Division of Engineering and Mathematics
School of Science, Technology, Engineering, and Mathematics
University of Washington Bothell

B ME 481 A Citizen Engineer (SLN 11128)
Fall 2016

Time and Location: TTh 0845 - 1045 in UW1-041

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Canvas Homepage: https://canvas.uw.edu/courses/1074834

Course Description

"[A] new epistemology of engineering practice and education is needed, one that is based on the idea of reflective and adaptive practice, systems thinking, engagement, and a holistic approach to global problems. This new form of engineering education and practice must be designed to cover a wide range of technical and nontechnical issues to train global citizen engineers and whole persons, capable of operating in a multicultural world, not just narrow-minded technical experts."

--Bernard Amadei, Engineering for Sustainable Development, p. 103

"Mechanical engineering will be challenged to develop new technologies and techniques that support economic growth and promote sustainability."

--ASME, 2028 Vision for Mechanical Engineers

Citizen Engineer is the first course in UW Bothell's Engineering Professional Development series. It focuses on environmental and societal impacts of engineered products and processes, and techniques for incorporating sustainability into engineering design. Although many of these techniques are grounded in engineering science, the course also draws on economics, ethics, and politics for insight into the interactions between engineering and larger global contexts. It explores what it means to be an engineer who is also an active, ethical participant in local, national, and global communities—a "citizen" engineer.

As builders of infrastructure and agents of technological change, engineers play a critical role in economic development: we create the built environment, and supply the products most people associate with a good life. Yet, while these products often raise living standards, making and

using them may also impose costs on society and the environment not accounted for in the design process. Pollution is an obvious example, as are increased dependence on scarce materials, and generation of more waste. Perhaps less obvious are economic and social disruptions brought about by technological innovations, such as the lifestyle changes brought about by the automobile, and loss of jobs associated with automation and computers. More troubling are the occasions when greed, professional negligence, willful violation of safety standards, and groupthink lead to the release of dangerous products, accidents, and disasters that kill and maim people. Although risk can never be eliminated entirely, an uncompromising commitment to ethical professional behavior, coupled with a sensitivity to context, can certainly reduce it.

In this course students learn how to incorporate the ethic of sustainability into engineering design. To be sustainable, a design must lead to a product or process that meets needs of the present, without compromising the ability of future generations to meet their needs. In taking into account societal needs, social justice requires that the needs of the poor whose basic needs have not been met take priority over those of others. In meeting societal needs, the integrity of the environment must be maintained to avoid depriving future generations of the same benefits enjoyed by the present.

Central to the definition of sustainability is the word "needs." Most engineers spend their working days tending to the needs of their clients, be it their employer or, if they are a consultant, a person or company to whom they are delivering a consulting service. The National Society of Professional Engineers' Code of Ethics obliges engineers to act in the interest of their employer. Yet its first canon requires that engineers "*hold paramount* the safety, health, and welfare of the public." In other words, engineers are obliged to serve the needs of the employer only insofar as their action does no harm to the public. Compared to the ethic of sustainability, the NSPE Code seems rather weak. Some analysts call for even stronger wording that includes an obligation not to harm the natural environment. Still, to be ethical, engineers need to be knowledgeable not only of their client's needs but also the needs of the greater community, and this requires being sensitive to and engaged with that community, especially in matters close to the engineer's own expertise.

To incorporate environmental sustainability into design, engineers must be able to apply science to understand and predict the effects of the design on the environment. To incorporate social justice, engineers must take into account the political, social, cultural, and economic context in which the product or process will be used. This course brings together both dimensions—engineering science and ethics—to help realize the goal expressed by Bernard Amadei in the quote at the top of this section: *"to train global citizen engineers and whole persons, capable of operating in a multicultural world, not just narrow-minded technical experts."*

An important part of this course is the community-based learning project, done in collaboration with a partner in the local community. Each student will work in a project team to deliver a solution to an engineering problem defined by the local partner and connected to the theme of sustainable development. Five partners are participating in the course; potential projects include rainwater catchment and storage, biodigestor and heating system, analysis of the proposed carbon tax on the ballot this fall in Washington State (Initiative 732), vertical garden irrigation, and waste-to-power generation system. The purpose of these projects is to provide experience in working with a client to scope out a problem, identify and consult with relevant stakeholders, gather data, research solutions, and present a final report, orally and in writing, to

the satisfaction of the partner. The final project deliverable is a team project report (one per team) and reflection essay (one per individual).

This course is unusual in that it meets both BSME degree and UW-wide general education requirements. Specifically, it may be counted under Areas of Knowledge as an Individual & Societies (I&S) course,15 credits of which are required for graduation. Second, it may be counted as "Additional Writing," 10 credits of which are required for graduation. Finally, it is approved as a DIV course, fulfilling the Diversity requirement that all UW students must meet.

A substantial amount of writing is therefore required, and students will encounter subject matter well outside the usual technical areas of engineering. Perhaps more than any other engineering course at this campus, this one focuses squarely on linking engineering to UW Bothell's core mission of fostering transformational education, engaged scholarship, and an inclusive culture.

Learning Outcomes

At the end of this course, students will be able to:

1. Define sustainability, and identify and evaluate strategies for achieving it.
2. Apply engineering science to analyze environmental effects of industrial processes.
3. Implement sustainability tools, such as life cycle assessment and environmental sensitive design, to reduce energy consumption and mitigate environmental impacts.
4. Describe roles and responsibilities of the engineering profession in sustainable development.
5. Define social justice, and identify and critique the engineering profession's relationship to it.
6. Work productively on a team to define an engineering problem in a community-based learning project and deliver a solution that satisfies the partner's needs.

ABET Learning Outcomes

The learning outcomes for this course map to ABET outcomes (f), (g), (h), (i), and (j):

(f) Understanding of ethical and professional responsibility.
(g) Communicates effectively.
(h) Broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.
(i) Recognition of the need for, and an ability to engage in, lifelong learning.
(j) Knowledge of contemporary issues.

Course Materials

The following textbook is available for purchase at the UWB Bookstore:

Bradley A. Striebig et al, *Engineering Applications in Sustainable Development* (Cengage Learning, 2016).

The following books may be downloaded in their entirety from UW Libraries. Assigned parts will be posted in Canvas and accessible from the Module in which they are assigned.

Donna Riley, *Engineering and Social Justice* Morgan (Claypool, 2008).
George D. Catalano, *Engineering Ethics: Peace, Justice, and the Earth* (Claypool, 2006).

Other readings will be posted in Canvas as they are needed.

Assignments

The assignments, due dates, and weightings are as follows:

1. **Homework problems and essays (30 %)**
   Questions are drawn from the assigned reading and end-of-chapter problems in the Sustainable Design textbook. Some are quantitative, others are open-ended questions requiring a paragraph or short essay response. Essay responses must be word-processed in the prescribed format. Solutions to quantitative problems may be written out by hand or word-processed. Staple all pages together, and submit at the start of class on the date shown in the schedule below. Lowest homework grade will be dropped.

2. **Position paper that takes a stand, and defends it with logical, evidence-based argument, on the following prompt (20%)**

   > Donna Riley, in "Engineering and Social Justice," argues, "The profession of engineering in the United States has historically served the status quo, feeding an ever-expanding materialistic and militaristic culture, remaining relatively unresponsive to public concerns, and without significant pressure for change from within." Riley locates the problem in the system of engineering education that has done little to encourage critical thinking and political engagement, or cultivate a mindset disposed to challenging existing power structures, which has historically been among the purposes of higher education, in contrast with vocational training and trade schools. Others find that this orientation toward the status quo contributes to lack of racial diversity and under-representation of women in the engineering profession. Your job: Critique this argument. Does it stand the test of evidence and logic? Is it reasonable? Persuasive? As a citizen engineer, what is your response?

   This essay should be 1000 - 1500 words in length. Use authoritative sources, and cite them. Any claim you make, whether for or against Riley's argument, or even if you are neutral with respect to it, must be backed up with evidence and logical argument. Use the IEEE format for citing sources and listing them in a References section at the end of the paper. No fewer than five sources must be used, and they must be authoritative, from such organizations as ASME, IEEE, ASEE, National Academy of Engineering, and National Science Foundation; books from university presses; academic journal articles obtained from UW Libraries data bases; and trustworthy national/global news sources such as New York Times, Wall Street Journal, and The Economist. Cite sources, and list them in a References section at the end in IEEE format (found at http://www.ieee.org/documents/ieeecitationref.pdf). For advice on writing well, see The Economist A-Z style guide (http://www.economist.com/styleguide/introduction). Make use of research and

writing resources here at UWB, including the Writing and Communication Center and our engineering librarian (details in next section). Take care not to plagiarize; your essay will be scanned by a plagiarism detection system in Canvas.

Word-process the essay in 14-point Times New Roman font. Double-space everything. Number the pages at the bottom right, except for the first page. Include your name at the top of the first page of the essay. Start the References section on a separate page at the end; words in the References do not factor into the required word count. Save essay as a pdf file and upload up into Canvas **no later than Friday, November 18, at 11:59 pm**.

3. **Community Based Learning Project (30%)**

The project, as described in the Course Description, provides a semi-structured opportunity to combine engineering practice with participation as a citizen in a sustainable development project in our local community. You will work in project teams of 3 students (possibly 4 if the enrollment isn't divisible by 3) in a collaboration with a partner organization to study the partner's problem, conduct the research required to solve the problem, identify and work with stakeholders in the community (which may include a city or county engineer or other expert, as determined by you and the partner), produce a final project report that addresses the need of the partner, and present the proposal orally and in writing to the partner.

The community partners include the following organizations:

Farmer Frog (**http://farmerfrog.org**)
UW Bothell Facility Services (**http://www.uwb.edu/sustainability**)
SaGE Farm (**https://www.facebook.com/SustainableAgricultureEducation**)
21 Acres Center for Sustainable Living (**http://21acres.org**)
Carbon Washington (**http://yeson732.org**)

Students will learn more about these projects on Tuesday, October 4. Kara Adams, the acting director of UWB's Community-Based Learning and Research (CBLR) Office, will be on hand to introduce the process of working on community-based projects. Representatives of the partner organizations have also been invited to attend. It is imperative that you attend this class meeting, as it's the only chance you'll have to meet the organizations and learn about the projects. Afterward, you will have a chance, individually, to sign up for the projects through the Expo system managed by the CBLR Office. You will receive instructions how to do this at the October 6 meeting. Sign-up is first-come, first-serve. Once 3 or 4 people have signed up for a project, they will become a project team partner with that organization for that project.

Once you have formed a project team, you will assign one person from the team to be the liaison with the organization. This person will handle all communications on behalf of the team. You will arrange your first meeting as a team with the partner. At that time, you will work out a mutually acceptable project plan and schedule. Your work will be carried out, and deliverables provided to me and your partner, in accord with the following schedule:

October 4: Students learn about the projects and partner organizations.

October 6: Deadline for signing up with partner through Expo system.

October 14: Deadline for having first meeting with partner. (Each team gives me a 1-page summary of this meeting in class on October 18.)

October 25 - November 29: Each Tuesday, starting October 25 and ending November 29, each team gives me a 1-page summary of their activities over the previous week. List dates and times of all communications with the partner, including site visits. Teams are required to communicate with their partner by phone, email, or in person at least one time each week during this period. These reports are to be handed to me in class in hard copy.

November 10: Deadline for submitting a draft of the problem statement and progress report. The problem statement should define the problem the team is working on. The progress report, which immediately follows the problem statement, summarizes results of research and consultations made to so far, lays out a timeline showing milestones accomplished and milestones still to be attained, and describes all work that needs to be done to complete the project to the satisfaction of your client, the partner organization. This document should be 3-4 pages in length, and submitted, one per team, in Canvas by 11:59 pm. At the same time, the document should be emailed to the partner.

December 2: Deadline for submitting the project proposal. The proposal, which should be 5-10 pages in length, includes the problem statement, along with the proposed solution to the problem. The solution may take various forms, depending on the project. In most cases, it will be a preliminary design that includes drawings and calculations, and a description of the work that will need to be done to build/implement the design. The design proposal, in this case, should contain sufficient information so that another group could execute the design based only on your report. In other cases, the solution may be an analytical report, with conclusions and recommendations. In all cases, the proposal is a response to the partner's needs, a solution to the problem that you and the partner, working together, have defined. Like a team of consulting engineers, your job is to satisfy the client, your partner. The report will be assessed on the basis of how well it satisfies your client, the quality of the engineering analysis, organization, clarity, and quality of the writing. This report is due in Canvas by 11:59 pm.

December 6 and 8: Teams orally present projects in class in a 15 minute presentation, with partners present.

The final grade on the project will be based on how well the team fulfilled all the above milestones and on feedback received from the partner. I expect, and hope, that all team members receive the same grade. However, it is possible a member will receive a lower grade than the rest of the group if he/she has been negligent in the performance of his/her duties as a team member.

4. **Reflection Essay, 5-6 pages, double-spaced (15%)**
   Each student submits this essay on Canvas **no later than 11:59 pm December 13**. In it you should reflect on your experience as a team member on the community-based project. What did you learn about project management? About working with a client and managing consultant-client relations? What worked well for you and the group? What didn't work well, and what would you change if you could do it again? What did you learn about the role of engineers in sustainable development?

This essay should be formatted the same as the position; this essay, however, does not require outside research or citing of sources. Write in the first person, as if you're recording your thoughts in a personal journal.

5. **Class Participation (5%):**
   Attend class prepared to discuss the readings assigned for that day, share answers to homework questions, and to participate in miscellaneous activities done in class.

Policies and Campus Resources

Classroom Conduct and Etiquette: Maintaining a productive learning environment requires everybody's cooperation. Turn portable devices to silent mode. If you must make a call or send a text, please do it outside the classroom. Laptops and tablets may be used for note-taking, though you will learn better by writing notes by hand. Using devices for purposes unrelated to the class causes you to lose credibility and may result in my calling you out for it in class or even asking you to leave the room. Be in class on time, and stay until the end.

Office hours and email: My office hours are listed at the top of the first page of this syllabus; I'm also available by appointment. *I prefer to answer questions in person*. If you need to email me, please do so in Canvas, and I'll respond usually within 24 hours.

Late Policy: Individual assignments will be penalized 0.5 grade points for each late day. For assignments related to projects, late submissions will be noted, and the final project grade reduced accordingly, unless the group has a valid reason for submitting late work.

Grading: Grades are recorded on a 4-point scale, in accordance with UW policy. I generally use the following conversion from a 100-point scale to the 4-point scale: 99-100=4.0, 97-98=3.9, 95-96=3.8, 93-94=3.7, 91-92=3.6, 90=3.5, 89=3.4, 88=3.3, 85=3.0, 82=2.7, 80=2.5. In exceptional circumstances, grades may be curved using the appropriate statistical measures. More information on the UW grading system can be found here: http://www.washington.edu/students/gencat/front/Grading_Sys.html

Incompletes: University rules state that "an incomplete is given only when the student has been in attendance and has done satisfactory work until within two weeks at the end of the quarter and has furnished proof satisfactory to the instructor that the work cannot be completed because of illness or other circumstances beyond the student's control."

Academic integrity: Students are responsible for knowing what constitutes a violation of the University of Washington Student Code, and they will be held responsible for any such violations whether they were intentional or not. The standards for student conduct and procedures for dealing with misconduct are prescribed in the Student Conduct Code for the University of Washington (http://app.leg.wa.gov/wac/default.aspx?cite=478-120). Issues concerning academic integrity and misconduct are handled by Student Affairs, with information available here: http://www.uwb.edu/studentaffairs/studentconduct.

Plagiarism is a serious academic offense. You should recognize it (see "What is Plagiarism?" at http://libguides.uwb.edu/content.php?pid=87430&sid=691950) and take strategies to avoid it in your own writing (see "Strategies for Avoiding Plagiarism" at http://libguides.uwb.edu/

content.php?pid=87430&sid=691952). If I suspect that an assignment has been plagiarized, I will ask for an explanation. Possible sanctions include failure on the assignment and reporting to Student Affairs.

Respect for Diversity: Diverse backgrounds, embodiments and experiences are essential to the critical thinking endeavor at the heart of university education. Students are expected to respect individual differences which may include, but are not limited to: age, cultural background, disability, ethnicity, family status, gender presentation, immigration status, national origin, race, religious and political beliefs, sex, sexual orientation, socioeconomic status, and veteran status. Students seeking support around these issues can find more information at http://www.uwb.edu/diversity.

Access and Disability Resources: It is the policy and practice of the University of Washington to create inclusive and accessible learning environments consistent with federal and state law. If you have already established accommodations with Disability Resources for Students (DRS), please communicate your approved accommodations to me at your earliest convenience so we can discuss your needs in this course. If you have not yet established services through DRS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not limited to; mental health, attention-related, learning, vision, hearing, physical or health impacts), you are welcome to contact DRS at 425-352-5307 or uwbdrs@uw.edu. DRS offers resources and coordinates reasonable accommodations for students with disabilities and/or temporary health conditions.

Class cancellation and inclement weather policy: Should illness, inclement weather, or other unexpected event require cancellation of a class meeting, I will post an announcement on Canvas at the earliest opportunity. Students can learn of campus operations status from the website or by calling the Campus Information Hotline at 425-352-3333. You may also sign up with an alert system that will contact you via email or text message if classes are canceled. For more information on the alert process, please see http://www.uwb.edu/alert. Class activities will be rescheduled as needed. Alternatively, I will record a lecture or create other online media to deliver the day's lesson on-line.

Support for Students: UW Bothell provides a wide range of services to assist students with academic, career, and personal matters.

Academic Advising for Engineering: Charlotte Emigh at cemigh@uw.edu, 425-352-3746

Counseling Center: http://www.uwb.edu/studentaffairs/counseling, UW1-080, 425-352-3183

IT Helpdesk: IT@uwb.edu, 425-352-3456

Library: www.uwb.edu/library, 425-352-5340. The Engineering Librarian is Penelope Wood (425-352-3467, woodpd@uw.edu). Please consult Ms. Wood with questions regarding use of library resources in conducting research for the project and other assignments.

Quantitative Skills Center: http://www.uwb.edu/qsc, UW2-030, 425-352-3170.
Student Success Center: http://www.uwb.edu/studentsuccesscenter, 425-352-3427
Writing and Communication Center: http://www.uwb.edu/wacc, UW2-124, 425-352-5253.

B ME 481 Schedule for Fall 2016

("Striebig" refers to Sustainable Design textbook, other readings will be posted in Canvas)

Date	Topic	Reading	Homework
Sept 29	What is sustainable development?		
Oct 4	Introduction to Projects Sustainability and engineering design	Striebig, 1.1 - 1.9	
Oct 6	Ethics and sustainability	Catalano	
Oct 11	Economic and policy considerations Sustainability and social justice 1	Striebig, 12.1 - 12.6 Riley, Ch 1	HW 1
Oct 13	Engineering science and sustainability Making arguments 1	Striebig, 2.1 - 2.5 Arguments 1	
Oct 18	Engineering science and sustainability Making arguments 2	Striebig, 2.6 -2..8 Arguments 2	HW 2
Oct 20	Sustainability and social justice 2	Riley, Chs 2 and 3	
Oct 25	Biogeochemical cycles Making arguments 3	Striebig, 3.1 - 3.10 Arguments 3	HW 3
Oct 27	Carbon cycle: Sources and flows Making arguments 4	Striebig, 6.1 - 6.5 Arguments 4	
Nov 1	Greenhouse gases, impacts, and control Sustainability and social justice 3	Striebig, 6.6 - 6.9 Riley, Ch 4	HW 4
Nov 3	Sustainability and social justice 4 Making arguments 5	Riley, Chs 5 and 6 Arguments 5	
Nov 8	Sustainable engineering best practices Making arguments 6	Striebig, 7.1 - 7.7 Arguments 6	HW 5
Nov 10	Energy, environment, and society	Striebig 8.1 - 8.4	
Nov 15	Sustainable energy	Striebig 8.5 - 8.8	HW 6
Nov 17	Industrial ecology and risk management **Position paper due Nov 18**	Striebig 9.1 - 9.7	
Nov 22	Life cycle analysis	Striebig 10.1 - 10.6	
Nov 24	THANKSGIVING — NO CLASS		
Nov 29	Green building	Striebig 11.5 - 11.6	HW 7
Dec 1	Work on projects (**proposals due Dec 2**)		
Dec 6	Project presentations		
Dec 8	Project presentations		
Dec 13	**Reflection essay due**		