UNIVERSITY *of*
DENVER

DANIEL FELIX RITCHIE SCHOOL
OF ENGINEERING & COMPUTER SCIENCE

APPLICATION TO THE NAE

GRAND CHALLENGES SCHOLARS PROGRAM (GCSP)

BY

RITCHIE SCHOOL *OF* ENGINEERING & COMPUTER SCIENCE

UNIVERSITY OF DENVER

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I.   Grand Challenges Scholars Program Vision

The Daniel Felix Ritchie School of Engineering and Computer Science at the University of Denver (DU) is committed to becoming a leader in educating engineers and computer scientists to meet the grand challenges facing our global society in the 21st century.

This is a strategic priority for the University overall under its new Chancellor, as expressed in the recently adopted DU 2025 Strategic Plan http://imagine.du.edu/du-impact-2025/. At DU, 70% of incoming undergraduate students self-identify as entrepreneurs and 70% study abroad. DU's slogan *'A Private University Serving the Public Good'* represents the mission-orientation of its students and faculty. Many of the University's units currently participate in (non-NAE) Grand Challenges (for example, the Graduate School of Social Work http://www.du.edu/socialwork/gsswnews/2016/10-11-challengesoct.html). New multi-discipline and interdisciplinary initiatives involving engineering have launched at scale across the University with focus on innovation and entrepreneurship (Project XITE) and community service (CCESL).

The Ritchie School has recently completed a strategic planning process and is implementing the initial phases for next academic year. This plan includes a commitment to project-based learning and addressing Grand Challenges throughout undergraduate and graduate education, research and scholarship.

II.   Definitions

Grand Challenges Scholars Program Applicant (GCSP Applicant) – a student in the Ritchie School who is completing an application for submission to the Ritchie School Grand Challenges Scholars Program.

Grand Challenges Scholar Candidate (GCS Candidate) – a Ritchie School major who has been accepted to the GCSP and is working with a GCSP Mentor.

Grand Challenges Scholar (GC Scholar) - a Ritchie School major who has completed the Grand Challenges Scholars program.

Grand Challenges Scholars Program Mentor (GCSP Mentor) – a faculty member or industry partner who is advising and guiding a GCSP Candidate on a topic tailored to one of the National Academy of Engineering (NAE) Grand Challenges topics. Mentors will be responsible for periodic monitoring of the GCS Candidate's progress in the overall program. If the mentor is an industry partner, a secondary faculty mentor will also be selected to help with the academic advising.

Grand Challenges Scholars Program Leadership Team (GCSP Leadership) – Selected Ritchie School faculty and staff, the Senior Associate Dean, and selected GCS Candidates who are responsible for the recruitment of GCSP Applicants, application review and acceptance of GCS Candidates, reviewing research plans, monitoring overall student progress toward completion of the program, and public relations for the Ritchie School Grand Challenges Scholars Program. The Ritchie School Dean is a non-voting advisory member.

III.   Ritchie School Grand Challenges Scholars Topics

In its 2017-2022 Strategic Plan, the Ritchie School of Engineering and Computer Science chose to focus its research and teaching on two "Global Goals": *Healthy Global Citizens* and *Smart, Sustainable World*. These Global Goals relate directly to the National Academy of Engineering's Grand Challenges and the

[UN's Sustainable Development Goals](). Of the 14 NAE Grand Challenges, we have currently 12 with identified faculty mentors (see Appendix B for the list of faculty):

1. Make solar energy economical
2. Develop carbon sequestration methods
3. Provide access to clean water
4. Restore and improve urban infrastructure
5. Advance health informatics
6. Engineer better medicines
7. Reverse-engineer the brain
8. Prevent nuclear terror
9. Secure cyberspace
10. Enhance virtual reality
11. Advance personalized learning
12. Engineer the tools of scientific discovery

Since our School's two Global Goals align well with both NAE Grand Challenges and the UN's Sustainable Development Goals, we expect broad faculty involvement in the GCSP.

IV. Program Components

The Grand Challenges Scholars Program has five completion components required to satisfy the expectations of students enrolled in the GSCP as follow:

1. Complete a Research Experience Project or independent research related to a Grand Challenge.
2. Participate in an Interdisciplinary Curriculum that prepares engineering and computer science students to work at the overlap with public policy, business, law, ethics, human behavior, risk, as well as medicine and the sciences.
3. Participate in entrepreneurship to prepare students to translate invention to innovation; to develop market ventures that scale to global solutions in the public interest.
4. Experience Global Dimension that develops the students' global perspectives necessary to address Challenges that are inherently global as well as to lead innovation in a global economy.
5. Participate in service learning for developing and deepening students' social consciousness and their motivation to bring their technical expertise to bear on societal problems.

V. Ritchie School Application Process

GCSP applicant will:

- Take a one Quarter Hour (QH) course in Fall or Winter during their first year, which introduces the students to the program, the NAE Grand Challenges, etc. This will also include an introduction to possible mentors and facilitate matchmaking between mentors and students
- Identify their overall NAE Grand Challenges subject area
- Choose a GCSP Mentor and work with their mentor on a plan for completing the GCSP components
    - Incorporate each of the five completion components of the Ritchie School GCSP (opportunities in each of the five areas are identified below); and
    - Identify the mix of competencies (2 at a high level, 2 at a moderate level, and 1 at a foundational level) for successful completion of the program.

VI.   Ritchie School Implementation

The five program components listed above will be addressed by Ritchie School GCS Candidates in the following ways:

1. Hands-on Project OR Research Experience

Engineering [the following are examples of grand challenges that are likely to be of interest to engineering students; however, students are free to choose any of the grand challenges listed in Appendix B: Make Solar Energy Economical, Restore and Improve Urban Infrastructure, Reverse-Engineer the Brain, Secure Cyberspace, Enhance Virtual Reality, Advance Personalized Learning, Engineer the Tools of Scientific Discovery]

> (1) Engineering Design course is a yearlong, multidisciplinary experience for all engineering students. The bulk of these projects relate specifically to Grand Challenges. Computer Science (CS) students have been involved in design projects on an *ad hoc* basis when the topic is relevant. Project solicitation will include a section on whether the projects are related to one of the Grand Challenges. GCS Candidates can identify Engineering Design as fulfilling their requirements for completion of the GCSP program.

> (2) Students in their junior year participate in an Engineering Integration course, which typically combines three or four students to work as a group to accomplish the design, manufacturing, and programming of an autonomous vehicle. There are options in this course to choose a GC related alternative project that GCS Candidates would be able to take advantage of as well.

> (3) Research faculty may include Research Experience for Undergraduates (REU) in their proposals. Many of the Ritchie Schools' Engineering and CS faculty research focuses on GC topics. GCS Candidates will be provided tailored research opportunities within the areas listed above.

Computer Science [the following are examples of grand challenges that are likely to be of interest to computer science students; however, students are free to choose any of the grand challenges listed in Appendix B Advance Health Informatics, Reverse Engineer the Brain, Secure Cyberspace, Enhance Virtual Reality, Advance Personalized Learning]

> Computer Science students have the opportunity to take a year-long capstone course. Additionally, computer science students can work with professors on Partners in Scholarship (PINS) projects and/or work on a hands-on project or research in the context of a departmental distinction project. All Cybersecurity students are required to spend one-quarter in an on-site industry capstone project. GCS Candidates working with Computer Science faculty in these ways can identify this as a portion of their experiences in the program.

Assessment of Accomplishments for Component 1:

- a. High level of accomplishment:
    - i. Engineering Design / Capstone presentation at a national conference, or
    - ii. Publication and presentation of research at a professional conference.
- b. Moderate level of accomplishment:
    - i. Engineering Design / Capstone presentation at a university-wide forum, or

   ii. Acceptance of an abstract and paper or poster for presentation in a regional or local conference.
  c. Fundamental level of accomplishment:
   i. Presentation of research with internal report and presentation of the results at a department seminar.

2. Interdisciplinary Curriculum

The interdisciplinary curriculum complements disciplinary fundamentals with courses in other fields related to their chosen Grand Challenge topic and prepares students to work at the intersection of public policy, business, law, ethics, human behavior, risk, and the arts, as well as medicine and the sciences.

As described in Section VIII, GCS Candidates, in consultation with their GCSP Mentors, will identify interdisciplinary minors or courses most appropriate for their personalized plan. The proposed minors/courses will be reviewed by the GCSP Leadership Team who can make recommendations for alternative courses/minors. Below we list some examples of curricular and extra-curricular activities that are suitable for fulfilling the requirements of the Interdisciplinary Curriculum component. In Appendix C, we provide a list of *suggested* courses and minors. We note that this list is neither restrictive nor comprehensive and the student, the mentor, and GCSP Leadership Team can identify additional courses/minors.

Engineering

> Current programs in engineering have 10 – 12 quarter hours (QH) of technical electives. Individual options are available for these technical electives and can be designed to accommodate the GCSP Candidates to meet the interdisciplinary component of the program.

> Students have the option to take courses in the summer or during winter-interterm sessions. A plan for adding courses should be developed between the student and mentor to best suit the student's schedule and needs.

Computer Science

> Computer Science majors are required to take another minor in addition to the required minor in Math. Many CS students pursue minors in Business, Physics, Biology or Chemistry among many others. The BS in Computer Science requires 20 QH of technical electives which allow students to individualize their course of study to complement the GCSP requirements. Additionally, up to 8 QH of elective credit can be approved from outside the Computer Science department.

> Computer Science students pursuing a BS or BA in Game Development are required to take 20 QH of courses from the Art and Emerging Digital Practices departments, and often receive a Minor degree in these disciplines.

University-Wide

> Interdisciplinary 'knowledge bridges', including new curricular offerings, are fundamental to the DU 2025 strategic plan adopted by the Board of Trustees this year, http://imagine.du.edu/du-impact-2025/. This is an opportunity to be considered in the future.

Assessment of Accomplishments for Component 2:

    a. High level of accomplishment:
        i. A combined GPA of 3.0 or greater within the interdisciplinary minor or approved set of thematic interdisciplinary courses used to fulfill this requirement. A minimum of 20 QH.
    b. Moderate level of accomplishment:
        i. A combined GPA of 3.0 within the interdisciplinary minor or approved set of thematic interdisciplinary courses used to fulfill this requirement. A minimum of 12 QH.
    c. Fundamental level of accomplishment:
        i. A combined GPA of 3.0 within the interdisciplinary minor or approved set of thematic interdisciplinary courses used to fulfill this requirement. A minimum of 8 QH.

3. Entrepreneurship

The entrepreneurship requirement prepares students to translate invention to innovation; to develop market ventures that scale to global solutions in the public interest.

The Daniels College of Business offers a minor in Entrepreneurship which can be combined with any of the majors offered by the Ritchie School.

Additionally, the University launched Project X-ITE (http://www.projectxite.org/) last year, a bold University-wide exploration on cross-discipline innovation, technology and entrepreneurship which involves many engineering students and faculty in cross-discipline, project-based innovation collaborations and events in the community. Through Project X-ITE, students have access to curricular, co-curricular and extra-curricular entrepreneurship activities with faculty across the campus and with leaders and entrepreneurs from the local community.

xPeriments: As part of Project X-ITE, students will have the opportunity to engage in 10-week experiential learning projects in partnership with local companies and non-profits. Each xPeriment will have a cross-disciplinary team working together on projects of interest and importance to the partner organizations.

Dynamize: DU Entrepreneurship Society – This on-campus, student-led entrepreneurship club allows students to work hand-in-hand with local entrepreneurs and each other, enabling the sharing of ideas and mentorship, as well as access to funding to turn innovative ideas into reality. Including pitch competitions, hack-a-thons, networking, internship opportunities and community entrepreneurship events, Dynamize enables students to get in-depth experience and connections to entrepreneurship. Membership in Dynamize is open to all undergraduate and graduate students at DU.

The Forge Innovation Clinic: Under the auspices of Project X-ITE, the Sturm School of Law at DU has launched a new multi-discipline for-credit social entrepreneurship clinical initiative called "The Forge Innovation Clinic". Through the Forge Innovation Clinic, students can access high-quality legal advice around intellectual property, employment contracts and agreements, and business entity formation. The services offered through The Forge complement the other entrepreneurship resources available.

Trish & Ralph Nagel Innovation Lab: The new Engineering and Computer Science building (130,000 square feet) opened Autumn 2016 includes an Innovation Floor, *the Trish & Ralph Nagel Innovation Lab*, dedicated to ideation, design-thinking, and rapid prototyping. The Innovation Floor includes both an incubator space (with teleconferencing and gaming capabilities) as well as a makerspace, allowing for

hands-on, innovative prototyping. The Innovation Floor is an open-access, interdisciplinary state-of-the-art facility designed to serve the entire campus and reach out into the community.

Assessment of Accomplishments for Component 3:

a. High level of accomplishment:
    i. Complete the Entrepreneurship minor, or
    ii. Serve in a leadership position in Dynamize or on the Project X-ITE Student Advisory Board, or
    iii. Participate in founding a startup company.
b. Moderate level of accomplishment:
    i. Complete 12 QH courses within the Entrepreneurship minor with a combined GPA of 3.0 or higher, or
    ii. Participate in a startup, or
    iii. Participate in a 2 Project X-ITE xPeriment offerings.
c. Fundamental level of accomplishment:
    i. Complete 8 QH courses within the Entrepreneurship minor with a combined GPA of 3.0 or higher.

4. Global Dimension

The Global Dimension requirement develops the students' global perspective necessary to address challenges that are inherently global as well as to lead innovation in a global economy.

The University of Denver is renowned for the proportion of undergraduates who study abroad through its Cherrington Global Scholars program, and for its Joseph Korbel School of International Studies. Both provide pathways for GCS Candidates to participate in study abroad programs and gain exposure to international issues. **DU is 4th in the U.S. among doctoral and research universities for the percentage of its undergraduates studying abroad**, according to the 2015 Open Doors report, and has the 8th most popular study-abroad program nationally, according to The Princeton Review.

Four Engineering Design projects have been sponsored by The Invictus Initiative (http://theinvictus.org/) in the past 3 years. The designs must use appropriate technology that is sustainable in the third world country where they are installed. These aspects of the design drive students to get into the shoes and the environment of the users. The Invictus Initiative Club is a DU sanctioned club and meets periodically on campus.

There are also a range of options for interterm-abroad experiences and courses in engineering and computer science to address global challenges. The University's quarter calendar provides flexible summer terms that are an ideal platform for those who cannot take a full quarter abroad during the academic year.

Engineers Without Borders - USA (EWB-USA) is currently building their presence on campus through projects related to the Center for Sustainability, and is building up to their first international project (2017, expected). GCS Candidates who participate in EWB-USA will have the opportunity to engage with students of other academic units such as the international development through the Josef Korbel School and anthropology. Involvement with EWB-USA as a volunteer will expose GCS candidates to a network of corporate partners that can lead to further internship and employment opportunities.

The Ritchie School is partnering with the United Nations Foundation to bring to Colorado 20 companies from around the world which were winners of the UN's Global Solutions Summit competition in the fall of 2016. The Global Solutions Summit highlighted exceptional innovators who were advancing one or more of the objectives of the UN's 17 Sustainable Development Goals. Bringing these companies to Colorado will provide project opportunities with a global focus for DU students through 2017. This initiative is likely to become an annual event. Student participation in a project with one of the companies will qualify for the Global Dimension requirement.

Finally, the School of Engineering is exploring specific tie-ups with a select few international Universities, including the University of Glasgow. The program with Glasgow is a 3+1+1 program where students will study at Glasgow for 2 years after completing their junior year at DU and receive the BS from DU after successful completion of their first year at Glascow (the 4th year) and an MS from Glasgow after successful completion of the second year at Glascow (the 5th year).

Assessment of Accomplishments for Component 4:

    a. High level of accomplishment:
        i. Study or work abroad for a quarter and present a reflection of their experience related to the GC to the Ritchie School, or
        ii. Participate in a service learning experience abroad or with a global impact, and present a reflection of their experience related to the GC to the Ritchie School
    b. Moderate level of accomplishment:
        i. Complete internship or co-op experience with an organization with a multi-national reach and write a reflection on the global impact of the experience, or
        ii. Participate in a project with one of the winning companies of the UN's Global Solutions Summit competition.
    c. Fundamental level of accomplishment:
        i. Participate in an on-campus organization with a global reach (e.g., Engineers Without Borders) and write a reflection on the global impact of the experience.

5. Service Learning

The goal of the Service Learning portion is to develop and deepen students' social consciousness and their motivation to bring their technical expertise to bear on societal problems through mentored experiential learning.

Service learning and community engagement are fundamental differentiating attributes of an education at the University of Denver, and there are both curricular, co-curricular, and extracurricular service learning opportunities available to students. The University's highly-regarded Center for Community Engagement and Service Learning (CCESL http://www.du.edu/ccesl/) provides strong connections to a range of GC-related opportunities. One co-curricular activity is the Scholar Shop, which "connects community organizations with students (undergraduate, graduate) and faculty to address public problems through research and/or creative work. Students and faculty bring diverse academic experience and interests (e.g., business, law, social sciences, arts, humanities, engineering, social work, law, computing, mathematics, environmental management and more) to these collaborations." This is cutting edge because faculty and students work together to address research questions identified together with communities, so ensures the relevance of their research to community problems.

Explorations are underway with GRID Alternatives as another GC pathway for students. "GRID Alternatives is a 501(c)(3) certified non-profit organization that brings together community partners,

volunteers and job trainees to implement solar power and energy efficiency for low-income families, providing energy cost savings, valuable hands-on experience, and a source of clean, local energy that benefits us all." – http://gridalternatives.org/.

At present, engineering students have worked with the Center for Sustainability to design and build various projects relating to sustainability, most recently a solar powered coffee bicycle. The Center is always looking for ways to improve sustainability around campus and in the greater community, and is generally very open to student-run ideas on ways to further such goals.

Other extracurricular opportunities related to the Grand Challenges may be available through organizations such as: Engineers Without Borders, the Center for Community Engagement and Service Learning, among others.

Finally, students pursuing Departmental Distinction in Engineering or Computer Science must work on an extracurricular project related to their major. GCS Candidates may identify this as a portion of their experiences in the program.

Assessment of Accomplishments for Component 5:

a. High level of accomplishment:
   i. Contribute a minimum of 60 hours of service to a service organization on a project related to their proposed Grand Challenges area(s), as well as writing a reflection on the service aspects of the experience or
   ii. Define, develop, and lead a service project of acceptable magnitude in collaboration with their mentor addressing aspects of their Grand Challenges topic area(s) as well as writing a reflection on the service aspects of the experience.
b. Moderate level of accomplishment:
   i. Contribute a minimum of 30 hours of service to a service organization on a project related to their proposed Grand Challenges area(s), or
   ii. Join and participate in Engineers Without Borders or The Invictus Initiative and participate in one of the chapter's projects as well as writing a reflection on the service aspects of the experience.
c. Fundamental level of accomplishment:
   i. Participate in a service organization through a project or volunteer experience with at least 30 hours contribution as well as writing a reflection on the service aspects of the experience.

VII.   Selection of GCS Candidates

Approximately 20 Candidates will be selected annually based on a completed application and interview process. In its 2017-2022 Strategic Plan, the Ritchie School is adopting an aggressive plan to increase diversity and drive inclusive excellence throughout all aspects of the School. Success in this effort is not only strategic vis-à-vis DU Strategic Plan *IMPACT 2025*, but also as a prospective critical competitive differentiator. The School believes that an 'all of the above' approach is vital to achieving aims in this category, from aggressive financial aid, to targeted recruiting efforts at appropriate recruitment fairs, to changes in pedagogical approach, and to consistent focus on extracurricular opportunities. Hence, as a

result of these inclusive excellence efforts, we expect the cohort of 20 students to form a diverse group with significant representation from traditionally under-represented minorities.

A GCSP Candidate must meet the following conditions to be admitted to the GCSP in the Ritchie School:

1. Enroll in a GCSP course (ENGR 1810/COMP 1810 - 1 QH) in either the Fall or Winter quarter during their first year. The course will include guidance on the submission of the GCSP Proposal.
2. GCSP Candidates must remain in good standing with a minimum 2.7 GPA at the time of application and maintain this 2.7 GPA at all times while considered a GCSP Candidate.
3. The GCSP applicant will identify a GCSP Mentor who is willing to work with them to meet the GCSP requirements. Working with their selected GCSP Mentor, applicants will prepare an application describing their intended activities and achievement levels to meet the GCSP program requirements. The expectation is for the GCSP applicant to be able to complete two areas with a high level of accomplishment, two areas with a moderate level of accomplishment, and one area with a fundamental level of accomplishment. Applicants may propose alternative approaches to each program component through consultation with their GCSP Mentor and with approval of the GCSP Leadership.
4. Submission of the GCSP Proposal includes a letter from the GCSP Mentor confirming the student meets the application requirements. The proposal package should include:
   a. A preliminary plan that identifies how each of the program components will be achieved and the proposed areas for high, intermediate and minimum levels of achievement.
   b. A preliminary, one-page statement of interest in the GC Subject research area proposed.
   c. Their academic plan showing proposed course selections that meet graduation requirements and GCSP requirements.
   d. A resume identifying career objective, education, work experiences, and current service activities.
   e. An unofficial transcript showing all completed coursework.
   f. Proposals will be due by the end of the Winter quarter of the first year (after completion of the GCSP introductory course).
5. After review of the proposal package the GCSP Leadership will ensure that all five program components are developed and integrated coherently within the grand challenge adopted by the candidate. GCSP Leadership will provide suggestions to improve the proposal and will schedule the candidate for an interview.
6. Each GCSP applicant proposal will be reviewed by the end of Spring Quarter by the GSCP Leadership Team. All complete and qualifying applications will be given an interview. We expect an enrollment of approximately 30 and 12 students in ENGR 1810 and COMP 1810, respectively (estimated approximately as one third of engineering freshmen and one fifth of computer science freshmen). Based on the proposal and interview results, the Leadership Team will identify a total of approximately 20 GCSP Candidates each year from the pool of approximately 42 students, with selections taking place by the end of the Spring quarter.
7. Selected Ritchie GCS Candidates will be eligible to receive up to $1200 in travel support to present their GC research or design project, and $750 in materials or equipment costs related to their research or design project. These funds are not to be directed toward travel costs for study abroad or travel related to other components. Departments and mentors can supplement these funds from their sources, which can be used to supplement travel or other material expenses. Faculty mentoring Ritchie GCS Candidates will also receive, as incentive, discretionary funds that they will be able to spend to upgrade their laboratories in a way to support more effectively the research or the design carried out by the GCS Candidates working in their laboratories. The

amounts will depend on the requirements of the proposed research and the level of involvement of the faculty member in the GCSP activities. These expenses are included in our yearly School budget. In addition, we have launched a fundraising effort through our School Advisory Committee (See Appendix D for the list of the members) to raise scholarships for meritorious GCS Candidates.

VIII.   GCS Candidate Expectations

1. After acceptance into the GCSP Program, GCSP Candidates are required to submit a set of goals for the first quarter. Quarterly reports are due to their GCSP Mentor that defines progress and accomplishments on each of their proposed program components. In addition, the intermediate goals for the following quarter need to be identified.
2. Good academic standing in the program is achieved by attaining at least a 2.7 quarter GPA once accepted to the program. The student's academic progress will be monitored by their GCSP Mentor. If a GCSP Candidate falls short of the quarter GPA requirement, a remediation plan is required to define the shortcoming and how it will be addressed. Students will not be permitted to continue in the program if they have two consecutive quarters below the expected 2.7 GPA.
3. GCSP Candidates will contribute to the program by providing peer feedback and regularly attending monthly GCSP symposium presentations. Symposia will be presented by a variety of speakers addressing topics of leadership, experts on Grand Challenges subjects, and presentations of progress reports from students in the GCSP. The GCSP Leadership will organize the symposium annually to meet monthly during Fall, Winter, and Spring academic quarters.
4. Final Deliverables include a research or design project report, completion of coursework, record of quarterly reports, including a report on their leadership experience, and finally a reflection report explaining how their experiences in the five GCSP components cohere within the context of their chosen Grand Challenge topic. The complete portfolio will be submitted to the GCSP Mentor. The GCSP Mentor will review documents and verify that the GCSP Candidate has met all expectations.

IX.   Grand Challenges Scholars Program Leadership Team

The development of the Ritchie School GCSP started in August 2016 within the context of the development of Ritchie School 2017-2022 Strategic Plan. An ad-hoc committee consisting of faculty, students, and staff was formed to draft the initial document. This document was sent to faculty, students, and colleagues for input and comments. In the next step, the document was presented to the School's Faculty Committee (elected shared-governance faculty committee of the School), who then took the proposed document to their faculty for a final review. The School's Faculty Committee voted and approved the document. Once it is approved by NAE, the program will be managed by a leadership team as described below. Any major change to the program will undergo faculty review and approval following our School's shared-governance processes.

The GCSP Leadership will consist of three (3) faculty members from the Ritchie School (one from each department), appointed by department chairs to staggered membership terms to permit continuity, two (2) faculty members from other Schools/Colleges at the University of Denver and the Senior Associate Dean. The non-Ritchie members will be selected from the Schools/Colleges of Business, Law, etc., in consultations with their Deans, to provide a broader interdisciplinary perspective to the Team. The two non-Ritchie positions will be rotated over time among the aforementioned Schools/Colleges to have inclusive representation from related disciplines. The Ritchie School Dean will be a non-voting member

of the GCSP Leadership team. After the program is established, three GCSP Candidates in their final year will be selected for GCSP Leadership Team roles, hence bringing the GCSP Leadership Team to a steady-state total of 10 (9 voting and 1 non-voting) members (Senior Associate Dean who is also serving as GCSP Director, 5 faculty members, 3 student members, and the Dean as non-voting member). Members of the Leadership Team are responsible for:

- Recruitment of GCSP Applicants,
- Application review and acceptance of GCSP Candidates,
- Reviewing research plans or design projects,
- Monitoring overall student progress toward completion of the program,
- Developing and implementing GCSP Candidate community-building events, socials, and GCSP public-relations events.

Ritchie School of Engineering and Computer Science Grand Challenges Scholars Program Application

Name:

Mentor:

Proposed Grand Challenges Topic Area:

(For each component below, define the targeted level of completion and activities/courses being proposed for each).

Hands-on Project or Research Experience:

Interdisciplinary Curriculum:

Entrepreneurship:

Global Dimension:

Service Learning:

Attachments

- Brief summary of the GC and prospective area to be investigated and why it is of interest (1 page maximum)
- Academic Course Planning with Grand Challenges Milestones Highlighted
- Resume
- Unofficial Transcript

Appendix B – First / Early Adopter Grand Challenges Faculty Members

This list includes Grand Challenges Faculty Members who have declared interest in the application stage. Additional faculty are expected to join after program approval.

Grand Challenges Topic	GCSP Mentor(s)
Make solar energy economical	George Edwards, David Gao, Amin Khodaei, Mohammad Matin, Jason Roney, Kimon Valavanis, Jason Zhang
Develop carbon sequestration methods	Ron DeLyser, Jason Roney
Provide access to clean water	Jason Roney, Matt Rutherford
Restore and improve urban infrastructure	Amin Khodaei, Jason Roney, Matt Rutherford, Kimon Valavanis, Jason Zhang
Advance health informatics	Lotta Granholm-Bentley
Engineer better medicines	Lotta Granholm-Bentley, Corinne Lengsfeld
Reverse-engineer the brain	Lotta Granholm-Bentley, Haluk Ogmen
Prevent nuclear terror	Ron DeLyser, Jason Roney
Secure cyberspace	Rinku Dewri, Ramki Thurimella
Enhance virtual reality	Brad Davidson, Chris GauthierDickey, Scott Leutenegger, Mario Lopez, Susanne Sherba, Nathan Sturtevant
Advance personalized learning	Ron DeLyser, Matt Gordon, Breigh Roszelle
Engineer the tools of scientific discovery	Ron DeLyser, Mohammad Mahoor, Jason Roney, Matt Rutherford, Kimon Valavanis, Chuck Wilson

Appendix C – Example Thematic Courses and Minors for Interdisciplinary Learning

As described in Section VIII, GCS Candidates, in consultation with their GCSP Mentors, will identify interdisciplinary minors or courses most appropriate for their personalized plan. The proposed minors/courses will be reviewed by the GCSP Leadership Team who can make recommendations for alternative courses/minors. Section VI.2 lists some examples of curricular and extra-curricular activities that are suitable for fulfilling the requirements of the Interdisciplinary Curriculum component. In this Appendix, we provide a list of *suggested* courses and minors. We note that this list is neither restrictive nor comprehensive and the student, the mentor, and GCSP Leadership Team can identify additional courses/minors.

Minors

Entrepreneurship - Minor

The university wide Entrepreneurship minor at Daniels focuses on action, decision making, experimentation, and hypothesis testing in the face of an uncertain future within a business context. Students who complete the Entrepreneurship minor will understand how to shape the business, economic, political, and social context along with the creation of their products or services.

BUS 1000: Gateway to Business (4hrs)

No Prerequisite

Practical glimpse into the global and competitive nature of business. From product ideation to product development, this course introduces students to business's role in society in promoting sustainability as the only successful business model for delivering value to customers and stakeholders of all kinds. Key business activities such as marketing, finance and accounting, working in team, and product/service innovation and creativity are introduced. Note: Business students take this course as part of the Business Core.

EVM 3350: Creating New Markets: The Messy Start Up (4 hrs, Autumn)

Prerequisite: BUS 1000

Start a company, launch a product, create a market, and learn how to embrace failure and manage uncertainty. In this hands-on course, student teams will actually create and run their own start-ups.

EVM 3360: Business Law for Entrepreneurs (4 hrs, Winter)

Prerequisite: BUS 1000

This course will highlight the legal and business issues entrepreneurs face as they conceive and launch a new venture. Using real world scenarios, we will explore issues throughout the new venture lifecycle.

EVM 3370: Metrics and Financial Tools for an Emerging Business (4 hrs)

Prerequisite: BUS 1000

Students are taught to link physical activity occurring in the business venture to the movement of numbers on financial statements.

EVM 3380: Leadership, Management, and Execution (4 hrs)

Prerequisite: BUS 1000

In the final course in the minor, students form multidisciplinary entrepreneurship project teams for transforming products or projects into practical realities, and to interact with alumni and community entrepreneurs.

Elective Course (4 hours)

Options include but are not limited to LLC 2003 Creativity & Leadership; COMP 2821 Introduction to Game Design; ENME 3820 Entrepreneurship through 3D Printing and any EVM non-required course. Submit other courses for approval to Dr. Sharon Alvarez, the Koch Chair of Entrepreneurship.

Business Analytics - Minor

Business Information Analytics involves using data to help businesses make decisions. Students completing this minor will gain critical thinking abilities that can be very important to potential employers in an increasingly competitive business environment.

24 credits, including:

INFO 1010	Analytics I: Data Management and Analysis 1	4
INFO 1020	Analytics II: Business Statistics and Analysis 1	4
INFO 3100	Automating Business Processes	4
INFO 3140	Foundations of Information Management	4
Electives	Select eight credits of INFO coursework	8
Total Credits		24

Medical Physics - Minor

At least 20 credits of physics.

Requirements include the following:		14-15
PHYS 1211	University Physics I	5
PHYS 1212	University Physics II	5
PHYS 1213	University Physics III	5
or PHYS 1214	University Physics III for Engineers	4
Plus:		
PHYS 2300	Physics of the Body	3
PHYS 2340	Medical Imaging Physics	3

Total Credits   20-21

Sustainability - Minor

A minimum of 20 hours from the following courses:

Required Courses

Gateway course

GEOG 2500: Sustainability and Human Society. *This course serves as the first course in the minor, addressing the three pillars of sustainability: environmental, economic, and social equity.*

Elective Lens courses - *16 elective credits, including at least one course from each of the three "lens" categories: Natural & Physical Sciences; Social Sciences; and Arts & Humanities.*

Natural/Physical Science Electives   4-8

BIOL 2010	General Ecology
BIOL 2050	Conservation Biology
BIOL 3020	Aquatic Ecology
BIOL 3030	Alpine Ecology
BIOL 3035	Invasive Species Ecology
BIOL 3055	Ecology of the Rockies
BIOL 3060	Tropical Ecology
BIOL 3070	Ecological Field Methods
BIOL 3095	Global Change Ecology
BIOL 3044	Coral Reef Ecology
CHEM 2240	Introduction to Environmental Chemistry
CHEM 3410	Atmospheric Chemistry
CHEM 3412	Environmental Chemistry & Toxicology
EALC 2001	Environmental Sustainability: Local and Regional Environmental Issues (LLC: restricted)
EALC 2002 restricted)	Environmental Sustainability: The Impact of Development on the Environment (LLC;
EALC 2003	Environmental Sustainability: Energy in American Society (LLC; restricted)
ENVI 2801	Water Quality of Western Rivers and Streams
GEOG 2700	Contemporary Environmental Issues
GEOG 2608	Human Dimensions of Global Change
GEOG 3610	Climatology

GEOG 3640	Climate Change and Society
GEOG 3700	Environment & Development
GEOG 3720	Mountain Environments and Sustainability
GEOG 3800	Geography of Colorado
GEOG 3830	Natural Resource Analysis & Planning
GEOG 3870	Water Resources & Sustainability
GEOG 2320	Andean Landscapes (Inter-term travel course)
GEOG 3880	Cleantech and Sustainability
GEOL 3100	Environmental Geology

Social Sciences & Korbel Electives   4-8

ANTH 3040	Anthropologies of Place
ANTH 3310	Indigenous Environment
ANTH 3500	Culture and The City
ANTH 3880	Culture, Ecology, Adaptation
ECON 3970	Environmental Economics
ENVI 3000	Environmental Law
GEOG 2401	The Human Population
GEOG 2410	Economic Geography
GEOG 2420	Geography of Tourism
GEOG 2430	World Cities
GEOG 3310	Culture/Nature/Economics-Human Ecology
GEOG 3340	Geographies of Migration
GEOG 3400	Urban Landscapes
GEOG 3420	Urban and Regional Planning
GEOG 3425	Urban Sustainability
GEOG 3440	Urban Transportation Planning
GEOG 3445	Sustainability and Transportation
GEOG 3730	International Environmental Policy
GEOG 3740	Environmental Justice in the City
GEOG 3890	Ecological Economics

INTS 2270   Sustainable Energy

INTS 2380   Comparative Development Strategies

INTS 3630   Global Environment

PLSC 2840   International Law & Human Rights

Arts & Humanities Electives   4-8

ARTH 3850   Art and the History of Science

COMN 2115   Performance & Social Change

COMN 3701   Topics in Communication (Communications and Climate Change) [1]

EDPX 3200   Data Visualization

EDPX 3350   Sustainable Design

EDPX 3700   Topics in Emergent Digital Culture (Biomedia) [1]

EDPX 3725   Activist Media

ENGL 2708   Topics in English (Native American and Aboriginal Land in Literature; Images of the Apocalypse in Literature and Film)[1]

ENGL 2715   Native American Literature

HIST 2710   From Sea to Shining Sea: Nature in American History to 1900

HIST 2720   Paved Paradise? Nature and History in Modern America

MFJS 3261   Green Screen: Cases and Concepts in Environmental Filmmaking

PHIL 2180   Ethics

PHIL 2785   Environmental Ethics

Additional elective credits may come from any lens category or other approved electives.

Other Approved Courses + Internships[2]   0-4

HRTM 3700   Topics in Hospitality Mgmt (Sustainability and Entrepreneurship)[1]

LDRS 2400   Leadership & Sustainability in Belize (Inter-term travel course)

MGMT 3100   Business Ethics and Social Responsibility

SJUS 2010   Social Justice: Exploring Oppression [LLC; restricted]

Capstone Seminar   4

GEOG 2550: Current Issues in Sustainability (topics vary by instructor)

Total Credits   24

[1] Topics courses must have Sustainability Attribute.

[2] Additional courses including topics courses, study abroad courses, independent studies, and internships may be approved for elective credit on a case by case basis by the Sustainability Minor Advisor.

Environmental Science - Minor

26 credits. Requirements include:

GEOG 1201	Environmental Systems: Weather	4
GEOG 1202	Environmental Systems: Hydrology	4
GEOG 1203	Environmental Systems: Landforms	4
BIOL 1011	Evolution, Heredity and Biodiversity	4
BIOL 1021	Evolution, Heredity and Biodiversity Lab	1
BIOL 2010	General Ecology	4
BIOL 2011	General Ecology Lab	1
GEOG 2700	Contemporary Environmental Issues	4
Total Credits		26

Geographic Information Science - Minor

20 credits of coursework. Requirements include the following:

GEOG 2010	Digital Earth[1]	4
GEOG 2100	Introduction to Geographic Information Systems (GIS)	4
GEOG 3200	Remote Sensing	4
Total Credits		12

[1] This course must be taken prior to completing the other courses for the minor.

A list of acceptable elective courses is available from the geography department.

Prerequisites: Students are expected to have completed the Analytical Inquiry-Natural Science requirement or equivalent prior to enrolling in GEOG 2000 Geographic Statistics. Completion of an introductory course in geography such as GEOG 1410 People, Places & Landscapes; GEOG 1201 Environmental Systems: Weather; or GEOG 1216 Our Dynamic Earth I is encouraged but not required.

Socio-Legal Studies – Minor

The minor requires 20 credits including one of the following: PLSC 1810 Introduction to Law and Society, SOCI 2120 Methods of Socio-Legal Inquiry, SOCI 2755 Legal Actors and Institutions. Remaining credits are selected from electives listed in the major. Only one course in the student's minor can be from that student's major area. Student may complete a pre-approved internship to fulfill up to 4 credits toward the minor. Major and minor courses cannot be double counted.

General areas of specialization

1. Public policy
    a. LDRS 2040 Leading Community Change
    b. LDRS 2050 Collaborative Leadership: Local Perspectives
    c. LDRS 2060 Collaborative Leadership: Global Perspectives
    d. ECON 3740 Health Economics
    e. PPSS 2100 Concepts of the Public Good
2. Business
    a. BUS 1000 Gateway to Business
    b. LGST 3100 Business Ethics & Social Responsibility
    c. LOS 3100 Entrepreneurship
3. Law
    a. LGST 2000 Foundations of Business Law
    b. ENVI 3000 Environmental Law
    c. LGST 3700 International Business Law
    d. L 4310 Introduction to Intellectual Property
4. Ethics
    a. PPSS 2050 Ethical Decision Making
    b. LGST 3710 E-Commerce Law and Ethics
5. Human behavior
    a. BIOL 3641 Systems Neuroscience
    b. BIOL 3646 Seminar: Cognitive Neuroscience
    c. PSYC 3262 Affective Neuroscience
    d. LDRS 2017 The Leadership Process
    e. LDRS 2018 Self as a Leader
    f. LDRS 2019 Leading Teams
    g. LDRS 2300 Transformational Leadership
    h. LDRS 2310 Leadership in a Virtual World
    i. LOS 3150 Working in Groups and Teams
6. Risk

a. INTS 3075 Security Research and Policy Analysis

   b. EALC 2001 Environmental Sustainability: Local and Regional Issues

   c. EALC 2002 Environmental Sustainability: The Impact of Development on the Environment

   d. CMGT 3438 Legal Issues & Risk Management

7. The arts

   a. EDPX 2000 Imaging in Emergent Digital Practices

   b. EDPX 2100 Codes in Emergent Digital Practices

   c. EDPX 2200 Cultures in Emergent Digital Practices

   d. EDPX 2300 Systems in Emergent Digital Practices

   e. EDPX 2400 Time in Emergent Digital Practices

   f. EDPX 3100 Programming for Play

   g. EDPX 3200 Data Visualization

   h. EDPX 3270 Making Networked Art

   i. EDPX 3320 Interactive Art

   j. EDPX 3350 Sustainable Design

   k. EDPX 3450 Visual Programming

   l. ARTS 1250 Drawing

   m. ARTH 2801 World Art I

8. Medicine

   a. Departments of Chemistry, Physics, Psychology, and Biology provide pre-med courses

9. Natural Sciences

   a. Departments of Biological Sciences, Chemistry & Biochemistry, Geography & the Environment, Mathematics, Physics & Astronomy provide courses in the natural sciences.

Appendix D – Members of the Ritchie School Advisory Committee

Alan Cullop - *CIO, DaVita Healthcare Partners*

Albert Kendrick – *CIO, FirstBank*

Amy Schellpfeffer – *Global Product Manager, Medtronic*

Carie Zoellner, *VP of IT and Digital Business, RE/MAX*
Cheryl Bisque - *CTO of Consumer Electronics, Amazon*

Craig Fletcher - *Senior Manager, VM Ware*

Dale Drew, *CSO, Level 3 Communications*

Danielle Osler, *Public Policy Council, Google*

David Anderson – *SVP, CIO, CH2M Hill*

David Roberts – *CEO, Reed Group*

Dawn Beyer – *Fellow, Lockheed Martin*

Harry Brumleve – *VP of Engineering, Hyprloco*

Ingrid Alonghi – *Co-founder, QuickLeft*

Jack Waters – *CTO, President of Network Solutions, Zayo Group*

Jason Carolan – *CTO, ViaWest*

Jay Jesse – *President, Founder, Intelligent Software Solutions (ISS)*

Jim Franklin – *Founder, SendGrid*

Joel Moxley – *Founder, Moxley Holdings*

John Swieringa – *EVP of Operations, DISH Network*

Julian Farrior – *CEO, Founder, Backflip Studios*

Kishore Nayak – *Former CIO, Gates Corporation*

Kirk Holland – *Partner, Access Venture Partners*

Mark Hopkins – *Founder, Crescendo Capital Partners*

Mark Turnage – *CEO, OWL Cybersecurity*

Rob Meilen – *Former CIO, Hunter Douglas*

Sally Hatcher, *Founder, MBio Diagnostics*

Scott Brave - *CTO, FullContact*

Steve Halstedt – *Managing Director, Centennial Ventures*

Vincent Melvin – *CIO, Arrow Electronics*