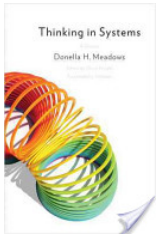
DGC2003h: Systems Thinking for Global Problems

- Course Intro
  - Website: http://www.cs.toronto.edu/~sme/DGC2003H
  - Books
  - Assignments
- Basic Ideas
  - Parts vs Wholes
  - Linear Thinking vs Systems Thinking
  - Reductionism vs Holism
  - Open vs Closed Systems
  - Stocks & Flow Models
  - Systems Dynamics Models

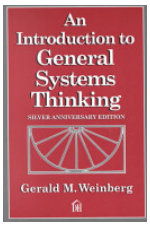
Course Goals

- To change your perspective
- To give you new thinking tools
- To provide concepts & terms to help understand dynamic, complex systems
- To persuade you to apply these ideas in your own research

Books

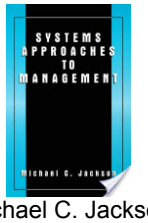


Donella Meadows
Thinking In Systems

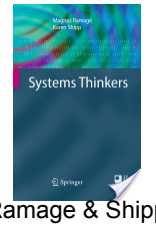


Gerald Weinberg
Intro to General
Systems Thinking

Bryan Walker
& David Salt
Resilience Thinking



Michael C. Jackson
Systems Approaches to Management



Ramage & Shipp
Systems Thinkers

Assignments

- **Class Participation**
  - Show up
  - Do stuff
  - Get points
- **A 5-minute talk about a prominent systems thinker**
  - Must agree on who does whom
  - Sources: Ramage & Shipp, course website
  - Bonus marks: Make it a Pecha Kucha!
- **Term Paper**
  - Do a Case Study
  - Or…?

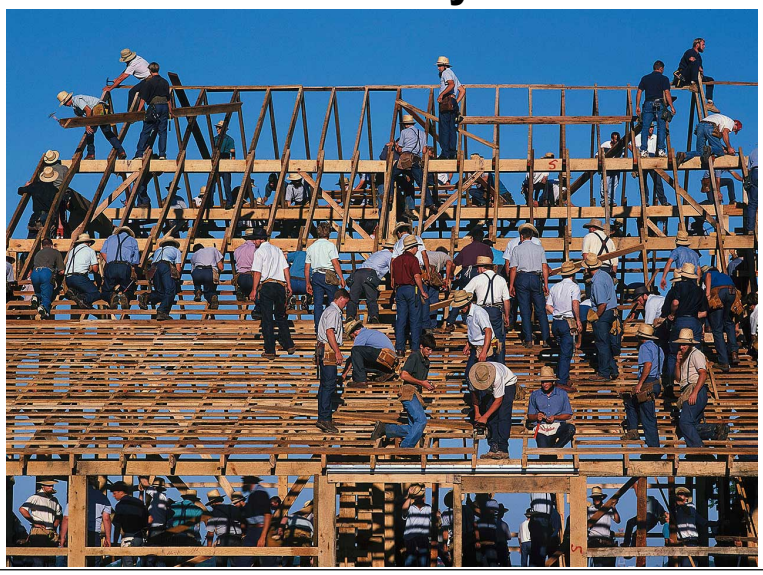
Why Systems Thinking?

- What makes a traffic jam?
- How do epidemics spread?
- Why does the stock market fluctuate?

So what is a system?

- Ackoff's definition:
  - A system is a set of two or more elements that satisfies the following conditions:
    - The behaviour of each element has an effect on the behaviour of the whole
    - The behaviour of the elements and their effect on the whole are interdependent
    - However subgroups of elements are formed, each has an effect on the behaviour of the whole and none has an independent effect on it
- Or, more simply:
  - Weinberg: "A system is a way of looking at the world"
    - Systems don't really exist!
    - Just a convenient way of describing things (like 'sets')

Here is a system



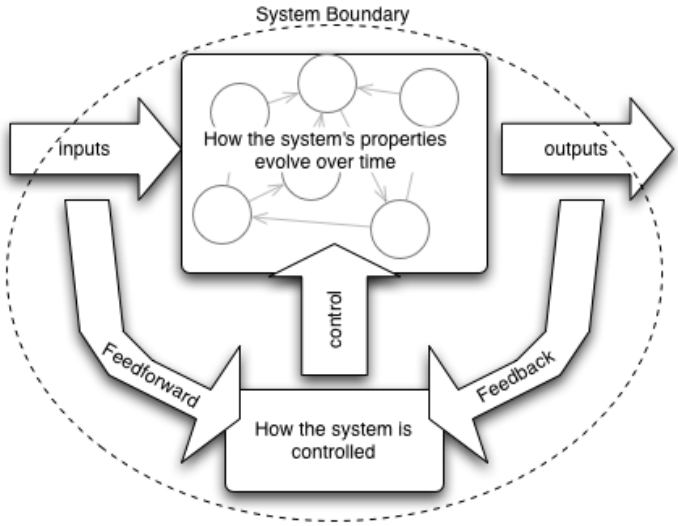
General Systems Theory

- How scientists understand the world:
  - Reductionism - break a phenomena down into its constituent parts
    - E.g. reduce to a set of equations governing interactions
  - Statistics - measure average behaviour of a very large number of instances
    - E.g. gas pressure results from averaging random movements of zillions of atoms
    - Error tends to zero when the number of instances gets this large
- But sometimes neither of these work:
  - Systems that are too interconnected to be broken into parts
  - Behaviour that is not random enough for statistical analysis
- General systems theory
  - Originally developed for biological systems:
    - E.g. to understand the human body, and the phenomena of 'life'
  - Basic ideas:
    - Treat inter-related phenomena as a system
    - Study the relationships between the pieces and the system as a whole
    - Don't worry if we don't fully understand each piece

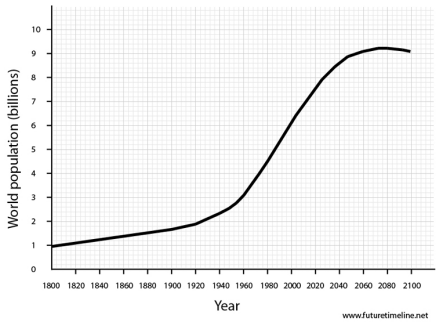
Elements of a system

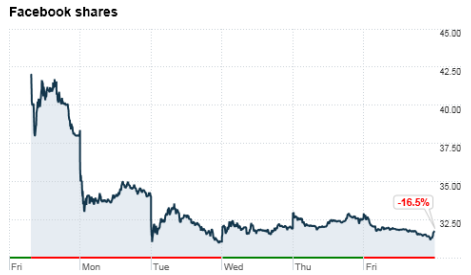
- **Boundary**
  - Separates a system from its environment
  - Often not sharply defined
  - Also known as an "interface"
- **Environment**
  - Part of the world with which the system can interact
  - System and environment are inter-related
- **Observable Interactions**
  - How the system interacts with its environment
  - E.g. inputs and outputs
- **Subsystems**
  - Can decompose a system into parts
  - Each part is also a system
  - For each subsystem, the remainder of the system is its environment
  - Subsystems are inter-dependent
- **Control Mechanism**
  - How the behaviour of the system is regulated to allow it to endure
  - Often a natural mechanism
- **Emergent Properties**
  - Properties that hold of a system, but not of any of the parts
  - Properties that cannot be predicted from studying the parts

Conceptual Picture of a System



Picturing systems





Causal Loop Diagrams