Online Ethics Center
FOR ENGINEERING AND SCIENCE

Case Studies for Engineering Ethics Across the Product Life Cycle

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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 uses reviewed case studies and life cycle assessment tools to help students develop needed ethical decision-making skills.

Body

Exemplary features: Adaptability for use in secondary education; extensive collection of cases on the ethics of lifecycle impacts and sustainability

Why it's exemplary: Real-world engineering decision making involves multiple actors and, for each, ethical considerations may arise at multiple levels—personal, professional, societal, or global. Our program of case studies and educational materials is exemplary in its interdisciplinary foundation, created collectively by engineers, policy experts, business professionals, and ethicists to provide clear examples for rising engineers to appreciate ethical issues from multiple angles.

Accompanying materials are rigorously assessed in the classroom by internal and external evaluators based on national educational goals and guidelines, with versions developed to suit a variety of instructional modes. Full cases are designed for university engineering students, while streamlined versions for secondary schools spread an awareness of lifecycle issues and environmental ethics early in formal education. Widespread dissemination using various media adds to national infrastructure for ethics education in engineering and environmental fields, with the goal of emphasizing societal ethics and indirect effects.

Program description: A central goal of engineering education is to provide students with an understanding of context for their designs and decisions. A common theme currently relates to the environment and public health, specifically what constitutes a fair distribution of emissions or impacts, who or what has value, and what exactly gets counted in an engineering analysis of benefits and costs. These questions can be quite effectively discussed in the context of lifecycle engineering, a design strategy that uses a “cradle-to-grave” approach to evaluate environmental and social impacts, incorporating material, energy, and economic flows as well as social and biological effects at different stages. While the use of lifecycle engineering and lifecycle assessment (LCA) tools is widespread, the modeling structure and interpretation of results involve ethical and value judgments that must be navigated carefully by the analyst and by the receiver of the results.

LCA is increasingly important in corporate and government decision making, yet there is a dearth of materials specifically designed to integrate ethics education into life cycle–oriented coursework. Our ethics education project centers on the integration of life cycle–oriented case studies in design, engineering, management, and public policy fields. Case studies are effective pedagogical tools, and particularly useful in enabling students to develop practical understanding of the ethical challenges they will face as practicing professionals by placing them in mock decision-making roles. We have conducted a thorough review of nearly 1,000 existing case studies from engineering, business, and public policy to determine common topics and themes that relate to product life cycles and environmental and health impacts. Our case studies cover current events and engineering design decisions that involve balancing local or direct effects with larger, indirect effects on society, including (a) mismanagement of industrial waste and ecological impacts from industrial accidents, specifically the inundation of several villages in Hungary

from a large-volume spill of red mud, a byproduct of aluminum production (production stage); (b) the upstream implication of material selection for consumer electronics, specifically the tradeoffs between Au-coated antennas and GaIn liquid metal reconfigurable antennas, a new technology being piloted by handset manufacturers (design stage); (c) implementation of state-level policy around compact fluorescent bulbs, balancing state targets for energy efficiency, indirect emissions as a result of reducing electricity demand, and direct potential emissions of Hg during lamp breakage, both accidental and intentional (use and disposal stages); and (d) whether federal/state agencies could and should require labelling of nanomaterials in consumer products, drawing parallels with labelling efforts for pharmaceuticals and food (use and disposal stages).

Following typical case study methods, students are presented with an engineering or design decision that they need to make, accompanied by background material that provides technical, environmental, and policy context. An accompanying teaching note guides instructors with ideas for classroom instruction, emphasizing the ethical concepts that are relevant to the case and written with proper terminology in collaboration with the Ethics Institute at Northeastern and assessed by an external evaluator. Instructional materials and video footage presenting each case, as well as shorter versions for younger audiences, are being created and will be hosted at the Ethics Institute as an additional teaching resource. The creation of the case studies involved a multidisciplinary collaboration among faculty members as well as graduate students. Undergraduate students and high school teachers are assisting in the creation of versions appropriate for secondary schools. These cases have been designed as one-week modules to be incorporated in existing courses and ethics workshops.

The educational goals of this project are to:

(1) Create engaging, practical, and effective case study and workshop materials that examine ethical dimensions of LCA practice and communication, for use in courses in engineering, management, and social science;

(2) Evaluate the effectiveness of these materials through robust educational assessment while improving student learning; and

(3) Engage other secondary school and college/university instructors through demonstration and provision of instructional guides and resources to accompany the case study and workshop materials.

The overall purpose of the project is to enable engineering students and the general public to have an understanding and meaningful discussions of indirect impacts of their activities, and how to balance direct benefits and indirect impacts. Our life cycle–oriented, case-based approach to engineering ethics education will fill gaps in case study resources by addressing fundamental ethical principles and macro-ethical issues on sustainability topics, developing novel, robustly assessed educational materials where few currently exist.

Assessment information: Our case studies and workshops are being piloted in engineering, business, and public policy classrooms. We have also been working with the Center for Advancing Teaching and Learning through Research at Northeastern and our external assessment advisor, Dr. Michael Loui, to develop assessment instruments and evaluation schemes that can be used across all of the cases. We now have a scheme that covers the common ethical concepts introduced in the cases—distributive justice, weighting/balancing risks, moral status, the precautionary principle, responsibility to report, and exploitation. The evaluation scheme is based on the framework presented by the Ethical Reasoning Value rubric published by the Association of American Colleges and Universities and will be applied to five separate classes of students over the coming year in order to test learning outcomes. This project grew out of the team’s experience with trying to fit existing engineering ethics cases into a life cycle–based framework. To provide a baseline for evaluating the new case studies, a review of learning assessments was carried out in spring 2015 for a mechanical/industrial engineering course, which currently uses a case study–based ethics module about the Bhopal chemical disaster, and retrospectively for the 150+ students who have passed through the course over the past several years. Review of assignments and responses informed the creation of case study teaching notes and the draft evaluation scheme. Continuing assessment will allow the project team to adjust the cases and teaching materials as necessary and add further instructional guidance where learning objectives are not being met.

Additional resources:

1. Devising State Policy on Compact Fluorescent Lamps: https://us.sagepub.com/sites/default/files/devising-state-policy-on-compact-fluorescent-lamps-case.pdf

Rights

Use of Materials on the OEC

Resource Type

Educational Activity Description

Parent Collection

NAE Exemplars in Engineering Ethics Education

Topics

Public Well-being
Sustainability
Case Study Method
Pedagogical Approaches

Discipline(s)

Engineering
Teaching Ethics in STEM