

ENGINEERING ETHICS

Introducing Ethics Case Studies Into Required Undergraduate Engineering Courses
Department of Philosophy and Department of Mechanical Engineering
Texas A&M University
NSF Grant Number DIR-9012252

Engineering Ethics: The Professional Challenge

Engineering ethics is attracting increasing interest in colleges of engineering throughout the nation. At Texas A&M University, evidence of this interest in professional ethics culminated in the creation of a new course in engineering ethics, as well as a project funded by the National Science Foundation to develop material for introducing ethical issues into required undergraduate engineering courses. A small group of faculty and administrators actively supported the growing effort at Texas A&M, yet this small group must now expand to meet the needs of increasing numbers of students wishing to learn more about the value implications of their actions as professional engineers.

The increasing concern for the value dimension of engineering is, at least in part, a result of the attention that the media has given to cases such as the Challenger disaster, the Kansas City Hyatt-Regency Hotel walkways collapse, and the Exxon oil spill. As a response to this concern, a new discipline, engineering ethics, is emerging. This discipline will doubtless take its place alongside such well-established fields as medical ethics, business ethics, and legal ethics. The problem presented by this development is that most engineering professors are not prepared to introduce literature in engineering ethics into their classrooms. They are most comfortable with quantitative concepts and often do not believe they are qualified to lead class discussions on ethics. Many engineering faculty members do not think that they have the time in an already overcrowded syllabus to introduce discussions on professional ethics, or the time in their own schedules to prepare the necessary material.

In the fall of 1990, Texas A&M received funding from the National Science Foundation to address these problems. The NSF-funded research project, "Introducing Ethics Case Studies Into Required Engineering Undergraduate Courses," was completed in August 1992. During the course of the project the co-principal investigators at Texas A&M, Professor Michael J. Rabins in the Department of Mechanical Engineering and Professor Ed Harris in the Department of Philosophy, developed and tested eleven student handouts and instructor's guides in eleven different courses in the agricultural, chemical, civil and mechanical engineering departments at Texas A&M. The principal investigators were pleased by the willingness of engineering professors to use the material developed during the two-year project. After observing presentation of the material on one or two occasions, many of the instructors were willing to present the material on their own. Student responses to the curriculum additions was overwhelmingly positive, and student and instructor evaluations suggested that there is a growing need to share this work with other engineering professors and professionals and to encourage more engineering instructors to present issues in professional ethics to their classes.

Texas A&M is making the results of the NSF project's research and development available to instructors who want to introduce ethical issues to engineering students and professionals. Eleven case studies (listed on the next page, along with appropriate classes into which the case can be introduced), including instructor's guides, student handouts and overhead transparencies, are now available in hard copy, as well as in floppy disk format for IBM

compatible users or in an ASCII format if requested on either a 5.25" or 3.5" disk. Case study summaries are provided prior to the listing. In addition, nine background pedagogical essays are provided on the following topics: Moral Concepts and Theories; Basic Concepts and Methods in Ethics; Ethics and Professionalism in Engineering; Organizational Loyalty and Professional Rights; Engineers and the Environment; Risk and the Engineering Decision-Making Process; Negligence and the Professional "Debate" over Responsibility for Design; Literature on Whistle blowing - An Overview; and Engineering Design: Literature on Social Responsibility Versus Legal Liability.

The entire output of this NSF-funded study is available in the form of a final report to the NSF.

For more information on the NSF project, contact Dr. Michael J. Rabins, Department of Mechanical Engineering, Texas A&M University, College Station, Texas, 77843-3123; Telephone (409)845-1251. Floppy disks and hard copies of all cases and essays are available at cost.

Case Studies In Engineering Ethics Major Engineering Thrust Ethical Issue Typical Courses

Synopses of Case Studies

The Aberdeen Three: In 1989, three engineers working on developing chemical weapons at a U.S. Army facility, the Aberdeen Proving Ground in Maryland, were indicted for a criminal felony. They were tried and convicted for illegally handling, storing and disposing of hazardous waste in violation of the Resource Conservation and Recovery Act from 1983-1986. This case shows the importance of the engineering profession's social and environmental responsibilities, in both legal and moral terms. In addition, it serves as an important case study in the escalating public concern over environmental and toxic waste, and the ways in which government is called upon to regulate engineering business. Aberdeen Three is particularly useful for students of environmental engineering; however, it also is a useful case for showing engineering students their responsibility to the public at large.

Accepting Gifts and Amenities: Most engineers probably believe that accepting small favors (such as inexpensive pens) from vendors is permissible. By contrast, most engineers probably believe that accepting large gifts or amenities is wrong. Drawing the line between permissible and impermissible instances of accepting gifts and amenities is not always easy, however. This case invites students to think about the issues involved in such decisions. It is particularly suitable for senior-level engineering courses.

American Society of Mechanical Engineers (ASME) vs. Hydrolevel Corp.: In 1971, McDonnell and Miller, an engineering firm, used an interpretation of an ASME code to undermine a boiler control device competitor, Hydrolevel Corp. As a result, Hydrolevel sued McDonnell and Miller, the Hartford steam Boiler Inspection and Insurance Company, and ASME on the basis of restraint of trade. In the ensuing trial, which went all the way up to the U.S. Supreme Court, Hydrolevel's lawyers argued that two key ASME subcommittee members acted not only on the conflicting self-interest of their companies, but also in violation of the Sherman Anti-Trust Act. The case of ASME vs. Hydrolevel Corp. shows how easily individuals, companies, and professional societies can find themselves embroiled in expensive legal battles that tarnish the reputation of the engineering profession as a whole. The case is appropriate for all engineering upper-level curricula, for it discusses not only conflicts of interest and various engineering codes of ethics, but also illustrates the roles of engineers within their professional societies.

B.F. Goodrich Air Force A7-D Brake Problem Case: In 1969, following brake failure at June, 1968 flight

tests, and because of the ensuing accusations by a former B.F. Goodrich employee, Kermit Vandivier, regarding qualification test report falsification and ethical misconduct on the part of specific B.F. Goodrich personnel, Senator William Proxmire (D-Wisconsin) requested a governmental inquiry into the brake qualification testing performed by B.F. Goodrich. The case is one of the most famous in the literature on whistle blowing. Yet, other ethical issues raised by the case involve engineering responsibility for failed innovation, how easy it is for events to escalate (in this case, to a formal Congressional hearing) when people fail to communicate and get their facts straight, and how innovative design often makes testing procedures obsolete, or worse yet, shows that they were in fact erroneous from the onset. While valuable for all engineering students, the case is particularly well suited for design, materials and professionalism courses.

Gilbane Gold: This case focuses on a popular videotape that depicts a hypothetical--but nonetheless realistic--account of the experiences of a young engineer who is caught between his obligations to his company, Z-CORP, and to the public. The issue at the center of the controversy has to do with the fact that Z-CORP is discharging arsenic and lead into the city sewer system. The case is suitable for courses in environmental engineering, and in courses exploring professional issues, such as an engineer's obligations to his company and to the public.

Kansas City, Missouri Hyatt Regency Hotel Walkways Collapse: As the United States' most devastating structural failure, in terms of loss of life and injuries, the Kansas City Hyatt Regency walkways collapse left 114 dead and in excess of 200 injured. In addition, millions of dollars in costs resulted from the collapse, and thousands of lives were adversely affected, all because of disputed conversations between an engineering design firm and a fabricator, and negligence on the part of the contracting engineering firm. The case provides a vivid example of the importance of accuracy and detail in engineering design and shop drawings (particularly regarding revisions), and the costly consequences of negligence in this realm. The case is particularly useful in structural design, statics and materials classes.

A Plow for Mexican Peasant Farmers: Mechanical engineering students in a capstone design course are asked to design a plow that is suitable for use by peasant farmers in Mexico. The case shows how technological change, especially in third-world countries, can raise value issues. It illustrates the problems created by the intersection of design considerations and these value issues, and prompts students to come up with creative solutions to the problems. It is appropriate for design classes in mechanical engineering and is a model for projects in capstone design courses in other branches of engineering.

Space Shuttle Challenger Disaster: The fatal launching of space shuttle Challenger in 1985 resulted from a haphazard concatenation of economic considerations, political pressures and scheduling backlogs. The reality of a failed booster joint seal design took a back seat to these considerations, despite the protestations of design engineer Roger Boisjoly and others. Ethical issues raised by the case involve engineering responsibility versus management decision-making, as well as the ethics of post-hoc whistle blowing and negligence in design. This case is particularly useful to students in design, dynamics and structures courses.

TV Antenna Tower Collapse: In this case, based on a real-world scenario, a television station was videotaping a crew raising the station's new television antenna tower. Unfortunately, on the day of videotaping, something went wrong with the lifting rig, and while the antenna was being hoisted the bolts failed. The result was a tragedy, with seven riggers falling 1200 feet to their death. The case raises serious questions about the design engineer's social responsibility to ensure safety on a construction site where riggers hoisting the antenna tower did not have sufficient technical expertise to know that they were endangered. Additionally, the case poses questions about product liability issues in engineering and ethics, particularly where knowledgeable bystanders, who could

avert a tragedy by speaking up despite inferred liability, are concerned. What is the engineer's social responsibility as compared to legal liability? While valuable for all engineering students, the case is particularly well suited for statics and structures courses.

Trench Boxes and the Construction Site: The use of safety equipment such as trench boxes can save many lives on construction sites. Unfortunately, trench boxes are not very cost effective, and because there is no legislation mandating their use, many contractors opt out of using trench boxes on construction sites. As a result, hundreds of worker's lives are lost each year, or at the very least, workers incur serious injuries because trench boxes are not operable on their construction site. The case raises the issue of legal liability for trench boxes versus the social responsibility of using them. What are the liability issues involved, and is it negligence to avoid their use? This case is of use to courses in geotechnical engineering, statistics, and construction engineering.

XYZ Rubber Company and the Case of the Bursting Hose: Since the 1940's, anhydrous ammonia has been used by farmers in the spring and early fall as a nitrogen fertilizer. Due to the toxicity of the ammonia vapors, however, serious accidents can result from its use. Such was the case in this study based on a real-world example. As a result of calamitous incidents involving hose ruptures, corporations were sued and forced to take their hoses off the market. Ethical questions raised by the case include what happens when professional codes and regulations lag behind technological innovations; what precautions must engineers take when trying to balance the benefits new technologies bring against risks to public safety often associated with engineering innovation; and what are engineering and corporate responsibilities to the public for failed innovation. This is an excellent case for studying risk assessment and can be applied particularly well to cases in design, fluids, materials, and agricultural engineering.