ESD.123 / 3.560

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

Instructors

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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

Sea Level Rise Over the Last Century

Figure by MIT OCW.
Introduction: Slide 9

ESD.123/3.560: Industrial Ecology - Systems Perspectives
Randolph Kirchain
Massachusetts Institute of Technology
Department of Materials Science & Engineering

Ozone Hole

Toxics

Massachusetts Institute of Technology
Department of Materials Science & Engineering

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Introduction: Slide 10

Courtesy of NASA.

Courtesy of U.S. EPA.
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)?

Inputs

- 2 Metals
- 3 Minerals
- 3 Forestry products
- 7 Agriculture
- 21 Energy materials
- 21 Construction

> 50 kg/person/day

Outputs

- 3 Recycled
- 2 Dissipated
- 6 Wastes
- 19 Air emissions
- 21 In use

Figure by MIT OCW.
Why Care About Materials & Economics or Environment?

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

Course Materials

- Readings will be distributed online
  - Used to distribute key course materials
    - Syllabus, Lecture Notes, Solutions, Case Tools
- Texts on Reserve:
- Software
  - SimaPro - Life-cycle Analysis

Grading Guidelines

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

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## 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