ME 4054W: SENIOR DESIGN PROJECTS

Week 14 – Tuesday
Design for the Environment
Notes

• Design Show: Next Tuesday

• Peer Evaluations Due Next Thursday
Motivation: World Population

World Population Growth, Actual and Projected, 1950-2050

- High
- Medium
- Low

What Can We Do?

• We design products
• Minimize environmental impact of those products
Product Life Cycle

• Resource extraction
  – Resources used or consumed to make the materials going in to your product

• Manufacturing
  – Impact of manufacturing your product

• Distribution
  – Impact of sending your product to market

• Customer use
  – Impact of using your product

• End of life
  – Impact of disposal
Life Cycles

Resources
- Maximize Renewables
- Natural Decay
- Deposit

Materials
- Natural Life Cycle
- Recycling
- Minimize Toxins & Inorganics

Production
- Recovery
- Reuse

Distribution
- Use
- Product Life Cycle
Timing of Environmental Impacts

- Reduced biodiversity due to deforestation
- Land degradation due to mining
- Emissions and waste generation from mining
- Natural resource depletion
- Air pollution from factory emissions
- Water pollution from factory discharges
- Waste generation during production
- Air pollution due to transportation emissions
- Waste generation from packaging
- Maintenance and cleaning materials
- Abrasion of materials
- Waste generation during recovery process
- Landfill leads to land degradation
- Landfill generates methane and groundwater pollutants
- Incineration generates air pollution and toxic ash
Environmental Cost: Raw Materials

- What is the environmental cost of the raw material?
- Are endangered species involved?
  *Example: Sustainable woods*
- Is an alternative with a lower impact available?
  *Example: Cardboard box filler vs. polymer foam*
- What is the environmental record of my supplier?

*Relative Environmental Impact of Various Metals*
Environmental Cost: Manufacturing

• Are environmentally damaging products used?  
  *Examples: solvents, flourocarbons*

• Am I "polluting" a pure material?  
  *Examples: paints, adhesives, coatings*

• What resources are required?  
  *Examples: water, power*
Environmental Cost: Distribution

- How much packaging is used?
- What are the packaging materials?
  Example: molded pulp vs. polymer foam
- How does package size match with standard pallet & container sizes?
- What is energy required to transport product to market?

PET has highest plastic recycling rate
Innovative package reduces weight
Environmental Cost: Customer Use

• What is the environmental cost of consumables?
• How much energy does product use? *Example: EnergyGuide ratings of home appliances*
• Does product produce residuals? *Example: 2-cycle vs. 4-cycle engine*

Coffee Filter Options: Reusable, unbleached paper, bleached paper
Environmental Cost: Disposal

- Does product contain toxic substances?
- Can product be recycled?
- Will product be recycled?
- Can product be disassembled for recycling?
- Are materials labeled?

Kodak Single Use Camera
None of the camera is landfilled
Environmental Impact Exercise

• What are the key environmental consequences of your project?
  – Consider raw materials, manufacturing, distribution, customer use, and end-of-life.

• Record ideas on a sheet of (recycled) paper

• 5 min
Design for the Environment

- Design decisions define the environmental impact of your product
- Most consumers won't pay more for an environmentally friendly product
- Therefore, your design team may need to set the environmental specifications
- Associated benefits:
  - An improved design overall
  - Your product will be better aligned to an international market
  - You will be prepared for "take back" legislation as it arises
  - Good Public Relations
Some Suggestions for DfE

- Minimize material usage
- Eliminate toxic materials
- Minimize part count
- Minimize consumables (esp. batteries)
- Strive for compatible materials
- Consider recycled materials
- Avoid coatings (painting, plating)
- Avoid adhesives
- Design for Disassembly
Design for the Environment Deliverable

Design Report: Evaluation Section

• Purpose & Need
  – Value of design to society

• Impact to Environment
  – Impact of material selection
  – Reducing raw materials
  – Pollution
  – Service
  – Disposal

• Design Alternatives
  – How can you make your design more environmentally friendly?
## AT&T Environmentally Responsible Product Assessment

<table>
<thead>
<tr>
<th>Life Cycle Stage</th>
<th>Materials</th>
<th>Energy use</th>
<th>Solid residues</th>
<th>Liquid residues</th>
<th>Gaseous residues</th>
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</thead>
<tbody>
<tr>
<td>Resource extraction</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>2</td>
<td>3</td>
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<tr>
<td>Manufacturing</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>2</td>
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<tr>
<td>Distribution</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Customer use</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
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<tr>
<td>End of life</td>
<td>3</td>
<td>3</td>
<td>2</td>
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</tr>
</tbody>
</table>

Rankings: 0=Poor, 4=Excellent
Summary: Design for the Environment

• Global stewardship requires that we design for the environment

• Environmental considerations arise throughout a product's life cycle:
  – Materials & purchased parts
  – Manufacturing
  – Distribution
  – Customer use
  – End of life

• Minimum requirement: Consider environmental impact of design decisions
DfE Information Resources

• "Design for the Environment" Tutorial: http://www.me.umn.edu/dfe/

2 Minute Writing

14 weeks ago, I asked what your goals were for this course…

• Did you accomplish your goals?

• Why/Why not?