Elec 4309 Senior Design

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What It Is and Why It Matters

- Ethics & Professional Responsibility
- Codes of Ethics
- Cases in Engineering Ethics
- Microethics & Macroethics in Engineering
- Risk Communication & Ethics
- Sustainable Development & Ethics
- Online Engineering Ethics Resources

ABET 2000 Criterion 3: Program Outcomes and Assessment

Engineering programs must demonstrate that their graduates have:

a. an ability to apply knowledge of mathematics, science, and engineering
b. an ability to design and conduct experiments, as well as to analyze and interpret data
c. an ability to design a system, component, or process to meet desired needs
d. an ability to function on multi-disciplinary teams
e. an ability to identify, formulate, and solve engineering problems

ABET 2000 Criterion 3: Program Outcomes and Assessment

f. an understanding of professional and ethical responsibility

g. an ability to communicate effectively

h. the broad education necessary to understand the impact of engineering solutions in a global and societal context

i. a recognition of the need for, and an ability to engage in life-long learning

j. a knowledge of contemporary issues

k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

What is Ethics?

The rules and ideals for human behavior. They tell us what we ought to do.

Wujek and Johnson 1992

What is a Profession?

A learned occupation requiring systematic knowledge and training, and commitment to a social good

Wujek and Johnson 1992

In Today's Headlines

August 18, 2001

Prosecutors Say Greed Drove Pharmacist to Dilute Drugs

Professional Responsibility

A type of moral responsibility arising from special knowledge possessed by an individual. For someone to have a moral responsibility for some matter means that the person must exercise judgment and care to achieve or maintain a desirable state of affairs.

Whitbeck 1998

Responsible Engineers

For responsible engineers the sought-after state of affairs is:

... the creation of useful and safe technological products while respecting the autonomy of clients and the public, especially in matters of risk-taking.

Martin and Schinzinger 1996

Professional Ethics

Professional ethics is as much a part of what members of a profession know--and others do not - as their "technical" knowledge. Engineering ethics is part of thinking like an engineer.

Professional ethics . . . belongs neither to common sense nor to philosophy but to the profession in question. Knowing engineering ethics is as much a part of knowing how to engineer as knowing how to calculate stress or design a circuit is.

Indeed, insofar as engineering is a profession, knowing how to calculate stress or design a circuit is in part knowing what the profession allows, forbids, or requires.

Davis 1999a

Codes of Engineering Ethics: Basic Principles

- Respect for human life and welfare, including that of posterity
- Truth, honesty, trustworthiness
- Fair play
- Openness
- Competence

Unger 1994

The Paramountcy Clause

- Hold paramount the safety, health and welfare of the public and protect the environment in performance of their professional duties.

AIChE Code of Ethics

- 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.

IEEE Code of Ethics

ABET Code Of Ethics Of Engineers

The Fundamental Principles:

- Engineers uphold and advance the integrity, honor and dignity of the engineering profession by:
  I. Using their knowledge and skill for the enhancement of human welfare;
  II. Being honest and impartial, and serving with fidelity the public, their employers and clients;
  III. Striving to increase the competence and prestige of the engineering profession; and
  IV. 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.

In Support Of Codes Of Ethics

Engineers should support their profession's code for at least four reasons:

1. Supporting the code helps protect engineers and those they care about from being injured by what other engineers do.
2. Supporting the code helps ensure each engineer a working environment in which resisting pressure to do what the engineer would rather not do is easier than it would otherwise be.
3. Engineers should support their profession's code because supporting it helps make their profession a practice about which they need feel no morally justified embarrassment, shame, or guilt.
4. Considerations of fairness call on an engineer to take on his share of these additional responsibilities insofar as other engineers do the same and he (by claiming to be an engineer) benefits from their doing so.

Davis 1999b

Traditional Engineering Ethics Issues

- Public safety and welfare
- Risk and the principle of informed consent
- Health and environment
- Conflict of interest
- Truthfulness
- Integrity and representation of data
- Whistle blowing
- Choice of a job
- Loyalty
- Accountability to clients and customers
- Plagiarism and giving credit where due
- Quality control
- Confidentiality
- Trade secrets and industrial espionage
- Gift giving and bribes
- Employer/employee relations
- Discrimination

Wujek and Johnson 1992, Rabins 1998

Ethical Responsibility

Ethical responsibility...involves more than leading a decent, honest, truthful life, as important as such lives certainly remain. And it involves something much more than making wise choices when such choices suddenly, unexpectedly present themselves. Our moral obligations must...include a willingness to engage others in the difficult work of defining the crucial choices that confront technological society and how to confront them intelligently.

Winner 1990

Microethics and Macroethics in Engineering

- Microethics is concerned with ethical decision making by individuals and the internal relations of the engineering profession.
- Macroethics refers to the collective social responsibility of the engineering profession and to societal decisions about technology.

Some Micro and Macro Issues in Science and Engineering Ethics

	Scientific Research	Engineering Practice
Microethics	Integrity Fair Credit	Health & Safety Bribes & Gifts
Macroethics	Human Cloning Nanosciemce	Sustainable Development Risk Communication

Ethics and Risk Communication

- Informed consent
- Limits to expertise

Technical Miscommunication

- Engineering codes, such as that of the *ASCE*, are written ambiguously so as to apply to a greater range of engineers.
- Codes neglect to provide a principal or cannon that indicates engineers to overlook their personal codes and ethics.
- The lack of such a principal allows engineers to exercise moral independence, which often times lead to disasters.
- All of which are initiated by miscommunications and misunderstandings that engineers had as to what their specific duties and limitations were.

Issues in Technical Communication

- Generalization of ethics and codes
- Influences of engineers and those around them
- Backgrounds of engineers
- Effect of society on engineers

Technical versus Cultural or Social Rationality

Adopted from Plough and Krimsky 1987

Technical Rationality	Cultural or Social Rationality
Trust in Scientific Evidence	Trust in Political Culture
Appeal to Expertise	Appeal to peer groups and traditions
Narrow, reductionist boundaries of analysis	Broad boundaries of analysis
Risks depersonalized	Risks personalized
Statistical risk emphasized	Impact on Family and Community Emphasized
Appeal to Consistency and Universality	Focus on Particularity

What are “Professional Codes of Conduct?”

- Rules to govern the conduct of members of a given profession, e.g., ASCE , ASME, IEEE, AIAA
- Codes of conduct help to win public confidence and help to stave off government regulation.

ASCE Code of Ethics (1996)

- First “Fundamental Principle” pledges engineers to “using their knowledge and skill for the enhancement of human welfare and the environment.” First Canon amended in order to require engineers to “... strive to comply with the principles of sustainable development in the performance of their professional duties.”
- According to the ASCE Board of Directors (1996), “Sustainable Development is the challenge of meeting human needs for natural resources, industrial products, energy, food, transportation, shelter, and effective waste management while conserving and protecting environmental quality and the natural resource base essential for future development.”

Code of Professional Responsibility

The engineer shall:

1. Honor the right of all individuals affected by an engineering project to participate to the appropriate degree in the decisions concerning the project.
2. Provide complete, accurate, and understandable information to all parties concerning all engineering decisions that may affect them.
3. Refuse to sanction or participate in, and encourage others to do likewise, projects that, even when approved by the appropriate clients or superiors, will cause unjustifiably harmful consequences.

Vesilind, 199

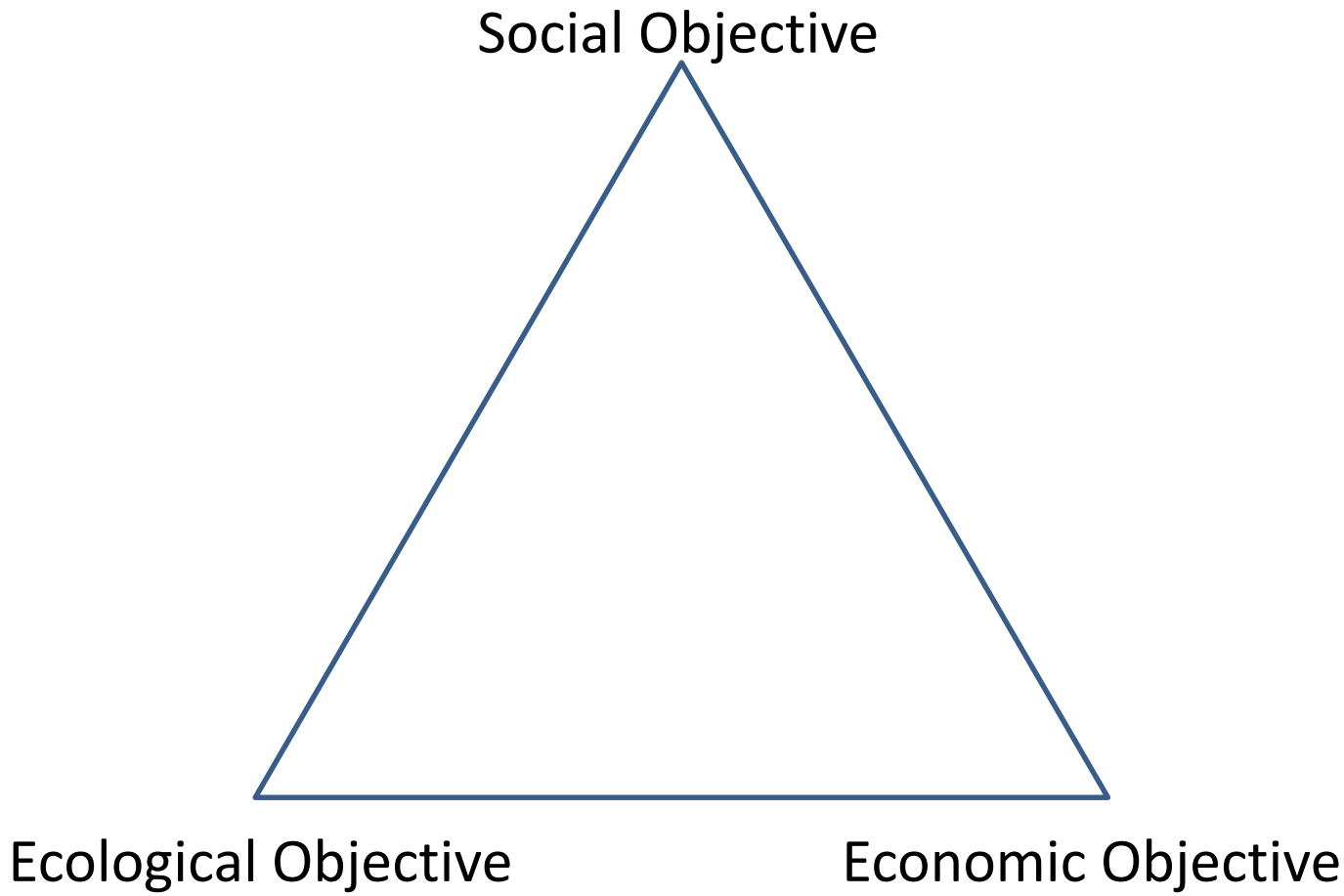
What is Meant by “legal?”

- The legality of behaviors are defined by statutes (e.g., laws enacted by legislatures), administrative regulations (e.g., NCAA rules), common laws (codified in judicial proceedings), constitutional laws (e.g., of organizations)
- Note that laws do not guarantee morality and morality does not guarantee laws

Sustainable Development

- Brundtland Commission report (1987) defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."
- UN Conference on Environment and Development in Rio de Janeiro (1992): Agenda 21 World Summit on Sustainable Development in Johannesburg (2002)
- World Engineering Partnership for Sustainable Development (WEPSD) (1992) Activity in other engineering societies, including:
  - American Society of Civil Engineers (ASCE)
  - Institute of Electrical and Electronics Engineers (IEEE)
  - American Association of Engineering Societies (AAES)

Objectives of a Sustainable Society



Sustainable System Goals

- Biological (ecological) system goals:
  - Genetic diversity
  - Resilience
  - Biological productivity
- Economic system goals:
  - Increasing production of goods and services
  - Satisfying basic needs or reducing poverty
  - Improving equity
- Social system goals:
  - Cultural diversity
  - Social justice
  - Gender equality
  - Participation

A Declaration by the U.S. Engineering Community to the World Summit on Sustainable Development (2002)

- Creating a sustainable world that provides a safe, secure, healthy life for all peoples is a priority for the U.S. engineering community. It is evident that U.S. engineering must increase its focus on sharing and disseminating information, knowledge and technology that provides access to minerals, materials, energy, water, food and public health while addressing basic human needs. Engineers must deliver solutions that are technically viable, commercially feasible, and environmentally and socially sustainable.

Ethical Considerations

- Achieving balance between inherent conflicts:
  - System Functionality and Performance
  - Development Cost and Recurring Cost
  - Development Schedule (Time to Market)
  - Development Risk (Probability of Success)
  - Business Viability and Success
- System Optimization:
  - Subsystems often suboptimal to achieve best balance at system level
  - Ultimate system purpose must prevail against conflicting considerations
  - Long-term considerations (e.g., disposal) may drive technical decisions
- Customer Interface:
  - Often must act as “honest broker”
  - Carries burden of educating customer on hard choices
  - Must think ahead to the next customer and next application
  - Must “challenge” all requirements

Engineering Ethics

Code of Ethics for Engineers (excerpt of NSPE)

I. Fundamental Canons -

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

- Hold paramount the safety, health and welfare of the public in the performance of their professional duties
- Perform services only in areas of their competence
- Issue public statements only in an objective and truthful manner
- Act in professional matters for each employer or client as faithful agents or trustees
- Avoid deceptive acts in the solicitation of professional employment.

(ref. Martin and Schinzinger)

Ethics References

- Ethics in Engineering, Second edition, Mike Martin, Roland Schinzinger, McGraw-Hill, 1989 (good general reference)
- Professional Responsibility For Harmful Actions, Martin Curd and Larry May, Kendall/Hunt Publishing Company (DC10 case)
- Controlling Technology: Ethics and the Responsible Engineer, Stephen Unger, Holt Rinehart and Winston (DC10 case)

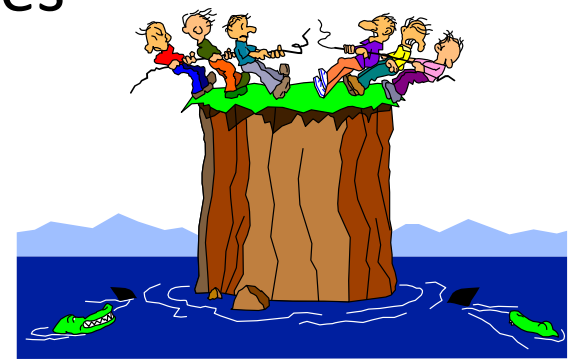
Personal Ethics - Everyday Examples

- Software piracy
- Expense account padding
- Copying of homework or tests
- Income taxes
- “Borrowing” nuts and bolts, office supplies from employer
- Copying of Videos or CD’s
- Plagiarism
- Using the copy machine at work

Ethical Issues are Seldom Black and White

Conflicting demands:

- Loyalty to company and colleagues
- Concern for public welfare
- Personal gain, ambition

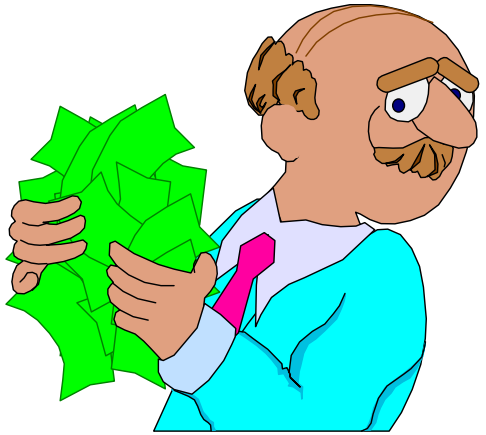


Ethical standards are usually relative and personal, there is seldom an absolute standard

Moral Dilemmas

Kickbacks

- A County Engineer in Virginia demanded a 25% kickback in secret payments for highway work contracts he issued. In 1967 he made such an offer to Allan Kammerer, a 32 year old civil engineer who was vice president of a young and struggling consulting firm greatly in need of the work. Kammerer discussed the offer with others in the firm, who told him it was his decision to make. Finally Kammerer agreed to the deal, citing as a main reason his concern for getting sufficient work to retain his current employees. (Martin and Schinzinger)



More Moral Dilemmas

Waste dumping

"On a midnight shift, a botched solution of sodium cyanide, a reactant in an organic synthesis, is temporarily stored in drums for reprocessing. Two weeks later, the day shift foreman could not find the drums. Roy, the plant manager, finds out that the batch had been illegally dumped into the sanitary sewer. He severely disciplined the night shift foreman. Upon making discrete inquiries, he finds out that no apparent harm has resulted from the dumping." (Martin and Schinzinger)

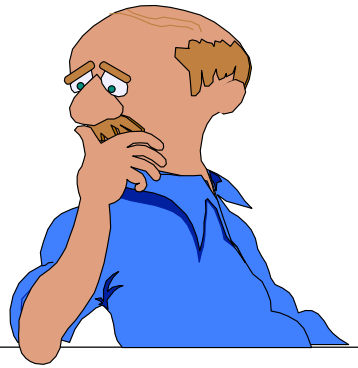
Should Roy inform government authorities, as is required by law in this kind of situation?

More Moral Dilemmas

I have a wife and kids...

- Older engineers, in particular, find job security in competition with ethical instinct. With considerable sympathy, I recall the dilemma of an older PE, in the shadow of a comfortable retirement, who was confronted by a new general manager of the plant in which he was employed as a facilities engineer. In consideration of plans for a plant expansion, the general manager insisted that the PE reduce footings and structural steel specifications below standards of good practice. The PE was told to choose between his job and his seal on the plans. Did he really have a choice?

(ref Martin and Schinzinger)



Whistle-Blowing

Always the LAST RESORT, it indicates serious corporate culture problems

Can be internal as well as external

Definition depends on one's point of view: (Martin and Schinzinger)

"Whistle-blowing" - the act of a man or woman who, believing that the public interest overrides the interest of the organization he[sic] serves, publicly "blows the whistle" if the organization is involved in corrupt, illegal, fraudulent, or harmful activity (Nader, Petkas, and Blackwell, 1972)

Some of the enemies of business now encourage an employee to be disloyal to the enterprise. They want to create suspicion and disharmony and pry into the proprietary interests of the business. However this is labelled-industrial espionage, whistle-blowing or professional responsibility - it is another tactic for spreading disunity and creating conflict (Roche-GM chairman, 1971)

Examples of Problems that Might Warrant Whistle-blowing

- Incompetence
- Criminal Behavior
- Unethical Policies
- Threat to Public Safety
- Injustices to Workers

Moral Guidelines to Whistle-Blowing

It is morally permissible for engineers to engage in external whistle-blowing concerning safety:

1. If the harm that will be done by the product to the public is serious and considerable
2. If they make their concerns known to their superiors
3. If getting no satisfaction from their immediate superiors, they exhaust the channels available within the corporation, including going to the board of directors.

(ref. Richard T. DeGeorge)

Whistle-Blowing

In order for whistle-blowing to be morally obligatory however, DeGeorge gives two further conditions:

4. He [or she] must have documented evidence that would convince a reasonable, impartial observer that his [or her] view of the situation is correct and the company policy wrong.
5. There must be strong evidence that making the information public will in fact prevent the threatened serious harm.

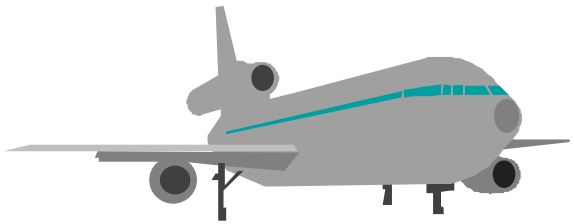
(ref. Martin and Schinzinger)

Whistle Blowing Examples

- C-5A Cost overruns
- BART
- DC-10 Cargo door
- Challenger

DC - 10 Cargo Door

- On June 12, 1972 A DC-10 left Detroit with 67 passengers, after reaching 12,000 ft, the cargo door blew off, collapsing floor and disrupting all hydraulic controls to tail section. Only the pilot's skill and the light load prevented a disaster.
- June 27, 1972 Daniel Applegate, Director of Product Engineering for Convair, the fuselage contractor, wrote a memo to his supervisors detailing potential problems of cargo door. The problem was first recognized in Aug 69. The same thing had also happened in a ground test in 1970.
- Recognized design flaws - floor, latch



DC - 10 Cargo Door

- After the Detroit near-disaster, NTSB (National Transportation Safety Board) investigation revealed several problems and recommended immediate design changes. FAA did not follow NTSB recommendations. FAA director John Shaffer and Douglas President Jackson McGowan reached a gentleman's agreement to voluntarily fix problem, but no further official action was taken.
- In July 1972, three inspectors at Long Beach plant certified that Ship 29 had been modified (but it was not). Two years later, after leaving Paris, its cargo door blew off at 13,000 feet, killing 346 people.

Why Did This Accident Happen?

- McDonnel Douglas was in precarious financial condition - trying to beat Lockheed L1011 to market
- Convair did not push too hard, since by contract, they may have been held liable for the costs of all design changes
- Engineers pressed the matter through normal channels to the highest levels within both companies, but did not take it any further, standard operating procedure at McDonnell Douglas and Convair was for engineers to defer to upper management, even though they were aware of serious design flaws

Were the engineers negligent?

A Reasonable Care Model of Professional Responsibility

A person, S, is responsible for the harm he or she causes when his or her conduct fits the following pattern:

(1) as a member of a profession, S has a duty to conform to the standard operating procedures of his or her profession, unless those standards are lower than those that a nonprofessional would adopt in a given situation, in which case S has a duty to conform to the higher standard:

(2) at time t, action X conforms to the standard of reasonable care defined in (1);

(3) S omits to perform X at time t,

(4) Harm is caused to some person, P, as a result of S's failure to do X.

(ref. Curd and May)

Product Liability

- The product should be systematically and carefully scrutinized to determine what damage it may cause
- Documentation of product development in respect of safety is important
- Insurance companies will demand this documentation before covering the risk

Product Liability

- **before PLA:** those affected had to prove that the damage had been caused by negligence on behalf of the manufacturer or distributor
- **now:** the burden of proof is on the manufacturer to demonstrate product safety considerations were integrated into design and production

Product Liability

- Three types of defects that incur liability:
  - design defects
    - exist before the product is manufactured
  - manufacturing defects
    - occur during the construction or production
  - defects in marketing
    - improper instructions and failures to warn consumers of latent dangers in the product.

Ethics & Product Liability Summary

- Ethics include the rules and ideals for human behavior
- Engineers have a professional responsibility
- Responsible engineers create useful and safe technological products
- Engineering ethics is part of thinking like an engineer
- The burden of proof for product liability is on the manufacturer