Sustainability in Engineering Design

ENGR 10
Introduction to Engineering
Sustainability – A Definition

"sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."

*(Our Common Future, Brundtland Commission of the United Nations, 1987)*
What are some current issues that are driving engineers (and others) to think about sustainability in design?
We all watched the video

*Sustainability explained through animation*

http://www.youtube.com/watch?v=B5NiTN0chj0

What are the four “Care Instructions” discussed in the video?
Form a small group and discuss how sustainability principles might affect something you design.


- http://www.greenstoreandmore.com

- http://jeffdayllc.com/green-construction/
What do you think?

If all people on Earth had the same consumption habits as Americans do, how many Earths would be needed to provide what the world’s population would consume?

a. 1 Earth  
b. 2 Earths  
c. 6 Earths  
d. 20 Earths
Show of hands

When you put your plastics on the curb for recycling, what happens to them?

1. They all get recycled
2. Many of them get thrown away
Sustainability is not a new concept

- U.S. National Environmental Policy Act of 1969 → its goal a national policy to
  "create and maintain conditions under which [humans] and nature can exist in productive harmony, and fulfill the social, economic and other requirements of present and future generations of Americans."
Three models of the three dimensions of sustainability

a) Triple bottom line (Elkington, 1998)

b) Three pillars of sustainability

c) Three spheres of sustainability
Elements of Sustainability

- **Economic** – example: develop a process to use industrial waste rather than have to pay to get rid of it

- **Social** – develop products that don’t disproportionately affect one population

- **Environmental** – example: develop processes and products that minimize pollution
If you wanted to make a product of plastic, which of the following would make it easiest to recycle?

A. Type 1  
B. Type 3  
C. Type 5  
D. Type 6  
E. I don’t know
What happened to my soda bottle?

Patagonia developed fleece in 1993

Recycling an aluminum can saves enough energy to power a 100W incandescent light bulb for approximately:

A. \(\frac{1}{2}\) hour
B. 1 hour
C. 4-12 hours
D. 1-2 days
E. 1 week
Which of these materials saves the most energy by recycling it?

A. Plastic
B. Lead
C. Steel
D. Aluminum
E. Paper
Watch YouTube Video: Going Green with Robotics & Automation
http://www.youtube.com/watch?v=LatqW98SMXU

- As you watch, think about how this applies to design and manufacturing

- Another take on sustainability: The Story of Solutions
http://storyofstuff.org/blog/movies/the-story-of-solutions/
How do we judge if a product or service is sustainable?

Life Cycle Assessment  
(Life Cycle Analysis, Cradle to Grave Analysis)

- Audit the total impact of the product’s (service’s)  
  1. resources  
  2. manufacturing  
  3. use  
  4. disposal

- In terms of  
  1. energy  
  2. materials

(“Life Cycle Assessment,” n.d.)
Life Cycle Assessment (LCA)

Categories of assessed damages
- Greenhouse gases (CO$_2$, CH$_4$, N$_2$O, H$_2$O, etc.)
- Ozone layer depletion
- Smog
- Mineral & fossil fuel depletion
- Habitat destruction
- Eutrophication (excessive nutrients)
- Pollutants
- Desertification
Sustainability Examples

- Dell netbooks shipped in bamboo packaging
  - Bamboo - highly renewable material as alternative to molded paper pulp, foams and corrugated cardboard

- CA Academy of Sciences
  - Green roof – natural insulation
  - Insulation from recycled jeans
  - Photovoltaics

- Shuto Expressway - Japan
  - Bridge lights powered using electricity generated from vibration caused by autos
Bio-Based Bottles

- Corn husks
- Pine bark
- Switch grass
- 100% Sugar cane
  - 70% less fossil fuels
  - 170% less greenhouse gases per ton

Released March 2011
According to Apple:
“The careful environmental management of our products throughout their life cycles includes controlling the quantity and types of materials used in their manufacture, improving their energy efficiency, and designing them for better recyclability.”
The story behind Apple’s environmental footprint.

Apple reports environmental impact comprehensively. We do this by focusing on our products: what happens when we design them, what happens when we make them, and what happens when you take them home and use them.

2010

Total Footprint 2012 estimate
Apple responsible for
30.9 million metric tons
GHG emissions

See what Apple is doing http://www.apple.com/environment/our-footprint/
According to Apple:
“That’s why we design [products] to use less material, ship with smaller packaging, be free of many toxic substances, and be as energy efficient and recyclable as possible.”
Packaging – iPhone 5

- “highly recyclable”
- retail box made primarily from bio-based materials
  - fiberboard containing 90 percent post-consumer recycled content.
- packaging extremely material efficient, allowing more units to be transported in single shipping container

<table>
<thead>
<tr>
<th>Material</th>
<th>Retail box</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper (fiberboard, paperboard)</td>
<td>121g</td>
</tr>
<tr>
<td>High-impact polystyrene</td>
<td>25g</td>
</tr>
<tr>
<td>Other plastics</td>
<td>3g</td>
</tr>
</tbody>
</table>
What is SJSU Doing?

- Reduce consumption by 15% by the end of FY 2009/10, as compared to 2003/04. (EO 987)
- Extensive recycling: SJSU 2009 waste diversion rate was 91% (compared to 59% in 2006)
- Facilities Development & Operations has “green fleet” of 68 electric maintenance carts
- Remodeled and new buildings - LEED* Certification
- Artificial turf at stadium (1 million gallons water annually)
- Other projects: see www.sjsu.edu/sustainability

*Leadership in Energy and Environmental Design
Actions on Campus - Examples

- Spartan Shops
  - 100% of used cooking oil recycled to create biodiesel for vehicles like school buses and trucks
  - Compostable/biodegradable cups, lids, and straws
  - Tableware composed of 100% post-industrial recycled fiber products
  - Use locally grown produce when available

- AS Computer Service Center in Student Union Computer Lab has e-waste drop off site

- Converting landscaping to low water plants
- Recycled water for toilets and landscaping
Student Union Project - LEED Goals

- Minimum of LEED Silver certification required
- Mechanical design is 20% more efficient than Title 24
- Installation of water efficient fixtures
- Installation of Cool Roof
- Use of Recycled Water for toilet flushing
Student Health & Counseling Facility

- LEED Silver Certification Required
- Installation of Cool Roof
- Mechanical design is 20% more efficient than Title 24
- Installation of water efficient fixtures
- Use of Recycled Water for toilet flushing
Sustainability in our future

- Phil Angelides (former CA State Treasurer): “between now and 2030, 75% of the buildings in the U.S. will either be new or substantially rehabilitated” (“What is,” 2008).

Read more:
http://www.time.com/time/health/article/0,8599,1809506,00.html#ixzz0WiKqMFHL
Green Collar Jobs

- Solar energy
- Wind energy
- Public transit
- Green Building design and construction
- Design/manufacturing of sustainable products
- Recycling and material reuse
- Energy efficient automobiles
- Environmental compliance specialist
- Many more . . .
Green in Your Education

- SJSU College of Engineering has a Green Engineering Minor
- 12 units total
- **Program goals**
  - Apply principles of green and sustainable engineering to engineering problems.
  - Analyze economic and environmental impact of biofuels, photovoltaics, rechargeable batteries, and fuel cells.
  - Use life cycle thinking in engineering activities.
  - Participate in student research projects that apply new, sustainable and environmentally sound technologies and methods to real world problems.

- More info: www engr sjsu edu gen greenengr
References


