



North Carolina Agricultural and Technical State University
Grand Challenge Scholars Program (GCSP)
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Grand Challenges Scholars Program at North Carolina A&T State University

I. Introduction

In 2008, the National Academy of Engineering (NAE) identified fourteen “Grand Challenges for Engineering” in the 21st century. Then in July 2014, North Carolina A&T State University (NCA&T) was among the engineering schools across the United States that committed to addressing the White House’s call for action to educate a “new generation of engineers”. As the largest producer of African-American undergraduate engineers and fifth in the nation for the percentage of undergraduate women engineering graduates (ASEE, 2015), NCA&T is poised to broadly and significantly impact the development of a diverse STEM workforce by empowering its graduates to design solutions for the technical challenges of today and tomorrow. NCA&T is an 1890 land-grant institution, and aspires to be the premier interdisciplinary and STEM centered university in America that builds on comparative advantages in engineering, technology, and business; and a strong civil rights legacy.” NCA&T is classified as a Carnegie Research University (High Research Activity), and is recognized as the top producer of African- American engineers in the United States. The university’s history as one of only eighteen 1890 land-grant universities is reflected in programs in agriculture, animal science, environmental science, engineering, and technology. For a number of years, NCA&T has sustained its position as third in the University of North Carolina (UNC) system in research funding.

In the College of Engineering (COE), educational excellence is achieved through the efforts of 92 faculty members distributed across seven comprehensive academic departments; specifically, Chemical, Biological and Bio Engineering, Civil, Architectural and Environmental Engineering, Computer Science; Electrical and Computer Engineering; Industrial and Systems Engineering, Mechanical Engineering, and the interdisciplinary Computational Science and Engineering program. In addition to the faculty, 46 COE support staff members work to ensure operational excellence and student success. The collective efforts of the faculty, with support from the staff, result in a COE enrollment of over 1800 students, with 200-300 engineering bachelor’s degrees being conferred annually. The quality of faculty and staff engagement with the students of NCA&T is a known parameter of student success, and aggressive efforts are in progress across the campus to ensure that the highly qualified faculty we recruit also value student engagement and success. Students consistently speak of the “family” environment mixing challenge and nurture.

Vision and Goals

The overarching goal of the College of Engineering at NCA&T is to equip all engineering majors with the skill and ability to contribute to solving the world’s “grand challenges”. In keeping with this goal, various high-impact activities and initiatives occur at the College and departmental levels. Thus, the goals of the COE Grand Challenge Scholars Program are to: (1) expand the breadth of faculty and student involvement in research, (2) promote a vigorous STEM-oriented academic environment, and; (3) increase the number of students entering engineering careers through collaborations with academic units and student support services throughout the campus. Regarding the latter, the GCSP program will collaborate with existing programs and activities on campus to leverage programming in the five required GCSP competencies, as well as those that provide additional academic support. For example, the Science,

Technology, Engineering and Math (STEM) Living Learning Community (LLC) is a residential community of undergraduate students enrolled in NCA&T STEM majors from which we will recruit some of our GCSP participants. The goals of the STEM LLC are to assist students in achieving academic and personal success while fostering university and STEM retention. Residents participate in a variety of academic, personal development and career exploration activities intended to build a sense of community and increase understanding of STEM disciplines. Since its inception in 2011, 103 engineering majors have participated in the STEM LLC at NCA&T. Engineering students comprised 78% of the STEM LLC, during the 2016-2017 academic year. Furthermore, the planned Director of GCSP, Dr. Marcia Williams, was formerly the Director of NCLSAMP for NCA&T and all of North Carolina, hence a strong working relationship between the two programs is already in place.

The University Honors Program is another example of a program with which GCSP at NCA&T will collaborate as opportunities permit. The Honors program already provides access to unique seminars, and the College regularly works with the Honors program to help COE Honors students meet the requirements of this distinctive program. One of the hallmarks of the Honors program is encouraging discussion, skill development and critical thinking, and Honors students also receive mentoring from faculty within their specific major. Engineering majors have consistently made up over 25% of the Honor's College undergraduate enrollment; therefore, we anticipate that several of our GCSP participants will come from this population of students.

II. GCSP Program Components

The proposed GCSP also builds and expands upon an initiative implemented by COE in 2015, entitled, *the Grand Challenge Engineering Program at NCA&T (GCEP@NCAT)*. GCEP@NCAT afforded engineering majors the opportunity to learn about the 14 NAE Grand Challenges, and engage in related interdisciplinary and experiential learning experiences. GCEP focused on three of the five components required by NAE: Entrepreneurship and Innovation, Global Dimensions (with cross-cultural perspectives), and Social Consciousness. The GCEP@NCAT program selected and recognized twelve students for their achievements in grand challenge-themed activities over the past two years. Participants engaged with faculty whose research included: developing materials for integration into composite materials for the construction of flight vehicles are able to dissipate energy; testing facilities for a Mars 2020 sample; using GPS sensors to analyze user mobility to improve their health; and, volunteering at a public teaching garden. The Grand Challenge Scholars program proposed in this application will enable cohort participation of NCAT students in a broader array of co-curricular and extra-curricular initiatives in a way that will prepare them for leadership as 21st century engineers and scientists.

GCSP Governing Structure

One of the lessons learned from NCA&T's prototype program is the importance of ensuring that the GCSP program is structured to involve a core team of College of Engineering (COE) leaders, and to engage faculty and strategic collaborators, to ensure the strength and sustainability of the program. Therefore, GCSP will be led by a steering committee, and partner with faculty mentors and program coordinators to achieve its goals.

Staff. The GCSP Director coordinates the day-to-day operations of the program, under the advisement of the GCSP Steering Committee.

GCSP Steering Committee. The Steering Committee is comprised of engineering faculty and staff, and select members of the COE Engineering Advisory Board. Steering Committee members will also serve as *Lead Faculty* in the implementation of the five (5) required program components, and assist the assessment of the GCSP participants' progression towards program goals. In addition, collaborations with other university initiatives whose programmatic models align with GCSP will enhance participants' experience and offer additional interdisciplinary interactions.

Faculty Mentors. Mentoring of GCSP participants will occur at several levels. *Grand Challenge Research Faculty* will mentor students engaged in undergraduate research experiences, and will meet monthly with GCSP participants. Steering Committee members who serve as *Lead Faculty* in the implementation of the five (5) required program components will serve as informal mentors, meet with participants each semester, and assist with the assessment of GCSP participants' progression towards program goals. The GCSP Director will also serve in an informal mentoring capacity.

III. **Scholar Selection and Continued Participation**

Each year, COE will promote the GCSP and recruit participants through social media, the COE web page, First-Year orientation sessions, freshmen colloquiums, the NCA&T STEM Living and Learning Community, and faculty recommendations. The program will recruit freshmen, and sophomores. While our goal is to increase our ability to offer flexibility for engagement, academic enrichment, and experiential learning, we will adhere to the University's policy on satisfactory academic progress for our recruitment and programmatic efforts. GCSP will require students to have a GPA of 2.5 or higher.

Students must complete and submit an electronic application that includes a brief essay on how the selected grand challenge aligns with their career goals as an engineer, and a letter of recommendation in support from their designated mentor to the Director no later than August 30 of the each fall semester. The GCSP Steering Committee will review applications and select a cohort of 20 underclassmen (i.e., freshman and sophomores) each year. The GCSP Director will notify students by September 30.

Selected students are required to develop an Activity Development Plan (ADP) that outlines their selected grand challenge, and proposed activities that meet the requirements for the five GCSP competencies. Participants will also be required to maintain an E-portfolio that will contain a representation of the work completed, demonstrate interconnectivity and alignment with their chosen grand challenge, and the students' reflection on their GCSP experiences. The Director and faculty mentors will review E-portfolios at the end of each year.

To remain in the program, GCSP participants must:

1. Be in good academic standing, and maintain a minimum GPA of 2.5 or higher
2. Meet monthly with GCSP research faculty or faculty lead
3. Update their ADP at the end of the academic year for review by the faculty mentor or Director
4. Update their E-portfolio
5. Attend GCSP-sponsored seminars and symposia

6. Be willing to attend the National GCSP Summit during their sophomore or junior year
7. Be willing to present their research project at the National GCSP summit and appropriate other symposiums during their senior year.

IV. **Program Sequence and Scholar Designation**

Sequence: A scaffold approach to GCSP student participation involves moderate activities for first-year students, and increased participation through matriculation. GCSP participants will select a grand challenge, as well as program activities aligned with their career trajectory. GCSP Participants must also select a *Grand Challenges Faculty Mentor* to counsel and direct the completion of his or her Activity Development Plan (ADP).

Scholar Designation: At the completion of the plan, students must:

- Submit a reflection paper that synthesizes their cumulative curricular, co-curricular and extracurricular experiences for their selected grand challenge for review by the GCSP Director and Steering Committee,
- Share their experiences and information about the Grand Challenge Scholars Program during the College of Engineering's participation in National Engineers Week (E-Week) activities, and,
- Submit a letter from their GCSP mentor that confirms their completion and recommends their designation as a GCSP Scholar

V. **Grand Challenges Scholar Program Competencies**

The GCSP prepares future engineers to serve as leaders in solving the grand challenges facing society. Completion of the required five competencies will afford students the opportunity to engage in research relating to their selected grand challenge, explore interdisciplinary coursework, gain an international perspective, engage in entrepreneurship, and contribute to the broader community through service learning.

GCSP participants are required to complete a separate activity for each of the five GCSP program components as described below. While students may participate in activities that may overlap in more than one component, they may not double-count that specific activity.

RESEARCH/CREATIVE. GCSP participants must engage in a research experience or project related to their selected grand challenge during the academic-year or summer. Documentation of their research may include poster and journal abstracts, publications, and copies of presentations, and must be submitted via the GCSP participant's E-portfolio. GSCP participants are required to present their research at a minimum of one conference or symposium, and seniors may present their research at the annual Grand Challenge Summit.

The GCSP program will also collaborate with the Office of Undergraduate Research (OUR) at NCA&T, an additional resource at the University in place to foster and display undergraduate research experiences related to the Grand Challenges. The COE faculty who conduct grand challenge-related research are referred to as *Grand Challenges Research Faculty*.

BUSINESS/ENTREPRENEURSHIP. GCSP participants will develop and cultivate their skills in entrepreneurship through offerings by the COE, the university, and the Greensboro community. Each GCSP participant must participate in at least two curricular or extra-curricular activity towards achieving this competency. Several opportunities for GCSP participation exist on campus and through partnerships and relationships with local organizations. GCSP participation in any of the activities described below will count towards their completion of the Business/Entrepreneurship competency; however, activities that overlap with other competencies may not be double-counted. GCSP participants must complete a minimum of two Business/Entrepreneurship activities related to their selected grand challenge. Opportunities to participate include the following:

- ***COE Maker Space:*** The COE Maker Space, run completely by NCA&T students, provides a space for students to put innovation into practice, from the conceptualization phase through prototype development. The COE has worked with its students to outfit the makerspace with state-of-the-art 3-D printers, a 3-D mill, super computers loaded with professional design software, hand tools, raw materials, laser printers, smartboards, LCD projectors, and even cameras for documentation purposes, where two student “super users” are in the lab during its hours of operation. (Note: Super users are students who have been trained on the use of all equipment, and assist any student or faculty member interested in using the makerspace). Although the makerspace is housed in the College of Engineering, it is open to all N.C. A&T students and faculty as long as they are working with an engineering faculty, staff, or student. A second COE makerspace that expands electrically focused maker capabilities will be completed during the fall 2017 semester. The super users will similarly manage its operations.
- ***NCA&T Center for Entrepreneurship and Innovation (CEI):*** The Center for Entrepreneurship and Innovation (CEI), directed by Dr. Thaddeus McEwen of the College of Business and Economics at NCA&T provides a combination of entrepreneurial-focused classroom instruction, experiential learning opportunities, Aggie Startup Lab, and community engagement activities and seeks to engage students from across NC A&T.
- ***Regional Innovation Projects:*** Regional partnerships with entrepreneurship-focused entities such as *Innovate GSO* (innovategso.org), *HQ Greensboro*, and the Greensboro Chamber of Commerce’s *CoLLAB* and *Launch Greensboro* enable GCSP participants to interact and learn from local entrepreneurs. These entities fuel the regional entrepreneurship movement in Greensboro, where Dean of the College is actively engaged with this regional innovation community, including being a member of the Executive Committee for Innovate GSO, and a member of the Greensboro Chamber. It is common for these entities to sponsor start-up workshops, provide business spaces for small start-up companies, and host “Lab Launch Accelerator” business pitch events that allow students and other participants to engage with new start-up companies, and learn how to actualize their ideas into business ventures.

GCSP participants may also participate in field trips to the local community makerspace known as *The Forge*. The Forge (forgegreensboro.org) offers tools, classes, events, and

workspaces to its members and the public. These include 3-D printers, laser cutters, and welding instruments, and technicians are available to consult with participants. Participation in Forge workshops further stimulates creativity and builds self-confidence in the students as they bring their ideas and designs into fruition. NCA&T currently funds 10 student memberships at the Forge.

- ***Pathways to Innovation.*** The COE became a member of *Pathways to Innovation* (a program enabled by a NSF grant at Stanford University) in 2015. The core Pathways team consists of the following COE faculty -- Dr. John Kelly, Prof. Robert Powell, Dr. Bala Ram, and Dr. Paul Stanfield -- all who are also *GCSP Steering Committee* (refer to Table 1). Four initiatives are currently in place: Maker spaces (both mechanical and electrical) led by Dr. Kelly, Ideation space led by Dr. Ram, Pop-up courses led by Dr. Stanfield, and Innovation and Entrepreneurship competitions led by Prof. Powell. Also since 2015, three NCA&T students (two engineering majors and one business major) were named *Innovation Fellows* via the Stanford initiative. The fellows have been instrumental in the implementation of two maker spaces on campus this semester: the Bluford Library Maker Space, launched in February 2017, and the COE Maker Space, launched in April 2017, with others planned in the future.

MULTIDISCIPLINARY ACTIVITIES. All engineering curricula at NCA&T require the Engineering Ethics and Design (GEEN 100) course. GEEN 100 covers the grand challenges through lectures on the 14 challenges, classroom presentations from faculty conducting grand-challenge related research, and discussion during first year colloquiums. The GEEN 100 course includes a “freshman challenge” component, in which students develop a concept and prototype that addresses one of the 14 challenges. Students who win the classroom competition display and present their prototypes to a panel of faculty and industry representatives. The GEEN 100 course and the Challenge Competition would qualify as a multidisciplinary activity in the GCSP participants’ ADP. GCSP participants must complete a minimum of two activities to meet requirements for the multidisciplinary competency. Several additional opportunities exist that may count towards achieving this competency. These may include:

- Pop-up courses held by the NCA&T Innovation Fellows
- Non-engineering courses (e.g. social science, business, humanities, etc.)
- Interdisciplinary research experiences (which may overlap with the Research competency, but will not be double-counted to ensure distinct GCSP experiences)
- Interdisciplinary colloquiums, workshops, seminars and conferences related to grand challenges
- Volunteering for FLL and FTC competitions
- Volunteering for Engineering Academy
- Participation in the COE Maker Faire

NCA&T manages all FIRST Lego League (FLL) and FIRST Tech Challenge competitions across the state of North Carolina for the international organization “FIRST” (www.firstinspires.org). The University liaison for that program is Dr. Kory Bennett of the College of Engineering, who reports to Dean Cogger for those activities (note: Dean Cogger is also a member

of the Board of Directors for FIRST headquarters). Dr. Bennett is also a member of the GCSP Steering Committee.

The COE Engineering Academy (E-Academy) is an outreach initiative designed to introduce elementary, middle, and high school students, and educators to engineering concepts, and career opportunities. The COE Maker Faire is a collaborative event between the COE and the University of North Carolina Morehead Planetarium and Science Center. This annual event provides hands-on demonstrations by COE faculty and students to middle and high school students from schools throughout the eastern region of NC, and relies on the participation of COE students as facilitators and volunteers. The COE Special Academic Programs Office administers both the E-Academy and Science Festival initiatives. Hence, those GCSP participants that engage in these activities as part of their GCSP Activity Development Plan will have the opportunity to strengthen their multidisciplinary (and multicultural) proficiencies through their participation.

MULTICULTURALISM. As an HBCU whose undergraduate population is over 80% African American, NCA&T serves a diverse body of students from throughout the world. This past year, NCA&T engaged more international and exchange students than at any time in the university's history— where individuals representing 46 nations enrolled in a wide range of disciplines and programs. In the College of Engineering, multiculturalism is most clearly visible in the demographics of the faculty and student enrollment. Hence, cross-cultural experiences and the development of cultural competency is critically important in professional preparation of the future engineers at NCA&T. Our strategic memorandum of understanding with Henan Polytechnic University—the first mining university in Chinese history -- is one example of cross-cultural initiatives in COE, where the first cohort of Chinese students graduated from NCA&T through this program in May 2016. The program enables students to complete their first two years of undergraduate study in China at Henan Polytechnic University, and the final two at NCA&T in Greensboro, NC. Ninety percent of the graduates of this program opted to continue their master's studies in the United States—with more than half of them enrolled in graduate programs at NCA&T.

The GCSP program will facilitate participants' multicultural experiences through recognition that this competency can be strengthened through both domestic and international experiences. Participants will develop cultural literacy through opportunities to explore the ways that cultures and histories impact behaviors, beliefs and human interactions in a transcultural world. Achieving this competency will cultivate an enhanced global awareness and celebrate multiple perspectives to invent strategies for our world's growth and development. GCSP students must complete a minimum of two multicultural activities during their program. These may include:

- Study abroad
- International internships (where NCA&T's Office of International Programs will be a prime partner)
- COE Global Engineers Leadership Program (GELP)
- Engineers without Borders
- International Festivals
- Non-engineering or Liberal Arts courses related to multiculturalism

The Office of International Programs offers study abroad options at over 200 universities in

nearly 60 countries. Additionally, the College of Engineering has been supporting a European student abroad program for its students from 2012-2016; and in 2017, the COE implemented and launched the COE Global Engineers Leadership Program (GELP), developed and supported by the College's Engineering Advisory Board. GELP includes visits to corporations, and cultural sites overseas to promote cultural awareness and learning. In 2017, twelve GELP students traveled from the College to Germany and Italy. The COE student participants will increase to 24 in 2018.

Liberal Arts courses in *International Studies* can assist GCSP students in their comprehension of international politics and diplomacy in the United States and abroad. Students gain knowledge of the operations of the State Department, U.S. embassies abroad, the United Nations or one of its agencies such as the International Labor Organization, or UNAIDS, as well as the roles of the Department of Homeland Security, the Central Intelligence Agency, the Defense Intelligence Agency, or the National Security Agency. Additionally, courses on *Race, Class, and Culture* connect the ideas and concepts to problems and opportunities in our local, national, and global communities, and assist students in the development of new insights into globalization and its effect on societal change. Ultimately, the nature of NCA&T as an HBCU and the vast array of existing opportunities for enriching our COE students' multicultural perspectives will be leveraged to help GCSP participants develop the cultural competence necessary for 21st century engineers.

SOCIAL CONSCIOUSNESS. NCA&T has a rich legacy of community engagement, and civil rights activism. The GCSP will build upon this legacy through activities designed to deepen participants' understanding of their role in addressing today's societal issues. Moreover, COE faculty and staff, and students are actively engaged in community service during the academic year as it is part of the culture of the University (NCA&T strengths in this area has earned the University "Community Engagement Classification" by the Carnegie Foundation for the Advancement of Teaching). GCSP participants must complete a minimum of two social consciousness activities. These may include:

- Habitat for Humanity
- Engineers without Borders (may not be double-counted)
- Tutor for Black Child Development Institute or Reading Connections
- Tutor for COE Leaders Enhancing Academic Development (LEAD) program
- Cultural Studies courses

A wide range of *Cultural Studies* courses offered at NCA&T include exploration of topics on the United Nations, U.S. Department of Agriculture, U.S. Agency for International Development, the World Bank, International Monetary Fund, private global industries, international nongovernmental organizations. Students can also explore issues of culture, diversity and poverty in the U.S. addressed through organizations such as the Poverty Law Center, Urban League, and NAACP Legal Defense Fund.

VI. Tracking and Assessment

Tracking and assessment will occur at various levels. Demonstration of completion of activities in each competency will be documented in participants' E-portfolios. E-portfolio reviews will assess completion of proposed activities as listed in the participant's Activity Development Plan, their progression toward Grand Challenge Scholar designation, and participants' reflections of their

experiences. Participants are expected to demonstrate mastery at each competency level. To achieve the Grand Challenge Scholar designation, participants must demonstrate a mastery of at least two activities at **Level 2** and **Level 3** for each component.

Leadership development is also essential to the GCSP program at NCA&T. GCSP will utilize a *Learn, Do, Lead Model* to assist participants' progression in the program. Our hypothesis is that GCSP participants will transition from a general understanding of the 14 grand challenges, and primarily, the four main themes of sustainability, health, safety/security, and joy of living; to developing skills aligned with their career goals, and ultimately demonstrate a deeper comprehension of their role as grand challenge engineers, and scholars.

VII. Funding Support

The NCA&T GCSP will be supported through various funding mechanisms. The Office of the Dean has set aside seed funding to support the GCSP's initial program activities. Current funding for operational support include corporate grants and gifts. Fundraising goals include the submission of grant proposals to corporate partners and foundations in support of programmatic expenses such as:

- Travel expenses for the GCSP Director, faculty leads, research mentors, and participants to attend a national GCSP event each year
- Food costs for GCSP meetings and events
- Honoraria and travel expenses for guest speakers
- GCSP research and project materials
- Marketing

Funds will also support initiatives led by student organizations and clubs, such as forums, competitions, and student-led talks and presentations on grand challenges. The COE also funds the GCSP Director's salary, while the GCSP Steering Committee serves on a voluntary basis.

VIII. Mentorship and Support

The COE is committed to providing the support and resources necessary for student success and academic excellence for **all** students; therefore, GCSP will have the support of key personnel throughout the college. Support at the College and departmental levels include the Assistant Dean of Student Affairs, the Associate Dean for Academic Affairs, the GCSP Director, and student service coordinators. GCSP Lead Faculty and Research Mentors will serve as formal mentors.

Additional University resources include the Center for Academic Excellence (CAE), and the Office of Student Affairs. The CAE offers tutorial services, student workshops, academic success seminars, and remedial courses for students. The Office of Student Affairs offers satellite office hours to assist with professional development and career counseling. GCSP participants who have experience beyond the first year will have an opportunity to serve as peer mentors. Upper level participants and program alumni will be recruited as mentors.