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Steve Eugene Watkins

Missouri University of Science and Technology, watkins@mst.edu

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Hypothetical Cases in Engineering Ethics

Steve E. Watkins

*Missouri University of Science and Technology, Rolla, Missouri USA and
United States Air Force Academy, Colorado USA*

Abstract

An important educational subject for engineering students is engineering ethics. Common instructional objectives are to develop knowledge of ethical principles, e.g. professional codes, and to apply these principles to specific situations. Case studies are useful instructional examples and exercises and cases are central to student ethics competitions. Historical case studies emphasize the relevance of ethics in engineering work. Hypothetical case studies can address specific ethical principles and provide great design flexibility. This paper discusses hypothetical cases in engineering ethics in the context of instructional exercises or student competitions. Recommendations are given for the development of versatile cases and for approaching a case study or analysis. Three custom cases that were used in the IEEE Student Ethics Competition are presented as examples.

Keywords

Ethics, Profession, Case Study.

Introduction

Case studies are valuable tools for developing knowledge and judgment concerning engineering ethics. Many definitions of a profession include a requirement for self-regulation and professional engineering societies recognize the importance of providing explicit guidance for ethical conduct, cf. development of the IEEE Code of Ethics¹. Engineering codes of ethics are commonly available and they are tailored to the society membership. Example codes are those from the National Society of Professional Engineers (NSPE)² and Tau Beta Pi, the Engineering Honor Society³. Student competitions that involve ethics are held by NSPE and IEEE^{2,4}. Other resources, which include review cases, are maintained by NSPE and the National Academy of Engineering (NAE)^{2,5,6}. Prominent historical cases are discussed in books and in the technical literature, cf. Williams' analysis of the Intel Pentium Chip case⁷. Historical case studies emphasize the relevance of ethics to engineering and serve as valuable instructional tools in the application of ethical principles. Hence, these cases are commonly used in meeting the ABET accreditation outcome in ethics⁸ and in preparing for professional licensure. However, there is a role for hypothetical case studies⁹. For instance, a custom ethics situation can be tailored to a specific audience, can target specific ethical issues, can limit the need for specialized engineering knowledge, and can be new to students. A multifaceted case study can aid students in discriminating among actions that are ethically neutral, clearly unethical, simply unwise, etc.

This paper discusses the development of hypothetical cases in engineering ethics. Such cases are useful for classroom exercises or competition content. Guidelines are made for case composition and analysis. Three custom ethics cases are included as examples.

Exercises and Competitions in Engineering Ethics

Engineering codes of ethics generally have a statement of principles followed by a listing of guidelines in which the principles are applied. For the Tau Beta Pi Code of Ethics of Engineers as shown in Table 1., these sections are labeled “The Fundamental Principles” and “The Fundamental Cannons,” respectively³. Common themes for the statement of principles include

- Engineering is a profession,
- Engineers have obligations to society and the public welfare, and
- Engineers must act according to the highest standards of behavior.

Specific ethical guidance within the listings, e.g. “The Cannons,” generally relate the following categories:

- Performance as engineers,
- Engineers’ role in society,
- Personal obligations of engineers, and
- Interactions with others.

For engineering students, the ethics components of curricula may consist of stand-alone courses, content within courses, seminar sessions, and classroom ethical expectation, e.g. academic conduct policies and honor codes. The educational intents include providing background for students to pursue professional licensure and supporting life-long development as ethical professionals. The classification of engineering as a profession is given, one or more codes of ethics are typically introduced, and supplementary material is then discussed. Supplements may include definitions of ethical concepts related to technical work, e.g. conflicts of interest, intellectual property, and safety, and the application of ethical concepts through case studies and exercises. Case-related activities may be instructor-led presentations of ethical situations, informal student discussions, or formal analysis assignments, cf. Watkins⁹. Historical case studies emphasize the relevance of ethics to engineering and demonstrate the consequences of unethical behavior. Activities with historical case studies may be limited by the available information on the ethical situation and by background technical knowledge needed to understand the situation. Also, these case studies may be well known or may have an obvious analysis; hence, their value as assignments for exercising student judgment is limited. Hypothetical cases can provide content flexibility.

Student ethics competitions are designed to promote the awareness of professional ethics and to provide opportunities for the analysis of ethical situations, cf. IEEE Student Ethics Competition⁴. Published case studies and commentary, if available, are useful resources for students as they prepare for competitions, but a hypothetical case is generally needed for the competition. A custom ethics situation can be tailored to a specific audience, can target specific ethical issues, can limit the need for specialized engineering knowledge, and can be challenging for all students.

Table 1. Code of Ethics of Engineers from Tau Beta Pi³

Code of Ethics of Engineers Tau Beta Pi, The Engineering Honor Society
The Fundamental Principles
Engineers uphold and advance the integrity, honor, and dignity of the engineering profession by: Using their knowledge and skill for the enhancement of human welfare; being honest and impartial, and serving with fidelity the public, their employers and clients; striving to increase the competence and prestige of the engineering profession; and supporting the professional and technical societies of their disciplines.
The Fundamental Canons
1. Engineers shall hold paramount the safety, health, and welfare of the public in the performance of their professional duties.
2. Engineers shall perform services only in the areas of their competence.
3. Engineers shall issue public statements only in an objective and truthful manner.
4. Engineers shall act in professional matters for each employer or client as faithful agents or trustees, and shall avoid conflicts of interest.
5. Engineers shall build their professional reputation on the merit of their services and shall not compete unfairly with others.
6. Engineers shall act in such a manner as to uphold and enhance the honor, integrity, and dignity of the profession.
7. Engineers shall continue their professional development throughout their careers and shall provide opportunities for the professional development of those engineers under their supervision.

Development of Custom Cases in Ethics

A custom ethics case should be developed to facilitate the desired analysis approach as required by course assignments or competition rules. The author uses a similar approach as that given by the IEEE Student Ethics Competition^{4,9}. This approach is organized as given in Table 2. The approach encourages the separation of known facts and assumptions while reaching conclusions as to ethically preferred responses. The conclusions must be based on explicit content within the relevant code of ethics. The approach encourages the recognition that that some actions may not be wise, may show poor judgment, or may be a mistake without being an ethical error.

Table 2. Approach for Ethics Case Analysis

Analysis Steps	Questions to Answer
Situation	What are the known facts?
Ethical Points	What are the ethical questions?
Consequences	What are the possible consequences for all concerned parties?
Code References	What guidance is given by the relevant code of ethics?
Recommendations	What are possible ethical responses for the concerned parties? What is the best ethical response and why?
Other Discussion	What assumptions are needed to reach an analysis? Would the analysis change if other facts were known? Are any of the described actions a result of mistakes, poor judgment, etc. rather than ethical lapses? Could the analysis be applied to other situations?

A. Recommended Content for Custom Cases⁹

A custom case provides opportunities to examine a desired professional environment, to target specific ethical concepts, and to tailor the case details to the specific student audience. For instance, the need for specialized engineering knowledge can be limited and the complexity of the situation can be made audience appropriate. The assignment or analysis can be guided by explicitly listing ethical questions or by posing specific situation responses for discussion.

A custom case has the following components:

- The professional workplace setting and relationships.
- The target ethical issues (and a specific code of ethics as a reference for the analysis).
- The sequence of events which include ethical content.
- The needed background and any explicit analysis format and questions.

The educational value and the challenge of custom cases can be enhanced as follows.

Multiple facets can be incorporated into the case to increase the case scope and challenge level. The second step in the case analysis should not be trivial or tied to a single issue.

All of the potential ethical questions should be identified.

Specific ethical concepts can be targeted to promote understanding. Ethical concepts can be chosen to introduce new concepts or to relate concepts to the workplace.

Potential ethical content can include the initial situation and the responses of the parties.

A progression of events can aid in addressing multiple issues and can relate to multiple aspects of the code.

The anticipated analysis can require discrimination among actions that are ethically positive, ethically neutral, clearly unethical, unwise, etc. An unwise action or a mistake may not be unethical.

B. A Sample Case (Case #1)

Consider the hypothetical case described in Table 3. An engineer feels that data reporting was mishandled and he attempts to handle the perceived issue with his supervisors. The potential ethical content includes the proper handling and reporting of data, the appropriate procedure for dissenting on ethical grounds, responsibilities of authorship, relationships among managers and the test engineers, and potential safety concerns. Also, possible consequences for the company and for the parties can easily be projected. The case statement guides the analysis by including several ethical issues. The case analysis should discuss the severity of the mishandling of the data and the report and the actions of the various parties during the progression of events.

The analysis for this case should conclude that the data reporting was mishandled and was misleading. A reference to code regarding highest standards of professional work is appropriate here. However, the more challenging issues are how to dissent and how dissent was handled. The test engineer is faced with a choice between formally responding on ethical grounds (such as formally objecting to the report or to his authorship of the report) and becoming a party to the ethical failure. The possible personal consequences are the threat to his promotion and the risk to his reputation, respectively. (An insightful analysis might note that this choice is not an “ethical dilemma” since some form of response is the ethical choice as opposed to the expedient choice.) The challenging judgments are if further dissent is needed, how formal and forceful such dissent should be, and how he should remove himself from the situation. The case does not give sufficient information to evaluate the safety aspects, but an analysis should note safety as a potential concern and perhaps discuss how the recommendations might change depending on the significance of this consideration, e.g. the appropriateness of informing the manufacturer.

Table 3. Ethics Case #1

Smith and Jones work in an experimental testing laboratory for Acme Corp. Smith has been the main testing engineer for five years and is up for promotion to laboratory supervisor (includes the testing laboratory and several other laboratories). Jones is being trained as a potential replacement as the testing engineer. The laboratories division supervisor is Brown who is retiring soon. The company's latest development project is an OEM control module for a well water pump. The pump manufacturer has promised an important contract if the module meets their approval. The original module prototype met the desired specifications with the exception of the temperature test. The prototype was sent back to the development engineers for rework. The next iteration of the module was sent to the testing laboratory for testing, but the temperature test was delayed since the needed equipment was out for recalibration. Jones wrote the report for the original prototype and the draft report for the reworked prototype.

At the weekly laboratory's division meeting, Smith reports that to Brown that the latest module "meets all tests" and that the report has "good numbers" for temperature performance. Jones questions Smith privately after the meeting since his draft report indicated that temperature testing was delayed. Smith says that the development team fix should be satisfactory, i.e. it was confirmed through simulation, and that they can do further testing later to confirm the simulation numbers once the needed testing equipment is returned. Smith says that a positive report to the manufacturer cannot be delayed or their testing laboratory "looks bad" and the contract could be at risk. Then, Jones privately speaks to Brown about the situation including his concern that his (Jones) name is on the overall testing report. Brown tells him that Smith is responsible for the details in the report and that he (Jones) should learn to work with Smith if he wants to take over the testing laboratory.

What are the ethical questions in this situation? Should Jones have said something immediately in the weekly meeting? Was Jones behaving ethically in speaking with Brown or were there other ethical options? After the private conversations with Smith and Brown, does Jones have an ethical responsibility to speak to Smith again? to inform others in the company, e.g. the development team? to inform the pump manufacturer? Should Jones be concerned about the ethical culture at Acme Corp., especially as the main testing engineer under Smith's supervision?

The listed questions encourage a discussion regarding Jones' initial efforts to address his concerns privately and his options for the next ethical step. The recommendations for the best ethical responses to the immediate issues could include ethical options regarding modifying the report's listed authors, documenting the actual testing, and pursuing formal dissent avenues within the company. A larger ethical issue is introduced regarding the ethical culture of the company and an explicit question is posed as to how this incident should guide the dissenting engineer's career choices.

Example Case Studies

Two additional cases are given in this section. These cases and the case that was introduced in the prior section were developed for recent IEEE Region 5 Student Ethics Competitions.

A. Case #2

The next case is shown in Table 4. An entrepreneur does not follow through on a verbal agreement with a technical consultant. The potential ethic issues include verbal agreements, intellectual property, and business practices. The case statement guides the analysis by requesting comments on the appropriate ethical responses of all parties.

Table 4. Ethics Case #2

Smith is a nontechnical entrepreneur who has the patent rights for chemical compound for cleaning up oil spills. The substance has an extremely long shelf life for typical storage situations. However, if it is subjected to elevated temperatures it degrades quickly. The intended application is for small quantities of the substance to be stored for small shop spills. Investors are interested in supporting the commercialization if an inexpensive temperature indicator is available, i.e. the indicator activates permanently when the critical temperature is reached. Off-the-shelf temperature indicator systems are too costly for the application.

Entrepreneur Smith approaches Jones who is an engineering consultant with expertise in temperature instrumentation. He has Jones sign a non-disclosure agreement regarding the specific chemical and needed storage specifications. Jones says that he believes that a temperature indicator solution is available by an unusual combination of components from several instrumentation suppliers. They reach a verbal agreement for Jones to specify the components and the basic indicator design at an hourly rate and to give Jones a sub-contract to calibrate the assembled system if the investors fund the project. Jones asks for a formal contract regarding their agreement and Smith asks for a copy of Jones' resume to share with the investors. Jones delivers a specification of the needed components and the basic design with a bill for the services provided and a copy of his resume; Smith says that he has not had time to prepare the contract due to preparing for the investors meeting. After the investor meeting, Smith pays Jones for his services and says that the investors are handling the calibration development with their own consultant. Jones complains about the loss of the sub-contract, but Smith says it was the investors' decision. Consultant Jones hears that a competing consultant (with a similar instrumentation background) has been approached by the investors to do the calibration work. He suspects that the investors are using the components and basic design from his initial work for the entrepreneur.

What are the ethical questions in this situation? Has the entrepreneur Smith dealt ethically with Jones? Should the consultant Jones inform the competing consultant of the situation? What ethical responsibilities do the investors have? What ethical responsibilities does the new consultant have?

B. Case #3

The third case is shown in Table 5. An engineer feels that his company is operating an unmanned aerial vehicle (UAV) without understanding legal and safety issues and he unsuccessfully relates his concerns to the company management. Also, he suspects that the UAV is being operated in a questionable manner. The potential ethical issues include safety concerns, legal compliance, privacy, and management decisions. The case statement guides the analysis to comment on the appropriate ethical responses of all parties.

Table 5. Ethics Case #3

John and Kevin are lead project engineers in a small company that provides service to power utilities. Management has initiated a development project for performing electrical power line inspection with unmanned aerial vehicle (UAV) technology, i.e. a camera mounted on a UAV. John is assigned to lead a team for the camera selection, communication link design, and image processing software development. Kevin is assigned to lead a team for UAV selection and related operational issues definition. The company has not used UAVs before.

John's team quickly selects a camera and starts link and software development. This team wants to obtain realistic link and image data; they obtain a quad-rotor UAV from a potential supplier as a rent-free loan. (This company is interested in bidding as the ultimate UAV supplier.) John's team starts flying their camera on this UAV near the power lines that are located on company property.

Kevin's team has another project to finish for a deadline and is not scheduled to start on the official UAV aspects for another month. Kevin feels that legal and safety aspects of UAV operation is not well understood by anyone in the company, as well as the requirements for operating near power lines. Kevin sends a memo to Sally, who is the company VP for development and direct supervisor for both John and Kevin. Kevin expresses his concern that the company is moving too fast by using the loaner UAV and by operating this UAV without fully understanding the legal and safety issues. Sally telephones in response and says "to not worry about it" and "the rapid development is a business decision not a technical one." Afterward Kevin's office staff complains that they feel spied upon by the UAV operating during their lunch in the company's outdoor area and that they have seen the UAV operating over the adjacent public park and farmers market.

What are the ethical questions in this situation? What ethical responsibilities does Kevin have? Should Kevin do anything regarding these questions? Should Kevin investigate the staff complaints?

Summary and Discussion

Engineering ethics cases are common elements as educational exercises and student competitions. Discussions of cases are useful exercises for reinforcing knowledge of ethical concepts and codes and for applying ethical standards to specific situations. Also, assignments with ethics cases can be used as measures within accreditation reports. Cases can either be historical or hypothetical. The historical cases clearly show the relevance of ethics to engineering and the consequences of ethical failures. However, such cases may have limited documentation and may require specialized technical background knowledge. They tend to deal with major failures and may be well known. Hence, hypothetical cases have a role. These cases can have great content flexibility and can be tailored to the educational or competition needs. They can deal with workplace situations that may not be covered in published cases or case studies.

The author has used and developed hypothetical cases for his institution and for the IEEE Student Ethics Competition. For the later, custom case development guarantees that competition cases are not known to the participants. Three of these cases are included to serve as models for case creation and to serve as practice cases for competition preparation. These cases are designed to work with a particular analysis approach. This approach organizes an analysis with steps as shown below.

1. A statement of ethical points,
2. A projection of consequences,
3. Relevant guidance from a professional code,
4. Recommendations for the ethical response, and
5. Other discussion and explicit questions.

Support of life-long development as ethical professionals is an intent of ethics instruction and competitions. The recognition of engineering as a profession is a key concept in which the engineering community has a duty of self-regulation. Formal codes of ethics express a consensus in meeting this obligation in part. Additionally, the highest obligation is to the safety and welfare of the public. The creation of custom cases should be done with these ideas in mind.

A custom case provides the opportunity to target desired ethical concepts and to tailor content. A multifaceted case provides varied scope to the ethical content and provides for a challenging analysis. The interaction of ethical problems and the resulting progression of events and consequences can be highlighted. Also, the discussion can be complex in that the anticipated analysis requires discrimination among actions that are ethically positive, ethically neutral, clearly unethical, unwise, etc.

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Biographical Information for Dr. Steve E. Watkins

DR. STEVE E. WATKINS is Professor of Electrical and Computer Engineering at Missouri University of Science and Technology, formerly the University of Missouri-Rolla. He is currently a 2016-17 Distinguished Visiting Professor at the United States Air Force Academy. He is active in IEEE, IEEE-HKN, SPIE, and ASEE including service as the IEEE Region 5 Ethics Competition Chair, the 2017 IEEE-HKN President-Elect, the 2015-2017 ASEE Zone III Chair, and the 2009 ASEE Midwest Section Chair. His Ph.D. is from the University of Texas at Austin (1989). Contact: steve.e.watkins@ieee.org



Hypothetical Cases in Engineering Ethics

Steve E. Watkins

Missouri University of Science and Technology / US Air Force Academy

steve.e.watkins@ieee.org

Engineering as a Profession

Defining characteristics of a profession are self-regulation and codes of behavior.

Case studies support student learning, ABET measures, and student competition preparation.

Case Studies in Engineering Ethics

Apply Ethics Principles

Target Specific Ethical Situations

Historical Cases:

Show relevance of ethics to engineering and show consequences of unethical behavior

Hypothetical (Custom) Cases:

Introduce new situation and provide flexibility with content and detail level

Analysis Steps	Questions to Answer
Situation	What are the known facts?
Ethical Points	What are the ethical questions?
Consequences	What are the possible consequences for all concerned parties?
Code References	What guidance is given by the relevant code of ethics?
Recommendations	What are possible ethical responses for the concerned parties? What is the best ethical response and why?
Other Discussion	What assumptions are needed to reach an analysis? Would the analysis change if other facts were known? Are any of the described actions a result of mistakes, poor judgment, etc. rather than ethical lapses? Could the analysis be applied to other situations?

Case Characteristics:

Appropriate Complexity & Technical Knowledge

Sufficient Detail to Limit Assumptions

Multiple Facets, i.e. avoid trivial or single issue situations

Ethical Content Includes an Initial Situation & Responses

Anticipated Analysis Requires Judgment

(positive, neutral, negative, unwise, mistake, ...)

Analysis can be guided by explicit questions.

Selected Resources

- Tau Beta Pi, The Engineering honor Society, “Code of Ethics of Engineers,” (Accessed 2017). Available: <http://www.tbp.org/about/InfoBook/ethics.cfm>.
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Example Case #1

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