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

B ME 481 A Citizen Engineer (SLN 11124)
Winter 2018

Time and Location: TTh 0845 - 1045 in UW1-102

Instructor: Steven W. Collins, Ph.D., P.E.
Email: swcollin@uw.edu
Website: http://faculty.washington.edu/swcollin

Office: Discovery Hall 452-M, Phone: (425) 352-5356
Office Hours: MW 8:30 - 10:30, TTh 11:00 - 12:00 and by appointment
Canvas Homepage: https://canvas.uw.edu/courses/1197336

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 ethics and sustainability into engineering design. The course draws on economics, ethics, culture, 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 significant costs on society and the environment that may not be taken fully into account in the design process. Pollution, depletion of natural resources, loss of jobs, and widening of social inequalities as a result of unequal access to new technologies, and loss of privacy are examples of such costs. More tragic are occasions when greed, professional

negligence, or incompetence results in the release of dangerous products, industrial accidents, and disasters that harm people, property, and environment. Although risk can never be eliminated, an uncompromising commitment to ethical behavior, coupled with a sensitivity to the social and political contexts, can certainly reduce it, while maximizing the benefit engineers bring to society.

This year's course theme is the engineering of sustainable buildings, especially housing. What factors go into the design, permitting, and construction of buildings that push the envelope on high performance while minimizing environmental impact, and yet are also affordable and accessible? How can we think about the relationships between a building, its inhabitants, the people who build it, the environment surrounding it, and the larger community encompassing it? How can a building further social justice? And what are the prospects for transforming our landscapes with buildings that make people healthy, bring them joy, harmonize with the environment, and enliven the surrounding community?

We probe these questions on three levels.

1. Philosophy: We will apply various ethical and philosophical approaches to develop insights into difficult and often hotly contested terms such as "justice," "good," "green," "ethical," and "sustainable."

2. Engineering science: We will learn about thermal properties of buildings, mechanical equipment used in them, and innovations in building methods, structure, and HVAC that are making buildings greener, higher performing, and more energy efficient.

3. Research and practice: We will work in project teams with our community partners on case studies of some of the most innovative buildings in the Puget Sound Region. These are buildings that are testing the boundaries of building codes with new technologies and designs, requiring close cooperation among architect, engineer, government official, builder, and certifier. This is the meat of the course: You will learn that building something on the cutting edge isn't only a technical feat; it also requires the coordination of many organizations that often have divergent interests, and the cooperation of many people.

The course is run very differently from the more structured core courses in the major. There is considerable writing, working in project teams, and interacting with experts in the local community. The readings in philosophy, ethics, and politics will be quite different from what you may be accustomed to. By its design, the course should push you outside your comfort zone, and into a mode of critical thinking not often experienced in the engineering classroom. You will be challenged to read, process, think, speak, and write with clarity, logic, and persuasiveness. These are the hallmarks of the "citizen engineer!"

Our lead community partner this term is Northwest EcoBuilding Institute (http://www.ecobuilding.org), whose Executive Director is Mr. Chris van Daalen. He will be supported by Evergreen Certified (http://evergreencertified.com), whose Principal is Mr. Tadashi Shiga, a UWB alumnus (and student of mine when I first came to UWB more than 20 years ago!). Both gentleman will be visiting us the second week of the quarter to introduce the projects.

I have been greatly influenced in my thinking about this course by Seattle-based architect Jason McLennan (http://jasonmclennan.com), an influential voice in the green building movement, and founder of the Living Building Challenge (https://living-future.org/lbc/). His acclaimed residence,

Heron Hall (http://heronhall.com) is one of our case studies, and we will read one of his books. I close here with two quotes from one of his more recent books entitled *Transformational Thought*:

> "Despite what we know, we are still focusing on the idea that green building and green development can allow us to keep living in the same way we've lived since the 1950s. What we need to understand is that our way of life has to change." (p. 13)
>
> "As professionals leading the charge toward greener ways of living, we must challenge assumptions that hinder our progress. *Responsibility naturally breeds sustainability"* [my italic[s]. (p. 74)

Let us endeavor to take responsibility for the consequences of our work as engineers. And let us, in the words affixed to Mr. Shiga's signature block, "inspire to greatness" in all that we do!

Learning Outcomes

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

1. Identify and evaluate the different ways of thinking about sustainability and justice.
2. Describe the dynamic interplay between social justice, sustainability, building codes, and the built environment, and evaluate the role of the engineer in this process.
3. Describe basic physical principles governing energy use in buildings, and evaluate strategies for reducing energy consumption and mitigating its environmental impacts.
4. Identify characteristics of the "green building," and compare the various systems (LEED, Passive House, Living Building Challenge) for rating and certifying such buildings.
5. Collaborate as part of a team with external partners to document the design, approval, construction, and certification of a green building, and communicate results that meet the partner's requirements.

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:

Jason F. McLennan, *The Philosophy of Sustainable Design* (Bainbridge Island, WA: Ecotone Publishing, 2004.

Michael J. Sandel, *Justice: What's the Right Thing to Do?* (New York: Farrar, Straus and Giroux, 2009).

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

Assignments

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

1. **Quizzes on assigned reading (10 %)**
   Expect a short quiz on any day when a reading from one of our two textbooks, or a reading from Asian 1 and Asian 2, is assigned. Each quiz will consist of a few questions on main points in the reading assigned for that day. Most questions are multiple choice, though there may also be one or two short answer questions. The quizzes will be open book; they will also be timed so that it will be necessary to do the reading beforehand to avoid wasting time looking up the answers. When reading, highlight important passages, and take notes in the margin to help with recalling main points during the quiz. Eight quizzes in total will be given, and the lowest quiz grade will be dropped.

2. **A total of 5 one-page essays ("1-Pagers") (20 %):**
   Where it is indicated in the schedule, prepare a short essay of 250-300 words on the reading assigned for that day. Note that the due dates depend on whether your last name starts with A-L or M-Z. Your essay should be two or three paragraphs in which you do two things: summarize something important the author is saying, and critique it with your own commentary. You may agree or disagree with the author, but whether or not you agree you should support your position and not merely assert it. Word-process the essay in 12-point Helvetica or Times New Roman font so that it all fits on one side of one page. Write your name and date at the top, along with the name of the reading as it appears in the syllabus. Each essay will be graded on quality of content and presentation. Turn in the essay, in hard copy, at the start of class on the day it is due.

3. **Ethics and Policy Essay (20%):** This essay, to be 1000 - 1500 words in length, applies ethical and sustainability arguments to advocate for or against a policy that makes affordable clean energy alternatives accessible to low-income residents of a major US city. An example of such a policy is the Emerald Cities Collaborative, in which Seattle participates along with overall other major cites (http://emeraldcities.org/cities/seattle/news/ec-seattle-helps-bring-solar-power-to-affordable-housing)
   Your essay should draw from the various approaches to justice and sustainability in the readings. It should also present one counter argument, followed by a refutation that shows the greater persuasiveness and reasonableness of your own position. You will need to show why the theory supporting your argument is stronger than the theory opposing it. You should also describe how your proposed policy would work. Your main sources should be our course textbooks and readings; you may supplement with additional sources as you see fit.

   The essay should be word-processed, in 14-point 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. Include list of references at the end. Cite sources using IEEE citation forma, which can be found here: https://ieee-dataport.org/sites/default/files/analysis/27/IEEE%20Citation%20Guidelines.pdf

Bring four copies of a draft of the complete paper—it shouldn't be the first, rough draft, but neither should it be the final version!—to class on **Tuesday, February 6**. On that day, we will have a peer writing session, facilitated by a consultant from the Writing Center. You will work in groups mainly of 4 students. Each student will read and critique the draft of each of the other students, following the instructions and coaching given by the facilitator. Using the feedback from your peer group, you will revise the essay. Attach the original version (the one your peer group edited), showing the markups you made in response to the feedback. Submit your essay in class, in hard copy, on **Tuesday, February 13**. In addition, upload the final draft, minus the edited version, to Canvas no later than 11:59 pm the same day. Be aware that the essays will be processed through the VeriCite plagiarism detection system on Canvas.

4. **Community Based Learning Project (30%)**
The project, as described in the Course Description, provides a structured opportunity to study a green building project. You will work in project teams of 4 students (possibly 3 or 5 if the enrollment isn't divisible by 4) in a collaboration with our community partner Northwest EcoBuilding Guild (http://www.ecobuilding.org), under the leadership of Executive Director Chris van Daalen. Supporting this work is EverGreen Certified (http://evergreencertified.com/team/), led by Tadashi Shiga. The goal of the project is to produce and deliver to the partner case studies of three certified-green buildings that have recently been built or are nearing completion in the Puget Sound area. The cases will become part of the "Code Innovations Database" (http://www.ecobuilding.org/code-innovations) being assembled by Mr. van Daalen's organization.

Each case study follows a specified format that includes the following sections:
1. Technical details: novel green technologies and methods incorporated into the design;
2. Motivations: Reasons why the builder wanted to build a green-certified building;
3. Code and Permitting: Steps taken by the builder and regulatory authorities to ensure compliance with applicable building codes.
Each team is assigned to one of the three sections listed above for each case study. A fourth team will have the task of documenting and compiling the research of the other groups.

Three buildings have been chosen as case studies:
Case Study 1: Cascade Built's first multifamily passive house in Seattle
Case Study 2: Build Urban's first solar thermal system for space heating and hot water
Case Study 3: Jason McLennan's Heron Hall, Net-Positive Living Building-certified building

Examples of completed case studies may be found in the Code Innovations Database on Northwest EcoBuilding Guild's website at (http://www.ecobuilding.org/code-innovations/case-studies/). Four of the cases will be assigned reading for the second class meeting. The following four cases are especially recommended and will be assigned as required reading early in the course:

Your research will involve web searches of documents; in-person interviews with the builder, regulatory authorities, and other informants as advised by the partner; and study of applicable building codes.

The project written report is due in both hard copy and posted to Canvas on **February 27.** Oral presentations will be made the following week (March 6 and 8), the final week of classes.

Additional reporting milestones are to be made throughout the quarter to demonstrate ongoing and successful progress. Further details about the project flow and milestone timeline will be given on January 9, when Mr. van Daalen and Mr. Shiga are scheduled to visit our class. The final grade will take into account not only the quality of the finished document but also the work in meeting the milestones along the way and quality of the oral presentation.

5. **Reflection Essay, 4-5 pages, double-spaced (15%)**
   Each student submits this essay on Canvas no later than **11:59 pm March 13.** In it you should reflect on your experience as a team member on the community-based learning project. What did you learn about the process of building a green-certified building? How was your relationship with the partner and with other members of your team? What worked well for you and the team? What didn't work well, and what would you change if you could do it again? How did the project, and course in general, change your way of thinking about sustainable development and the role engineers in it?
   Write in the first person, as if you're recording your thoughts in a personal journal.

6. **Class Participation (5%):**
   Attend class prepared to discuss the readings assigned for that day and to participate in class activities. Expect to be called upon at random to answer questions about the day's readings and to share opinions on the day's topics.

Policies

A list of STEM School policies and resources available to students can be found here: http://www.uwb.edu/getattachment/stem/about/stem-policies/classroom-policies-stem-fc-1-12-17.pdf

Grading: All assignments in this class are graded on the standard 4-point grade scale. The conversion between the letter and 4-point scale is given here: http://www.washington.edu/students/gencat/front/Grading_Sys.html

Absences and missed assignments: One or two absences will probably not hurt your grade, unless you happen to miss an exam.

Schedule of Topics, Readings, and Major Assignments

Date	Topic	Reading	Assignment
Jan 4	Course introduction		
Jan 9	Introduction to Projects Understanding Building Codes	See handout for a list of reading	
Jan 11	Utilitarianism, Libertarianism, and Markets	Sandel, Chs 2 - 4	1-pager A-L
Jan 16	Categorical Imperative, Justice as Fairness Building ME 1: Thermal envelope	Sandel, Chs 5 - 6 Buildings 1	1-pager M-Z
Jan 18	Affirmative Action and Just Desert	Sandel, Chs 7 - 8	1-pager A-L
Jan 23	Loyalty, Obligation, Common Good Building ME 2: Heating and Cooling	Sandel, Chs 9 - 10 Buildings 2	1 pager M-Z
Jan 25	Philosophy and History of Sustainable Design Building ME 3: Hot water, appliances	McLellan, Chs 1 - 2 Buildings 3	1 pager A-L
Jan 30	Project Work Session		
Feb 1	Principles of Sustainable Design I Building ME 4: Energy efficiency	McLellan, Chs 3 - 5 Buildings 4	1 pager M-Z
Feb 6	Principles of Sustainable Design 2	McLellan, Chs 6 - 8	1 pager A-L
Feb 8	Technologies and Levels of Sustainable Design Peer Writing Workshop	McLellan, Chs 9 - 10	1 pager M-Z
Feb 13	Comfort, Well-Being, Economics in Design	McLellan, Chs 11, 13	Essay Due!
Feb 15	Holism and Aesthetics in Design Buddhist ethics	McLellan, Ch 14, 15 Asian 1	1 pager A-L
Feb 20	Ethics and sustainable design in Japan	Asian 2	1 pager M-Z
Feb 22	Guest presentation (tentative) Engineering the off-grid building	Reading TBA	
Feb 27	Project report due date		Projects due!
Mar 1	Toward a just, resilient, and sustainable future	Transformations	
Mar 6	Project presentations		
Mar 8	Project presentations		
Mar 13	Reflection essay due in Canvas 11:59 pm		Reflection essay due

* Readings in blue font will be posted in a “Readings” folder in Canvas with links from the module corresponding to the day the reading is assigned.

**A separate schedule for the community-based learning project milestones will be distributed the second week of the quarter.