Grand Challenge Scholars Program Operational Document

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Submitted by
College of Engineering
The Trustees of Boston University
Boston MA 02215

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Introduction

Boston University

The Boston University mission: Boston University is an international, comprehensive, private research university, committed to educating students to be reflective, resourceful individuals ready to live, adapt, and lead in an interconnected world. Boston University is committed to generating new knowledge to benefit society.

We remain dedicated to our founding principles: that higher education should be accessible to all and that research, scholarship, artistic creation, and professional practice should be conducted in the service of the wider community—local and international. These principles endure in the University's insistence on the value of diversity, in its tradition and standards of excellence, and in its dynamic engagement with the City of Boston and the world. Boston University comprises a remarkable range of undergraduate, graduate, and professional programs built on a strong foundation of the liberal arts and sciences. With the support and oversight of the Board of Trustees, the University, through our faculty, continually innovates in education and research to ensure that we meet the needs of students and an ever-changing world.

The College of Engineering

Global. Prestigious. Innovative: Boston University's College of Engineering creates the engineers who shape the lives of future generations and make the world a better place. Students come from around the world to be a part of our selective, esteemed engineering community. And once here, they learn by doing. They're challenged with innovative classroom teaching, applied design projects, and research opportunities. They develop the insight, teamwork, and ability to identify solutions to pressing social problems. And they do it all in the vibrant heart of Boston, one of the most important urban technology centers in the US.
We offer undergraduate, graduate, PhD, distance learning, and certificate programs, taught by acclaimed faculty—many of whom are internationally recognized for their research. And our growing campus features modern classrooms, cutting-edge research laboratories, a broad array of lectures, symposia, student clubs, and competitions.

The College of Engineering mission is to:
- Educate new generations of engineers to impact every part of society.
- Advance the frontiers of knowledge via engineering science and research.
- Produce innovations from research and translate them into use for the betterment of society.
- Participate as global leaders in all dimensions of science, education, technology, and society.

Our ambitious strategic plan focuses on two overlapping themes: Growth in Excellence and Creating the Societal Engineer, who has a passion to advance society. The plan emphasizes

experiential education, research in engineering's Grand Challenges with translational impact, and the creation of engineers as leaders in society.

Vision and Goals for the Grand Challenge Scholars Program at Boston University

Our vision for the program is entirely consistent with our vision for the **Societal Engineer**. The Societal Engineer has a sense of purpose and appreciation for how an engineering education and its experiences are superior foundations for improving society. To create the Societal Engineer, Boston University embeds not only the powerful, quantitative and creative problem-solving skills inherent to all engineers, but also a set of equally important complementary attributes:
- Comfort and effectiveness at communication tasks
- Systems-level thinking
- Global awareness
- A passion for participating in, and understanding of, the innovation and entrepreneurial process from product design to deployment
- Awareness of how public policies impact technology innovation and advancement
- A social consciousness and appreciation for how products advance our quality of life while creating jobs and economic opportunity

The Societal Engineer inspires people from many backgrounds to work together to help create a safer, greener, more sustainable, healthier, better-connected, more energy-efficient and productive world with enough food, drinkable water and economic opportunity for all.
Here at the College of Engineering, we believe engineers can make a real difference in the world.

Our existing theme of the Societal Engineer is compatible with and can support a more complete GCSP program touching on each of the GCSP elements with requisite promotion, recruiting, management, and assessment components, which follow next.

Steering Committee

The BU College of Engineering GCSP Steering committee consists of the following individuals:

Title	Initially	Role
Dean	Ken Lutchen	Owner
GCSP Director	Thomas Little	Administration/Oversight
Sr. Associate Dean	Sol Eisenberg	Undergrad Curriculum, Global Programs
Assistant Dean	Wynter Duncanson	Social Consciousness, Outreach
Innovate@BU Director	Gerry Fine	Entrepreneurship and Innovation

The role of the GCSP Steering Committee is to establish goals for the program, advise on curricular or programmatic improvements, and to resolve budget needs. Operational and administrative activities will be associated with a GCSP Working Committee.

GCSP Working Committee

The working committee consists of the GCSP Director and a set of active or previous GCSP Mentors selected by the Dean for participating in the program. Once the program is established, we will engage student GC scholars with junior or senior standing in the Working Committee.

The role of the GCSP Working Committee is to
1. Schedule and facilitate an annual GCSP information session to recruit, mentor, and assess students in the program
2. To facilitate introductions between students and potential mentors
3. To work with students to develop personal GCSP program plans
4. To review and approve GCSP program plans
5. To review program plans for each student on an annual basis and progress towards completion
6. Support the GCSP community, PR, and other activities

Program Components

The program has five required competencies that must be completed as part of the NAE specification:

1. **Talent Competency:** mentored research/creative experience on a Grand-Challenge-like topic
2. **Multidisciplinary Competency:** understanding multidisciplinary of engineering systems solutions developed through personal engagement
3. **Viable Business/Entrepreneurship Competency:** understanding, preferably developed through experience, of the necessity of a viable business model for solution implementation
4. **Multicultural Competency:** understanding different cultures, preferably through multicultural experiences, to ensure cultural acceptance of proposed engineering solutions
5. **Social Consciousness Competency:** understanding that the engineering solutions should primarily serve people and society reflecting social consciousness

Service learning also includes a crucial reflection piece, which includes reflective writing on topics such as what did you learn, does the group need further assistance, should you have chosen a different task to be more successful and a discussion of your own personal growth and understanding of the situation due to the project.

Lastly, the GCSP will strive to achieve **thematic connectivity** between these five elements. This means, for example, carrying a theme of 'economical solar energy' to each of the five competencies above.

BU Program Elements

The aforementioned competencies will be realized in the BU ENG program leveraging existing programs as follows.

1. **Talent Competency**
   a. Select and engage a senior design project (4 CR) in one of the Grand Challenges
      Or
   b. Conduct research related to a grand challenge under the guidance of a GCSP Mentor as a funded experience (e.g., REU, UROP, etc.) or as an independent study project (4 CR) for credit
      Or
   c. Complete, or contribute to a structured project experience within a club or organization related to the Grand Challenges (e.g., engineering project sponsored by Engineers Without Borders)

2. **Multidisciplinary Competency**
   a. Complete Hub Electives (courses) that provide units of multidisciplinary themes including: Philosophical Inquiry and Life's Meanings, Aesthetic Exploration, Historical Consciousness, Social Inquiry, and Ethical Reasoning (all required for all ENG degree programs starting with the class of 2022). (16 CR)
      AND
   b. Participate in multidisciplinary senior design team (4 CR) under the guidance of a mentor and engaging students or stakeholders from disciplines outside of engineering
      Or
   c. Participate in multidisciplinary design team in a club or related organization or related design or venture competition under guidance of a mentor and engaging students or stakeholders from disciplines outside of engineering

3. **Viable Business/Entrepreneurship Competency**:
   a. Complete the Technology Innovation Concentration, a four-course concentration (16 CR) offered to ENG students, or the new Innovation and Entrepreneurship minor, a five-course (20 CR) sequence.
      Or
      Complete SI480 (4 CR), The Business of Innovation, plus a TIC experiential component, or the combination of SI 480 plus SI 482 (4 CR), Strategy for Technology-Based Firms.
      Or
   b. Show evidence of independent, substantive Entrepreneurial-related work such business venture or business plan development.

4. **Multicultural Competency**:
   a. Participate in the BU Study Abroad (12 CR)
      Or
   b. Participate in an approved abroad experience (e.g., European Innovation Academy)
      Or
   c. Travel as part of approved globally-oriented project (e.g., Global Health and Engineers Without Borders)
      Or
   d. Participate in a substantive project related to challenges in other cultures or countries particularly challenges identified via Engineers Without Borders or with faculty performing and mentoring Global Health technologies and implementation, or with other experiential project organizations such as SPARK, Global Apps etc. in which the application is driven by a multicultural or global challenge not a local one.

5. **Social Consciousness Competency**:
   a. Participate in the ENG Technology Innovation Scholars Program (TISP) intended to support K-12 outreach, including reflection
      Or
   b. Participate in an approved service-oriented experience (e.g., Global Apps Club creating apps to benefit community-based organizations)
      Or
   c. Participate in a course project (4 CR) (e.g., Cross-College Challenge) that is explicitly is driven by a challenge in underserved communities.

Constraints on path selection:
   1. Experiences cannot be counted to satisfy multiple competencies
   2. Up to two non-credit bearing experiences are allowed; the remainder shall be associated with credit-bearing activities

The details of each of these program Elements are described next.

Talent Competency

Students can meet the talent competency through a major research or hands-on project or experience related to one of the GC topics. These scenarios are elaborated below.

1. Students may elect to perform a senior design project within one of the published NAE Grand Challenge areas. A student wishing to use this option should identify the Sr. Design topic as early as possible to in consultation with their (a) senior design instructor, (b) project sponsor, and (c) GCSP Topic Mentor. Once approved, the research element proposal, and subsequent deliverables, should be hosted in the student's GCSP portfolio.

Four review points should be baked into the senior design project plan:
   a. October 1: Review and approval of the project and project scope relative to the GCSP Topic (approval by Topic Mentor)
   b. December 15: mid-project check-in
   c. April 1: initial portfolio review
   d. April 15: final portfolio review and signoff

2. Research lab experiences require a statement of proposed work endorsed by their research sponsor and approved by their GCSP Topic Mentor. Projects should include a statement of work and a project plan outlining major deliverables. Internships or projects originating from co-curricular activities will require similar documentation and commitment by the hosting organization: a statement of work, project plan and deliverables.

The review schedule for non-senior design projects follows the milestones above, but adapted to the period of performance. This means review points of:

   a. Prior to the project start: Review and approval of the project and project scope relative to the GCSP Topic (approval by Topic Mentor)
   b. Mid project: mid-project check-in
   c. 2 weeks after to project completion, but not later than 4 weeks prior to degree completion: initial portfolio review
   d. 4 weeks after project completion, but not later than 2 weeks prior to degree completion: final portfolio review and signoff

All substantive hands-on or research projects will be considered. These include NSF REU efforts, UROP, projects originating from organizations including the Global Apps Initiative, Engineers Without Borders, the Imagineering Competition, as examples.

Assessment of the Talent Competency for addressing the GCSP attributes will be based on the rubric attached found in the appendix.

Multidisciplinary Competency

The multidisciplinary component will be realized through meaningful interaction with non-engineers in a group, customer, or team-based settings. Engineering students are expected to learn how to bridge between other engineering and non-engineering disciplines, learning domain-specific language, needs, and expectations; and developing successful relationships in the context of addressing the Grand Challenges. This competency is realized by a combination of the multidisciplinary coursework offered by the BU Hub (see section on BU Hub or https://www.bu.edu/hub/advising-and-the-hub/hub-requirements-for-students/) and through an experiential component. All students must satisfy the Hub requirements as part of their degree programs as a baseline requirement. An extensive list of Hub courses can be found here: https://www.bu.edu/hub/hub-courses/.

The additional experiential component can be satisfied with different options; we outline a few anticipated ways within the BU ENG plan:

1. Participate in a multidisciplinary senior design team involving stakeholders from outside of the ENG disciplines. An example might be a project developing a technology used by customers in a different discipline (health care, law, public health, etc.). The project must satisfy thematic connectivity within a student's CG Topic Area.

2. Participate in a club or related organization or related design or venture competition with well-defined mission and significant multidisciplinary engagement. Examples include Engineers Without Borders, The Global Apps Initiative, or Mass Catalyst Competition. In each case, students must articulate the multidisciplinary elements present in the experience, their level of engagement, and the tangible contributions proposed and achieved.

Approval of Multidisciplinary Component

Students are encouraged to discuss their proposed multidisciplinary work with their GCSP Mentor to develop a satisfactory plan and to ensure viable completion in the program. Proposals, and subsequent activities, will be evaluated based on the extent of multidisciplinary interaction (the diversity of disciplines) and the proposed or realized contact time. Results should be characterized and quantified, and with any tangible outcomes reported in a student's GCSP portfolio. For example, a student should quantify how many meetings with a particular class of stakeholder and the nature of the multidisciplinary interaction. Additional assessment of this multidisciplinary component will be based on the rubric provided in the appendix.

A proposal for satisfying the multidisciplinary component is required that includes the proposed activity, the stakeholders, the contact time, and expected outcomes, and should address the rubrics provided in the appendix for this competency. The proposal should be included as part of the GCSP portfolio. Review of progress for this component will occur during annual review with a student's GCSP Mentor.

Viable Business/Entrepreneurship Competency

This component requires a student to consider how to bring a technology to market either as a commercial venture or to promote positive societal impact. BU Engineering has a rich set of opportunities to demonstrate this component. Options include completing all of, or a subset of, the ENG Completing the Technology Innovation Concentration plus completing an entrepreneurial project.

The ENG Technology Innovation Concentration consists to two core courses, SI 480, the Business of Innovation, and SI 482, Strategy for Technology-Based Firms, plus two electives and a substantive project. Students can fulfill their entrepreneurship component by either completing the TIC requirements, by completing the two core courses (SI 480, SI 482), or by

completing SI 480 plus a substantive and managed innovation experience or project. The project will use the same processes and requirements as dictated by the TIC Experience.

Students must complete SI 480 prior to initiating a TIC Experience. TIC proposals must articulate the elements of innovation or entrepreneurship that will be addressed and reported on in the overall effort. Student proposals can be combined with other efforts, for example, Senior Design or a research project. However, approval by each participant is required. For example, (a) the senior design instructor, (b) project sponsor, and (c) GCSP Topic Mentor. Once approved, the entrepreneurship proposal, and subsequent deliverables, should be hosted in the student's GCSP portfolio.

For senior design-related projects, four review points should be baked into the entrepreneurship plan and proposal:
    e. October 1: Review and approval of the project and project scope relative to the GCSP Topic (approval by Topic Mentor and TIC Coordinator)
    f. December 15: mid-project check-in
    g. April 1: initial portfolio review
    h. April 15: final portfolio review and signoff (by Topic Mentor and TIC Coordinator)

Similarly, for Research lab experiences used for the entrepreneurial element that may occur during the academic year or during the summer, a statement of proposed work endorsed by their research sponsor and approved by their GCSP Topic Mentor and TIC coordinator is required. Projects should include a statement of work and a project plan outlining major deliverables. Internships or projects originating from co-curricular activities will require similar documentation and commitment by the hosting organization: a statement of work, project plan and deliverables.

The review schedule for non-senior design projects follows the milestones above, but adapted to the period of performance. This means review points of:

    e. Prior to the project start: Review and approval of the project and project scope relative to the GCSP Topic (approval by Topic Mentor and TIC coordinator)
    f. Mid project: mid-project check-in
    g. 2 weeks after to project completion, but not later than 4 weeks prior to degree completion: initial portfolio review
    h. 4 weeks after project completion, but not later than 2 weeks prior to degree completion: final portfolio review and signoff (by Topic Mentor and TIC Coordinator)

Assessment of the Viable Business/Entrepreneurial Competency for addressing the GCSP attributes will be based on the existing TIC rubric provided in the appendix.

Multicultural Competency

GCSP students are expected to gain multicultural perspective and awareness, especially as they relate to the Grand Challenge Topics. This awareness can originate from interacting with people on an international scale, working with multicultural stakeholders to understand local issues and concerns, participating in efforts that have multicultural or global scope, and working with students with international and/or global perspective.

The multicultural dimension can be satisfied through participation in one of many international experiences offered at Boston University. One way to complete this requirement is through Study Abroad, a program that places BU students in various cities around the world for a semester of full-time coursework abroad. Approximately 20% of our current ENG students participate in this program. Other possible ways include participation in approved abroad experience outside of the university (e.g., the European Innovation Institute focused on global entrepreneurship and innovation); and by significant participation in co-curricular activities that have multicultural scope such as Engineers Without Borders or the Global Apps Initiative. Projects originating with faculty (faculty research experiences) will also be considered to satisfy the multicultural dimension if they provide sufficient opportunities to address multicultural or global issues or engage multicultural/global stakeholders.

Approval of Multicultural Competency Activities

Participation in Study Abroad will satisfy the Multicultural element. Other activities require approval by a student's GCSP Mentor.

Students are encouraged to discuss their proposed Multicultural activities with their GCSP Mentor to develop a satisfactory plan and to ensure viable completion in the program. Proposals, and subsequent activities, will be evaluated based on the extent of global or multicultural concern, and the scope of contact time with these issues and activities.

Results of these activities should be characterized and quantified, and with any tangible outcomes reported in a student's GCSP portfolio.   For example, a student should quantify how many meetings with a particular class of stakeholder and the nature of the multicultural interaction. Additional assessment of this multicultural component will be based on the rubric provided in the appendix.

A proposal for satisfying the Multicultural Dimension is required that includes the proposed activity, the stakeholders, the contact time, and expected outcomes. The proposal should be included as part of the GCSP portfolio. Review of progress for this component will occur during annual review with a student's GCSP Mentor.

Social Consciousness Competency

Students are expected to demonstrate participation in curricular or co-curricular activities that deepen their social consciousness and provide reflection on the role of engineering in addressing social issues.

Completion of this requirement is achieved by participating in an approved service-oriented or community-engaging experience such within the Global Apps Initiative, Engineers Without Borders, or a Senior Design project with a strong social outcome focus (e.g., focus on a project for Global Heath). Students participating in the ENG Technology Innovation Scholars Program that provides K-12 outreach and student mentoring will satisfy the Social Consciousness element. An example project might be the development of assistive technologies for mobility or visual impaired people in association with a local organization; or investigation of health challenges in developing countries.

All Social Consciousness activities will require a written reflection component. The reflection should include both a reflection on the service impact and a personal reflection on how the service impacted the student.

Similar to other elements, the Social Consciousness element requires a proposal, check-ins, and final approval. Proposals and reflections should be hosted on a student's portfolio.

Approval of Social Consciousness Activities

Students are encouraged to discuss their proposed Social Consciousness activities with their GCSP Mentor to develop a satisfactory plan and to ensure viable completion in the program. Proposals, and subsequent activities, will be evaluated based on the extent of service impact scope of contact time with these issues and activities.

Results of these activities should be characterized and quantified, and with any tangible outcomes reported in a student's GCSP portfolio. Assessment of the Social Consciousness component will be based on the rubric provided in the appendix.

A proposal for satisfying the Social Consciousness component is required that includes the proposed activity, the stakeholders, the contact time, and expected outcomes. The proposal should be included as part of the GCSP portfolio. Review of progress for this component will occur during annual review with a student's GCSP Mentor.

Recruiting, Mentoring, and Evaluation

We will promote the GCSP through a central ENG website and communication through existing communication channels to our undergraduate ENG population beginning with the incoming class of students. These include, but are not limited to, regular email communications to each class year about upcoming opportunities such as our Technology Innovation Concentration,

Study Abroad; communications done within the context to Senior Design; Communications originating from Innovate@BU, and regular promotional activities associated with the ENG Communications group. In addition, the GCSP Director will host annual Information Sessions to describe the program and recruit new participants. The Director will also brief the various BU clubs on how they can be involved to support different program elements in their own initiatives. We also expect to use the successes of individual GC Scholars and their work product to promote the goodness brought forth in the effort. These promotional efforts provide the basis for the follow-on selection, mentoring, and evaluation activities.

Recruiting and Selection of GCSP Students

In addition to the activities described above, the primary recruiting will be through the annual informational session and by student interaction with Grand Challenge Topic coordinators. However, we anticipate a substantial responsibility borne by individual students to meet the broad GCSP requirements. Here is the basic flow:

1. Students learn of the GCSP program through one of the communication vehicles above
2. Student attend GCSP Information Session and identify topics of interest
3. Students meet with GCSP Topic Coordinators to identify opportunities
4. Students do the leg work to find a topic-specific GCSP Mentor in their topic area
5. Mentors work with students to develop a plan
6. Plan is submitted through application portal with supporting materials (letter of reference, transcript information) by December 15 of each year
7. GCSP Working Committee reviews plans with respect to plan rubrics and approves, rejects, or requests revisions to plan proposals.
8. Student works to plan, with revisions as necessary, posting updates and work product to portfolio
9. Students follow planned check-ins with mentors until completion
10. Students awarded degree designation

Notes on scholar selection: The Working Committee will develop and manage the admissions process. Due to the nature of the program requiring additional effort beyond the baseline degree program, we estimate a participation rate of less than 10%. Some aspects of the program will be self-limiting. For example, the availability of research mentors. In terms of admissions criteria, we will rely on an assessment of the potential for a student to meet the goals of the program based on their plans with respect to plan rubrics. Supporting evidence may include letters from mentor(s), current transcript, and essay as part of the proposed plan. In the event that we reach the limit of our capacity to support students (estimated to be 10%), we will either limit based on ranked assessments or will opt to increase our limit. We seek some flexibility to work this out after we gain more experience with student uptake into the program.

Student and Program Evaluation

Students will be evaluated on progress and completion for each of the GCSP competencies based on the rubrics described in the appendix for each competency.   Input will be provided based on the participants in each element, typically the project mentor or in some cases an instructor or concentration coordinator (as in the technology innovation area). For example, for a senior design project, the entrepreneurial work will be assessed by the TIC coordinator. For some other project focusing on a different competency, the project supervisor or mentor will provide an evaluation against the corresponding rubric.

Program evaluation will be realized by annual review of completed student CSPS portfolios and will be performed by the GCSP Working Committee. Portfolios will be evaluated against the goals of the NAE program, with the intent of identifying areas for improvement. Annual review will occur in September—October to correspond with the university annual assessment deadline in November.

Uniqueness of BU ENG Plan

The College of Engineering at Boston University is a major research organization with nearly 1800 undergraduates and over 1000 graduate students. The research expends nearly $90 Million in extramural funds via its core faculty and research center. Our research is driven to enhance knowledge and application of engineering science to society's grand challenges. Among our Multidisciplinary research centers is our recently granted NSF Engineering Research Center on Cellular Metamaterials. We also recently opened a 9 story, 170,000 sq foot Kilachand Center for Integrated Life Science and Engineering focusing on neuroscience and synthetic biology and biological design. The Center is supported by a $100 Million endowment gift that will fund research at the intersection of life science and engineering.

For over a decade now Boston University's College of Engineering has designed and continuously enhances its educational program under the guiding philosophy of *Creating the Societal Engineer*® (http://www.bu.edu/eng/about/boston-university-creating-the-societal-engineer/). The *Societal Engineer* is a person using the powerful problem solving skills associated with an engineering education and a set of additional empowering attributes to address society's challenges and improve quality of life regardless of their career path. The additional attributes of the Societal Engineer include "broad" communication skills, systems thinking, global awareness, cultural awareness, comfort with cross-functional teams, a passion and understanding of the innovation and entrepreneurial process, an appreciation for the role public policy plays in technology innovation, a commitment to motivate a diverse pipeline of people top pursue STEM careers, and finally a social consciousness.

Creating the Societal Engineer is accomplished via innovative curricular that embraces the concept that the era of the single discipline engineer is over, and by a wide array of experiential programs. For example, about 25% of our undergraduates participate in a semester abroad program. We have many service learning programs including a chapter of Engineers Without

Boarders and a Global Health initiative. We have created a Technology Innovation Concentration in partnership with our business school. We have an Engineering Product Innovation Center (EPIC) which is a 15,000 sq. ft maker space that we embed in our curriculum required courses as well an Imagineering Lab for students to innovate on anything they want that is not course required. There are Entrepreneurship Clubs, Global App Initiatives, Energy Club, Habitat for Humanity, Social Impact and Global Venture Clubs, and much more.

It is evident that the goals of the GCSP is highly synergistic with our goals to Create the Societal Engineer, so much so that we have structured the requirements to become a GCSP to be as inclusive and aligned with the Societal Engineering concept as possible. In short, we view a GCSP as a subset of Societal Engineers that achieve the GCSP competencies via experiences and courses centered specifically around one or more of the identified NAE Global Challenges. We purposely will not require any GCSP to focus on a single NAE challenge for all four years and for all GCSP competencies because so many of our students want to be exposed to how technology can impact multiple societal challenges. Indeed, we design our program to incentivize our students to the power of engineering and the GCSP competencies to solve many of society's grand challenges.

Appendix: BU Hub – Synopsis of the BU Hub and its Relationship to GCSP Goals

Note: All Engineering students will meet Hub requirements through the existing ENG curriculum. Courses or co-curricular activities indicated by the GCSP either add to, or satisfy the existing degree program curricula. We expect that the GCSP students will typically exceed the BU Hub requirements through the addition of more depth in coverage of the Hub attributes from the GCSP elements.

The Hub's Six Capacities, Constitutive Areas, and the Signature Cross-College Challenge (from http://www.bu.edu/gened/practical-guide-for-faculty/six-capacities/)

The founding president of Boston University, William Fairfield Warren, arrived in Boston from his post as a Methodist missionary in Germany. Warren carried with him German ideas about the modern university as a synthesis of liberal arts and professional training, and a belief in higher education as a way to promote understanding among diverse peoples of the globe. More than a century later, Warren's commitments to global engagement, to the lifetime love of learning and the pursuit of truth, and to combining the liberal arts and sciences with professional training still define undergraduate education at BU. Updating those traditions to meet the needs of the 21st century, the six BU Hub capacities identify the core knowledge, skills, and habits of mind that BU undergraduates need to thrive in their professional, personal and civic lives.

1. **Philosophical, Aesthetic, and Historical Interpretation**
2. **Scientific and Social Inquiry**
3. **Quantitative Reasoning**
4. **Diversity, Civic Engagement, and Global Citizenship**
5. **Communication**
6. **Intellectual Toolkit**

The BU Hub is designed to equip students to engage with complexity, diversity, and change, and with enduring features of human cultures. Its six capacities and their constitutive areas expose students to a broad range of knowledge and disciplines, encourage a sense of social responsibility and a commitment to social justice, cultivate a set of widely applicable habits of mind, such as analytical, interpretative, quantitative and communication skills, and develop the ability to apply knowledge in diverse settings.

While the BU Hub does not identify a definitive corpus of knowledge that every student is expected to know, it maps out the core areas of knowledge, skills, and habits of mind that all undergraduates will develop. The BU Hub is flexible, integrated into students' courses of study, and can be pursued along pathways of the students' choosing. In this respect it differs from many standard general education programs: students develop the core knowledge, skills and habits of mind across all four years, in the major and outside the major, in co-curricular activities as well as courses. By featuring courses and co-curricular experiences that help

students develop more than one area, the BU Hub encourages students to draw connections among fields of study and ways of thinking.

The BU Cross-College Challenge (https://www.bu.edu/hub/more-hub-experiences/cross-college-challenge-xcc/) (XCC or HUB XC 433) is the Hub's signature project-based, one-semester, 4-credit elective course **open to juniors and seniors from all 10 undergraduate schools and colleges**. For the Class of 2022 and beyond, XCC also fulfills 4 Hub units. A variety of on-campus and community clients present real-world projects, and students develop the following skills within the context of their team project:

- Creativity/Innovation
- Oral Communication
- Research and Information Literacy
- Teamwork/Collaboration

Today's rapidly changing, interconnected world demands graduates with the ability to think critically, to conduct research amidst an overabundance of information sources, and to explore profound questions and approach problem-solving with imagination and creativity, both individually and as members of a team. Students must also learn to make a range of informed life decisions that will sustain them and enable them to put their education to good use in the world. Cultivating these multipurpose skills explicitly and intentionally is a crucial dimension of BU students' preparation for a broad and ever-evolving spectrum of personal, educational, professional, and civic opportunities.

Finally, as Boston University seeks to educate students who are, in the words of its mission statement, "reflective, resourceful individuals ready to live, adapt, and lead in an interconnected world," the BU Hub calls on students to begin the lifelong pursuit of personal qualities that embody BU's values and aspirations for its graduates.

We hope BU students will learn
- **intrepidness** in thought and action
- **empathy** from walking imaginatively in others' shoes
- **resilience** in recovering and learning from disappointments and setbacks
- **nimbleness** needed to recognize opportunity and respond creatively to changing circumstances
- **humility** in the face of all they do not yet know and understand
- **self-discipline** needed to achieve their goals
- **self-sufficiency** required to take responsibility for themselves and their actions
- **responsibility** to others as **ethical** members of communities
- **self-awareness** necessary for a thoughtful, well examined **wisdom** and **curiosity** about themselves, others, and the world.

Mapping of GCSP dimensions to the BU Hub:
(From http://www.bu.edu/gened/practical-guide-for-faculty/learning-outcomes-for-each-bu-hub-area/)

Relevant to Multicultural and Social Consciousness Competencies: Diversity, Civic Engagement, and Global Citizenship (4 units)

Relevant to Social Consciousness Competency: The Individual in Community—one unit

- Students will analyze at least one of the dimensions of experience—historical, racial, socio-economic, political, gender, linguistic, religious, **or** cultural—that inform their own worldviews and beliefs as well as those of other individuals and societies.
- Students will participate respectfully in different communities **such as** campus, citywide, national and international groups, and recognize and reflect on the issues relevant to those communities.

Relevant to Multicultural Competency: Global Citizenship and Intercultural Literacy—two units

- Students will demonstrate, through comparative analysis, an understanding of global diversity as expressed in **at least** two different languages, cultures, religions, political systems, **or** societies.
- Students will demonstrate detailed understanding of at least two cultural contexts through foreign language **or** culture study at BU, participation in a language or culture living-learning community at BU, **or** study abroad. This will involve reflection on the challenges and pleasures students discover in orienting themselves in new and unfamiliar cultures.

Ethical Reasoning—one unit
- Students will be able to identify, grapple with, and make a judgment about the ethical questions at stake in **at least** one major contemporary public debate, and engage in a civil discussion about it with those who hold views different from their own.
- Students will demonstrate the skills and vocabulary needed to reflect on the ethical responsibilities that face individuals (**or** organizations, **or** societies or governments) as they grapple with issues affecting both the communities to which they belong and those identified as "other." They should consider their responsibilities to future generations of humankind, and to stewardship of the Earth.

GCSP Portfolio Hosting

All GCSP students (applicants and Scholars) are expected to use an electronic portfolio that minimally allows faculty access to student-posted work. We will allow different vehicles for hosting portfolios including:

- BU student personal web sites (http://people.bu.edu)
- BU Google Apps (http://www.bu.edu/tech/support/google/)
- ePortfolio (https://www.bu.edu/eportfolio/).

Requirements for electronic portfolios:

1. Post and maintain current plan for each GCSP element
2. Access to portfolio by Program Director, Mentors, academic administrators, project stakeholders
3. Host results and deliverables from program plans

Draft Rubrics

		To what extent does the effort demonstrate the ability to:	High 5	4	3	2	Low 1
Entrepreneurship Competency	**Teaming**	*Collaborate as member or leader of a project team.*					
	Customer Needs Assessment	*Summarize background research customer need data in a concise and convincing way.*					
	Market Assessment	*Summarize background research on market and competitor data in a concise and convincing way.*					
	Communication	*Present complex technical concepts to a general audience that direct towards business-focused outcomes.*					
	Cost and Value Quantification	*Relate engineering cost to customer value; defining value in terms of quantified financial impact vs. recurring and non-recurring engineering costs.*					
	Financial Forecast	*Show a revenue and cost forecast over 5 years for the product or concept proposed.*					
	Investment Decision	*Identify a unique and sustainable business case or model, worthy of investment with real dollars.*					

		To what extent does the effort demonstrate the ability to:	High 5	4	3	2	Low 1
Engineering/ Research Talent Competency	**Identify CG Area**	*Identify and state the problem in a GC area clearly and succinctly. Demonstrate understanding of the challenge and its relation to needs.*					
	Problem identification and scope	*Formulates questions and plan for inquiry that identifies skills, knowledge, people, tools and other resources for the problem in GC theme. States the problem.*					
	Focus and relevance	*Describe how the focus of the effort is relevant to the problem and the grand challenge; and the plan including resources is feasible.*					
	Needs Analysis	*Parse and articulate customer needs and how to reinforce; describe functional system inputs and outputs as a black box.*					
	Concept Generation	*Explore and document multiple strategies for design concepts.*					
	Tradeoff Analysis	*Describes process and decision-making for design selection within concept space.*					
	Supporting research	*Identify and collect qualitative and quantitative information in multiple disciplines from print and archival sources, electronic data, interviews, surveys, etc.*					

	Data collection, interpretation, and visualization	Record, archive, analyze, interpret, and communicate data and models for data collected from experiments, analysis, and the literature.					
	Justification and support of approach and results	Explain, justify, draw conclusions from research; support design decisions, defend results; propose future work.					

Competency		To what extent does the effort demonstrate the ability to:	5	4	3	2	1
Multidisciplinary Competency	Multidisciplinary Perspectives	Adopt and articulate multiple perspectives on a grand challenge problem; defending each					
	Application of multidisciplinary knowledge	Demonstrate and apply knowledge from multiple disciplines as it applies to grand challenge problem.					
	Integration of modes of thinking and literary expression	Integrate alternative, discipline-specific modes of thinking; and use of literary practices such as reflection, instructional design, video presentation, storytelling.					
	Alternative Insights	Explore and elaborate on alternative insights from each of multiple disciplines for a grand challenge					

		To what extent does the effort demonstrate the ability to:	5	4	3	2	1
Multicultural Competency	Cultural Interconnectedness	Represent and describe how technology impacts individuals, nations, and global economy and their ability to interconnect					
	Impact of global organizations	Understand and represent how decisions made by national or international organization impact individuals, societies, cultures, economies and the environment in the context of engineering.					
	Cultural Impact on Engineering	Quantify the impact of factors such as culture, politics, geography, gender, and economics on engineering					
	Awareness	Show knowledge of cultural differences, beliefs, and values; represent different cultural vantages; recognize stereotyping and bias.					
	Interaction	Communicate and interact positively with individuals from different cultural groups and learn from diverse perspectives. Sustain relationships					
	Use of Technology	Demonstrate the knowledge of the technological culture of different communities					

		To what extent does the effort demonstrate the ability to:	5	4	3	2	1
Social Consciousness Competency	**Community Needs**	*Thought put into creating a meaningful and innovative project that meets community needs*					
	Collaboration	*Engage with community stakeholders in collaboration to develop project solution.*					
	Service Plus Learning	*Project integrates and balances coursework and research with teaching, learning and service to community*					
	Reflection	*Reflect on social and service contributions using different media.*					
	Quality of Life	*Drive or participate in improvements in civic responsibility, quality of life with sustainable impact*					

Note: These rubrics were adapted in part from existing rubrics for the ENG Technology Innovation Concentration and rubrics published as part of the University of Texas at Austin NAE Grand Challenge Scholars Program. We anticipate that the rubrics will evolve as experience in assessing the competencies matures.