Ethics in Engineering and Research

Lecture #2

Ethics and Professionalism

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Ref: Introduction to Engineering Ethics, M.W. Martin and R. Schinzinger, 2nd edition

Engineering Professionalism

- Engineers create products and processes to improve food production, shelter, energy, communication, transportation, health and protection against natural calamities – and to enhance the convenience and beauty of our everyday lives.

- avoid allowing technological risks to overshadow technological benefits (Practice Engineering Ethics)

Improvement through Engineering

Food Production

Communication

Transportation

Ethics and Excellent in Engineering

- Moral values should be embedded in engineering projects as standards of excellence
- Example: Design a chicken coop that would increase egg and chicken production, using materials that were readily available and maintainable by local workers
- Goal: to increase chicken and egg production
- Constraints: use readily available materials, maintainable by local workers
- Moral values (?)
  - ❑Safety
  - ❑Respect for persons
  - ❑Respect for environment
  - ❑Humane condition for chickens

- Moral values can give rise to *ethical dilemmas*

- *Ethical Dilemmas:* situations in which moral reasons come into conflict, or in which the applications of moral values are problematic, and it is not immediately obvious what should be done.
- Formulate moral reasons: For example:

At what point does the aim of increasing chicken and egg production compromise humane conditions for the animals?

Micro and Macro Issues in Engineering

- Micro Issue: concern the decisions made by individuals and companies in pursuing their project
- Macro Issue: concern more global Issues (direction in technology development, law enforcement, collective responsibility of groups (engineering society, consumer groups)
- Example: Ford Explorer and Bridgestone case from Reference Book

As an illustration, consider debates about sport utility vehicles (SUVs). Micro issues arose concerning the Ford Explorer and also Bridgestone/Firestone, who provided tires for the Explorer. During the late 1990s, reports began to multiply about the tread on Explorer tires separating from the rest of the tire, leading to blowouts and rollovers. By 2002, estimates were that 300 people had died, and another 1,000 people were injured, and more recent estimates place the numbers much higher. Ford and Bridgestone/Firestone blamed each other for the problem, leading to the breakup of a century-old business partnership. As it turned out, the hazard had multiple sources. Bridgestone/Firestone used a flawed tire design and poor quality control at a major manufacturing facility. Ford chose tires with a poor safety margin, relied on drivers to maintain proper inflation within a very narrow range, and then dragged its feet in admitting the problem and recalling dangerous tires.

- Micro Issue: Inspection on own safety design by Ford Explorer and Bridgestone
- Macro Issue: SUVs are among the most harmful vehicles on the road. Should “the SUV issue” be examined within engineering as a whole, or at least by representative professional and technical societies? If so, what should be done?

Who should involve besides engineering professional? Consumer group, lawmaker, transport authority?

Can you give other examples related to micro and macro issues in your country/society?

What is engineering ethics?

Engineering ethics consists of the responsibilities and rights that ought to be endorsed by those engaged in engineering, and also of desirable ideals and personal commitments in engineering.

Engineering ethics is the study of the decisions, policies, and values that are morally desirable in engineering practice and research.

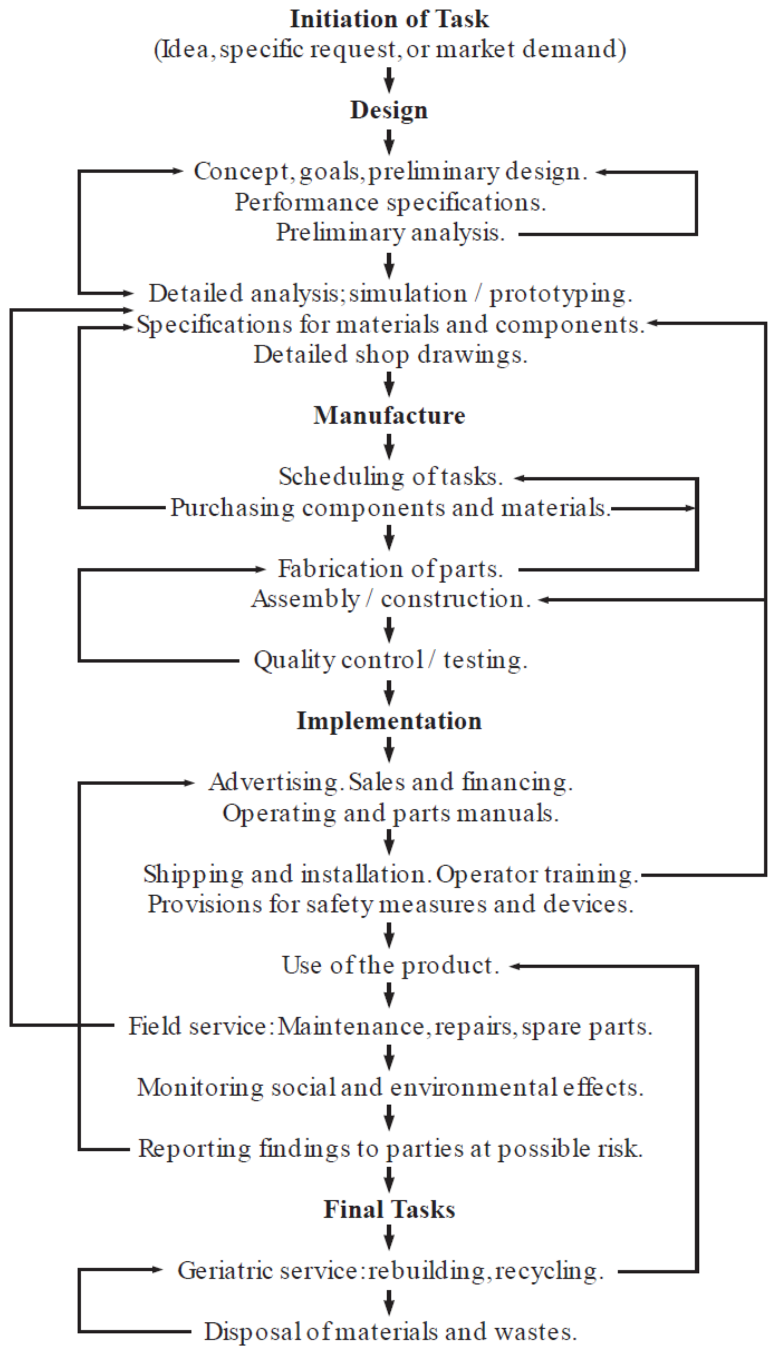
Why study engineering ethics?

- contributes to safe and useful technological products
- giving meaning to engineers' endeavours
- increase moral autonomy

Moral Complexity in Engineering

- Engineers encounter both moral and technical problems during product development (from a mental concept to physical completion)

- See next slide for engineering tasks along the product development



Progression of Engineering Tasks

Table 1–1 Engineering tasks and possible problems

Tasks	A selection of possible problems
Conceptual design	Blind to new concepts. Violation of patents or trade secrets. Product to be used illegally.
Goals; performance specifications	Unrealistic assumptions. Design depends on unavailable or untested materials.
Preliminary analysis	Uneven: Overly detailed in designer's area of expertise, marginal elsewhere.
Detailed analysis	Uncritical use of handbook data and computer programs based on unidentified methodologies.
Simulation, prototyping	Testing of prototype done only under most favorable conditions or not completed.
Design specifications	Too tight for adjustments during manufacture and use. Design changes not carefully checked.
Scheduling of tasks	Promise of unrealistic completion date based on insufficient allowance for unexpected events.
Purchasing	Specifications written to favor one vendor. Bribes, kickbacks. Inadequate testing of purchased parts. 贿赂腐败
Fabrication of parts	Variable quality of materials and workmanship. Bogus materials and components not detected.

Tasks	A selection of possible problems
Assembly/ construction	Workplace safety. Disregard of repetitive-motion stress on workers. Poor control of toxic wastes.
Quality control/testing	Not independent, but controlled by production manager. Hence, tests rushed or results falsified.
Advertising and sales	False advertising (availability, quality). Product oversold beyond client's needs or means.
Shipping, installation, training	Product too large to ship by land. Installation and training subcontracted out, inadequately supervised.
Safety measures and devices	Reliance on overly complex, failure-prone safety devices. Lack of a simple "safety exit."
Use	Used inappropriately or for illegal applications. Overloaded. Operations manuals not ready.
Maintenance, parts, repairs	Inadequate supply of spare parts. Hesitation to recall the product when found to be faulty.
Monitoring effects of product	No formal procedure for following life cycle of product, its effects on society and environment.
Recycling/disposal	Lack of attention to ultimate dismantling, disposal of product, public notification of hazards.

Potential Moral Problems in Engineering

- Lack of vision – biased toward traditional pursuits overlooks suitable alternatives, groupthinks promotes acceptance at the expense of critical thinking
- Incompetence – among engineers carrying out technical tasks
- Lack of time or lack of proper materials – related to poor management
- Silo mentality – keeps information compartmentalized rather than shared across different departments
- Improper use or disposal of the product by unwary owner or user
- Dishonesty in any engineering tasks and pressure by management to take shortcuts.
- Inattention to how the product is performing after it is sold and when in use

Responsible Professionals

- Case study of responsible engineer (Read about Saving Citicorp Tower

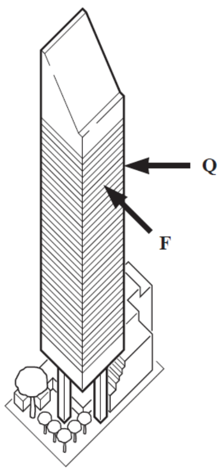


FIGURE 1–3
Axonometric view of Citicorp tower with the church in the lower left-hand corner. Wind loads: F, frontal and Q, Quartering. (Adaptation of an axonometric drawing by Henry Dong, Anspach Grossman Portugal, Inc., in Buildings Type Study 492, *Architectural Record*, Mid-August Special Issue [1976]: 66.)

Saving Citicorp Tower

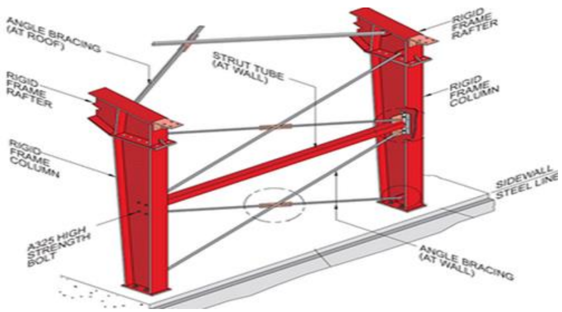
Structural engineer Bill LeMessurier (pronounced "LeMeasure") and architect Hugh Stubbins faced a challenge when they worked on the plans for New York's fifth highest skyscraper. St. Peter's Lutheran Church owned and occupied a corner of the lot designated in its entirety as the site for the new structure. An agreement was reached: The bank tower would rise from nine-story-high stilts positioned at the center of each side of the tower, and the church would be offered a brand new St. Peter's standing freely underneath one of the cantilevered corners. Completed in 1977, the Citicorp Center appears as shown in Figure 1–3. The new church building is seen below the lower left corner of the raised tower.

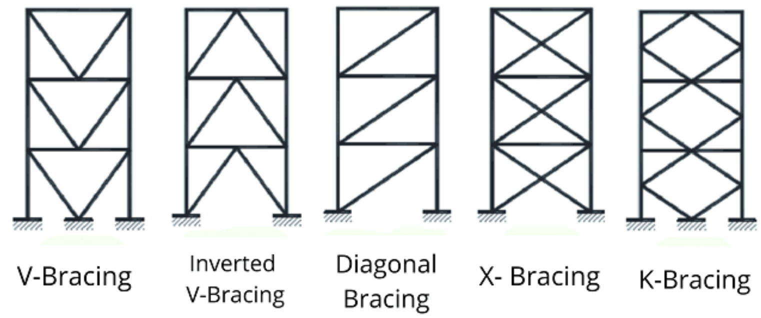
LeMessurier's structure departed from the usual in that the massive stilts are not situated at the corners of the building, and half of its gravity load as well all of its wind load is brought down an imaginatively designed trussed frame, which incorporates wind braces on the outside of the tower.[11] In addition, LeMessurier installed a tuned mass damper, the first of its kind in a tall building, to keep the building from swaying in the wind.

Questions asked by an engineering student a year after the tower's completion prompted LeMessurier to review certain structural aspects of the tower and pose some questions of his own.[12] For instance, could the structure withstand certain loads caused by strong quartering winds? In such cases, two sides of the building receive the oblique force of the wind, and the resultant force is 40 percent larger than when the wind hits only one face of the structure straight on. The only requirement stated in

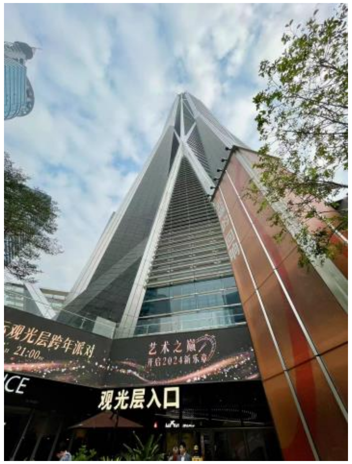
[11] Buildings Type Study 492, Engineering for Architecture: "Citicorp Center and St. Peter's Lutheran Church," *Architectural Record* (Mid-August

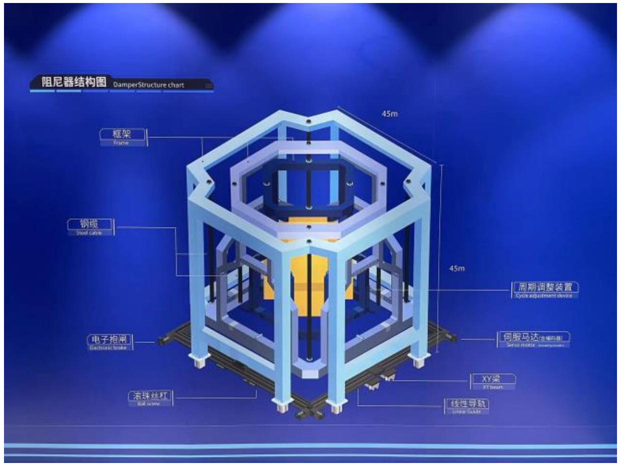
Wind Brace





Tuned Mass Damper





Key points in the case study

- Need strengthening of building for safety of the building
- The corrective work would be disruptive and expensive (amount is larger than insurance coverage)
- LeMessurier faced an ethical dilemma (conflict between
  - ❑his responsibility to ensure safety of his building
  - ❑his responsibility to various financial constituencies
  - ❑his own interest
- Decision and Action
  - ❖Met with insurers, lawyers, bank management and city building department to describe the problem
  - ❖Corrective actions
  - ❖Alerted the mayor’s Office of Emergency Management and the Red Cross

- Consequences
  - ❖Parties were able to settle out of court
  - ❖LeMessurier and his joint-venture partners were charged the $2 million his insurance agreed to pay
  - ❖The total repair bill had amounted to more than $12.5 million.
  - ❖In acting responsibly, LeMessurier saved lives and preserved his integrity

Meaning of Responsibilities

- *Obligations*. Responsibilities are *obligations*—types of actions that are morally mandatory
- *Accountable*. Being responsible means being morally accountable, being answerable for meeting particular obligations

    Voluntary wrongdoing – we knew we were doing wrong and were not coerced; caused by recklessness

    Unintentional negligence – We might not have known what we were doing, but we should have known; e.g., poor engineering due to complete incompetence

- *Conscientious, integrity*. Diligently try to do right thing even under difficult circumstances.

    conscientious = done according to one's inner sense of what is right

- *Blameworthy/Praiseworthy*.

Engineering as Profession

- Professions: those forms of work involving *advanced expertise*, *self-regulation*, and concerted service to the *public good*
- Advanced Expertise: sophisticated skills (knowing-how) and theoretical knowledge (knowing-that), work typically requires extensive formal education (technical or arts)
- Self-regulation: setting standards for admission to the profession, drafting codes of ethics, enforcing standards of conduct, and representing the profession before the public and the government
- Public Good: The occupation serves some important public good by making a concerted effort to maintain high ethical standards throughout the profession.

For example,

Medicine is directed toward promoting health,

Law toward protecting the public's legal rights,

Engineering toward technological solutions to problems concerning the public's well-being, safety, and health.

Ethical Corporations

- Much engineering has been embedded in corporations (also every common in other professionalisms nowadays; law, science, medicine)
- large projects that require many individuals work together
- Sense of Corporate Responsibility
- Just as individual, corporates have responsibilities (obligations), accountability, integrity (virtue of responsibility, blameworthy/praiseworthy
- Corporations should have internal structures consisting of policy manuals and flowcharts assigning responsibilities to individuals

Discussions

Disputes arise over how a person becomes or should become a member of an accepted profession. Such disputes often occur in engineering. Each of the following has been proposed as a criterion for being a "*professional engineer*" in the United States. Assess these definitions to determine which, if any, captures what you think should be part of the meaning of "engineers."

(a) Earning a bachelor's degree in engineering at a school approved by the Accreditation Board for Engineering and Technology. (If applied in retrospect, this would rule out Leonardo da Vinci, Thomas Edison, and Nikola Tesla.)

(b) Performing work commonly recognized as what engineers do. (This rules out many engineers who have become fulltime managers but embraces some people who do not hold engineering degrees.)

(c) In the United States, being officially registered and licensed as a professional engineer (PE). Becoming registered typically includes:

(1) passing the Engineer-in-Training Examination or Professional Engineer Associate Examination shortly before or after graduation from an engineering school,

(2) working four to five years at responsible engineering,

(3) passing a professional examination,

(4) paying the requisite registration fees.

(Only those engineers whose work directly affects public safety and who sign official documents such as drawings for buildings are required to be registered as PEs. Engineers who practice in manufacturing or teach at engineering schools are exempt. Nevertheless, many acquire their PE licenses out of respect for the profession or for prestige.)

(d) Acting in morally responsible ways while practicing engineering. The standards for responsible conduct might be those specified in engineering codes of ethics or an even fuller set of valid standards. (This rules out scoundrels, no matter how creative they may be in the practice of engineering.)

scoundrels = dishonest person