Ethics and Professionalism in Engineering

ELEC 3040/3050
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ABET Engineering Accreditation Commission
"Criteria for Accrediting Engineering Programs"

"Engineering programs must demonstrate that their students attain:

1. An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
2. An ability to apply engineering design to produce solutions that meet specified needs …
3. An ability to communicate effectively with a range of audiences.
4. An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments …
5. An ability to function effectively on a team ….
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions.
7. An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Technology, society and ethics

"Ethics" (American Heritage Dictionary)

- "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."
- "Rules or standards governing conduct, **especially those of a profession**."

As **engineering professionals**, what obligations do we have to society, regarding the decisions we make?

- Why is ethical behavior, and the perception of ethical behavior, important in engineering?

Engineers as "professionals"

- Engineers design systems/processes that affect the public in many ways
  - Bridges, power systems, heart pace-makers, electronic spying equipment, controls, file-sharing tools, electomagnetic emissions …
- Almost every element of design work can have a public consequence
  - Design trade-offs may affect reliability, safety, etc.
  - Social context of a design project is too often ignored in the excitement/pressure of design details and deadlines
- The public must trust that engineers design products that are well-designed and safe
  - Design decisions must be based on sound engineering principles

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 local individuals, to maintain and operate the system
  - Effect of international politics on contracting and engineering decisions

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

Case Study: The Bay Area Rapid Transit System[1] (Whistle-Blowing)

- BART high-tech rail system (1970s) 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", insubordination and lying to management.
  - The engineers sued, and eventually settled for $25K each
  - One month after deployment, a train overshot a station and crashed!

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 – how and when?)
  - At what point should an engineer give up expressing concerns when supervisors disagree with or ignore concerns?
  - What other actions might the engineers 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?
  - What "dilemmas" are faced by an engineer in such a situation? (Family, professional, societal responsibilities)

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, cell phones, 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?)

    (Common case studies: automotive recalls/non-recalls)
  - With some recent findings indicating no hazard, what should an engineer do today when designing products that will emit radiation?

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?*
  - Inappropriate presumption of guilt for all students?
  - Invasion of privacy?
  - Possible use for non-academic purposes?

1. Practical Engineering Design, Bystrom & Eisenstein

Case Study: File-sharing services (*Napster*, *Kazaa*, et al.)

- Excellent technology and "engineering design" for sharing files via Internet
  - Can be a valuable tool in many situations
- What are the ethical and social implications of these technologies?
  - Facilitate illegal activities (copying of copyrighted materials)?
  - Is the designer and/or company liable for how its technology is used?

Other recent case studies

- Apple vs. NSA (access to iPhone)
- Non-repairable electronics
- Self-driving cars (decision making)
- VW emissions scandal (EPA tests)
- Net neutrality
- "The great lightbulb conspiracy" (planned obsolescence)

Basic questions to ask yourself regarding a design project

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

Ethical dilemmas

- An ***ethical dilemma*** is "a complex situation that often involves an apparent *mental conflict between moral imperatives*, in which to obey one would result in transgressing another."

  (Source: http://en.wikipedia.org/wiki/Ethical_dilemma)

- An ethical dilemma has three elements*

  1. A decision has to be made by an individual about the best course of action to take.
  2. There are multiple possible courses of action to choose from.
  3. Each possible course of action compromises some ethical principle. (i.e. there is no "perfect solution")

* Source: "What is an Ethical Dilemma", Karen Allen, Ph.D., LMSW

“Subtle” statements from supervisors leading to ethical dilemmas*

- They would probably not say:
  - “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 this 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 and provide support for members regarding ethical dilemmas:
  - 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
  - "Ethics in Computing", Dr. Edward F. Gehringer (CS Dept., N.C. State Univ.) http://ethics.csc.ncsu.edu

IEEE Code of Ethics

http://www.ieee.org/about/corporate/governance/p7-8.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 hold paramount the safety, health, and welfare of the public, to strive to comply with ethical design and sustainable development practices, and to disclose promptly factors that might endanger the public or the environment;

(Tenets 2-10 follow)

IEEE Code of Ethics (continued)

http://www.ieee.org/about/corporate/governance/p7-8.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 by individuals and society of the capabilities and societal implications of conventional and emerging technologies, including intelligent systems;
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;

(continued)

IEEE Code of Ethics (continued)

http://www.ieee.org/about/corporate/governance/p7-8.html

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, national origin, sexual orientation, gender identity, or gender expression;

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.

NSPE Code elaborates on these canons in
Section II. Rules of Practice
Section III. Professional Obligations

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

Professional licensure*

"Why Should You Get Licensed?

- Licensure is the mark of a professional, demanding an extra measure of competence and dedication.
- **Employers** find licensed professional engineer employees to be more dedicated, with enhanced leadership and management skills.
- **Employers** look to licensure in evaluating the advancement potential of employees.
- Licensed engineers achieve an enhanced status in the eyes of the public (engineer equated with professionals licensed in other fields)
- Licensure is an indicator of dedication to integrity, hard work, and creativity
- Licensure is an assurance that the engineer has passed at least a minimum screen of competence.

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/

Practical considerations concerning licensure

- 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 a legal requirement for a career as a consulting engineer or a private practitioner
- Licensure required for engineers in certain **government** positions, particularly those considered higher level and responsible positions.
- Licensure required, in some states, to **teach** engineering design (to prepare students for engineering practice)
- Engineers in **construction** must communicate and exchange ideas and views with other licensed design engineers, despite growing complexity and the increasing diversity of modern construction processes and techniques.
- Engineering licensure important in **industry**, given heightened public attention concerning product safety, environmental issues, and design defects.
- 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.

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

Professional licensure (continued)

Why licensure (continued):

- 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.
- Engineers must adapt to a rapidly changing workplace-restructuring, downsizing, outsourcing, privatization, and re-engineering.
- Engineers should prepare for 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.
- State engineering boards increasingly seek and obtain authority to impose civil penalties against unlicensed individuals who unlawfully engage in the practice of engineering

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

Steps to professional licensure

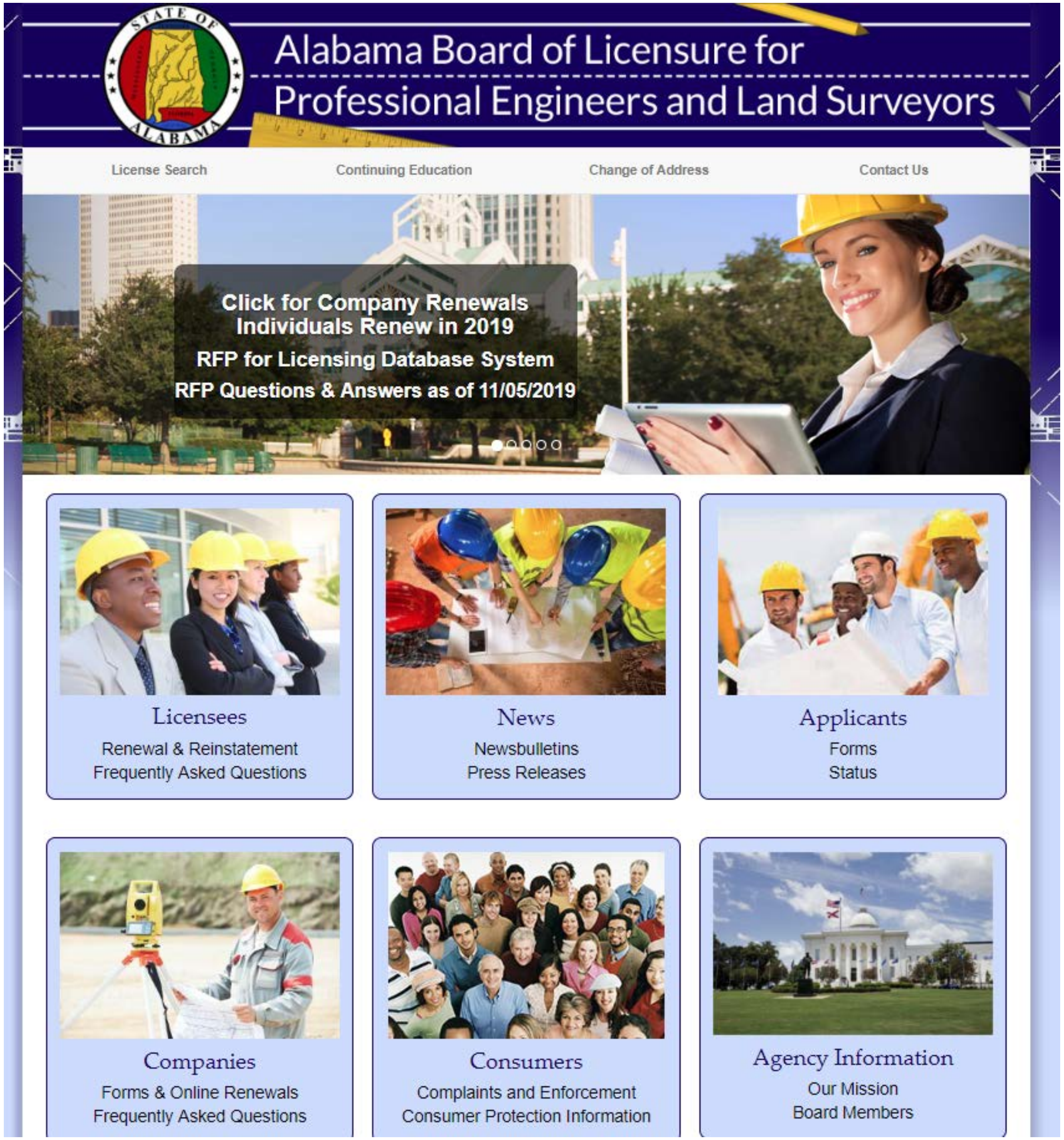
National Council of Examiners for Engineering and Surveying (NCEES)
http://www.ncees.org

- develops, administers, and scores examinations used for engineering licensure in the United States
- facilitates professional mobility and promotes uniformity of the U.S. licensure

Three-step process:

1. Pass the Fundamentals of Engineering (FE) exam – administered by NCEES as a computer-based test:
   - http://ncees.org/exams/fe-exam/
   - for students close to finishing an accredited undergraduate engineering degree
2. Apply for Engineering Intern (EI) certification in your state
   - http://www.bels.alabama.gov/FE-Applications.aspx
3. Pass the Principles of Engineering (PE) exam
   - for engineers who have gained at least four years' post-college work experience in their chosen engineering discipline
   - tests ability to practice competently in a particular engineering discipline.
   - http://www.bels.alabama.gov/PE-Applications.aspx

http://www.bels.Alabama.gov



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