

# Lecture #2

## Environmentally Responsible Design and Manufacturing

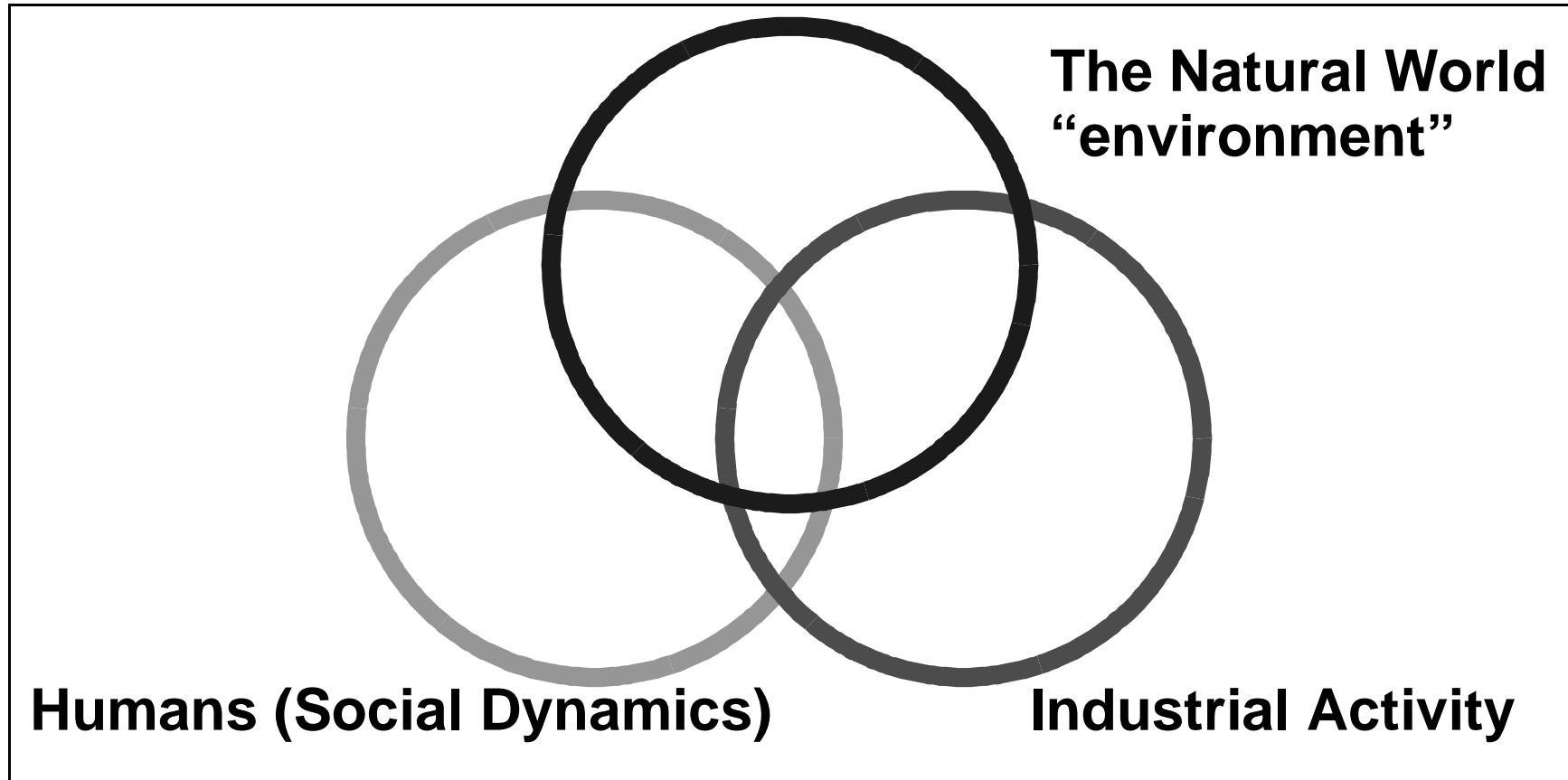
Prof. John W. Sutherland

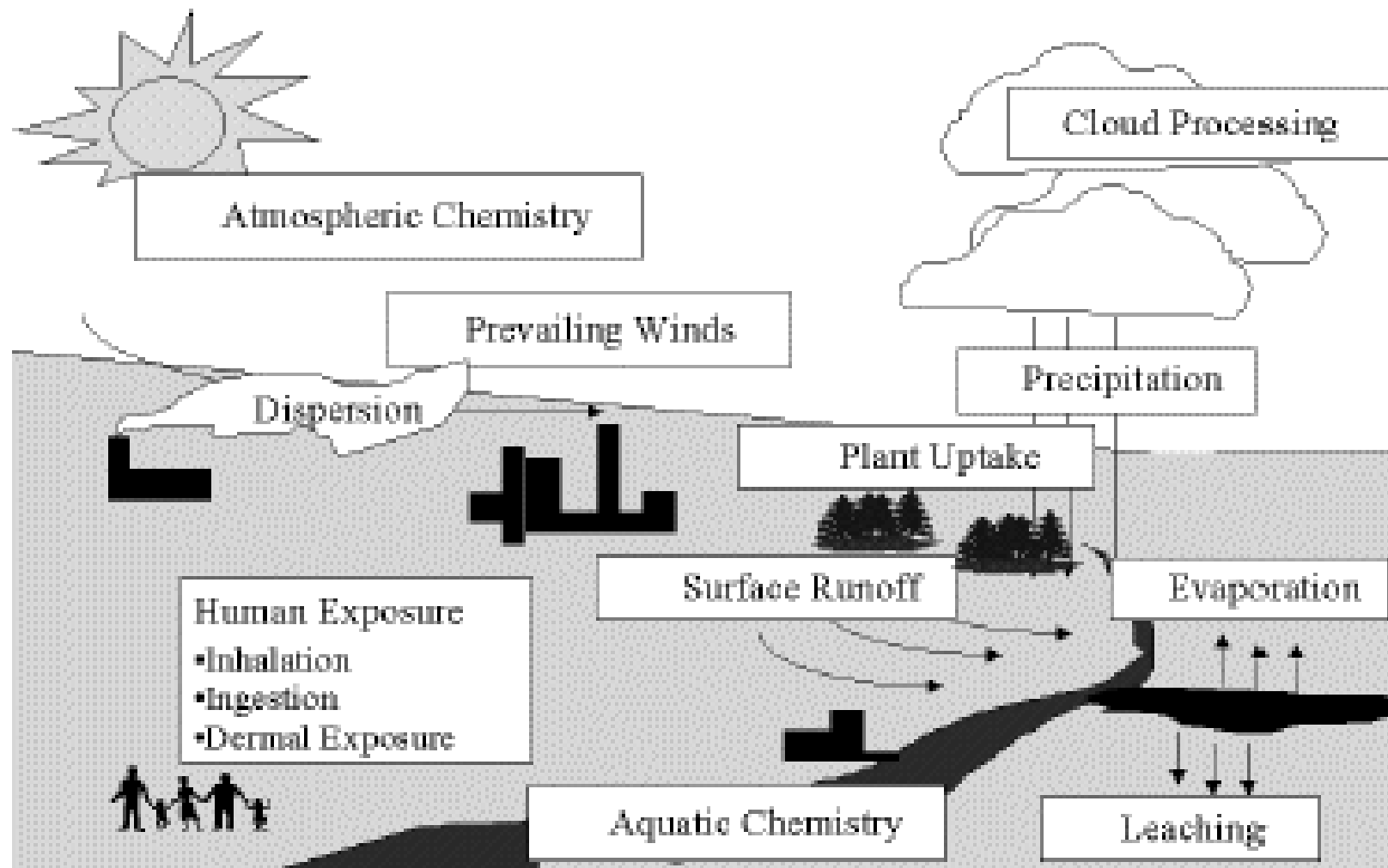
Jan. 14, 2004

# Agenda for Next 2 Classes

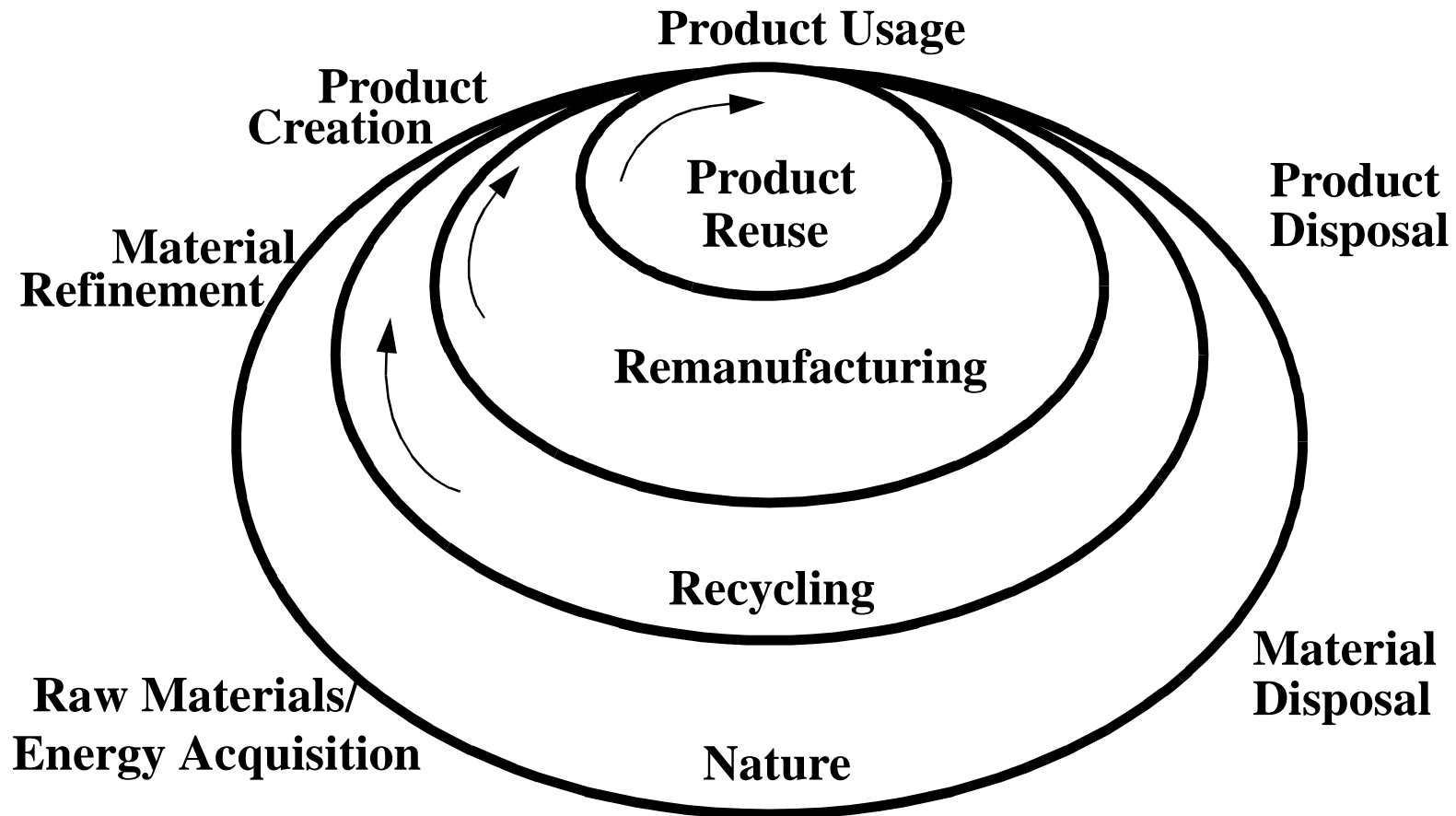
- **More Introduction**
  - **Overview**
  - **Motivation**
  - **Definitions**
  - **Basics**
  - **?**
- **Environmental Measures**
  - **Characterizing waste**
  - **Toxicity**
  - **?**

# Overview

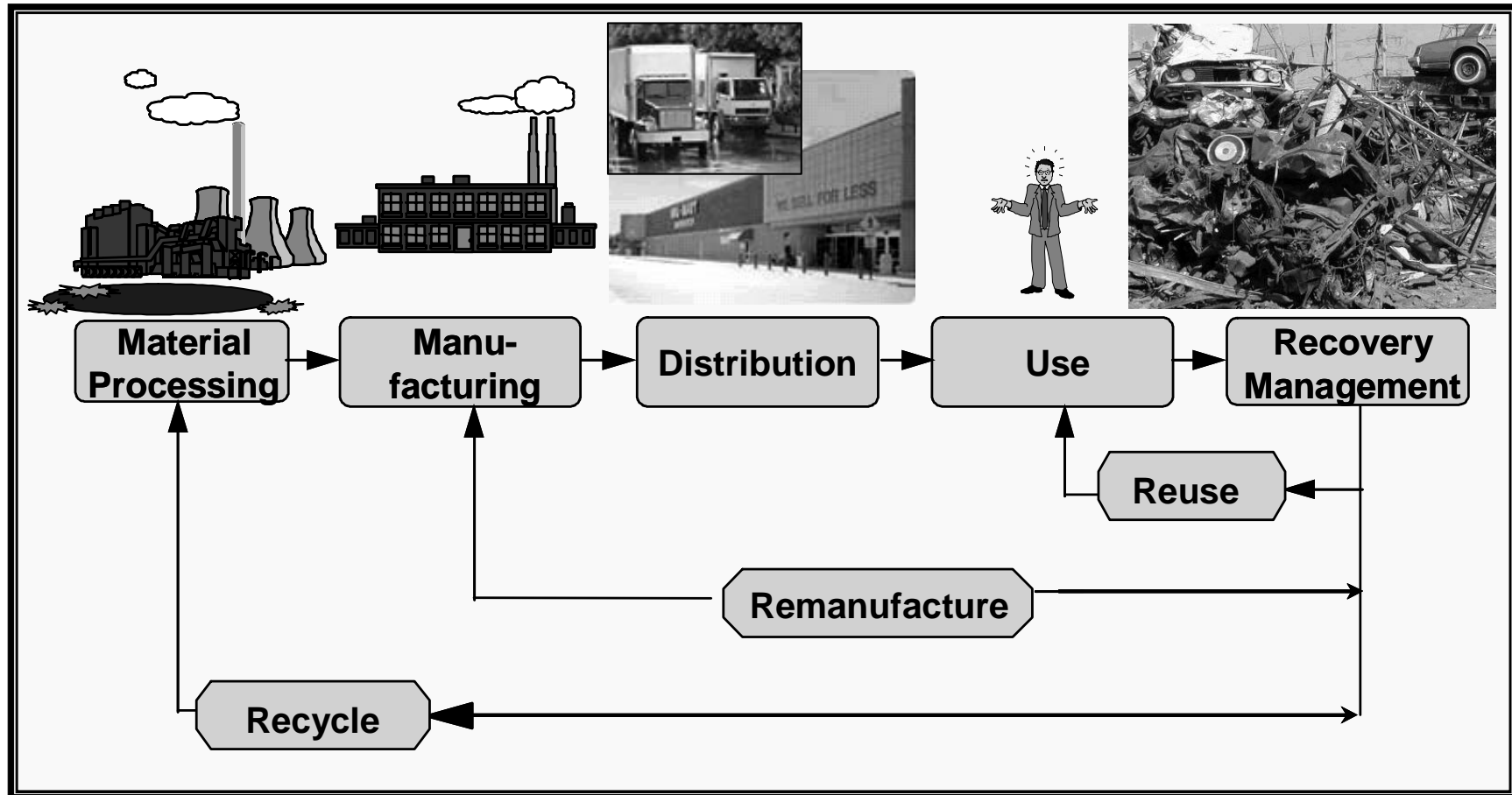




# Material Life Cycle for a Product



# Stages in Product Life



# The Product

- **Extracting raw materials: creates waste, diminished resources, consumes energy**
- **Material processing (refining & bulk processing): toxic wastes, by-products, and energy**
- **Manufacturing: waste, energy, secondary materials**
- **Transportation: energy**
- **Use: energy**
- **Post-use**
  - **Re-use: Product into another use cycle**
  - **Disposal: treatment, landfill, incineration**
  - **Recycling: Material recovery**
  - **Refurbishment: rework -- largely aesthetic**
  - **Remanufacturing: bringing product to “like-new” status**
  - **Dis-assembly: breaking down products into components**
  - **Demanufacturing: Opposite of Manufacturing**

# Wastes

- **Solid waste**
  - landfill
  - mining waste
- **Liquid waste**
  - contaminated discharges to water
  - roof run-off
  - pesticides
- **Gas releases**
  - CO<sub>2</sub>, volatiles, CFCs
- **Aerosol emissions**
  - micron-sized solid & liquid particles in the air
  - combustion by-products

# Resources

- **Wastes discharged to the environment may diminish the utility of existing resources: lakes, rivers, watershed, hazardous waste, air**
- **Limited availability of some resources**
  - **Petroleum**
  - **Some minerals (e.g., platinum)**
  - **Some high-grade ores**
  - **Forests**
- **As wastes accumulate and resources are diminished -- impact.**

# Types of Impact

- **Global**
  - Global Warming
  - Ozone Depletion
- **Regional**
  - Loss of bio-diversity
  - Contaminated air (e.g., pollution, acid rain) and watersheds
  - Loss of vegetation
- **Local / Plant / Manufacturing Facility**
  - Soil contamination
  - Accidents (Bhopal, Valdez)
- **Process**
  - Worker health and safety

# Revisiting Motivation

- **Continuing population increases**
- **Energy & resource use dependent on GDP/capita**
- **Developing countries**
  - GDP increasing at a fast rate
  - Large populations
  - Future problems in terms of energy, resources, and waste
- **Threats on the horizon**
  - Global warming
  - Energy availability
  - Resource depletion
  - Waste management

# Sustainability

**One definition:**

**Satisfy the needs of today without compromising the ability of future generations to meet their needs.**

## Industrial Ecology

**The means by which humanity can deliberately and rationally approach and maintain a desirable carrying capacity, given continuing economic, cultural, and technological evolution/development**

# Solutions

- What actions are needed to be sustainable??
- Option #1
  - Reduce consumption of energy, goods, and services
  - Modify consumer expectations
- Option #2
  - Change the way we satisfy our needs
  - Adopt ERDM principles
  - We don't know how to do this yet!!

# Another Concern

- While environmental challenges are often global in nature, let's view things from a U.S. perspective...
- What makes a company competitive??
- Taylor & history (Ind. Rev., Wage Incentive Plans, Apollo program, Quality)
- Japan -- no energy resources -- impact on products
- Northern Europe -- diminishing landfills
- Sutherland's theory: "real or artificial challenges drive technological change"

# NSF EBM -- U.S. Attitudes

- **“If you want an environmental product, then you are going to have to pay more.”**
- **“We aren’t improving the process, because if we did, then the EPA would come after us for our past problems.”**
- **“We think it’s better to be a follower than the leader.”**
- **“Our suppliers are the experts.”**
- **“Our biggest problem is that we don’t know what laws will be passed next.”**

# Global Benchmarking

## Government Activities—Relative Competitiveness\*

Activity	Japan	U.S.	Europe
Take-back legislation	**	*	****
Landfill bans	**	*	***
Material bans	*	*	**
LCA tool and database development	***	**	****
Recycling infrastructure	**	*	***
Economic incentives	**	*	***
Regulate by medium	*	**	*
Cooperative/joint efforts with industry	**	*	****
Financial and legal liability	*	****	*

\*Number of asterisks indicate comparative strength, and are intended to be indicative of level of effort and emphasis as much as actual level of success.

# Global Benchmarking

## Industrial Activities—Relative Competitiveness

Activity	Japan	U.S.	Europe
ISO 14000 certification	****	*	***
Water conservation	**	***	*
Energy conservation/CO2 emissions	****	**	**
Decreased releases to air and water	*	***	**
Post Industrial solid waste reduction/recycling	****	**	***
Post-consumer recycling	**	*	****
Material and energy inventories	***	*	**
Alternative material development	**	*	***
Supply chain involvement	**	*	**
EBM as a business strategy	****	**	***
Life-cycle activities	**	**	**

# Global Benchmarking

## Research and Development Activities—Relative Competitiveness

Activity	Japan	U.S.	Europe
Relevant Basic Research (> 5 years out)			
Polymers	**	***	**
Electronics	**	***	*
Metals	***	*	**
Automotive/Transportation	**	*	***
Systems	**	*	***
Applied R&D (< 5 years out)			
Polymers	*	***	**
Electronics	***	**	**
Metals	***	*	**
Automotive/Transportation	***	*	***
Systems	**	*	***

# Words of Wisdom

- **“Waste is equivalent to inefficiency.” Kubota**
- **“Being second to market with innovation is not a way to maintain industrial leadership. That is not a situation in which we want to place our key industrial sectors.” J. Logan testimony before U.S. Senate**
- **“Proactive companies take a leadership position that allows them some influence over the form of future constraints.” R. M. Day (World Resources Inst.) commenting on BMW’s leadership in product take-back**

# More Wisdom

- **“In the jargon of the business world, the economy is a wholly owned subsidiary of the environment. All economic activity is dependent on the environment, on its underlying resource base. If the environment is finally forced to file under Chapter 11 because its resource base has been polluted, degraded, dissipated, and irretrievably compromised, then the economy goes bankrupt with it because the economy is just a subset within the ecological system.”**  
**Senator Gaylord Nelson, Wisc. (Father of Earth Day)**