National Academy of Engineering (NAE)
Grand Challenges Scholars Program (GSCP)

Proposing a GCSP at Your School

Revised August 2018

A. **National Academy of Engineering Grand Challenges**

Identifying relevant problems and designing creative solutions to the problems, identified by NAE as "Grand Challenges," is the DNA of engineering. Solutions to the most significant problems confronting humanity today have to be more than just practical and cost effective; they must address complex and interrelated factors that are deeply imbedded within cultural, political, social, ethical, and economic contexts. The workforce of the 21st century has to be mindful of the intended value, unintended impacts and context-specific challenges of an endeavor, especially where society is most vulnerable.

The National Academy of Engineering (NAE) Grand Challenges for Engineering, announced in 2008, is a cross-disciplinary initiative that presents an aspirational vision of what engineering needs to deliver to all people on the planet in the 21st century. In just 15 words, the vision it calls for is:

"Continuation of life on the planet, making our world more sustainable, healthy, secure and joyful."

With input from people around the world, an international group of leading technological thinkers was asked to identify specific game-changing goals for improving life on the planet. The committee identified the following fourteen Grand Challenges as exemplars (http://www.engineeringchallenges.org/) and suggested that they cover the four cross-cutting themes: **SUSTAINABILITY**, **HEALTH**, **SECURITY**, and **JOY OF LIVING**.

(1)   Make solar energy economical
(2)   Provide energy from fusion
(3)   Develop carbon sequestration methods
(4)   Manage the nitrogen cycle
(5)   Provide access to clean water
(6)   Advance health informatics
(7)   Engineer better medicines
(8)   Prevent nuclear terror
(9)   Secure cyberspace
(10)   Restore and improve urban infrastructure
(11)   Reverse-engineer the brain
(12)   Enhance virtual reality

(13)   Advance personalized learning
(14)   Engineer the tools of scientific discovery

These are ambitious goals that will require a new generation of engineers, scientists, social scientists, politicians, and artists who will collectively:
- Create new capabilities,
- Provide pragmatic solutions for basic human needs,
- Develop new entrepreneurial opportunities,
- Reinvent human interactions,
- Transform systems thinking,
- Be the architects of a sustainable society,
- Be mindful of unintended consequences,
- Connect technology with society,
- Interact with non-engineering partners,
- Design and implement context-sensitive solutions.

The Grand Challenges for Engineering initiative has two components: *Engineering System* and *Talent Building*. The *Engineering System* component is comprised of the specific Grand Challenges. The *Talent Building* component is the Grand Challenges Scholars Program (GCSP), which prepares the workforce to undertake the *Engineering System* component.

B. **Grand Challenges Scholars Program (GCSP)**

At the NAE Grand Challenges Summit held at Duke University in March 2009 (http://summit-grand-challenges.pratt.duke.edu/), a consortium of founding institutions – Duke University's Pratt School of Engineering, The Franklin W. Olin College of Engineering, and the University of Southern California's Viterbi School of Engineering – jointly announced the NAE Grand Challenges Scholars Program (GCSP) to educate engineering students who will play leading roles in addressing the NAE Grand Challenges:
http://engineeringchallenges.org/GrandChallengeScholarsProgram.aspx.

The Grand Challenges Scholars Program was inspired by the NAE Grand Challenges for Engineering and reflects the rapidly evolving nature of engineering education. While promoting and catalyzing the GCSP, NAE does not dictate an engineering curriculum to any university. The GCSP simply identifies five competencies that a student must achieve to prepare them to address the global Grand Challenges for Engineering. Each prospective GCSP institution defines its approach to educating students about and supporting students' development in five competencies. In brief, the five GCSP student competencies are:

- **Talent Competency**: Mentored research or creative experience on a Grand Challenge-like topic

- **Multicultural Competency**: understanding different cultures, preferably through multicultural experiences, to ensure cultural acceptance of proposed engineering solutions

- **Multidisciplinary Competency**: Understanding multidisciplinarity of engineering systems solutions developed through personal engagement

- **Viable Business/Entrepreneurship Competency**: Understanding, preferably developed through experience, of the necessity of viable business model for solution implementation

- **Social Consciousness Competency**: Understanding that the engineering solutions should primarily serve people and society reflecting social consciousness

Addressing the NAE Grand Challenges will require the efforts and talents of many graduates educated in a range of engineering and non-engineering disciplines, the majority of whom are currently high school age or younger.

The GCSP is not based on a specific curriculum but rather on expanding the mindsets and skillsets of students so they can make sense of, connect to and apply engineering skills to global, engineering system problems, i.e., Grand Challenge-like problems. It has the qualities of a movement rather than a project, where inspiration and engagement are driven by the power of the idea, while local administrative decisions are made in accordance with the local practices of each university.

For this movement to grow and thrive, it will be critical for GCSPs across the nation and around the world to connect with each other, collaborate, and engage truly diverse students. Therefore, the explicit objective of the GCSP is to develop a vibrant worldwide network of Grand Challenges Scholars Programs within participating colleges and universities. The goal of each institutional program is to prepare students for the multicultural, multidisciplinary, entrepreneurial, socially-conscious global engagement needed for 21st century engineering, through an educational supplement that is adaptable to any university anywhere in the world.

C. **Joining the Global Network of GCSPs**

The first step for a school interested in starting a GCSP is for the dean of engineering at the university/college to join the GCSP Community by using the link available on the GCSP website under the "Becoming a Member/Join GCSP" tab on the left: http://engineeringchallenges.org/GrandChallengeScholarsProgram.aspx

Interested schools should also join the listserv:
http://www.engineeringchallenges.org/GrandChallengeScholarsProgram/14741/subscribe.aspx. Schools that join the community are automatically sent an invitation to perform the second step: submitting a written proposal to establish a GCSP at their institution (for further information, see Section E below). **Schools are strongly urged to contact the Steering Committee Chair to secure a mentor to assist in proposal preparation.**

Programs approved for GCSP designation will become an essential part of the NAE Grand Challenges network of schools. Member institutions will have access to an online community of GCSPs as well as workshops and programs intended to support the development and ongoing work of the GCS community. These electronic and face-to-face networks will allow GCS program directors, faculty, staff, and students to exchange ideas and research progress and to present best practices to further refine the program. In addition, they will assist in the creation of new networks and communities of practice that will in turn increase access to and awareness of funding opportunities, post-graduate opportunities for students, etc.

D. Essential Elements of a GCSP

GCSP is a combined curricular, co-curricular, and extracurricular program with five competencies especially designed to prepare students to address major global challenges facing society in this century.

Each participating institution creates its own unique realization of how the competencies are implemented but must possess the following essential elements of a GCSP: (a) recruitment and selection of a diverse cohort of engineering and non-engineering students who hail from all parts of the world; (b) an innovative and institutionally-tailored program that includes a suite of diverse curricular, co- and extra-curricular experiences, as well as multiple paths for completing GCSP requirements; (c) thematic continuity and connectivity in each student's GCSP trajectory; (d) programmatic and individual student assessment; (e) institutional GCSP governance and sustainability; (f) mentorship plan for GCSP faculty and students; and (g) student recognition. No one-size-fits-all program will be imposed, and each GCSP must be inherently flexible to achieve appropriate intellectual breadth, depth and coherence of each student's individual program within their institutional GCSP. However, it is recommended that applications for an institutional GCSP adhere to the following criteria.

(a) Grand Challenges Scholar Recruitment and Selection.
   Objective: To identify, recruit and select a diverse cohort of domestic and international undergraduate students majoring in a variety of disciplines who will be educated to design and create solutions to the NAE Grand Challenges as broadly defined under the four crosscutting themes. Each institutional GCSP will determine how student recruitment and selection are best accomplished within

the mission and character of the individual school. The following aspects of the recruitment and selection processes should be discussed in the proposal: student mentorship through the recruitment and selection process, along with the number of students anticipated for admission each year and the characteristics of those students (e.g., majors, year at institution, etc.). It is advised that recruitment processes are consistent with the institutional and contextual values as well as the goals and vision for the program and its diversity. Note that some institutions establish minimum GPA's for participating students while others do not in order to increase the odds of securing a diverse cohort. The programs are encouraged to aim for the goal of producing 20 GCSP graduates per year, as outlined in the White House pledge. (Such a goal may not be practical for smaller institutions and, as such, should not be viewed as an absolute requirement, but rather a goal for those programs that can reasonably achieve it).

In general, students selected for a GCSP should be:
(i)   in good academic standing as determined by the institution (although individual institutions may want to provide an opportunity for students of lower academic standing who demonstrate promise to join the program as a way of promoting and furthering their motivations – if this is the case, the individual programs must clearly articulate their reasoning),
(ii) committed to addressing one or more of the Grand Challenges in their academic and professional endeavors, and
(iii) aware and eager to address the importance of social and global issues that Grand Challenges raise.

(b) *GCSP Experiences.*
Objective: To design, implement, and integrate the engineering and non-engineering curricular as well as co- and extra-curricular experiences necessary to tackle a Grand Challenge theme or a specific Grand Challenge problem. Within the GCSP context, this is achieved through the five GCSP components listed below. Substantial flexibility is given in how these five components are implemented at each institution. Regardless of the individual program design, each individual GC Scholar's trajectory must be deep, broad and coherent in terms of its connection to one of the specific NAE Grand Challenges or a grand challenge theme. Mechanisms should be in place to support and mentor each student as well as track and assess each student's performance on the individual GCSP components. Well-designed and well-documented meta-curricular experiences could contain aspects that satisfy more than one of the competencies the program aims to develop (e.g., components related to entrepreneurial, multicultural and social consciousness competencies lend themselves nicely to design and implementation of such experiences). While such are encouraged, in these instances students will need to choose which component requirements such an experience counts for, since students may not "double-dip;" that is, they may not use the same experience to satisfy the

requirements of more than one GCSP component. More specifically, the five GCSP student competencies are:

(i) Talent Competency: This is a creative technical competency, development of which requires mentored project or research experience. Each GC Scholar must participate in a substantial team or independent project relating to a Grand Challenge theme or specific challenge. Some examples of the experiences that may support student development of the Talent Competency are: participation in formal undergraduate research programs, senior theses, on-site internships, or capstone design projects.

(ii) Multicultural Competency: Multicultural awareness is necessary for working effectively in an increasingly interdependent world. Students may participate in curricular or extra-curricular experiences that help students develop skills and attributes necessary for continued innovations in a global economy and address ethical issues of global concern. While an experience abroad lends itself more organically to development of multicultural competency, students may also choose to participate in a domestic experience that focuses on global or cross-/multi-cultural implications of a GC theme or problem. Some examples of the experiences that may allow students to develop this competency are: completion of formal coursework relevant to multicultural competency development; participation in global internships or those that emphasize global nature of engineering work; conducting research in global health or global environmental challenges, etc.

(iii) Multidisciplinary Competency: Bridging engineering to other disciplines is essential for solving the NAE Grand Challenges. An overall curricular as well as co- and extra-curricular program must be designed to prepare students to work at the boundary between various engineering and non-engineering disciplines, such as public policy, international relations, business, law, ethics, human behavior, risk, medicine, the natural sciences, arts, etc. Each GCSP should have an institutionally tailored mechanism that thematically draws together the engineering and non-engineering curricular components of each student's course of study. In other words, if a student chooses to develop this competency through a double-major or a minor in a non-engineering discipline, this choice must be intentional in weaving in a GC theme or problem. Some examples of relevant experiences include: participation in an explicitly interdisciplinary course or a GCSP seminar series.

(iv) Viable Business / Entrepreneurship Competency: Implementing innovation is central to technology development. Each GC scholar must participate in a curricular or co-/extra-curricular experience that involves the process of translating invention and innovation into a viable business model for solution implementation or a market venture. This may be either risk-taking ventures for business or introducing technology for not-for-

profits in the public interest. Examples of relevant experiences that students may choose to participate in include: submittal of an invention disclosure; participation in a start-up competition, a course in entrepreneurship; application for a patent or other form of intellectual property. In addition, students might elect to participate in an engineering entrepreneurship program such as VentureWell's University Innovation Fellows Program.

(v) Social Consciousness Competency: Working for the benefit of others is the foundation of a civil society. Students may participate in a curricular or extra-curricular component that deepens their social awareness and heightens their motivation to bring their technical expertise to bear on societal problems. For example, students may choose to develop this competency through some of the following experiences: completion of formal classes in social action; participation in internships for global service organizations such as Engineering World Health or Engineers Without Borders; participation in curricular service-learning experiences like Engineering Projects in Community Service (EPICS); conducting research that focuses on improving the human condition; significant meaningful participation in an institution's community service or tutoring program. The number of hours expected for completing this competency will vary with the intensity of the activity, but it is expected to be substantial.

(c) *Thematic Continuity and Connectivity*.
Objective: To ensure that a Grand Challenge theme or a specific Grand Challenge problem is intentionally imbedded across and within each of the five GCSP competencies for each GC scholar. A well-connected program of study would not only be coherent and connected around a GC theme, but also be one where development of a single GCSP competency is explicitly linked to development of one or more of the other competencies. For example, interning at an organization and/or performing research on global health or clean energy may allow a student to simultaneously develop talent, multicultural, and social consciousness competencies. It is expected that awareness of unintended consequences, responsible conduct of research, and professional ethics are integral parts in developing all five competencies.

(d) *Programmatic and Individual Student Assessment*.
Objective: To ensure consistency of institutional programs with the GCSP core principles and ideas set forth by NAE; as well, to ensure alignment of individual student's development with the goals and objectives of individual institutional GCSPs. To this end, each program must develop both programmatic and individual student assessment plans that are consistent with the goals, objectives, and context of each institution, while also staying true to the goals and spirit of the NAE Grand Challenges Scholars Program.

(e) *Institutional GCSP Governance and Sustainability*.

Objective: To ensure that the institutional governance plan is viable and sustainable (including financial sustainability), given the unique aspects of each individual institutional GCSP. Each institutional program must have a GCSP director; it is also recommended that each institutional GCSP has a steering committee that provides advice and programmatic oversight. Finally, it is desirable that the steering committee includes students as partners in the programmatic implementation (and, for some programs, as programmatic co-designers). The primary roles of the GCSP director and steering committee are to establish the GCSP program, recruit and select students, support and monitor programmatic and individual student progress, provide mentorship to GCSP faculty/advisors and GC scholars, approve students who have successfully completed the program, fund-raise and establish other resources for programmatic support, etc. Each program director must compile the names and accomplishments of students who receive Grand Challenges Scholar designation upon graduation and convey this information to the steering committee. Acquiring the names of GC scholars and descriptions of their accomplishments is essential for the annual report submitted by the GCSP to the NAE. Cooperation of the institutional GCSP committees is also sought in longitudinal tracking of Grand Challenges Scholars. The recruitment and selection of the director and/or the organization of this committee, as well as the duration of their tenure, are at the institution's discretion.

In terms of financial sustainability, though there is no specific funding level required by NAE, each institutional program must create a plan for supporting various activities and experiences (e.g., study abroad; student engagement in research, service or entrepreneurship activities; on-campus events for students; participation in annual GCSP events, course release or stipend for the GCSP director and/or active faculty; costs for GCSP meetings and events on campus; guest speaker travel expenses and honoraria; printing expenses to market the GCSP, etc.)

(f) *Mentorship for GCSP Faculty and Students.*
Objective: To design and implement viable and sustainable practices of mentoring GCSP-affiliated faculty and students. It is recommended that each institution establishes practices that support development of GCSP-affiliated faculty and advisors; this mentorship may include education about GCs and GCSP, conversations about holistic educational practices that stretch beyond formal curricula and include informal spaces, attendance of the annual GCSP meetings in Washington D.C., etc. It is also important that each student works with a GC advisor to support their development as a GC scholar, to guide their progress, and to ensure thematic continuity and connectivity. To this end, each program must be intentional about the ways in which students are supported both through the process of application to GCSP and while in the program as well as how faculty mentors are assigned, including specific responsibilities to which mentors must commit.

(g) *Student Recognition.*

   Objective: To establish institutional practices of recognizing and celebrating students who have earned a GC Scholar status. Institutions approved for the GCSP designation may, upon getting permission from NAE, display the National Academy of Engineering Grand Challenge Scholar logo on their web site, official publications and press releases. Students who successfully complete their GCSP requirements, as certified by their home institution, will receive a letter of recognition from the President of the National Academy of Engineering as a Grand Challenges Scholar and be included in the annual NAE Grand Challenges Scholar press release and web listing of all scholars. Specific institutions often add additional recognitions, such as a designation on the student's transcript, permitting students to wear a medallion as part of their regalia at graduation, special receptions or events to recognize scholars and their achievements, etc.

E. Submitting a GCSP Proposal.

Schools that join the GCSP Community through the GC Scholars website will be invited to submit a proposal for an institutional program. **Institutions intending to develop a proposal are strongly encouraged to reach out to the Chair of the Steering Committee to secure a mentor to guide them through proposal preparation**. The following information must be included in the proposals submitted:

Cover Page.

   The cover page must include the name of the candidate school, name and signature of the engineering dean, name and signature of the GCSP director, and the GCSP director contact information (name, title, email, phone number). Note that the director will be the primary contact between your program and the national GCSP.

GCSP Vision, Mission, and Goals.

   Each proposal must contain general statements about the vision and mission for the proposed GCSP that are aligned and consistent with the institutional vision and mission and those of the School/College of Engineering. Programmatic goals must be included with an explanation of how they fit with the institutional and contextual values and mission.

Essential Elements of GCSP.

   Each proposal must include detailed description of seven essential elements of the proposed institutional GCSP, as described in Section D above and the template presented below. It is recommended that proposals include sample trajectories of GC scholars and other concrete evidence about the ways in which the proposed program is designed and will be implemented. It is recommended that the description of the *GCSP Experiences* element of the proposed GCSP includes a summary of the options students have for developing each of the five

competencies, such as existing courses and co-curricular and extra-curricular activities at the institution. It may be useful to include a schematic or a diagram that describes an example of how a student may satisfy all of the program requirements.

Unique Aspects.
As appropriate, proposals should describe any unique aspects of proposed institutional program that allow for understanding of the context in which the program is designed and implemented. For example, will non-engineering students be recruited into the program? Will accepted students receive scholarships? Will they participate in an on-campus program such as an honors, student ambassador or other special program? In order for students to complete one or more aspects of your program, will you be partnering with EPICS, Engineers Without Borders, University Innovation Fellows, Habitat for Humanity, senior design, freshman engineering, study abroad, service learning, tutoring, or other local organizations or programs? Do you plan to target non-honors students, honors students or some other specific groups?

Other.
Describe any other salient aspect of your program not included above.

Approved institutional GCSPs can be viewed at www.nae.edu/gcsp.

Submit your proposal to Dr. Jenna P. Carpenter (carpenter@campbell.edu, the NAE Grand Challenges Scholars Program (GCSP) Steering Committee Chair, for distribution and review by the GCSP Steering Committee.

F. NAE GCSP Steering Committee.

The current National Academy of Engineering Grand Challenges Scholars Program Steering Committee includes:

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