



Online Ethics Center
FOR ENGINEERING AND SCIENCE

Enacting Macroethics: Making Social Justice Visible in Engineering Education

Author(s)

Jon Leydens
Juan Lucena
Kathryn Johnson

Description

This activity is considered an NAE Exemplar in Engineering Ethics Education and was included in a 2016 [report](#) with other exemplary activities. This activity describes a program where undergraduate students in collaboration with faculty have the opportunity to explore open-ended problems and critically examine the ethical dimensions of engineering problem defining and solving (EPDS) in design.

Body

Exemplary features: Focus on macroethics issues in engineering problem defining and solution finding; use of learning progressions to advance ethics knowledge throughout the students' education

Why it's exemplary: Practicing engineers define and solve complex, open-ended, and often ill-structured problems. But undergraduate engineering students get few opportunities in their curriculum to explore open-ended problems or to critically examine the ethical dimensions of engineering problem defining and solving (EPDS) in design. Many problems are predefined and/or closed-ended, so key assumptions embedded in the problem setting are rendered invisible. Those assumptions feature interplays between the technical and nontechnical, particularly of macroethical

dimensions of engineering design.

Taking a multicourse, multidisciplinary approach, our program focuses undergraduate students' attention on the complexity inherent in problem setting so macroethical assumptions common to actual EPDS become visible. Working against disciplinary silos, our approach emphasizes (a) macroethical issues of social justice, (b) macroethical assumptions in EPDS processes, and (c) interplays between technical and nontechnical dimensions of EPDS in design.

Program description: Students and faculty work collaboratively so that the undergraduate engineering education experience fosters rich, enhanced, integrated engineering science, design, and humanities/social science experiences. Although roughly 30–40 students are enrolled in the Humanitarian Engineering program minor in any given year, many more students benefit from the enacting macroethics initiative by taking the courses described below as electives. Each year, over 350 undergraduates and 10–12 instructors participate in the enacting macroethics initiative (shown in table 1). Participants also include communities and marginalized groups that engineers sometimes neglect to serve as well as corporate clients with whom students interface.

When students complete our program, they should be able to identify macroethical, social justice issues that are inherent in assumptions made in EPDS processes. Herkert (2005, p. 373) has clarified the distinction between micro- and macroethics: “‘Microethics’ considers individuals and internal relations of the engineering profession; ‘macroethics’ applies to the collective social responsibility of the profession and to societal decisions about technology.” Although microethics is not ignored, macroethics remains a primary focus of our initiative. Students also show evidence of recognizing and reflecting on the interplays between technical and nontechnical dimensions of EPDS across diverse cultural, ethical, and interdisciplinary contexts. In other words, these soon-to-be engineers practice sociotechnical EPDS.

TABLE 1 Participants in the Enacting Macroethics initiative per academic year

Course	Number of Students	Number of Faculty
---------------	---------------------------	--------------------------

EENG 307	55	1
EGGN 301	25	1
EGGN 401	25	1
EGGN 492	150	3-5*
LAIS 377	50	2
LAIS 425	25	1
LAIS 478	25	1
TOTAL	355	10-12

** Faculty social context consultants*

Our approach is distinctively interdisciplinary and cross-curricular, with one or more courses in the engineering sciences, design, and humanities/social sciences. One course is in the engineering science core: students in mechanical and electrical engineering are required to take EENG 307: Introduction to Feedback Control Systems (IFCS), a third-year course with a section that uses two recurring examples of control systems—in wind energy and active prosthetics—to convey both the technical course concepts and the degree to which social justice dimensions are inherent in defining and solving control systems problems. Although IFCS is not currently required for students in our HE program, the courses mentioned below are all either required or on a menu of options.

A design sequence exemplifies another approach to macroethical instruction. Students begin by taking EGGN 301: Human-Centered Problem Definition, where they learn to place users' perspectives at the center of defining problems by developing listening and empathy skills in order to define problems with (not for) others. With that foundation, they take EGGN 401: Projects for People, where they



further define design alternatives, paying close attention to what key stakeholders want and care about and to what will contribute to both their and societal well-being. Finally, in EGGN 492: Senior Design, students work on one of the HE projects such as designing bikes for persons with disabilities, energy efficiency of Native American houses, and prenatal technologies for low-income mothers. Senior Design teams also work with social context consultants, who use a Socratic approach by raising some of the most relevant macroethical, social justice–related questions described below.

Courses in the humanities and social sciences place these macroethical questions in the context of actual case studies. For instance, in LAIS 478: Engineering and Social Justice, students learn to identify and challenge the engineering mindsets and ideologies that get in the way of engineers becoming agents for social justice. They also question how these mindsets contribute to the exclusion of macroethical concerns in problem definition and solution. In LAIS 425: Intercultural Communication, students learn to identify nuanced assumptions embedded in EPDS as they emerge from national, ethnic, ethical, and other normative frameworks. In LAIS 377: Engineering and Sustainable Community Development, students learn to move beyond the limitations of existing engineering problem-solving methods and apply criteria for sustainable community development to engineering projects in order to assess how they contribute to communities' well-being.

In the IFCS design course sequence and in the HSS courses, we aspire to have students explore as many of the following Enacting Macroethics initiative questions as possible:

- In talking with your clients or community partners, what forms of listening enabled you to understand their needs, desires, and aspirations? How did this listening impact your process of defining and later solving the problem?
- What social structural conditions maintain conditions of inequality, and how might your design address such conditions?
- How have you understood a community's political agency and the resources the community members can leverage to carry out, develop ownership of, and maintain the project over the long term?
- What resources and opportunities has your design helped create or could it help create?
- What risks and harms—technical, social, cultural, ethical—has your design intentionally sought to preclude?

- And most importantly, what human capacities has your design endeavored to enhance?

These questions act as heuristics to guide the analysis of engineering case studies and of student EPDS design activities. The final question builds primarily from the work of Nussbaum, which provides a clear end goal for macroethical work.

Assessment information: Quantitative and qualitative educational research methods have facilitated student learning assessment across multiple curricular spaces. For instance, in EENG 307: IFCS, student surveys helped establish a baseline on students' prior exposure to macroethical, social justice issues and their preclass understanding of the meaning of social justice. Quantitative analyses have shown that a majority (71%) of respondents report having been exposed to social justice in their courses at CSM. Also, more than 80% of respondents considered it somewhat or very appropriate for professors to teach social justice concepts in both technical and nontechnical classes and for practicing engineers to consider social justice when designing engineering solutions. Qualitative research using grounded theory methods includes semistructured focus groups and interviews. Findings of the initial qualitative analysis (fall 2014) indicate that some students report a need to switch mental gears when moving between technical and social factors in engineering; that the professor's attempts to connect course material to real-world applications may be too abstract for some students; and that many students appreciated the efforts to integrate social justice into the course, partly because they felt it would provide leverage for learning technical elements. The fall 2015 IFCS iteration aims to directly address these issues; using wind energy and active prosthetics as recurring examples across the course, we are assessing degrees of improved learning of multiple technical and macroethical course concepts.

Across courses in the Enacting Macroethics initiative, evidence of student learning includes cognitive and attitudinal dimensions. Several courses include pre- and postcourse evaluations measuring student understanding of key complex concepts and interrelations (e.g., between engineering and social justice, their willingness to engage social justice through engineering practice, and how after courses they see their career alternatives in a different light). Each course has final projects and/or presentations that act as summative assessment mechanisms. For instance, in EENG 307: Introduction to Feedback Control Systems, final projects involve an investigation of a real-world control system and its broader social justice implications. In LAIS 425: Intercultural Communication, students complete pre- and

postcourse video self-interviews using the same question prompts; in a final paper, students identify the differences between the two self-interviews, particularly key cognitive and attitudinal shifts.

Beyond course-level assessment, evidence of the Enacting Macroethics initiative's impact also emerges through institutional support for the HE program in which it is housed. Evidence suggests shifts in our institutional culture, in a university with deep connections to extractive industries and fossil fuels. Thanks to the HE program, we now enjoy a regular and well-funded lecture series (4-6 lectures per year) that engages corporate, NGO, and academic actors in analyzing, for example, the social justice dimensions of mining on nearby communities. Furthermore, career services, fund raising initiatives, and recruitment/retention programs have begun to focus on the HE program as an instrument for progressive institutional change. This has resulted in more than \$500K in gifts from donors who realize the potential of the HE program for the ethical education of engineering graduates.

The authors would like to thank the Schultz Family Fund and the National Science Foundation (Grants SES-0930213 and EEC-1441806) for their support of the efforts described above.

Additional resources:

Johnson K, Leydens JA, Moskal BM, Silva D, Fantasky JS. 2015. Social Justice in Control Systems Engineering. Presentation at the ASEE Conference, June 14-17, Seattle. Available at <https://peer.asee.org/social-justice-in-control-systems-engineering>

Leydens JA, Lucena JC. 2014. Social justice: A missing, unelaborated dimension in humanitarian engineering and learning through service. International Journal for Service Learning in Engineering 9(2):1-28. Available at <http://library.queensu.ca/ojs/index.php/ijsle/article/view/5447>

Leydens JA, Lucena JC, Nieuwsma D. 2014. What is design for social justice? Presentation at the ASEE Conference, June 15-18, Indianapolis. Available at <https://peer.asee.org/what-is-design-for-social-justice>

Lucena JC, Leydens JA. 2015. From sacred cow to dairy cow: Challenges and opportunities in integrating of social justice in engineering science courses. Presentation at the ASEE Conference, June 14-17, Seattle. Available at

<https://peer.asee.org/from-sacred-cow-to-dairy-cow-challenges-and-opportunities-in-integrating-of-social-justice-in-engineering-science-courses>

Lucena JC, Schneider J, Leydens JA. 2010. Engineering and sustainable community development. Synthesis Lectures on Engineers, Technology, and Society 5(1):1-230. Available at

www.morganclaypool.com/doi/abs/10.2200/S00247ED1V01Y201001ETS011

Colleagues interested in additional resources are invited to contact the authors.

Also, an article about the possibility of a CSM Humanitarian Engineering major is available at <http://oredigger.net/2016/05/humanitarian-engineering-major-proposal/>

Rights

Use of Materials on the OEC

Resource Type

Educational Activity Description

Parent Collection

NAE Exemplars in Engineering Ethics Education

Topics

Social Justice

Ethical Decision-Making

Discipline(s)

Engineering

Teaching Ethics in STEM