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FOR ENGINEERING AND SCIENCE

The University of Virginia SEAS Senior Thesis: A Culminating Activity

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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 asks students to develop a thesis portfolio that asks students to reflect on the ethical and social issues embedded in their senior project.

Abstract

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Exemplary features: Multiyear program interweaves technical education with ethics and STS education

Why it's exemplary: The University of Virginia School of Engineering and Applied Science (SEAS) senior thesis activity is exemplary because it challenges students to integrate social and ethical analysis with engineering by building on an understanding of the relationship between engineering, technology, and society. It is also exemplary because it provides this ethics education to every engineering student at a large research institution.

Program description: The UVa School of Engineering and Applied Science (SEAS) requires that all undergraduate students— approximately 650 students annually—complete a senior thesis in their final year. For this culminating activity students integrate their work on a technical project with research on an ethical, social, or policy issue related to the technical project. They develop and demonstrate their capacity for social analysis, ethical reasoning, and written communication, abilities cultivated during a four-year experience that includes four courses offered by the Science, Technology, and Society (STS) Program. The thesis requirement is managed by the STS Program, with much of the work done as part of two fourth-year courses. The senior thesis consists of a portfolio of documents:

- A prospectus: This document, written in STS 4500: STS and Engineering Practice, is a plan and justification for undertaking a technical research or design project and writing an STS research paper.
- A technical report: This document is written under the supervision of an engineering faculty member as a report on a research or design experience done either as part of a capstone or design course or an independent study. It is written in the language and style of the specific engineering discipline.
- An STS research paper: This document, written as part of STS 4600: The Engineer, Ethics, and Professional Responsibility under the supervision of an STS faculty member, is focused on an ethical, social, or policy issue related to the technical project.
- A sociotechnical synthesis: This document briefly describes the technical report and STS research paper and articulates the synthetic connection between the two.

These four documents are bound together, submitted as the senior thesis portfolio, and kept (in circulation) at the UVa Science and Engineering Library.

The SEAS senior thesis demonstrates the student's learning processes in integrating

the technical and the social/ethical. Be it analysis of the social implications of a technology, grappling with a policy issue surrounding a particular technology, or a sociohistorical study of an engineering endeavor, students are challenged to develop a narrative about their technical work, the social/ethical implications of that work, and how the two are intertwined. The senior thesis is best understood in the context of the broader curriculum.

SEAS requires all engineering students to take four STS courses that aim to develop students' (1) competence in ethical awareness and analysis; (2) oral and written communication skills; and (3) understanding of the relationships among science, technology, and society and the implications of these relationships for engineering practice. These three goals are integrated in the course offerings culminating in the SEAS senior thesis. Hence, it is not possible to understand the significance of the thesis without explaining the full curriculum. The first course focuses on breadth, the second on depth in a particular subject, and the third and fourth courses on synthesis and integration. Ethics, especially professional ethics, is introduced in the first course, touched on in the second and third courses, and the major focus of the fourth course.

STS 1500: Science, Technology, and Contemporary Issues – This course is designed to introduce students to the relationship between engineering, technology, and society and to strengthen writing and speaking skills. Among many other things, the course provides students with an introduction to engineering ethics and the legal and social dimensions of engineering practice.

STS 2000/3000: Science and Technology in Social and Global Context – All engineering students take at least one 2000-/3000-level STS course in their second or third year. These courses examine specific social and/or ethical issues involving science and technology from humanities and social science perspectives. Students might, for example, explore technology in utopian thought or environmental policy or the history of technology. This provides depth in understanding the intertwining of engineering, science, technology, and society.

STS 4500: STS and Engineering Practice – Students write the prospectus as part of this course, which also has subject matter content, engaging students with the challenge of framing and solving engineering problems in a manner that requires attention to social dimensions. Students are introduced to STS theories and methods as a means to prepare them for their STS research paper.

STS 4600: The Engineer, Ethics, and Professional Responsibility – This course on ethical issues in engineering challenges students to analyze ethical issues in a systematic way. Much of the course is also devoted to completion of the STS research paper on an ethical, social, or policy aspect of the technical project.

STS 4500 and 4600 are taught in classes with approximately 30 students. We offer over 20 sections of each course.

The four-course curriculum is based on the premise that to effectively teach engineering ethics, students must be exposed to the subject matter more than once in their curriculum, and the more often, the better. Hence, the first course introduces ethics and the second courses address ethics, values, and decision making in a more specific area of specialization (e.g., information technology or nanotechnology). The two-semester senior-level courses allow students to do research on a topic of their choice as long as it addresses an ethical, social, or policy issue related to a technical project they are working on with an advisor in their major. A second premise of the UVa senior thesis is that it recognizes that ethical issues in engineering practice do not arise abstractly or theoretically or in a vacuum. They are embedded in social contexts and, to come to grips with these issues and figure out whether and how to take action, engineers need concepts and language with which to analyze social context. The field of STS provides concepts and methods that help to do just this. Students use STS to think about the social and technical together. This culminates in writing the STS research paper.

The four-course and senior thesis requirements fulfill at least three of ABET's student outcomes criteria: an understanding of professional and ethical responsibility, an ability to communicate effectively, and the broad education necessary to understand the impact of engineering solutions in a global and societal context. The courses also ensure that students produce a portfolio of work that can be and is used in the ABET assessment and evaluation process.

Assessment information: We know we have achieved our goals when we see our

students writing and speaking competently and confidently about the social and ethical implications of technology and engineering, using language and concepts from the social sciences and humanities in relation to technologies, engineering challenges, and engineering endeavors. We use a variety of assessment resources. Because the senior thesis experience is managed through the two fourth-year STS courses, student evaluations of these courses provide short-term, immediate feedback. For longer-term feedback, we pay attention to surveys of alumni undertaken by SEAS, for example, about the influence of curriculum experiences on current work life. We rely most heavily on an examination of the STS research papers. Each year after the final thesis portfolios have been submitted, faculty who have taught the senior thesis courses engage in a joint assessment activity by examining and rating a sample of the STS research papers on a specified set of criteria. The criteria used for this assessment vary somewhat each year, but they are targeted to connect to the ABET student outcomes (mentioned above). [We use materials from this assessment during ABET reviews.] This assessment process reveals to what extent students are able to do the kind of analysis we aspire for them to do. We identify what is lacking in the lower-quality papers and what is exemplified in the best papers and use this information to guide our teaching. In addition to assessment, this activity helps the faculty to develop shared standards for grading.

Another kind of feedback on how we are doing occurs when STS faculty evaluate STS research papers for presentation at an annual SEAS event recognizing excellence in undergraduate engineering. Each year SEAS holds an Undergraduate Research and Design Symposium to celebrate students who achieve excellence in their technical research, design, and STS research. This past year approximately 30 students were nominated by their STS instructors to present at the symposium, a dozen were selected, and two received special awards.

Other signs that we are achieving our goals come from the achievements of our students. For example, this past year three students were invited to present their STS research projects at the Science and Technology Global Conference hosted at the National Academy of Sciences in April 2015. The conference allowed the students to interact with graduate students and faculty who focus exclusively on the ethical, social, and policy aspects of science and technology. Faculty also work with students who want to have their STS research papers published. In summer 2015 a student published his paper in *Intersect: The Stanford Journal of Science, Technology, & Society*.

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Resource Type

Educational Activity Description

Parent Collection

NAE Exemplars in Engineering Ethics Education

Topics

Pedagogical Approaches

Discipline(s)

Engineering
Teaching Ethics in STEM