

ESD.123 / 3.560

**Systems Perspectives on Industrial Ecology:**  
Evaluation Concepts and Methods on  
the Environmental Impact of Systems



3.080 Econ & Enviro Issues In Materials Selection  
Randolph Kirchain

Introduction: Slide 1

## Instructors

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- **Randolph Kirchain**
  - Assistant Professor,  
Department of Materials Science and Engineering  
& Engineering Systems Division
- **Frank Field**
  - Associate Director for Education,  
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- **Jeremy Gregory**
  - Research Associate,  
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## Today's Mechanics

- Please fill in the sign-up sheet which is going around
  - Email list will be important for communicating with you about course updates
- Information requested
  - Name
  - Department
  - Year
  - Email

Central Question of the Course:

**How can Engineers make  
Economically & Environmentally Informed  
Material, Process, Architecture, & Policy  
Decisions?**

## Overview of Course: Philosophy

- Conceptual
  - Engineers can fundamentally change the environmental footprint of modernity
  - To effect change, engineers require tools to identify “better” design and operational options
- Pedagogical
  - Engineers are highly trained in analysis
  - Engineers receive little training in evaluation
  - Engineers receive effectively NO training in evaluating environmental impact

## Overview of Course: Learning Objectives

- Learning Objectives
  - Awareness of environmental perspectives on technological activity
  - Awareness of environmental evaluation theories and tools
  - Proficiency with
    - Life-cycle thinking
    - Life-cycle assessment methods
  - Awareness of policy mechanisms for driving environmental decisions
  - Ability to address analyses with incomplete data
  - Appreciation for multi conditional solutions

# Why Do We Care?

## Global Warming

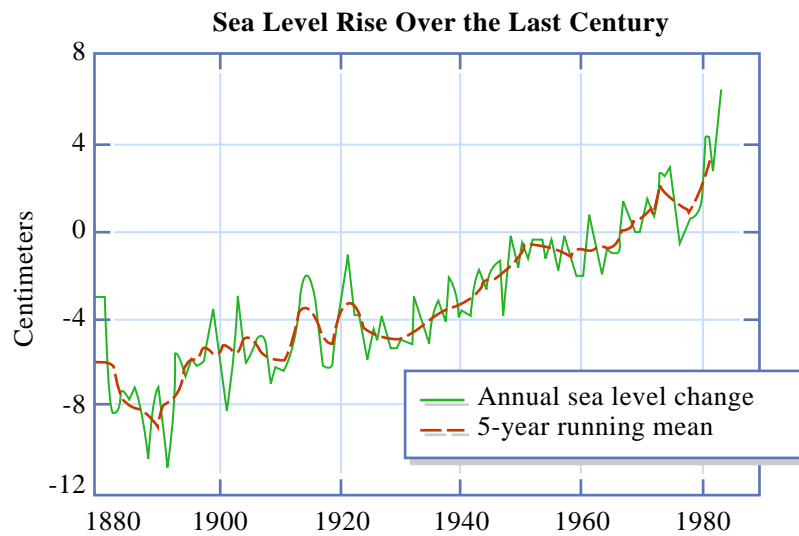
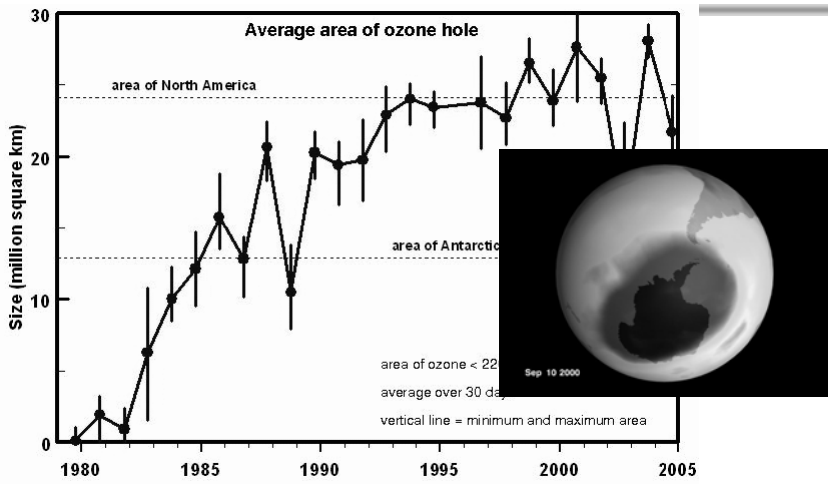


Figure by MIT OCW.

# Ozone Hole



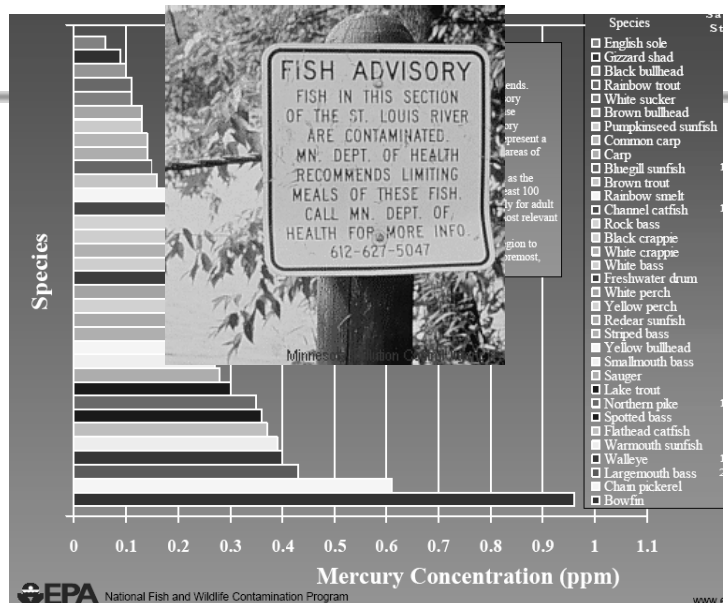
Courtesy of NASA.

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# Toxics



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Courtesy of U.S. EPA

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## Current Issues of Concern

- Global warming & climate change
- Ozone layer depletion
- Soil degradation and loss of wetlands & agricultural land
- Species extinction
- Concentration of toxics
- Depletion & degradation of resources

## How does Industrial Activity Affect the Environment?

- Direct
  - Manufacturing burden
    - Consumption of energy
    - Emissions to the environment
  - Concentration in the environment
    - Most materials still eventually in up in landfills
    - Toxicity for some materials
- Indirect
  - Performance of the products into which they are transformed
    - Energy Efficiency
    - Recyclability

Is this *really* a problem?

How much do  
**YOU**  
consume per day?

How much do YOU use per day (kilograms)?

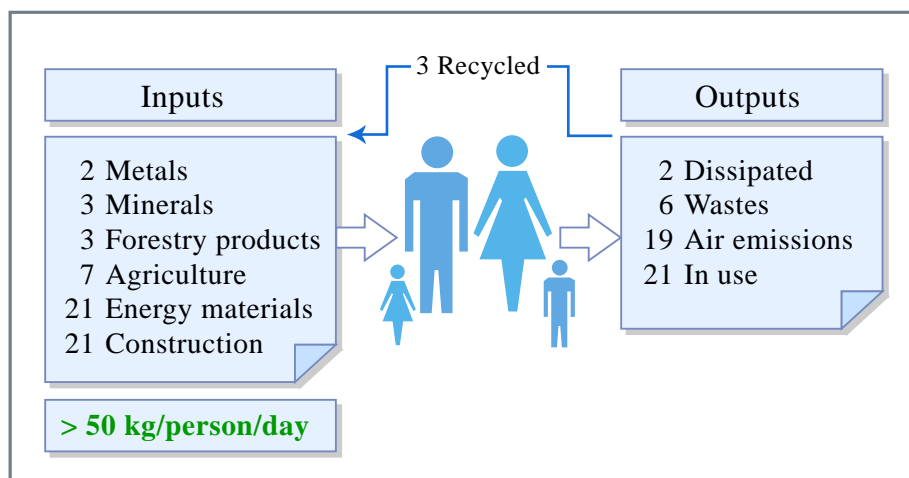
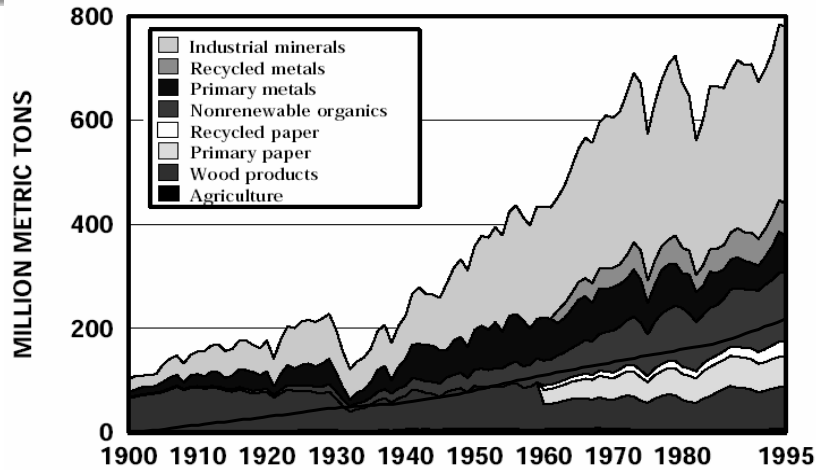


Figure by MIT OCW.

## Why Care About Materials & Economics or Environment?



Courtesy of Annual Review, Inc. Used with permission.  
Source: Figure 3 in Matos, G., and L. Wagner. "Consumption of Materials in the United States, 1900-1995." *Annu Rev Energy Environ* 23 (1998): 107-22.



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## How Can We Affect This?

- Human Behavior
  - Change patterns of consumption
    - Waste less
- Change the rules
  - Dematerialization
    - Get the same function from less material
  - Materials substitution
    - Apply less harmful materials
  - Waste Mining - Reuse, Recycle
    - Find ways to make use of streams currently wasted



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## Course Materials

- Readings will be distributed online
  - Used to distribute key course materials
    - Syllabus, Lecture Notes, Solutions, Case Tools
- Texts on Reserve:
  - *The Hitch Hiker's Guide to LCA*,  
H Bauman and A Tillman, Studentlitteratur AB, 2004
- Software
  - SimaPro - Life-cycle Analysis



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## Grading Guidelines

• Assignments	35%
• Case 1 Presentation / Report	20%
• Case 2 Presentation / Report	30%
• Class Participation	15%



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## Calendar

- Today: Intro and Overview
- Feb 9 - Mar 2: Views on Industrial Ecology
- Mar 7 - Apr 4: LCA: Method Basics
- Apr 6: Case 1 Presentations
- Apr 11 - Apr 20: Environmental Evaluation & Advanced Methods
- May 2 - May 4: Aggregate Materials Flows
- May 9 - May 16: Environmental Policy Strategies
- May 18: Case 2 Presentations

## Initial Assignments

- Assignment 1 - NEXT Class - Thurs Feb. 9
  - Read Frosch Paper
  - <1 Page Writeup
    - Definition in your words of industrial ecology
    - Description of a technological activity (i.e., product, system, or technology policy) which serves as a good example of industrial ecology principles or where strong opportunity exists
  - Select Environmental Paradigm from Colby to defend
- Assignment 2 - Session 3 - Tuesday Feb 14
  - Prepare short (15 min) presentation on selected paradigm
    - Describe paradigm
    - Defend paradigm using at least one concrete example of product or material/product system