GLENN DEPARTMENT OF
CIVIL ENGINEERING
CLEMSON® UNIVERSITY

Design Experiences: ARCH Initiatives

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A Gravel Paradise

For Bob Brookover, Paradise is a gravel lot. Located near Memorial Stadium—Death Valley to millions of Clemson Football fans—it's a tailgating spot that's been in his family for years. It's where kids play catch and adults enjoy picnic food and drinks while relaxing on six Saturdays every fall.

Brookover, a PRTM senior lecturer, was concerned Clemson University was intent on paving his paradise and putting up a parking lot.

"Other than Holtzendorf and the tennis center lot, we have a band of grass from when you enter campus on 93 with Thornhill Village, President's Park, Bowman, Riggs, Lot 1, Lot 2A—all the way to the lake," Brookover said. "Putting a paved lot in 2A wouldn't really bring anything to the party from the perspective of easing parking issues and would detract from that nearly continuous green space."

University officials, however, had different priorities. With each additional football championship comes a demand for more tailgate spots. The University must maximize the number of parking spots in each lot. The graveled lot, 2A, doesn't have designated spots marked by traditional yellow stripes. It's a free-for-all on game days and school days. In addition, the lot doesn't have a formal traffic pattern, which means traffic can back up as drivers attempt to navigate in or out of their created parking spot.

Any design to pave Lot 2A would have to meet the University's needs and consider tailgaters' desires. Balancing the needs of all stakeholders is just one skill that civil engineering sophomores gained as they collaborated on this design.

This project, and others like it, are the basis for the Springer I course, which is the beginning of the newly adopted Arch Initiatives curriculum. Faculty explored this new curriculum model through an NSF grant called RED (Revolutionizing Engineering Departments.)

Professor Wayne Sarasua (right) leads Springer I students through Lot 15 on Clemson's campus to examine design challenges and conceptualize traffic flow.

Led by Wayne Sarasua, a Glenn Department of Civil Engineering professor that specializes in site design and transportation operations, the student teams designed a lot that maximizes parking, while considering stakeholder feedback, water drainage, and construction costs and timelines.

"Paving a gravel lot will create drainage problems," Sarasua explained. "Students have to consider how that impacts the area while efficiently using the space available."

To the Revolution

If the previous project sounds like it's more complex than what sophomore civil engineering students typically design, it's because it is.

Arch Initiatives was developed by a team led by Jennifer Ogle, professor and department chair. The research team includes Brad Putman, former associate dean of undergraduate studies for the College of Computing, Engineering and Applied Sciences; Jesus M. de la Garza, professor and director of the School of Civil & Environmental Engineering and Earth Sciences; Lisa Benson, professor of engineering and science education; Russ Marion, professor of educational leadership; CJ Bolding, student services manager, and Sarasua.

"We are revolutionizing the delivery of civil engineering instruction at Clemson University," **Ogle said.**

Arch Initiatives disrupt the status quo and facilitate new forms of interaction between students, faculty, and industry partners. Beginning sophomore year, students take Springer I & II, which provides the foundation for successful teamwork, professional ethics, critical thinking, design processes, and professional formation as a civil engineer. Springer I introduces construction management, hydrology, and the site/transportation subdisciplines.

Springer II is the second in the two-course sequence and introduces students to the connection between structures, materials, and geotechnical subdisciplines. In a traditional engineering curriculum, students may not grasp the link between the information learned in class and its real-world application. Springers bridge that gap.

"The Arch brings problem-solving and design to the center of the curriculum while integrating crucial professional communication skills into our technical classes," said Nigel Kaye, Ph.D., a fluid mechanics professor.

Lecturer Omar Amer prepares a composite for strength testing.

Kaye is one of the four professors who teach Springer I as a team. The faculty team consists of a site and transportation professor, a hydrology professor, a construction management professor, and a communication professor. Professors rotate through the class, teaching their content one week a month. In addition to individual assignments within the subdisciplines, student teams complete team assignments that combine communication and technical content.

In Springer I, students work together to develop each segment of the project, consulting with the professors for content. Once the student teams have a conceptual design, they present their ideas to various stakeholders, which includes professional engineers and University officials, through a charrette. The charrette process provides an opportunity for the students to practice the public speaking skills they've developed by delivering individual speeches.

This is when Brookover and other stakeholders can share their concerns and make suggestions – such as providing more green space. The teams are tasked with incorporating that feedback into their final design. Stakeholder advice will often include the importance of developing strong written and oral communication skills.

Colin Kinton, P.E., recently served as a stakeholder for the site/transportation component of the students' designs in Springer I. Kinton, a senior project manager at Traffic, Planning and Design, Inc. in Asheville, always advises students to build their communication skills.

"I am often asked by engineering students what advice I can provide on which classes to take or what is needed to transition into a professional engineering career," he said. "My response is always to take more classes in technical writing or communications. I am always impressed with the technical competence of young engineers; however, technical competence is only about half of the pie."

Communication is a key component in the Arch Initiatives, which is why the department hired a full-time communication professor to coach and mentor students throughout their time in the department.

While Springer I focuses on oral communication, Springer II focuses on writing. Assignments build in complexity, helping students gain confidence and develop their writing skills through projects, including a field memo, cover letter, resume, and a team lab report.

CEMENT mentor Logan Wade brainstorms with Professor Wayne Sarasua and classmates.

Cementing the Future

Sophomores receive additional care as they transition from general engineering into their specific majors. The department often loses students in the transition, especially underrepresented students. To combat this, the department created the CE-MENT peer-mentoring program. New students are paired with civil engineering juniors and seniors who help guide them through their journey. Through outreach and relationship-building, we hope to increase the diversity in our student population, department, and, eventually, the field.

"I became a CE-MENT mentor because I wanted to help create a stronger community within the department that I grew to love throughout my time here at Clemson. This program not only allowed me to interact with more people in the department, but it allowed me to grow and come out of my shell," said Eddie Lewis, a senior civil engineering student.

The CE-MENT mentoring program binds incoming sophomores to the department just like cement is a binding agent in Springer II. Strong concrete contains the right mixture of cement, water, and aggregates. Likewise, this course has a strong foundation built with the right ingredients: written communication, materials, geotechnical and structural engineering. These subdisciplines are brought together through a semester-long lab. The teams test the strength of different concretes, foundation sizes, foundation materials, and beam shapes. Through the testing, students gain insight into the failure mechanisms, structural mechanics, and material properties while also gaining technical writing skills.

"This program not only allowed me to interact with more people in the department, but it allowed me to grow and come out of my shell."

EDDIE LEWIS
RECENT graduate

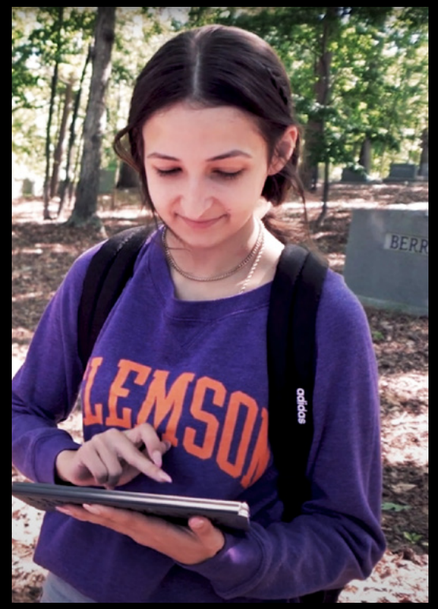
Shaping our World

By their junior year, students are well-prepared to take on more challenging projects to meet the grand challenges facing our society. In three-hour studio block courses, the students design projects with a stronger emphasis on developing connections and creating stakeholder involvement.

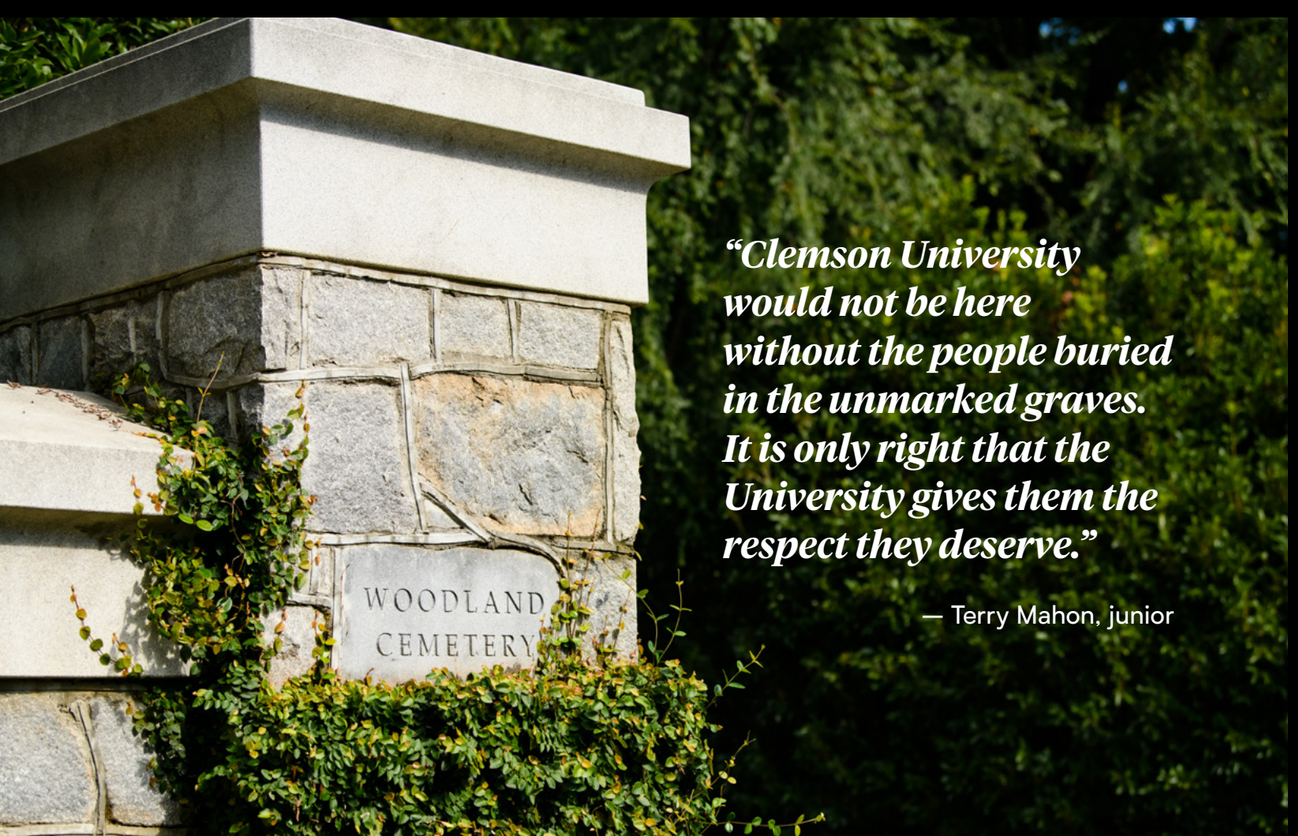
A junior studio class recently accepted the monumental challenge to create a design for the Woodland Cemetery Historic Preservation project. The goal of the project was to recognize and preserve more than 600 unmarked graves. The students created aesthetically appealing designs that shared the complex histories of the enslaved people, convicted laborers, and employees who helped build the University. The students' goals involved more than designing a path that accounted for steep grades, stormwater run-off, and maintenance. In this process, students gained understanding of macro ethics – like how design contributes to gentrification of communities – and the roles they play as change agents.

Student teams collaborated with Rhondda Thomas, the Calhoun Lemon Professor of Literature, and community members to preserve the gravesites and honor all who are buried in the cemetery. Many of the unmarked graves are of enslaved men and women of color who helped build the University. Thomas and the historic preservation committee are ensuring those sites are properly maintained and recognized, and when possible, the personal stories are shared.

The junior studio goes beyond technical skills, inviting students to learn about complex societal issues with no clear answer. Students learn to develop solutions based on the community's needs and desires. The responsibility of learning and protecting leadership moves more toward the students. Emphasis is placed on using the strengths of the team to create value and collaboration.



CLOCKWISE from bottom left:
Entrance to Woodland Cemetery. A student gathers data on the cemetery grounds. The 1965 aerial photo of cemetery hill. A record of laborer names who helped build Clemson University.



"Clemson University would not be here without the people buried in the unmarked graves. It is only right that the University gives them the respect they deserve."

— Terry Mahon, junior

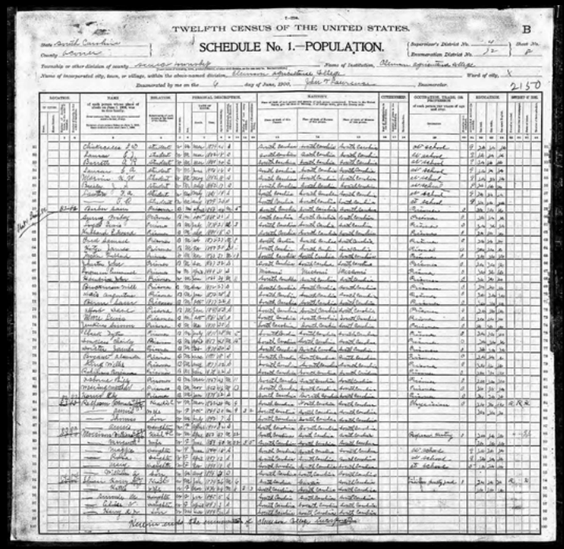
Students continue to build their communication skills through a variety of oral and written communication assignments, including client letters, social media posts, multi-media presentations, and field memos.

The Woodland Historic Preservation project provided an opportunity for students to step outside their often-narrow frame of personal reference. They gained an appreciation for the University's complex history and a new perspective on others' life experiences.

"Working on this Woodland Cemetery Historic Preservation project has been nothing short of a rewarding experience," said Terry Mahon, a junior. "Clemson University would not be here without the people buried in the unmarked graves. It is only right that the University gives them the respect they deserve."

Each team presented its design to University officials and aspects of the students' work are being considered in the final design.

You can view the students' work on the class Adobe Spark website.



The Crown Jewel

A point of pride—and a rite of passage for every graduate of the department —is the capstone course. Capstone remains a program highlight, but it's also evolving in our curriculum. The Keystone Design Experience is the crown jewel of the Arch Initiatives and brings together our students' technical and professional skills to create positive impacts on the world.

Maintaining a team and project-based format, students design theoretical projects on University property – including recreation centers, boutique hotels, conference centers, and study halls. Students are assigned a specific subdiscipline to lead throughout the design process. Each student then works with their consultant to create the best approach for their project. The team-based project teaches students how to effectively serve on a team and develop leadership and time management skills while meeting the project goal objectives. Professional and ethical responsibilities inform students' designs that also consider global, economic, environmental, and social contexts.

The projects may require students to travel across the state to observe civil engineering projects or to connect to communities and/or clients.

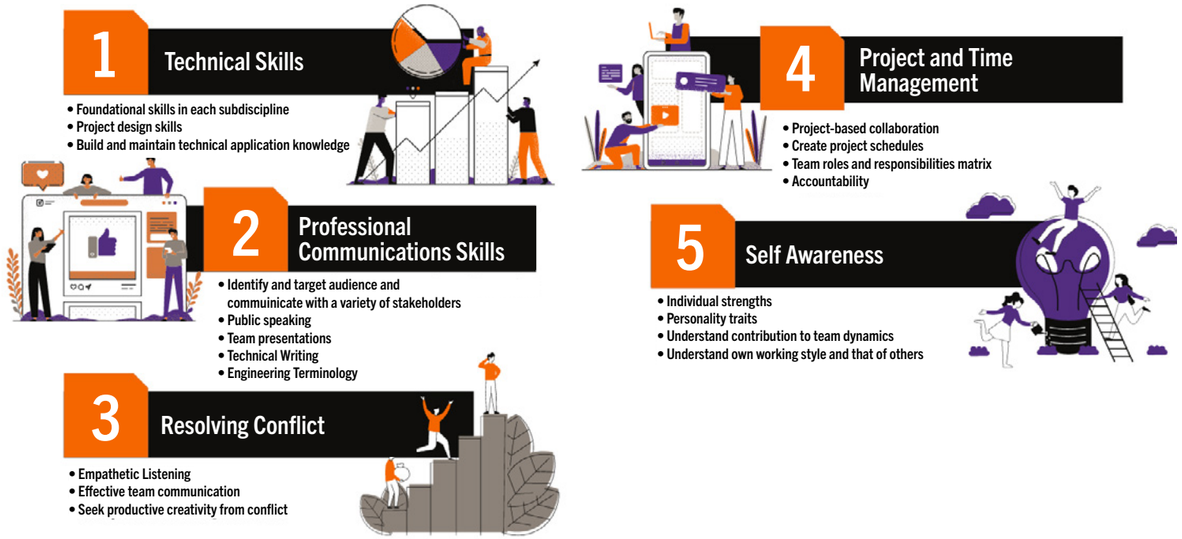
Industry leaders often partner with the Keystone faculty to develop a project that can truly impact the world before they graduate – creating value in the communities where they live and learn. In addition, industry leaders serve as external reviewers throughout the design process.

Technology and communication are integrated throughout the Keystone experience and are more essential in today's post-pandemic world. Through technology, civil engineers understand and design in complex and dangerous situations. These virtual experiences also offer students the opportunity to participate in situations that would otherwise be inaccessible.

Of course, no project is complete until the team can professionally articulate their concepts to the client. In Keystone, the students have ample practice in effectively communicating their ideas through proposals, client letters, presentations, and reports. The final project is a team presentation of their design.

After three years of intense design and communication training, students are prepared to join the workforce with the skills, understanding, and vision to create any client's version of paradise.

ARCH Initiative: Skills Gained



Building the Case

2021 By the Numbers

383
Undergraduates Enrolled

91
Graduates Enrolled

24
Faculty

4
Lecturers

1
Professor of Practice

86%
FE Exam Passing Rate

Our Mission

To create an inclusive, supportive and engaging environment for our students to become professional civil engineers prepared to make a global impact. We partner with alumni and friends to underpin society by addressing its grand challenges, while proactively expanding our students' perspectives through scholarship, teaching, research, and outreach.

Our Values

1. Honesty, integrity, and transparency
2. Student-focused
3. Inclusive community
4. Professional service
5. Continuous Improvement and Innovation

Instilling Communications as a Core Skill

"I am often asked by engineering students what advice I can provide on which classes to take or what is needed to transition into a professional engineering career. My response is always to take more classes in technical writing or communications. I am always impressed with the technical competence of young engineers; however, technical competence is only about half of the pie. An engineer needs to be able to communicate their design effort to an audience that may include the client, team members, approval agencies and the public."

Colin Kinton, P.E.
Senior project manager at Traffic, Planning and Design, Inc.

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