquiry project supports is The Paralympic Soccer program. This program is funded by a grant from the Department of Veteran Affairs. The grant supports research and camp activities, including the cost of flying veterans across the country to attend the camps at Clemson. The team recently started hosting camps in other cities—Phoenix and Seattle.

In the future, Arthur-Banning hopes that the Creative Inquiry project can partner with established Veterans Affairs supported games and events such as the Invictus Games or Warrior Games. Since United States military veterans sacrifice for their country, the Creative Inquiry team wants to do everything they can to support them as they acclimate post-service.

The Computer's New Clothes

by Sarah Dorsey

Clothing, for all involved, is expensive. Buyers for department stores must know what styles are in fashion and will sell. If a buyer receives a bulk order of unpopular clothes, that drives profits down quickly. Clothing designers go through multiple designs and productions before making a final decision. As e-commerce grows, so does the demand to streamline the design process. Simulation graphics creates a bridge from the designer to buyer and holds promise to eliminate the need for prototyping. The VF Corporation, owner of some of the most popular shoe and clothing brands such as Lee Jeans, Vans and North Face, recognizes this need and partnered with Clemson's Creative Inquiry program to sponsor a Corporate Creative Inquiry (CCI) led by Dr. Victor Zordan in the School of Computing and Dr. Olga Kuksenok in the Department of Materials Science and Engineering.

Clemson students in the Simulation Methods in Graphics and Engineering CCI are working on a platform that virtually models how fabrics act, look and react using a computer graphic simulation system. The project ultimately hopes to create a prototype visualization package that can be the interface between designers and clothing stores. In this platform, designers are able to see a digital prototype and can edit undesirable features or move on to new designs. "For VF Corporation, this provides an inside look on the industry, and saves them time and money on clothing designs that buyers will not buy, and clothing designs that may fail quickly," Zordan said. The simulations can also predict wear and tear patterns using the physical characteristics of the desired fabric. With the right algorithm, the virtual system could prevent the common scenario of clothes that rip or stretch after a few uses. This would eliminate the cost of fabric and raw materials while increasing corporate profits.

Steven Borisko and Colton Smith, both senior computer science majors, are two of the students working on computer development for the project. The computer models consist of a network of points and springs that act similarly to the way fabric stretches and reshapes. The team can then see how the fabric deforms when digital objects contact it, similar to what may happen in a real world washing machine. With the cloth simulation, they can determine ..."where the wrinkles, and after longer periods of time, the tears or rips in the fabric will be." Borisko pointed out. "This makes the company look more reliable when they can present failure modalities to clothing buyers," Smith explained. Smith also created a visual representation of fraying for the computer model. "It's really more complicated to make it than it sounds. You have to make the program detect the edges of the computerized cloth and put wavy fringes representing fraying on the edges of this cloth," Smith said. This visual appearance helps buyers assess what real products will look like.

The team can model multiple scenarios such as the newly developed washing machine test and tie-dye models, out of the general premise of computerized graphic simulation modeling. At its essence, this project attempts to streamline the design and critique process all while reducing waste for the designers, increasing sales for the clothing buyers and by extension providing more durable clothes for consumers. VF has responded positively at the prospects of this technology after seeing what the students have created, focusing mainly on educating them and guiding many of the students' interests in animation for movies towards other applications in the business arena. Saving money, the environment and giving businesses excellent visualization and communication tools has potential to launch this technology into a highly competitive and rewarding sector.

SUPPORT CREATIVE INQUIRY

What Do Your Dollars Do?

Gifts to Creative Inquiry directly support student research. You can support students in multiple ways including, but not limited to student travel to national and international conferences to present research and supplies for student research activities.

How to Donate

Make your tax-deductible gift by calling 864-656-5896,
giving online at **ci.clemson.edu/give**
or sending a check payable to:
Clemson Fund, PO Box 1889, Clemson, SC 29633
Note the check is for the Creative Inquiry Operating Fund.

Special Thanks to our Donors

Dr. & Mrs. William C. Alexander
Dr. Lawrence R. Allen
Mrs. Martha M. Ball
Dr. Elizabeth A. Baxley
Mr. Nathan L. Bohlmann
Mr. James R. Bottum
Bradley Family Foundation
Mr. & Mrs. Phil Bradley
Dr. Jeromy J. Britton
Mrs. Lisa C. Laudeman Campbell
Mrs. Sue G. Campbell
Mr. W.R. Campbell, Sr
Mr. & Mrs. Chalmers Carr III
Dr. Thomas M. Duncan
Eli Lilly & Company Foundation
Mrs. Sandra M. Fitt
Dr. Lawrence D. Fredendall
Mrs. Carolyn K. Funke
Dr. Jennifer E. Gerow
Mr. & Mrs. William T. Gillespie
Dr. Richard E. Goodstein
Ms. Lisa C. Grant
Mrs. Verna G. Howell
Mrs. Betty Hund
Dr. Debra Jackson
Dr. Antonis Katsiyannis
Dr. John A. King
Mrs. JoVanna J. King
Mrs. Lisa J. King
Ms. Patricia H. McAbee
Dr. Janice G. Murdoch
Dr. William T. Pennington
Mr. Marion L. Powell IV
Mrs. Margaret C. Pridgen
Mrs. Libby Rauch
Dr. Mary E. Richardson
Mrs. Kirsten J. Robertson
Mr. Wayne Roper
Mrs. Catherine T. Sams
Dr. Thomas R. Scott
Mr. & Mrs. Goz Segars
Dr. Jeromy B. Snider
Dr. Barbara J. Speziale
Mr. Joseph D. Swann
Titan Production Company, LLC
Mr. Harrison F. Trammell
Dr. Roger J. Troutman
Dr. Kay L. Wall
Ms. Anolyn K. Watkins
Dr. Charles K. Watt
Mrs. Karen A. White
Mrs. Kristen M. Williams
Dr. & Mrs. Samuel M. Willis, Jr

Bradley Awards for Mentoring

Phil and Mary Bradley made the first major gift to Creative Inquiry and have endowed an annual award to recognize mentors for outstanding work with undergraduate students. The Phil and Mary Bradley Faculty Award for Mentoring in Creative Inquiry consists of a plaque and a salary supplement. The Bradleys recently added an award for graduate student mentors.

Congratulations to the 2019 Recipients

Faculty Recipient:
Dr. Anastasia Thyroff,
Marketing

Graduate Student Recipient:
Kylie Smith,
Biological Sciences

Previous Faculty Award Recipients

2018 Dr. Arelis Moore de Peralta, Languages; Youth, Family and Community Studies
2017 Dr. Vladimir Reukov, Bioengineering
2016 Dr. Michael Sehorn, Genetics and Biochemistry
2015 Dr. Michael Childress, Biological Sciences
2014 Dr. Heather Dunn, Animal and Veterinary Sciences
2013 Dr. Marian Kennedy, Materials Science and Engineering
2012 Dr. John DesJardins, Bioengineering
2011 Dr. Delphine Dean, Bioengineering
2010 Dr. June Pilcher, Psychology
2009 Dr. Karen Kemper, Public Health Services
2008 Dr. Susanna Ashton, English
2007 Dr. Mark Charney, Performing Arts

Previous Graduate Student Award Recipients

2018 Christopher Mayerl, Biological Sciences
2018 Drew Morris, Psychology
2017 Dotan Shvorin, Industrial Engineering
2016 Alice Brawley, Psychology

Carr Family Endowment

Chalmers Carr III and Lori Anne Carr established an endowment to support Creative Inquiry teams working in fruit and vegetable crop production, rural economic development or community and business development. The recipients of this award receive a financial supplement to further enhance their project activities. See page 24.

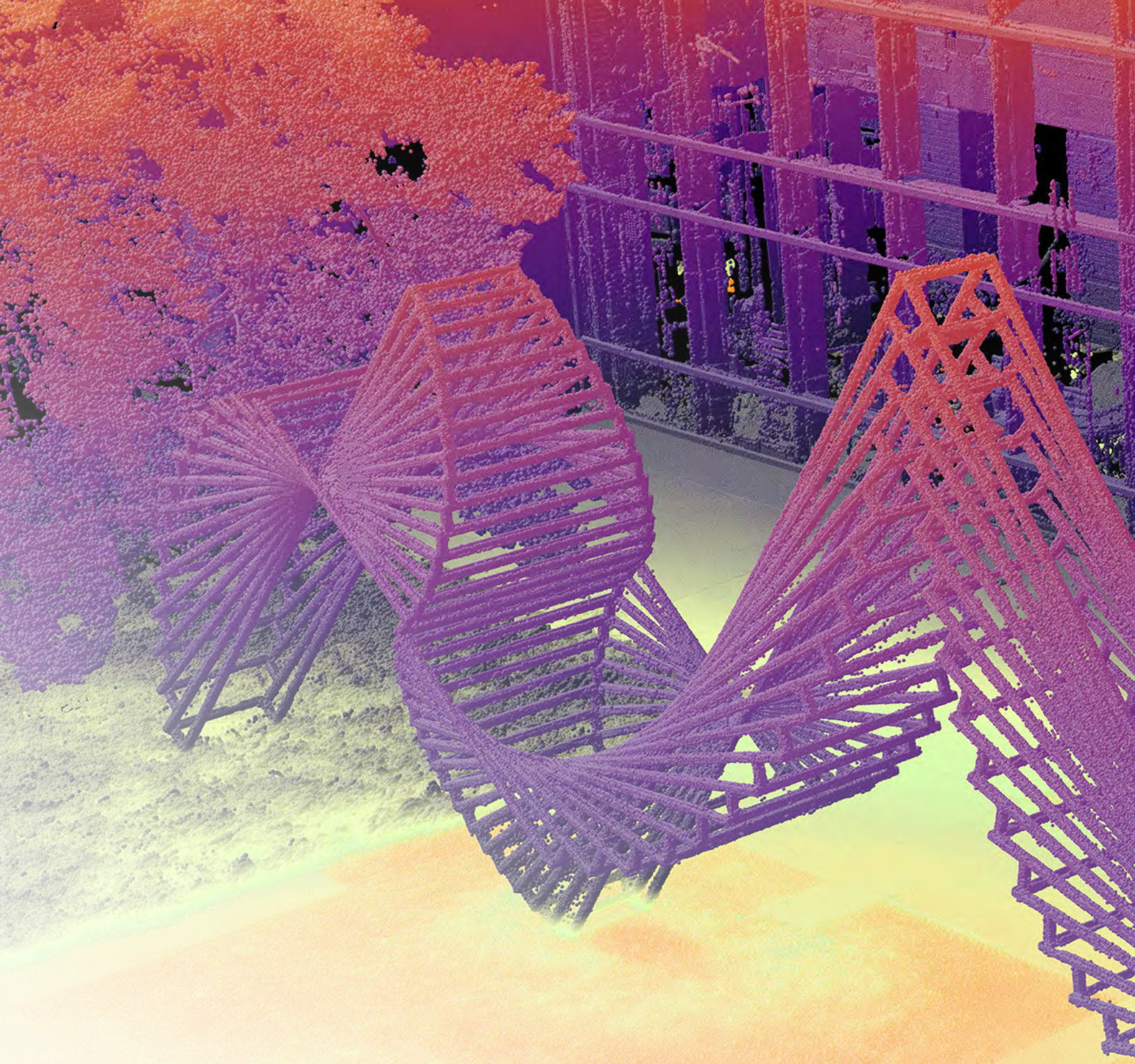
CLEMSON CREATIVE INQUIRY
CARR FAMILY ENDOWMENT

Carr Family Endowed CI Recipients

2019 & 2018 Dr. Douglas Bielenberg
Breaking bud: environmental control of bloom time in peaches

2017 & 2016 Dr. Feng Chen
Characterization of aromas and health benefiting chemicals of SC peaches

2015 Dr. John McGregor
Shelf–life extension of fresh peach slices by surface crust freezing



CLEMSON®
CREATIVE INQUIRY
CLEMSON.EDU/CI