



Online Ethics Center
FOR ENGINEERING AND SCIENCE

Humanitarian Engineering, Past and Present: A Role-Playing First-Year Course

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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.

Body

Exemplary features: Multidisciplinary faculty; use of role playing and interactive teaching, which exemplifies the strategy of using games as a pedagogical approach

Why it's exemplary: This course is exemplary because it teaches engineering content in a complex social environment where ethical questions are part of engineering practice. Whether they role-play engineers, businessmen, scientists, or laborers, students learn and practice engineering content (fluid flow, chemical precipitation, sand filtration, water analysis) while also learning to understand the different points of view that often complicate the simplest technical solution. Debating macroethical questions (should the city install a new sewage system even though the law still allows dumping of sewage into canals and rivers?), students learn to address complex social problems with creativity, cross-cultural communication skills, and an appreciation for diverse viewpoints. The interactive format encourages engagement and deep learning, while student reflections at the end of the role-play help them examine their own views and understand the views of others. Later design projects invite students to practice what they've learned in a contemporary context.

Program description: This role-playing activity takes place over 7 weeks in the first half of a first-year general education class. Enrollment is 30-60 first-year students, predominantly but not exclusively engineering majors. The course is cotaught by faculty in humanities, social sciences, and engineering disciplines. Goals of the course are to introduce students to the multiple perspectives, disciplines, and abilities needed to solve complex, open-ended problems: the ability to identify answerable questions and to select and evaluate suitable solutions through the application of more than one discipline; to work effectively as collaborators on a team; to effectively research and use sources; to communicate clearly, effectively, and with appropriate evidence; to understand and articulate the differences in experiences of a complex problem; and to understand one's own and other people's values when they concern complex engineering problems.

Image



Students work collaboratively in the second half of the term to propose an engineering solution to a problem of sanitation or water access; in the first half of the term, they role-play an actual 19th-century urban sanitation project. Set in Worcester, MA, in the 1890s, this game provides a complicated context of labor dissatisfaction, social inequality, rapid urbanization, and cutting-edge engineering resources and practices, simulating for students a complex engineering problem. The question of how best to mitigate the extreme pollution in the Blackstone River and Canal becomes a launching point for students to discover some of the social, environmental, and economic difficulties that complicate professional engineering practices. As they inhabit roles, conduct research using primary sources, and discuss their perspectives with other players, students learn to understand the technical and nontechnical issues deeply from a particular perspective. As they come to terms with the ethical issues and begin to understand how different values are weighted in a diverse community and what tradeoffs are made, they exercise agency as game players.

This active, immersive, interactive role-playing game includes introductory engineering and science content (e.g., as students learn about fluid flow or structure in preparation for designing a prototype sewage system or when they conduct water quality tests for chemical pollutants and bacteria). At the same time, and based on the science of both quantitative and qualitative data, students must decide where they will stand on an issue and try to persuade others. If the law doesn't require improvements to the polluted river, for instance, should a politician or city engineer recommend improvements? What about when sewage overflows into working-class

neighborhoods threaten the health of a population? Does it matter that they don't speak English and cannot vote? Or that other engineering projects are being urged by industrialists? What if the city engineer has the chance to help develop a state-of-the-art sewer design? Decisions in this game have consequences, and the dilemmas are morally ambiguous rather than clear-cut and didactic. At the end of the role-play, students reflect on their decisions and discuss them with the class. Because the ethical lessons go well beyond the prescriptions that tend to dominate ethical education when considering codes of conduct and standards of ethical practice, these activities and especially the indefinite nature of many of the decisions help students develop into better, wiser engineers who are able to make their own, autonomous decisions.

Course activities include community dialogues that entail (1) scoping an engineering problem (by ascertaining what the overflow really means, whether it is a threat, and how great a threat it is); (2) deciding whether to take action (when law and some moral codes are not entirely in sync); and (3) deciding which action to take (as students present different sewage engineering designs). These goals include many of ABET's student outcomes: oral, written, and visual communication; ability to function on a multidisciplinary team; ability to analyze and interpret data; understanding of professional and ethical responsibility; and the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context. This education includes the ability to conduct research: to find and evaluate a variety of sources in order to help make important decisions. The method of the course is to assign roles based on real 19th-century people and activities and objectives for each role. Students must conduct research, find potential allies, identify foils, and negotiate tradeoffs in order to realize their goals and objectives. In many cases they have a specific objective but their characters are indeterminate on some ethical issue, so they must think through their positions and later reflect on their ethical choices. Activities include combinations of research, hands-on experiments, and scientific and moral arguments using both quantitative and qualitative data. For instance, after examining 19th-century water quality sets and mapping them against city maps that reveal economic status, players deliver arguments (informed by data as well as economic, environmental, and moral values) about policy.

In the last half of the semester students work in teams to identify and design engineering solutions to water and sanitation problems in the developing world.

Here they must once again consider the tradeoffs between economic strength, social well-being, and environmental sustainability. A team of faculty advisors including engineers and nonengineers works with these students as they learn to define a problem and propose a solution. For instance, a team of students might design a sanitation station (laundry, toilets) for a Namibian village that combines engineering technology for sanitary conditions with sensitivity to cultural practices, so that the women of the village are most likely to value and use the station.

Assessment information: To understand their roles and meet their objectives, students playing the game identify primary and secondary sources that were available in the 1890s and provide a list of the sources consulted. To assess their information literacy, we review these sources and analyze them for quality and variety based on assessment methods reported in a number of studies completed in recent years focusing on ways to assess information literacy skills outcomes of undergraduates (see Boudreau and Hanlan 2014). Interdisciplinary teams of faculty review student posters for engineering content. Here, students present their final projects and are evaluated according to the extent to which they have identified an answerable question and evaluated and selected a suitable solution through the application of multiple perspectives and disciplines. Communication is evaluated by reviewing essays, visual displays (posters, slideshows, graphics), and presentations for clarity, effectiveness, and sound use of evidence to support conclusions. Qualitative assessment of information literacy, ethical reasoning, and creative thinking is done by assigning and reviewing reflective essays, which provide insights into how students use and interpret these sources. This assessment was inspired by the work of researchers investigating professional competencies in engineering education through assessment of student portfolios and reflective writing (see Boudreau and Hanlan 2014). At the end of the role-playing activity, students submit an essay describing the interplay between technical and nontechnical concerns and reflecting on their ethical choices. At the end of the second term, after completing the team project, students again reflect on how their awareness of different experiences of the problem guided their problem-solving process. While we have not yet assigned these reflective essays to game players, we did assign them to the game developers (also students) who were responsible for creating authentic historical roles with complex ethical content. Here are the words of one of these students: “I needed to know more than the basic facts of my characters’ identities. I was looking to learn about their ethics, their morals, and their intrinsic motivation, especially in relation to the pollution caused by the sewage in the Blackstone River. I

found myself asking questions about my characters that were sometimes difficult to answer. Who were they mentally and emotionally? What was their attitude about their community? What did they want to see happen in order to fix the sewage problem? What didn't they want to see?" In a pilot study of this role-playing game, students were asked two additional questions as part of their end-of-term course evaluations: How much have you learned about ethics in this class? and How much has the work you've done in this seminar kindled your interest in thinking about the ethical dimensions of science, engineering, or business? The average score on a Likert scale of 1 (not very much) to 5 (very much) was 4 for the first question and 4.6 for the second.

Additional resources:

1. Bordoloi LM, Winebrake JJ. 2015. Bringing the liberal arts to engineering education. *Chronicle of Higher Education*, April 27. Available at <http://chronicle.com/article/Bringing-the-Liberal-Arts-to/229671/>
2. Boudreau K. 2015. To see the world anew: Learning engineering through a humanistic lens. *Engineering Studies* 7(2-3):206–208. Available at www.tandfonline.com/doi/full/10.1080/19378629.2015.1062506
3. Hanlan LR, Boudreau K. 2014. A game-based approach to information literacy and engineering in context. IEEE Frontiers in Education Conference, October 22–25, Madrid. Available at <http://digitalcommons.wpi.edu/gordonlibrary-pubs/4/>

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