Ethics and the Social Impact of Engineering Projects

ELEC 3040/3050
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From ABET:
"Criteria for Accrediting Engineering Programs"

"3. Engineering programs must demonstrate that their students attain:

(b) an ability to design and conduct experiments to acquire needed data, and to analyze and interpret data to solve engineering problems

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

(f) an understanding of professional and ethical responsibility

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

(j) a knowledge of contemporary issues"

Technology and society

- "Ethics" definitions (American Heritage Dictionary)
  1. "Branch of philosophy that deals with the general nature of good and bad and the specific moral obligations of and choices to be made by the individual in his/her relationship to others."
  2. "Rules or standards governing conduct, especially those of a profession."
- As engineers, what are our responsibilities to society, regarding the decisions we make?
- In engineering design, consider "should we?" as well as "can we?", and "what are the potential effects on society?"

Engineers as "professionals"

- Engineers design systems & processes that affect the public in many ways
  - bridges, power systems, heart pace-makers, electronic spying equipment, database, file-sharing tools, electomagnetic emissions …
- The public must trust that engineers design products that are well-designed and safe
- Almost every element of design work can have a public consequence
  - Consider social context of a design project
  - Often ignored in excitement/pressure of design work
  - Design trade-offs may affect reliability, safety, etc.

Case Study: The Plagiarism Detector[1]

- Web tool to detect plagiarized items in papers
  - unattributed phrases, sentences, paragraphs from Internet sources (even with slight modifications)
  - detects sharp changes in writing style within a paper
  - variation of writing style from past submissions
  - "good design" - technically advanced and efficient
- *Question: What about the use of this tool?*
  - Improper presumption of guilt for all students?
  - Invasion of privacy?
  - Possible use for non-academic purposes?

1. Practical Engineering Design, Bystrom & Eisenstein

Case Study: *Napster*, *Kazaa*, et al.

- Excellent technology and "engineering design" for sharing files via Internet
- What are the ethical and social implications of these engineering designs?
  - Facilitate illegal activities (copying of copyrighted materials)?
  - Is the designer/company liable for how its technology is used?

Case study: Low-frequency electromagnetic fields[1]

- By 1994, some studies linked weak low-frequency magnetic fields to cancer & other health problems
  - Power distribution, CRTs, etc.
  - Statistical significance and conclusions often controversial
  - More recent studies have diminished these concerns
- Engineering problem – design safe products without full understanding of emission dangers

1. "Engineering case studies for electrical and computer engineering students", IEEE Trans. Educ., Aug. 2000

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Case study: Low-frequency electromagnetic fields

- Ethical & public safety issues
  - In light of 1994 studies, what should engineers do when there's doubt about safety?
  - Instead of dealing with a potential hazard, is the engineer "off the hook" by simply providing a warning?
  - How does the engineer balance safety vs. cost?

    (Must the product be totally safe at all costs?)
  - With some recent findings indicating no hazard, what should an engineer do today when designing products that will emit radiation?

Case Study: The Bay Area Rapid Transit System[1]

- BART high-tech rail system with fully automated control, on-board sensors, etc.
- 3 BART engineers expressed concerned about incomplete testing of the control system
  - BART management ignored their concerns
  - The engineers bypassed "chain of command" and went to BART board of directors.
  - The bypassed manager fired the engineers for "leaks".

1. "Engineering case studies for electrical and computer engineering students", IEEE Trans. Educ., Aug. 2000

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BART Case Study (continued)

- Issues:
  - Should engineers "blow the whistle"? (If so – when?)
  - At what point should an engineer give up expressing concerns when supervisors disagree (or ignore)?
  - What other actions might they have taken?
  - What degree of professionalism is expected of contractors?
  - What amount of testing is sufficient for a design?
  - What responsibility does a company have to report product concerns or reliability issues to the public?

Case Study: Electrification of Afghanistan[1]

- "Electricity transforms the way people live."
- Issues:
  - Was the best technical approach employed?
    - Use of available natural resources
    - Socio-economic history (this is a war zone)
  - Qualifications:
    - Of contractors, to build the system
    - Of customers, to maintain and operate the system
  - Effect of international politics on contracting and engineering decisions

1. "Re-engineering Afghanistan", IEEE Spectrum., Oct. 2011

Basic questions to ask yourself regarding a design project

- Who might be affected?
- Is development of the product safe?
- Is development of the product ethical?
- What is the effect of the project on natural resources? on human welfare? on human rights?
- What could go wrong?
- What are the risks and liability?
- How might the product be used, other than for its intended purpose?

“Subtle” statements from supervisors leading to ethical dilemmas*

- Probably not:
  - “Could you falsify this data for me so we can ship the product.”
- More subtle pressure is likely:
  - “We have invested a lot of time and money in the design.”
  - “We really need this system to work.”
  - “The company’s future depends upon this.”
  - “Is there any way that we can made adjustments to make it pass the certification?”
  - “Is it close enough that we could certify it? It really meets the needs and the standard has a margin of error built in to it.”

*Source: Design for Electrical and Computer Engineers, R. M. Ford & C. S. Coulston, McGraw-Hill, 2008

Professional Codes of Ethics

- As professionals, we must:
  - earn and maintain the public's trust
  - fulfill our obligations to the public
- Most professional organizations publish codes of ethics:
  - Institute of Electrical and Electronics Engineers (IEEE)
  - National Society of Professional Engineers (NSPE)
- Good on-line engineering ethics resources:
  - Texas A&M Engineering Ethics Case Studies: ethics.tamu.edu
  - Ethics center for engineering and science: www.onlineethics.org
  - IEEE Ethics Resource Center
    http://www.ieee.org/web/aboutus/ethics/resources.html

IEEE Code of Ethics

http://www.ieee.org/portal/pages/iportals/aboutus/ethics/code.html

"We, the members of the IEEE, in recognition of the importance of our technologies in affecting the quality of life throughout the world, and in accepting a personal obligation to our profession, its members and the communities we serve, do hereby commit ourselves to the highest ethical and professional conduct and agree:

1. to accept responsibility in making engineering decisions consistent with the safety, health and welfare of the public, and to disclose promptly factors that might endanger the public or the environment; (continued)

IEEE Code of Ethics (continued)

http://www.ieee.org/portal/pages/iportals/aboutus/ethics/code.html

2. to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;

3. to be honest and realistic in stating claims or estimates based on available data;

4. to reject bribery in all its forms;

5. to improve the understanding of technology, its appropriate application, and potential consequences;" (continued)

IEEE Code of Ethics (continued)

http://www.ieee.org/portal/pages/iportals/aboutus/ethics/code.html

6. to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;

7. to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;

8. to treat fairly all persons regardless of such factors as race, religion, gender, disability, age, or national origin; (continued)

IEEE Code of Ethics (continued)

http://www.ieee.org/portal/pages/iportals/aboutus/ethics/code.html

9. to avoid injuring others, their property, reputation, or employment by false or malicious action;

10. to assist colleagues and co-workers in their professional development and to support them in following this code of ethics.

NSPE Code of Ethics for Engineers

http://www.nspe.org/Ethics/

Preamble

"Engineering is an important and learned profession. As members of this profession, engineers are expected to exhibit the highest standards of honesty and integrity. Engineering has a direct and vital impact on the quality of life for all people. Accordingly, the services provided by engineers require honesty, impartiality, fairness, and equity, and must be dedicated to the protection of the public health, safety, and welfare. Engineers must perform under a standard of professional behavior that requires adherence to the highest principles of ethical conduct."

NSPE Code of Ethics for Engineers

I. Fundamental Canons

Engineers, in the fulfillment of their professional duties, shall:

1. Hold paramount the safety, health and welfare of the public.
2. Perform services only in areas of their competence.
3. Issue public statements only in an objective and truthful manner.
4. Act for each employer or client as faithful agents or trustees.
5. Avoid deceptive acts.
6. Conduct themselves honorably, responsibly, ethically, and lawfully so as to enhance the honor, reputation, and usefulness of the profession.

Source: http://www.nspe.org/Ethics/

NSPE Code of Ethics for Engineers

II. Rules of Practice: Canon 1

1. Engineers shall hold paramount the safety, health, and welfare of the public.

a. If engineers' judgment is overruled under circumstances that endanger life or property, they shall notify their employer or client and such other authority as may be appropriate.

b. Engineers shall approve only those engineering documents that are in conformity with applicable standards.

c. Engineers shall not reveal facts, data, or information without the prior consent of the client or employer except as authorized or required by law or this Code.

d. Engineers shall not permit the use of their name or associate in business ventures with any person or firm that they believe are engaged in fraudulent or dishonest enterprise.

e. Engineers shall not aid or abet the unlawful practice of engineering by a person or firm.

f. Engineers having knowledge of any alleged violation of this Code shall report thereon to appropriate professional bodies and, when relevant, also to public authorities, and cooperate with the proper authorities in furnishing such information or assistance as may be required.

Source: http://www.nspe.org/Ethics/

NSPE Code of Ethics for Engineers

II. Rules of Practice: Canon 2

2. Engineers shall perform services only in the areas of their competence.

a. Engineers shall undertake assignments only when qualified by education or experience in the specific technical fields involved.

b. Engineers shall not affix their signatures to any plans or documents dealing with subject matter in which they lack competence, nor to any plan or document not prepared under their direction and control.

c. Engineers may accept assignments and assume responsibility for coordination of an entire project and sign and seal the engineering documents for the entire project, provided that each technical segment is signed and sealed only by the qualified engineers who prepared the segment.

Source: http://www.nspe.org/Ethics/

NSPE Code of Ethics for Engineers

II. Rules of Practice : Canon 3

3. Engineers shall issue public statements only in an objective and truthful manner.

a. Engineers shall be objective and truthful in professional reports, statements, or testimony. They shall include all relevant and pertinent information in such reports, statements, or testimony, which should bear the date indicating when it was current.

b. Engineers may express publicly technical opinions that are founded upon knowledge of the facts and competence in the subject matter.

c. Engineers shall issue no statements, criticisms, or arguments on technical matters that are inspired or paid for by interested parties, unless they have prefaced their comments by explicitly identifying the interested parties on whose behalf they are speaking, and by revealing the existence of any interest the engineers may have in the matters.

Source: http://www.nspe.org/Ethics/

NSPE Code of Ethics for Engineers

II. Rules of Practice : Canon 4

4. Engineers shall act for each employer or client as faithful agents or trustees.

a. Engineers shall disclose all known or potential conflicts of interest that could influence or appear to influence their judgment or the quality of their services.

b. Engineers shall not accept compensation, financial or otherwise, from more than one party for services on the same project, or for services pertaining to the same project, unless the circumstances are fully disclosed and agreed to by all interested parties.

c. Engineers shall not solicit or accept financial or other valuable consideration, directly or indirectly, from outside agents in connection with the work for which they are responsible.

d. Engineers in public service as members, advisors, or employees of a governmental or quasi-governmental body or department shall not participate in decisions with respect to services solicited or provided by them or their organizations in private or public engineering practice.

e. Engineers shall not solicit or accept a contract from a governmental body on which a principal or officer of their organization serves as a member.

Source: http://www.nspe.org/Ethics/

NSPE Code of Ethics for Engineers

II. Rules of Practice : Canon 5

5. Engineers shall avoid deceptive acts.

a. Engineers shall not falsify their qualifications or permit misrepresentation of their or their associates' qualifications. They shall not misrepresent or exaggerate their responsibility in or for the subject matter of prior assignments. Brochures or other presentations incident to the solicitation of employment shall not misrepresent pertinent facts concerning employers, employees, associates, joint venturers, or past accomplishments.

b. Engineers shall not offer, give, solicit or receive, either directly or indirectly, any contribution to influence the award of a contract by public authority, or which may be reasonably construed by the public as having the effect of intent to influencing the awarding of a contract. They shall not offer any gift or other valuable consideration in order to secure work. They shall not pay a commission, percentage, or brokerage fee in order to secure work, except to a bona fide employee or bona fide established commercial or marketing agencies retained by them.

Source: http://www.nspe.org/Ethics/

NSPE Code of Ethics for Engineers

Part III. Professional Obligations

1. Engineers shall be guided in all their relations by the highest standards of honesty and integrity.

a. Engineers shall acknowledge their errors and shall not distort or alter the facts.

b. Engineers shall advise their clients or employers when they believe a project will not be successful.

c. Engineers shall not accept outside employment to the detriment of their regular work or interest. Before accepting any outside engineering employment they will notify their employers.

d. Engineers shall not attempt to attract an engineer from another employer by false or misleading pretenses.

e. Engineers shall not promote their own interest at the expense of the dignity and integrity of the profession.

Source: http://www.nspe.org/Ethics/

NSPE Code of Ethics for Engineers

III. Professional Obligations

2. Engineers shall at all times strive to serve the public interest.

a. Engineers shall seek opportunities to participate in civic affairs; career guidance for youths; and work for the advancement of the safety, health, and well-being of their community.

b. Engineers shall not complete, sign, or seal plans and/or specifications that are not in conformity with applicable engineering standards. If the client or employer insists on such unprofessional conduct, they shall notify the proper authorities and withdraw from further service on the project.

c. Engineers shall endeavor to extend public knowledge and appreciation of engineering and its achievements.

Source: http://www.nspe.org/Ethics/

NSPE Code of Ethics for Engineers

III. Professional Obligations

3. Engineers shall avoid all conduct or practice that deceives the public.

a. Engineers shall avoid the use of statements containing a material misrepresentation of fact or omitting a material fact.

b. Consistent with the foregoing, engineers may advertise for recruitment of personnel.

c. Consistent with the foregoing, engineers may prepare articles for the lay or technical press, but such articles shall not imply credit to the author for work performed by others.

4. Engineers shall not disclose, without consent, confidential information concerning the business affairs or technical processes of any present or former client or employer, or public body on which they serve.

a. Engineers shall not, without the consent of all interested parties, promote or arrange for new employment or practice in connection with a specific project for which the engineer has gained particular and specialized knowledge.

b. Engineers shall not, without the consent of all interested parties, participate in or represent an adversary interest in connection with a specific project or proceeding in which the engineer has gained particular specialized knowledge on behalf of a former client or employer.

Source: http://www.nspe.org/Ethics/

NSPE Code of Ethics for Engineers

III. Professional Obligations

5. Engineers shall not be influenced in their professional duties by conflicting interests.

a. Engineers shall not accept financial or other considerations, including free engineering designs, from material or equipment suppliers for specifying their product.

b. Engineers shall not accept commissions or allowances, directly or indirectly, from contractors or other parties dealing with clients or employers of the engineer in connection with work for which the engineer is responsible.

6. Engineers shall not attempt to obtain employment or advancement or professional engagements by untruthfully criticizing other engineers, or by other improper or questionable methods.

a. Engineers shall not request, propose, or accept a commission on a contingent basis under circumstances in which their judgment may be compromised.

b. Engineers in salaried positions shall accept part-time engineering work only to the extent consistent with policies of the employer and in accordance with ethical considerations.

c. Engineers shall not, without consent, use equipment, supplies, laboratory, or office facilities of an employer to carry on outside private practice.

Source: http://www.nspe.org/Ethics/

NSPE Code of Ethics for Engineers

III. Professional Obligations

7. Engineers shall not attempt to injure, maliciously or falsely, directly or indirectly, the professional reputation, prospects, practice, or employment of other engineers. Engineers who believe others are guilty of unethical or illegal practice shall present such information to the proper authority for action.

a. Engineers in private practice shall not review the work of another engineer for the same client, except with the knowledge of such engineer, or unless the connection of such engineer with the work has been terminated.

b. Engineers in governmental, industrial, or educational employ are entitled to review and evaluate the work of other engineers when so required by their employment duties.

c. Engineers in sales or industrial employ are entitled to make engineering comparisons of represented products with products of other suppliers.

8. Engineers shall accept personal responsibility for their professional activities, provided, however, that engineers may seek indemnification for services arising out of their practice for other than gross negligence, where the engineer's interests cannot otherwise be protected.

a. Engineers shall conform with state registration laws in the practice of engineering.

b. Engineers shall not use association with a nonengineer, a corporation, or partnership as a "cloak" for unethical acts.

Source: http://www.nspe.org/Ethics/

NSPE Code of Ethics for Engineers

III. Professional Obligations

9. Engineers shall give credit for engineering work to those to whom credit is due, and will recognize the proprietary interests of others.

a. Engineers shall, whenever possible, name the person or persons who may be individually responsible for designs, inventions, writings, or other accomplishments.

b. Engineers using designs supplied by a client recognize that the designs remain the property of the client and may not be duplicated by the engineer for others without express permission.

c. Engineers, before undertaking work for others in connection with which the engineer may make improvements, plans, designs, inventions, or other records that may justify copyrights or patents, should enter into a positive agreement regarding ownership.

d. Engineers' designs, data, records, and notes referring exclusively to an employer's work are the employer's property. The employer should indemnify the engineer for use of the information for any purpose other than the original purpose.

e. Engineers shall continue their professional development throughout their careers and should keep current in their specialty fields by engaging in professional practice, participating in continuing education courses, reading in the technical literature, and attending professional meetings and seminars.

Source: http://www.nspe.org/Ethics/

Professional licensure

Source: www.nspe.org

"Why Should You Get Licensed?

Licensure, first of all, is the mark of a professional. The licensure process demands an extra measure of competence and dedication. While not all engineers find licensure mandatory for their chosen career paths, the PE initials after their names can provide many advantages. Employers in all disciplines indicate that they find licensed professional engineer employees to be more dedicated, with enhanced leadership and management skills. These employers look to licensure in evaluating the advancement potential of employees.

Licensed engineers also achieve an enhanced status in the eyes of the public, which equates the engineer with professionals licensed in other fields.

Licensure is an indicator of dedication to integrity, hard work, and creativity, and an assurance that the individual engineer has passed at least a minimum screen of competence. Of course, licensure is just a starting point for professional growth and development, and participation in professional activities is part of the ongoing activities of a true professional ."

Source: http://www.nspe.org/Ethics/

Professional licensure (continued)

Regardless of the career path you choose to take, there are a number of practical considerations concerning licensure of which you should be aware:

- Only a licensed engineer may prepare, sign and seal, and submit engineering plans and drawings to a public authority for approval, or seal engineering work for public and private clients.
- Licensure for individuals who wish to pursue a career as a consulting engineer or a private practitioner is not something that is merely desirable; it is a legal requirement for those who are in responsible charge of work, be they principals or employees.
- Licensure for engineers in government has become increasingly significant. Many federal, state, and municipal agencies require that certain governmental engineering positions, particularly those considered higher level and responsible positions, be filled only by licensed professional engineers.
- For those considering a career in education, many states have been increasingly requiring that those individuals teaching engineering must be licensed. Exemptions to state laws are under attack, and in the future, those in education, as well as industry and government, may need to be licensed to practice. Also, licensure helps educators prepare students for their future in engineering.

Source: http://www.nspe.org/Ethics/

Professional licensure (continued)

Why licensure:

- With the growing complexity and the increasing diversity of modern construction processes and techniques, the engineer in construction must readily be able to communicate and exchange ideas and views with other licensed design engineers.

- For those pursuing careers in industry, licensure has recently taken on increased meaning with heightened public attention concerning product safety, environmental issues, and design defects. Employers have found it advantageous to identify to the courts and the public those employees who have met at least a minimum level of competence.

- Engineers in the military must have the credentials to stay with the service in the face of downsizing or to make the transition to the private sector.

- The scope of engineering practice is constantly changing, and engineering activities that may be exempt today may eventually shift into a practice area that one day requires a license (for example, research and development may find practical application in the facilities design/construction process, requiring the practitioner to be licensed).

Source: http://www.nspe.org/Ethics/

Professional licensure (continued)

Why licensure:

- State engineering boards are increasingly seeking and obtaining the authority to impose civil penalties against unlicensed individuals who unlawfully engage in the practice of engineering

- Engineers must adapt to a rapidly changing workplace-restructuring, downsizing, outsourcing, privatization, and re-engineering. Engineers should prepare to make the transition into a consulting relationship with former employers and clients in the event of a corporate outsourcing and respond if their corporation decides to bring design and engineering services in-house. Only by becoming licensed can an engineer perform the broad scope of engineering services within an area of competence as defined under state law.

Source: http://www.nspe.org/Ethics/

Steps to professional licensure

- National Council of Examiners for Engineering and Surveying (NCEES) http://www.ncees.org
  - develops, administers, and scores the examinations used for engineering licensure in the United States
  - facilitates professional mobility and promotes uniformity of the U.S. licensure

Two-step process:

1. Fundamentals of Engineering (FE) exam – administered by state boards (http://www.bels.alabama.gov/examinfo.htm)
   - for students close to finishing an accredited undergraduate engineering degree
   - Application deadline Jan. 15 for April exam
2. Principles and Practice of Engineering (PE) Exam
   - tests ability to practice competently in a particular engineering discipline.
   - for engineers who have gained at least four years' post-college work experience in their chosen engineering discipline

References

- Design for Electrical and Computer Engineers, Ralph M. Ford & Chris S. Coulston, McGraw-Hill, 2008
- Practical Engineering Design, Maja Bystrom & Bruce Eisenstein, CRC Press, 2005
- Engineering Design for Electrical Engineers, Alan D. Wilcox, Prentice-Hall, 1990
- Computer Engineering 2004 – Curriculum Guidelines for Undergraduate Curricula in Computer Engineering, Chapter 6 "Professionalism".
- Texas A&M Engineering Ethics Case Studies for Undergraduate Curricula: ethics.tamu.edu
- Online ethics center for engineering and science: www.onlineethics.org
- IEEE Ethics Resouces: http://www.ieee.org/web/aboutus/ethics/resources.html
- NSPE Ethics Resources: http://www.nspe.org/Ethics/EthicsResources/

Ethics Assignment

Due Friday, 11/18/2011

- Four page paper discussing an engineering ethics case study
  - Double-spaced, 12-point font
- Main reference must be a paper in an IEEE or ASEE publication (NOT "Wikipedia")
  - IEEE Xplore is available from the AU Library web site
- Discuss the ethical issues involved in the case study:
  1. Identify the ethical issue
  2. Explain the ethical dilemma
  3. Relate the ethical issue(s) to the IEEE Code of Ethics
  4. Discuss a potential solution to the dilemma
- The paper will be graded with the rubric on the next slide

Program Outcome 10: Graduates will demonstrate understanding of ethical responsibility and professional integrity issues related to the practice of electrical/computer engineering.

Target courses: ELEC 3040 (ELEC majors) – Ethics case study paper.
ELEC 3050 (ECPE majors) – Ethics case study paper.

		Rubric			
		1 – Unsatisfactory	2 – Developing	3 – Meets expectations	4 – Exceeds expectations
Performance Indicators	Has knowledge of the IEEE Code of Ethics	Unaware of existence of the Code, cannot discuss elements of the Code.	Aware of, and can discuss some aspects of the Code, but incompletely or inappropriately.	Aware of, and can identify and discuss how to apply the Code to practice.	Provides unique insights in the application of the Code to practice.
	Can recognize an ethical dilemma	Unable to recognize a situation as an ethical dilemma.	Recognizes only some obvious situations that pose ethical dilemmas; unable to recognize others.	Recognizes most situations that pose ethical dilemmas.	Recognizes any situation that poses an ethical dilemma.
	Can explain an ethical dilemma	Unable to explain any issues involved in an ethical dilemma.	Explains some issues, but incompletely or inappropriately.	Adequately explains the issues involved in an ethical dilemma.	Provides unique insights into the issues involved in an ethical dilemma.
	Can discuss possible solutions to an ethical dilemma	Unable to offer possible solutions to an ethical dilemma.	Offers solutions, but may not be appropriate or applicable for a particular ethical dilemma.	Offers and explains at least one reasonable solution to an ethical dilemma.	Offers multiple solutions to an ethical dilemma, and discusses tradeoffs.