Design for Environment and Ethics in Engineering

24-370 - Spring 2011

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Reminders and Announcements

- HW8 (bonus) due Wednesday
- Project 3 due May 5th
  - Design II students may turn in on May 7th
- Faculty Course Evaluations
- Questions about HW or Project?

Environment and Ethics

- Design for Environment (DFE) principles
- Economic Input-Output Life Cycle Assessment (EIOLCA) estimator
- Ethics principles for design engineers

Environmental Impact

- How might engineering affect environment?
  - Human health: pollutants
  - Resource depletion: fossil fuels, water, minerals
  - Ecological damage: global warming, acid rain, ozone
  - All affect human quality of life, directly or indirectly
- Why is this hard to combat?
  - Tragedy of the Commons
  - Economic externalization
  - Relative importance difficult to assess

Design for Environment

- Understand the product
  - Its manufacture
  - Its use (Design II)
- Understand the impact
  - Life Cycle Assessment (LCA)
- Reduce the impact
  - Design for Environment (DFE)

DFE Guidelines

1. Select low-impact materials
2. Reduce material amount
3. Eco-manufacturing
4. Optimize distribution
5. Reduce use-phase impact
6. Maximize first life
7. Mitigate end of life

See: www.epa.gov/dfe,

Life Cycle Assessment

- Process-based LCA
  - Traditional means
  - Study each process, analyze impact
  - Pros: thorough, specific
  - Cons: time-consuming, difficult sub-process links
- Economic Input-Output LCA
  - Based on broad economy-wide trends
  - Pros: fast, accounts for all processing
  - Cons: order-of-magnitude accuracy

Performing EIO-LCA

- Identify sectors involved in the life cycle
  - Production
  - Distribution
  - Use
  - End of life
- Analyze impact within each
  - Relative contributions
  - Identify most important impacts

EIO-LCA estimator

- Online: www.eiolca.net
  - Tool developed by CMU Green Design Institute
  - Based on Leontief's methods
- Estimates of:
  - Materials and energy resources
  - Environmental emissions
- Based on:
  - Type of product or service
  - Entire supply chain
  - Large scale production or industry

Using EIO-LCA estimator

- Model
  - Year of basis models
  - Purchaser vs Producer (distribution)
- Sector
  - Broad, detailed sectors
  - Keywords
  - Check model at bottom
- Amount of economic activity
  - Millions of dollars spent (multipliers)

EIO-LCA estimator results

- Category of results
  - Economic activity
  - Greenhouse gasses
  - Energy
  - Hazardous waste
  - Toxic releases
  - Water use
- Sector
  - Top-level and (biggest) sub-sectors involved
- Formatting
  - Sort, display more, download, create visuals

EIO-LCA Exercise

- What products shall we analyze?
  - Production impacts?
  - Usage impacts?
- Which environmental impacts?
  - Relative import?
- Obtain key results
- How might we reduce impact?
  - What parts of life cycle most damaging?
- Compare with alternative product

Ethics

- What is ethics?
  - The systematic study of reasoning about how we ought to act, considering all impacts
  - A system of rules of conduct
- What is ethical behaviour?
  - Actions that maximize benefit and minimize harm
  - Compliance with a code of ethics
- Why mechanical engineers?
  - We exercise great power, to help or harm, in the physical realms of human life

ASME Ethics Principles

Mechanical engineers shall uphold and advance the integrity, honor and dignity of the engineering profession by:

i. Using knowledge and skill for the enhancement of human welfare;

ii. Being honest and impartial, and serving with fidelity the public, employers and clients;

iii. Striving to increase the competence and prestige of the engineering profession.

ASME Ethics Canons

1. Hold paramount the safety, health and welfare of the public in performing professional duties.
2. Perform services only in areas of competence.
3. Continue professional and ethical development throughout career and provide opportunities for such development of their supervised.
4. Act as faithful agents or trustees, and avoid conflicts of interest or the appearance of conflicts of interest.

ASME Ethics Canons

5. Build professional reputation on the merit of services and not compete unfairly with others.
6. Associate professionally only with reputable persons or organizations.
7. Issue public statements only in an objective and truthful manner.
8. Consider environmental impact in the performance of professional duties.

Ethics and Law

- Law reflects (imperfectly) ethics of society
- Liability
  - E.g. due to negligence
- Fraud
  - E.g. due to misrepresentation of expertise
- Intellectual property
  - Ownership and protection of
- Consult with supervisors, counsel
- See D&S Ch. 17: www.mhhe.com/dieter

Ethics Discussion Exercises

- Is it ethical to design a bridge with ***fos*** = 2?
  - Standards and laws for such construction
  - Communication with supervisors and authorities
- Do you *have* to report a potential safety risk?
  - Yes, if in your expertise
- Can you consult outside your expertise?
  - Not even if the employer knows
- Can you accept swag from supplier?
  - Appearance as important
- Can you help with public relations?