# Lecture #7

# Environmentally Responsible Design and Manufacturing


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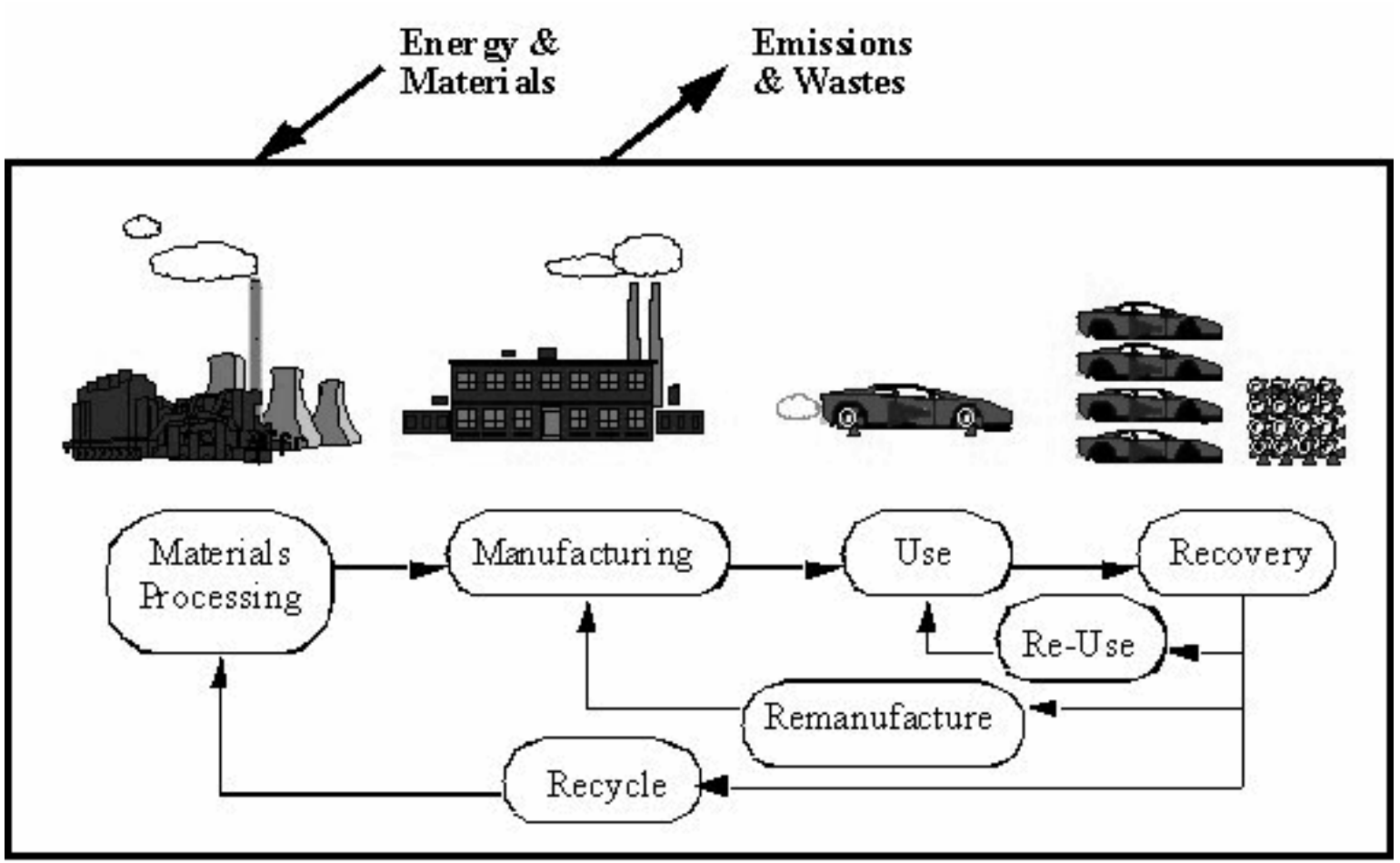
# Last 2 Lectures

- **Laws and Regulations**
- **Environmental Controls**
- **What can a company do to make more money??**
  - **If demand is high, produce products more quickly. Reduce cycle time. Process efficiency.**
  - **Charge more for better performing products**
  - **Reduce product cost. Operate more efficiently -- less waste.**
- **Waste Mgmt. -- all cost / no value -- PREVENTION!!**

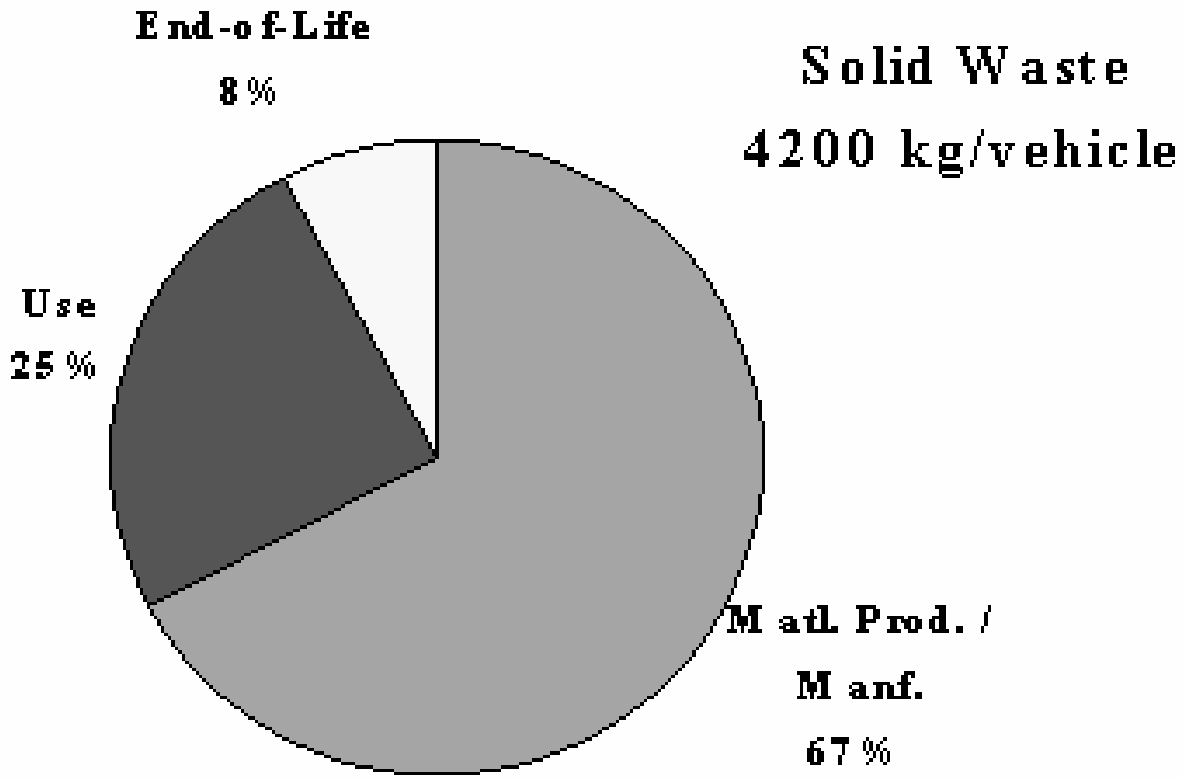
# A Typical Product -- An Automobile



# USAMP Study

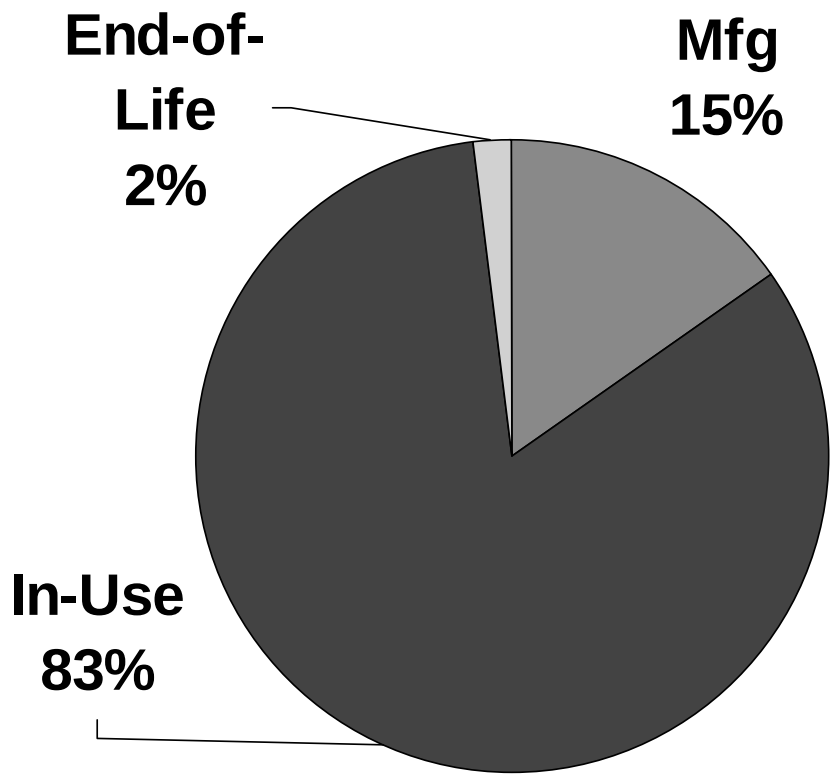
- **U.S. Automotive Matls. Partnership - LCI**
- **Generic 1995 mid-size vehicle (Chevrolet Lumina, Dodge Intrepid, and Ford Taurus).**
- **For each part within the vehicle, the material type and mass were identified.**
- **Vehicle mass = 1532 kg**
- **Gasoline as fuel source**
- **Fuel efficiency of 23 mpg (city 20 and highway 29 mpg)**
- **Service life of 120,000 miles.**

# Solid Waste



# Energy Usage

**Energy = 1TJ**
**= 1 Trillion Joules**



# Next Steps...

- **Do nothing?**
  - **Cost of tracking regulatory changes keeps increasing.**
  - **Cost of containing waste keeps increasing.**
  - **Waste = inefficiency = cost = time.**

- **Alternative Approach**
  **Focus on making products better performing -- more energy efficient; processes less wasteful; products that better use materials; etc.**

# Overview

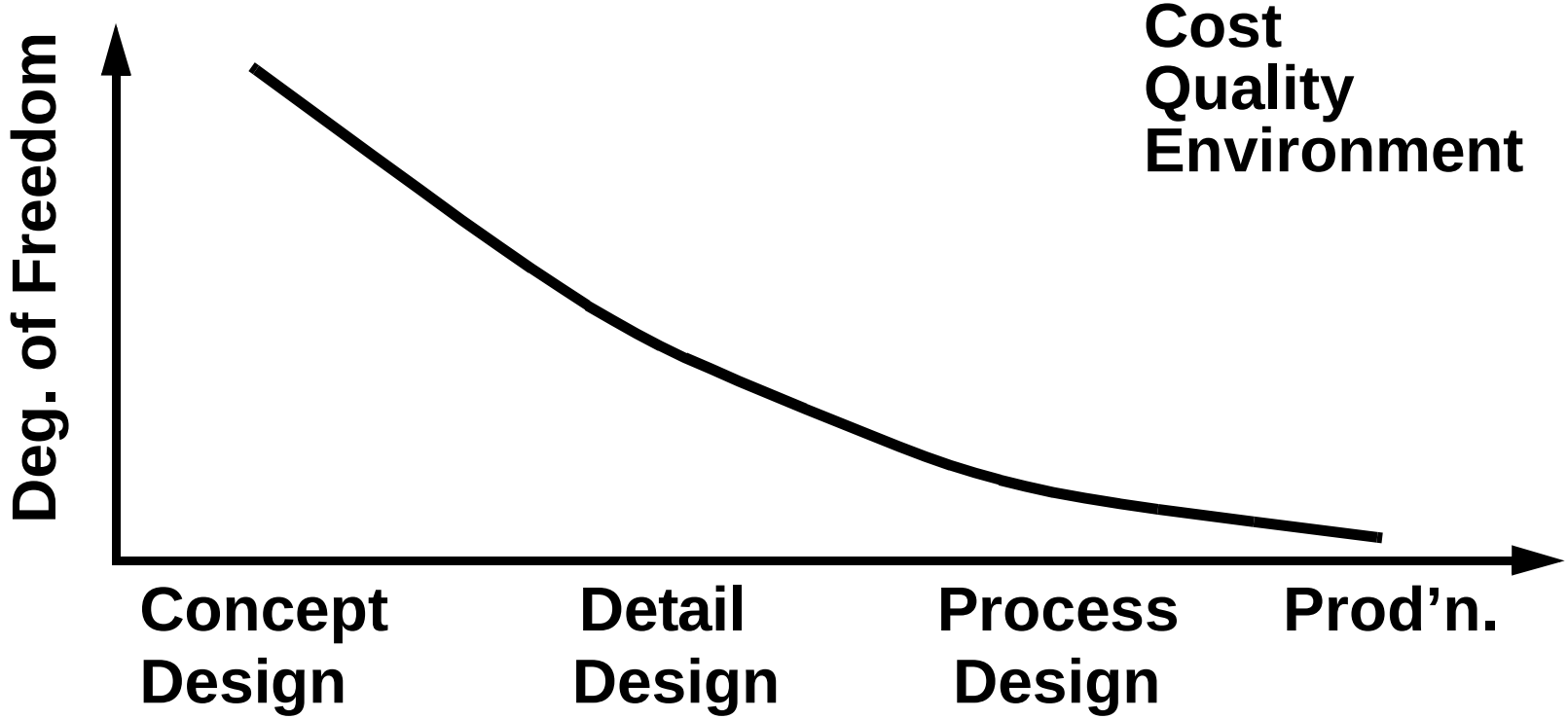
**Over the next several lectures, we will focus on product design issues and their relationship to the environment.**

# Objective:

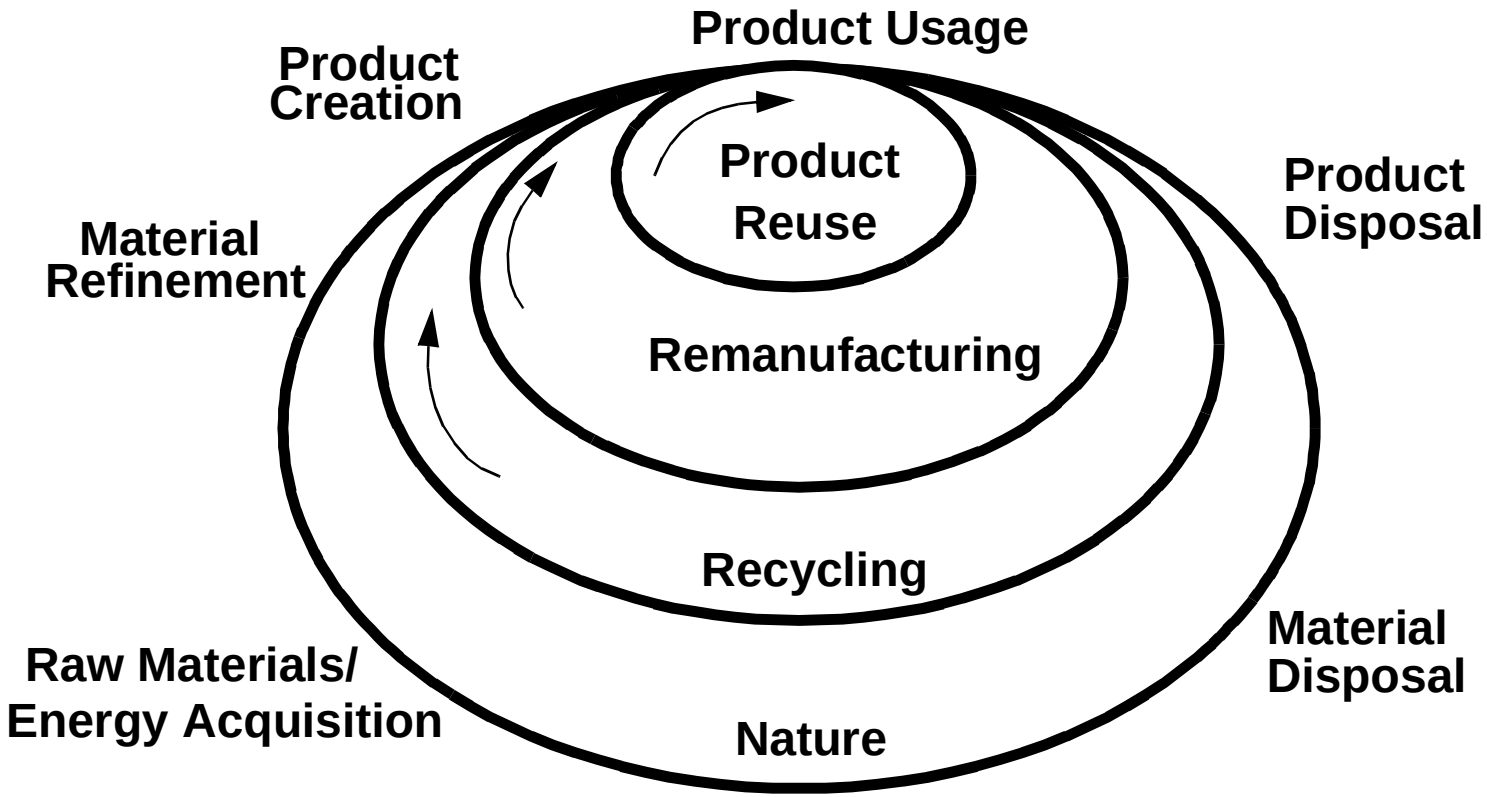
**To understand how products influence the environment and how design decisions may be made to reduce environmental impact**

# Why Focus on Design?

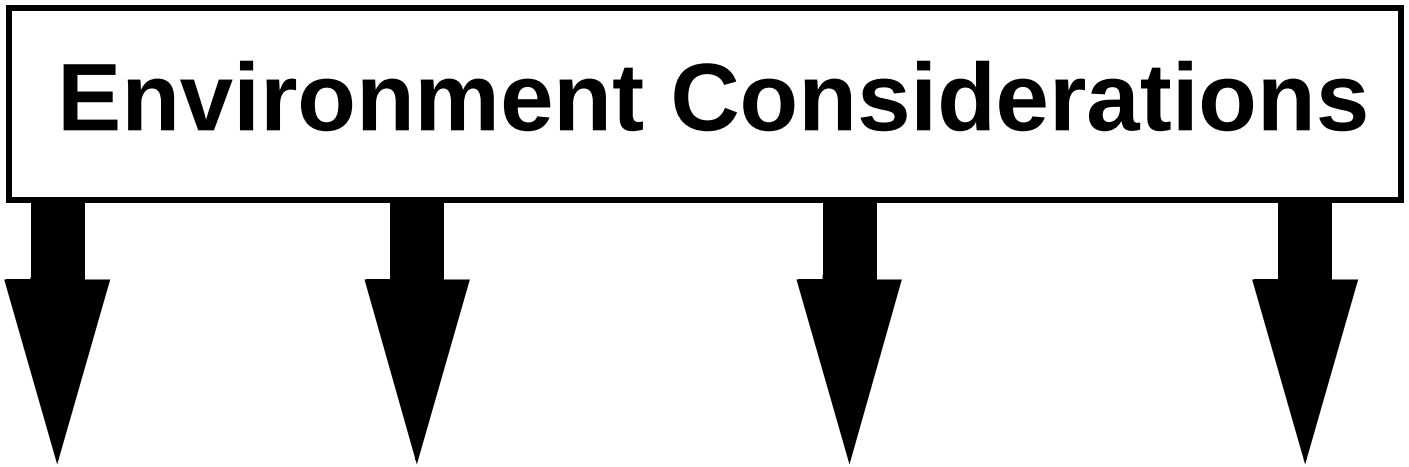
**Where should we place our effort to get the best "environmental return"??**



# The Scope of Product Design



# The Scope of the Problem




**In-plant Scale: Industrial Hygiene and Safety Issues**

**Local Scale: Smog, Ground-water Pollution, Oil Spills, Toxic Sediments**

**Regional Scale: Acid Rain, Over-grazing of arable land, pesticides Air/Water shed**

**Global Scale: Climate changes, Ozone depletion, Loss of habitat & biodiversity reduction**

# Steps in Product Design

- **Product Definition (Concept Design) - System Design - Response to marketing/need - Pest Control Example**
- **Module definition - Assemblies**
- **Detailed Product Design - I**
  **Material Selection & Feature Definition**
- **Detailed Product Design - II**
  **Dimensions & Tolerances**
- **Prototyping, Testing, Production**

# What Do We Consider When Designing a Product??

- **Customer Needs**
- **Form, Fit, & Function**
- **RAM-D: Reliability, Availability, Maintainability, Dependability**
- **Cost, Performance, Ease of Use, Value to Customer**
- **Other??**

# Design for Manufacturability

**During product design, make decisions that facilitate that manufacture of a product (Concurrent / Simultaneous Engr.)**

**Extend this notion to other considerations...**

# DFX (Design for X)

**X = A, Assembly**
**X = E, Environment**
**X = M, Manufacturability**
**X = R, Reliability**

**Many other options**

# More on “Design for the Environment” (DFE)

**DFE is a philosophy that advocates that consideration be given to the environment when developing new products and processes**

- **Efficient use of materials**
- **Waste and pollution prevention**
- **Energy Conservation**

# Why Not DFE?

**(Oft quoted reasons for not doing DFE...)**

- **If it ain't broke, don't fix it.**
- **Once we sell it, it ain't our problem.**
- **If it causes a problem, we will fix it.**
- **DFE costs money.**
- **Customers don't want it.**

# Why Not DFE?

**“If it ain’t broke, don’t fix it.”**

- **In 1991, $80.6 Billion spent on pollution by industry**

- **10 tons of materials required to sustain one person at our present standard for one year (94% is waste within six months of extraction)**

# Why Not DFE?

**“Once we sell it, it ain’t our problem.”**

- **“Cradle to grave” decisions made at concept design stage**
- **Ultimate responsibility for post-use handling of product is assigned to the generator of the waste (RCRA)**

  **“Take-back” underway in Europe and elsewhere - laws are already on the books in the U.S.**

# Why Not DFE?

**“If it causes a problem, we will fix it.”**

- **90% of all costs are in the product at concept design**
- **May not be possible to retrofit**
- **Loss of quality reputation and profits**

# Why Not DFE?

**“DFE costs money.”**

- **DOW WRAP (Waste reduction always pays) program began in 1981 has historically had an annual ROI of 100% or better (one year 470%)**
- **Reduction of costs is the norm for DFE**
- **European study reports that 16% of production costs in a machining facility are associated with cutting fluid - waste treatment, mist collectors, filters, etc.**

# Why Not DFE?

**“Customers don’t want it.”**

- **Roper survey: willing to pay 6.6% more for “green” products**
- **Nielsen survey: 80% of consumers increased their buying of environmentally friendly products**
- **$8.8 Billion displaced product sales into green products in 1995**
- **“May take some time for customers to adjust.....”**

# Achieving DFE

- **The starting point for DFE has to be an understanding of how a product/process effects the environment**
- **Life Cycle Analysis/Assessment/Inventory (LCA/LCI)**
- **Life cycle techniques study the product or process as it evolves over time**

# LCA

**Definitions:**

**Life Cycle Analysis: A quantitative evaluation of all effects of a product or process**

**Life Cycle Assessment: A qualitative evaluation of all effects of a product or process**

**Life Cycle Inventory: A listing of all inputs and outputs**

# LCA

**Major Problem**

- **There is no agreed manner by which to conduct a life cycle analysis or assessment**
- **There is no "cookbook"**
- **Metric problems.... What is the value of a "clean" lake? How to combine ozone depleting emissions and energy consumption measures?**
- **Lots of unknowns!! (whose data are you using???)**

# LCA and the Designer

- **LCA is the starting point for DFE**
- **Because there is no set method for LCA, designers applying DFE must sketch out their own LCA**

  ***Recommendation*: Begin by flowsheeting the activities of the product/process.**