ENGR 482
Engineering & Ethics

Engineering Responsibility

Assigned reading:
- Harris, Prichard & Rabins, Engineering Ethics: Concepts and Cases, Chapter 5: “Responsible Engineers”
- These slides can be found at:
  - http://ceprofs.tamu.edu/rjames/

Most valuable attributes of an engineer

- Character:
  - Honesty & Integrity (virtues)
  - Responsibility (reliability)

- Skills & knowledge:
  - Technical knowledge
  - Analytical skills
  - Computation skills
  - Communication skills

Responsible--definition

- Responsible: 1) liable to be called on to answer; liable to legal review or in case of fault to penalties; 2) able to answer for one’s conduct and obligations; able to choose for oneself between right and wrong... (Webster’s Ninth New Collegiate Dictionary)

Responsibilities of engineers

- Legal responsibilities: Not to cause harm; to compensate when harm is caused; to practice in accord with Engineering Practices Act
- Moral responsibilities: To recognize and discharge our duties and obligations; understand and adhere to a Code of Ethics

Responsibility:

Seeing what needs to be done...
... and doing it!

Ways in which harm is caused
- Intentionally—this is often criminal
- Recklessly—acting in a way that we recognize might cause harm
- Negligently—by failing to exercise due care

Three models of responsibility
- Minimalist or Malpractice model
- Reasonable Care model
- Good Works or Supererogation model

Minimalist or Malpractice model of responsibility:
- Engineers have a duty only to conform to accepted practice and fulfill only basic duties prescribed by terms of employment.
- Those who would follow this model might be most concerned with not doing anything “wrong”.
  - “That’s not my responsibility, someone else will take care of that.” (Example: the Gilbane Gold case)

Reasonable Care Model of Responsibility:
- Adhere to accepted standards of practice, and...
- Take reasonable care to ensure that mistakes are prevented and the public welfare is protected
- Exercise and apply skill, ability and judgement reasonably and without neglect
  - keep abreast of evolving changes in knowledge and practice
- recognize when minimal standards of practice might not be sufficient to prevent a harm, and take additional actions to prevent such a harm in those cases

Characteristics of the Reasonable Care model
- Concern for preventing harm, rather than trying to prevent causing harm
- Oriented towards the future, toward avoiding problems and protecting the public
- Attitude of concern or caring
- Example: Roger Boisjoly’s actions before the launch of the Challenger
Good Works (Supererogation) Model of Responsibility:

- "...above and beyond the call of duty."
- Example: A local consulting engineer offers to design a parking lot for a church at her cost, with no charge for her own time.

A hypothetical scenario...

- Suppose an airline maintenance engineer contacts an airframe manufacturer with a question about a new maintenance procedure that his crews have proposed, indicating that his crews have experimented with this procedure and have demonstrated that it can significantly reduce maintenance time and costs.

A hypothetical scenario cont'd...

- The procedure in question involves the removal of jet engine & pylon as a unit for replacement of a spherical bearing which served to support the engine/pylon.
- The manufacturer's recommended procedure is to remove the engine, then the pylon.
- Maintenance personnel wish to remove the engine & pylon as a unit, supporting the engine with an engine stand mounted on a forklift, positioned at the cg of the engine/pylon unit.

Engine and pylon assy...

- 13,477 lb (pylon + engine)
- 1,865 lb (pylon)
- 6 ft

13,477 lb (pylon + engine)

In pairs, discuss and answer the following questions...

- How would the manufacturer respond if he follows...
  - minimalist model of responsibility?
  - reasonable care model?
  - good works model?
- What responsibilities do you think the airframe manufacturer's engineer has? How should he/she respond to this request?
The case isn’t hypothetical...

- In 1979, improper servicing procedures during maintenance of an American Airlines DC-10 caused undetected fractures in the bulkhead supporting the pylon.
- Eight weeks later on 25 May, during takeoff from Chicago O’Hare, AA Flight 191 lost the No. 1 engine from the left wing, severing hydraulic control and power lines near that pylon, causing loss of control, crash, and 273 deaths.

DC-10 case, continued...

- American Airlines maintenance crews were using forklifts to remove the DC-10 engines for pylon mounting bearing replacement, a shortcut that reduced service efforts by 200 man-hours per engine.
- McDonnell-Douglas (the manufacturer) knew that AA and Continental were using this non-standard procedure, and suspected that this might increase the risk of airframe damage.

References:

NTSB Report on the 1979 Chicago Crash
WASHINGTON, D.C. 20594, December 21, 1979
(found on web at...http://www.rvs.uni-bielefeld.de/publications/Incidents/DOCS/ComAndRep/OHare/NTSB/COPY/ohare-full.html)

How should we view our professional responsibilities?

- The reasonable care model is the best model for engineers.
- Codes demand it (“...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)
- Public expects it (Principle of Proportional Care: When people have a greater ability to harm, they have a greater obligation to prevent harm.)

Some Impediments to Responsibility

- Self-interest
- Fear
- Self-deception
- Ignorance
- Egocentric tendencies
- Microscopic vision
- Uncritical acceptance of authority
- Antagonism toward outside regulation
- “Groupthink”
- Cumbersome business organizations

Missouri City Antenna Tower

- For more details, see:
  - http://ethics.tamu.edu/ethics/tvtower/tv3.htm#analysis
  - Case 45, pp 343 in textbook (ed. 2)
**Scenario**
- Antenna & 1000 ft. tower designed by engineer
- Contractor (rigger) awarded erection contract
- During erection, rigger realizes lifting points on antenna sections can't be used without fouling antenna baskets
- Rigger asks to remove baskets and replace them after erection

**Scenario, cont'd.**
- Engineer denies rigger's request to remove baskets (the last contractor he allowed to remove baskets caused expensive damage to antennas)
- Rigger develops plan to mount extension on antenna section to lift it
- Rigger asks engineer to review the plan

**Scenario, cont’d.**
- Engineer declines to review rigger's plan to mount extension on antenna, citing increased liability
- Rigger proceeds with lift of antenna
- Extension boom fails, antenna falls, striking stay cable, tower falls, seven workers are killed

**Tower erection method**

**Free body diagram of antenna section during lift, with rigger’s extension boom**
Antenna section after collapse

Extension boom and failed u-bolts

Wreckage of antenna and crane

Some questions...

- Were the engineer's actions the right actions?
- No, seven workers died.
Should the engineer's moral responsibility take precedence over his legal responsibility?
- What model of responsibility did the engineer follow?
  - Minimalist model?
  - Reasonable care model?
  - Good works model?
- Was the engineer's responsibility for a safe and workable design met with lifting lugs that could not be used by the rigger?

Were the riggers morally responsible for this accident?
- Did they recognize that the modification they attempted required engineering skills to accomplish?
- Did they ask an engineer for assistance?

What could the engineer have done differently?
- Agree to review the riggers' plans?
- Allowed riggers to remove antenna baskets?
- Offer to design a better extension boom?
- Decline to review the plans, but suggest (or require?) that the riggers should hire an engineer to review their lifting plans?