



Dwight Look College of
ENGINEERING
TEXAS A&M UNIVERSITY

Texas A&M University
Dwight Look College of Engineering

**National Academy of Engineering
Grand Challenge Scholars Program Proposal**

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Grand Challenge Scholars Program

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Grand Challenge Scholars Program: Vision & Overview

Texas A&M University is strongly committed to educating engineers to meet the Grand Challenges facing society in the 21st century. Towards this end, since 2012 the Dwight Look College of Engineering has launched several initiatives that already engage more than 3,000 engineering students annually:

- **AggiE Challenge** - The program was established in fall 2012 to engage undergraduates in multidisciplinary and vertically integrated teams to pursue solutions for some of the grand challenges in engineering. Student teams work closely with faculty and graduate students and receive course credit. More than 500 engineering undergraduates have participated in the program since its inception.
- **Aggies Invent** - These 48 hour events challenge students to innovate solutions and build rapid prototypes to need statements provided industry and faculty. Each event generally involves 60 or more students in multidiscipline/multi-level teams. The first Aggies Invent was held in August 2014. Currently, we are organizing seven events per academic year.
- **Engineering Project Showcase** - This annual event provides a forum for teams of undergraduate students from all engineering majors to present their projects to industry. The 2015 Engineering Project Showcase included over 150 team projects representing the work of more than 600 engineering students.
- **Engineering Innovation Center (EIC)** - The EIC was established in the fall of 2013 to nurture innovation by providing undergraduates with access to state-of-the-art prototyping tools, equipment, material, and support staff. The EIC consists of 20,000 square feet of space, including significant collaborative space, conference rooms, a green room, and significant space for building prototypes. In spring 2015 alone, more than 1,400 engineering students utilized the EIC for capstone design, AggieE Challenge, and design competitions such as Aggies Invent.

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The Grand Challenge Scholars Program (GCSP) will complement and leverage the above programs. It will be a selective, three-year program that will attract, retain, and graduate future leaders who are equipped to solve engineering grand challenges facing our society today and in the future. The Grand Challenge Scholar (GCS) will achieve in-depth understanding of their technical areas in the context of research related to a Grand Challenge (GC) problem while also gaining interdisciplinary, entrepreneurial, global, and service learning expertise and experiences. Grand Challenge Scholars will be prepared to be global leaders, in all sectors: academe, government, and industry.

Students will apply to the GCSP at the beginning of their sophomore year, with decisions made during the same semester; students will participate in the program for the remainder of their undergraduate experience. The GCSP will incorporate the above programs, other Texas A&M programs, such as Startup Aggieland and Engineers Without Borders, and will culminate with an undergraduate research thesis. GC Scholars will participate in regularly planned GCSP activities, including an annual Grand Challenge Scholar Program Symposium. Each GC Scholar will have a GC Faculty Mentor who will supervise their GCSP thesis research and also mentor the student in other aspects of the program. The GC Scholars will serve as ambassadors of the Texas A&M GCSP program, both internally at Texas A&M and externally.

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The GCSP will be a three-year program. The program will be promoted to freshman and applications will be due early in the fall of the sophomore year.

- During the first year in the GCSP (the sophomore year), GC Scholars will work with GC Faculty Mentors to plan their customized GCSP curriculum, ensuring that it meets all five GCSP components. The GC Faculty Mentors will also supervise the GCSP research experiences and theses. GC Scholars will be assigned an initial GC Faculty Mentor based upon the interests identified in their application; as the GC Scholars identify and refine their research topic, their GC Faculty Mentor assignments may be adjusted.
- During the second year in the GCSP (the junior year), GC Scholars will be actively engaged in the research for the GCSP thesis and will make progress on achieving the other components of the GCSP.
- During their third year in the GCSP (the senior year), GC Scholars will complete their GCSP requirements and will mentor students in the first and second year of the GCSP. They will also serve as GCSP ambassadors, by participating in outreach and recruitment activities for K-12 students, by presenting their GC thesis work at internal and external conferences and meetings, and generally representing the program as needed.

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During the spring of each year, the program will host a Grand Challenge Scholar Program Symposium that will be open to the entire campus community. The symposium will serve to bring visibility to the Engineering Grand Challenges in general and to the Grand Challenge Scholar Program at Texas A&M in particular. The symposium will feature a keynote address by a prominent engineer on a topic relevant to the grand challenges. All current GC Scholars will participate in some manner in the event: graduating GC Scholars will present their work with short highlight talks and posters during a reception, 2nd year GC Scholars will present posters describing their current research, and all GC Scholars will participate in special networking activities with the keynote speaker.

Grand Challenge Scholar Program Curriculum

The objective of the five-component GCSP curriculum is to provide the GC Scholar with the engineering and non-engineering expertise and meta-curricular expertise necessary to address a Grand Challenge. Each Texas A&M GC Scholar, working with their GCS Faculty Mentor, will develop a customized plan for achieving a specified level of engagement and competence in each of the five GCSP curricular components and for ensuring curricular connectivity across these five components and a Grand Challenge problem. While the GCSP components can be achieved with activities other than traditional coursework, the level of engagement expected for deep engagement/competence would be equivalent to 9+ credit hours (three courses), for medium engagement would be equivalent to 5-8 credit hours (two courses), and exposure would be equivalent to 3-4 credit hours (one course). In cases where a component is satisfied with activities other than traditional coursework, an assessment of the level of engagement will be done by the GCSP Director for programs and activities that are expected to be used by multiple scholars; GC Scholars will work with their GC Faculty Mentor and/or the GCSP Director to determine the level of engagement for other activities.

The Texas A&M GC Scholar will develop deep research expertise by engaging in a multiple-semester research project on a GC theme culminating in a thesis. In addition, each GC Scholar will achieve at least a medium level of engagement in interdisciplinary expertise and at least medium engagement in at least one of the other components, entrepreneurship, global dimension, and service learning, and at least exposure in the other two. GC Scholars will have the option to request that their in depth experience be related to a component other than research; in this case, their GC Faculty Mentor would supervise this activity and the student would produce a report documenting their activity that would serve as their GCSP thesis.

The Texas A&M GCSP has a broadening curriculum requirement that GC Scholars take at least one course that focuses on non-engineering topics such as economics, public policy, business law, medical ethics, etc., that is directly related to the grand challenge on which they are focusing and

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which provides a broader perspective on the challenge. This course would likely fall under one or more of the five GC curricular components.

Each of the five curricular components of the GCSP curriculum, and potential ways that the GC Scholars can obtain the necessary level of engagement/competence, is described below. Texas A&M has a number of existing programs that address one or more of the five GC curricular components and which the GC Scholars can utilize in their customized GCSP curriculum. It is possible, and indeed desirable, for the GC Scholar's activities to fall under multiple curricular components. For example, the thesis research on the GC problem may naturally involve interdisciplinary curriculum or global dimension, and, depending on the project, could also involve entrepreneurship or service learning.

Research Experience and GCSP thesis - "Deep" engagement

The Texas A&M GCSP requires that each GC Scholar complete a multi-semester (at least 2) research experience relating to a Grand Challenge theme or project and write a GCSP thesis documenting their project. While all students will have a GC Faculty Mentor who will supervise their thesis, the research project might be an independent research project conceived of and performed by the student or the student could work with a faculty member who is doing research related to one of the Grand Challenges. The GC scholar will gain deep engagement and competence in this component.

During the first year in the GCSP (the sophomore year), the GC Scholar will work with the GC Director to identify a research topic and an advisor (the GC Faculty Mentor) who will supervise the student's thesis research but who will also provide guidance on other components of the student's GCSP curriculum. The research will be performed over multiple semesters, most generally during the 2nd year in the program (the junior year), but may extend to the 3rd year in the GCSCP (the senior year) as well depending on the project. During the semesters that the student is actively engaged in the research, they will register for 3 credits of undergraduate research with their thesis advisor. Depending on their major, these research hours might be applied to some of their degree requirements, e.g., by serving as a technical elective.

GC Scholars will be encouraged to participate in the Texas A&M Undergraduate Research Scholars (URS) program that guides students in the process of writing the thesis, and generally in the research experience. Student theses are published with the university, just as master's theses or doctoral dissertations. The URS program qualifies as an honors capstone experience for the university honors program.

GC Scholars will be strongly encouraged to present/submit their research to peer-reviewed venues. They will also be encouraged to present their work in venues providing exposure to industry or K-12 students, parents, and teachers such as the Texas A&M Engineering Project Showcase. Additionally, they will participate in the annual GCSP Symposium that will be held during the spring of each year on campus. In particular, graduating GC Scholars will present

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their work with short highlight talks and posters and 2nd year GC Scholars will present posters describing their ongoing research.

Interdisciplinary – at least "Medium" engagement

The Texas A&M GCSP requires that each GC Scholar develop interdisciplinary knowledge and experience to prepare them to participate in and to lead multidisciplinary teams attacking Grand Challenge Problems. The scholar will gain at least a medium level of engagement in this component.

It is anticipated that most GC Scholars will satisfy this component with a combination of coursework in support of their GCSP thesis research and co-curricular activities. The GC Scholar will work with their GC Faculty Mentor to identify non-engineering coursework required for or supportive of their GCSP thesis research. GC Scholars will also be encouraged to identify coursework or training opportunities that will prepare them for leadership and management of multidisciplinary teams, such as Texas A&M Engineering's Zachry Leadership Program, which is a five semester program designed to provide engineering students with a broader perspective in the world in which they live and work and to prepare them to become future leaders who are well-versed in the free enterprise system, collaborative decision making, and who exemplify the spirit of servant leadership.

All Texas A&M GC Scholars will be expected to gain experience working in multidisciplinary teams. Some GC Scholars may satisfy this requirement through their thesis research. However, if they do not, there are other opportunities for them to obtain this experience. One example is Texas A&M Engineering's AggieEChallenge Program that was established in fall 2012 to engage undergraduates in multidisciplinary and vertically integrated teams to pursue solutions for some of the Grand Challenges in engineering; student teams work closely with faculty and graduate students and receive course credit.

Entrepreneurship – at least "Exposure"

The Texas A&M GCSP requires that each GC Scholar develop knowledge of the innovation process by which technical inventions are translated into market ventures in the business or non-profit sector. The scholar will gain at least an exposure level of engagement in this component.

GC Scholars can satisfy this requirement through formal coursework or through the many co-curricular entrepreneurship and innovation opportunities available at Texas A&M.

There are several interesting interdisciplinary academic programs that GC Scholars can participate in to satisfy this component. For example, the Zachry Leadership Program is a five semester program that prepares engineering students to become future leaders who are well-versed in the free enterprise system. Students can also earn an Entrepreneurship Minor or a Business Management Certificate that are offered in collaboration with the Mays Business School. GC Scholars may also elect to take relevant courses from the Mays Business School.

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GC Scholars can also participate in the many extra-curricular opportunities available to Texas A&M students. For example, Startup Aggieland that was among the nation's first student-designed campus business accelerators for students or the Aggies Invent 48-hour design competitions that push students to innovate and gain experience with rapid prototyping tools and techniques.

Global Dimension – at least "Exposure"

The Texas A&M GCSP requires that each GC Scholar develop global awareness necessary for working effectively in today's global economy. The scholar will gain at least an exposure level of engagement in this component.

GC Scholars can satisfy this requirement through formal study abroad or through coursework or other activities that enable them to develop global awareness and experience.

In terms formal study programs involving international travel, Texas A&M has a number of summer or 2-5 week programs specifically designed for engineering students, e.g., a two week, 3 credit hour, "Maymester" in India program in which computer science and engineering students learn about and visit the IT industry in India or a five week summer program in Brazil for aerospace engineers in which students can take courses in their major from Texas A&M faculty while participating in synergistic cultural activities. GC Scholars from Texas A&M's College Station campus can also satisfy this requirement by spending a semester at the Qatar campus, and vice versa.

In addition to study abroad, there are many other options available to GC Scholars to gain global experiences. For example, GC Scholars might take formal coursework, their GCSP thesis may involve international collaboration, they may participate in an international internship, or they might participate in an international experience with Engineers Without Borders or other similar program.

Service Learning – at least "Exposure"

The Texas A&M GCSP requires that each GC Scholar participate in a meaningful service learning experience. The objective of this component is to deepen the GC Scholar's social awareness and heighten their motivation to bring their technical expertise to bear on societal problems. The scholar will gain at least an exposure level of engagement in this component.

GC Scholars can fulfill this requirement by participating in a formal program such as Engineering Projects in Community Service (EPICS) or by participating in a significant manner in a relevant service organization such as Engineers without Borders. Other types of community service activities, such as serving as peer teacher for undergraduate courses or as a tutor for K-12 students in STEM courses, can also be used to satisfy this component.

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Program Administration

The GCSP will have a Director who is a visible and respected senior faculty member. They will be responsible for overall program administration and GCSP events. In recognition of the significant workload of this position, the Director will receive support from the college to allow them to reduce teaching or other service obligations.

The GCSP is a three-year program. It will be promoted to freshman and applications will be due early in the fall semester of the sophomore year.

Each GC Scholar will have a GC Faculty Mentor who serves as the Scholar's thesis advisor and general mentor for GCS program components. During their first year in the GCSP (the sophomore year), the GC Scholar will work with the GCSP Director to identify a research topic and GC Faculty Mentor for their GCSP thesis. The GCSP Director will serve as the GC Scholar's Faculty Mentor until they have identified the GCSP thesis advisor.

The Texas A&M GCSP will be a selective and rigorous program. It is expected that the total number of GC Scholars in the program at any time will be around 150, and it is anticipated that each year's cohort will include about 50 GC Scholars, though the precise number is not fixed and will depend on the quality of the applicants.

Selection of Scholars

The GCSP will be promoted to all freshman in the engineering program at Texas A&M. The GCSP Director and current GC Scholars will offer GCSP Informational and will reach out to both disciplinary student groups and to organizations such as Society of Women Engineers (SWE), National Society of Black Engineers (NSBE), Society of Professional Hispanic Engineers (SHPE), American Indian Science and Engineering Society (AISES), Society of Asian Scientists and Engineers (SASE), and Mexican American Engineers and Scientists (MAES). The entire campus community will be invited to the annual GCSP Symposium in the spring where current GC scholars in the 2nd and 3rd year of the program will present their research and a GCSP Informational will be held in conjunction with the GCSP Symposium to give the program maximum visibility and exposure.

The application deadline for the GCSP will be early in the fall semester of the sophomore year. Applications will be reviewed by the GCSP Review Committee, which will be chaired by the GCSP Director, and will include other faculty engaged in the GCSP, such as GC Faculty Mentors. Reviewers will evaluate the applications based on the student's potential for and interest in engineering the Grand Challenges, and their awareness of social and/or global consciousness.

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Decisions will be made rapidly so that students can begin engaging in the GCSP in the fall of their sophomore year.

To be eligible for the Texas A&M GCSP, students must:

- be an engineering student in good standing with a Texas A&M GPA of at least 3.25,
- be committed to engineering of the Grand Challenges, and
- have an awareness of social and/or global consciousness.

To apply for the Texas A&M GCSP, student must submit the following materials as specified by the application deadline:

- a completed application with required information,
- an essay describing their interest in the GCSP, including their commitment to engineering the Grand Challenges and an awareness of social and/or global consciousness, their prior engagement in relevant activities, and future career goals,
- a current two page resume,
- at least one letter of recommendation from a Texas A&M faculty member that addresses, if possible, the student's potential for and interest in engineering the Grand Challenges, and the student's awareness of social and/or global consciousness.

Program Requirements and Student Tracking

To maintain active status in the GCSP, students need to:

- remain a student in good standing with the university and a student in the college of engineering with an overall Texas A&M GPA of at least 3.25,
- meet with the GCSP Director during each regular semester (Fall or Spring) in which they are enrolled in courses at Texas A&M,
- actively participate in GCSP activities such as the annual GCSP Symposium,
- submit an annual GCSP report in May of each year describing their GCSP activities for the past year, their plans for the coming year and for meeting all GCSP requirements prior to graduation.

To achieve the GC Scholar distinction at the time of graduation, students need to:

- successfully complete all degree requirements for a degree in the college of engineering at Texas A&M with an overall Texas A&M GPA of at least 3.25, and
- successfully complete all program requirements for the GCSP, including completion of the GCSP thesis.

Program Management and Oversight

The GCSP Director has primary responsibility for overall program management. This includes organizing overall GCSP events, such as the annual Symposium, managing the recruitment and selection of students, monitoring student progress, and approving students who have successfully completed the program.

The GCSP Director is responsible for compiling the names and accomplishments of the students who receive Grand Challenge Scholar designation upon graduation and conveying this information to the national GCSP Steering Committee. The GCSP Director is also responsible for working with the national GCSP Steering Committee for longitudinal tracking of Grand Challenge Scholars.

The GCSP Director is responsible for managing the recruitment, selection, training and ongoing support of GC Faculty Mentors. This includes insuring that the GC Faculty Mentors are informed about and receive training on all the requirements of the GCSP and that each GC Scholar has regular and meaningful interactions with their GC Faculty Mentor. This will be facilitated by regular (at least once a semester) meetings of the GC Faculty Mentors so they can share best practices and be kept informed of new or modified programs relevant to the GCSP and incorporating feedback about the mentoring relationship into the GC Scholar annual reporting process. Mechanisms will be put in place to recognize the GC Faculty Mentors, including listing them on the GCSP webpages, along with the GC Scholars.

The Texas A&M GCSP will have a GCSP Oversight Committee that will provide guidance to the GCSP Director on all aspects of the program. The composition of the GCSP Oversight Committee will be adjusted to meet the needs of the program, but will include at least representatives from the office of the Dean of Engineering at Texas A&M, from Texas A&M faculty in the NAE, and from the faculty who have served as GC Scholar Faculty Mentors. The Oversight Committee will meet at least annually to review the status of the program and to provide feedback and guidance to improve the program.

APPENDIX 1: Relevant Existing TAMU Programs and Organizations

- AggieE_Challenge: <http://engineering.tamu.edu/easa/areas/enrichment/aggie-challenge>
- Aggies Invent: <https://engineering.tamu.edu/aggiesinvent>
- Business Management Certificate:
<https://engineering.tamu.edu/academics/certificates/business-management>
- EPICS (Engineering Projects in Community Service):
<http://engineering.tamu.edu/easa/areas/enrichment/epics>
- Engineering Innovation Center:
<http://engineering.tamu.edu/easa/areas/enrichment/aggie-challenge>
- Engineering Project Showcase:
<https://engineering.tamu.edu/easa/areas/enrichment/eic/programs/project-showcase>
- Engineers without Borders (EWB): <http://ewb.tamu.edu/>
- Study Abroad: <http://engineering.tamu.edu/global/studyabroad>
- Texas A&M Undergraduate Research Scholars (URS): <http://hur.tamu.edu/UGR/UGRS>
- Zachry Leadership Program:
<https://engineering.tamu.edu/academics/certificates/zachry-leadership-program>
- Society of Mexican American Engineers and Scientists (MAES): <http://maes.tamu.edu/>
- National Society of Black Engineers (NSBE): <http://nsbe.tamu.edu/>
- Society of Hispanic Professional Engineers (SHPE): <http://shpe.tamu.edu/>
- Society of Women Engineers (SWE): <http://swe.tamu.edu/>

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APPENDIX 2: Example GC Scholar Activities

The following table provides examples of type of activities and the level of engagement for the Texas A&M GC Scholar Program. GC Scholars are required to achieve deep engagement in research, at least medium engagement in interdisciplinary curriculum, and at least medium in one of the entrepreneurship, global dimension, or service learning, and at least exposure in the remaining two.

| Level of Engagement | Deep | Medium | Exposure |
|------------------------------|---|--|---|
| Research Project | <ul style="list-style-type: none"> Participate in undergraduate research on a Grand Challenge Problem. Produce a thesis and present the work at the GCSP Symposium during the junior and senior year. Participate in Texas A&M Undergraduate Research Scholar (URS) program | Not applicable | Not applicable |
| Interdisciplinary Curriculum | Participate in the Zachry Leadership Program in a manner that is aligned with the GCSP thesis | Participate in an AggieE_Challenge project (3 hours course credit) during the 1 st year in the GCSP and take a non-engineering course in support of GC thesis research during the 2 nd year in the GCSP. | Not applicable |
| Entrepreneurship | <ul style="list-style-type: none"> Participate in the Zachry Leadership Program Complete an entrepreneurship minor | <ul style="list-style-type: none"> Substantial participation in Startup Aggieland Activity (could also be deep exposure if significant enough) Completion of two formal courses on entrepreneurship and the innovation process | <ul style="list-style-type: none"> Participate in multiple entrepreneurship activities or club, e.g., Aggies Invent, member of TAMUHack, etc. Completion of one formal course on entrepreneurship |
| Global Perspective | Semester or more study abroad experience that is aligned with GC thesis | <ul style="list-style-type: none"> Summer or 5+ week study abroad experience (equivalent of 2 courses) Leadership of a 5+ week EWB project | <ul style="list-style-type: none"> 1-2 week global experience (equivalent of 1 course) Participation in EWB project |
| Service Learning | | 2 or more semester involvement in EPICS | Perform semester-long community service (e.g., peer teaching) |