SUSTAINABILITY AND THE BUILT ENVIRONMENT

CLASS NOTES FROM THURSDAY, MARCH 4th, 2004

- Administrative Items
  - -Read article by Tim Wirth for Tuesday's class
  - -Maximum three page writing assignment due next Thursday discussing interrelated problems and systems thinking
  - -Read Cradle to Cradle and write a 5-10 page response by mid-April. More info will come.

- Traditional Thinking Governs the Modern World
  - -Linear thinking
  - -Engineering thinking
  - -Cartesian thinking

    Rene DesCartes (circa 1619) had a life-changing dream during which were revealed to him four principals for evaluating reality:

    1. Never accept anything for truth that is not clearly defined as such
    2. Everything can and should be divided into parts for analysis, and then divided and divided again and again to facilitate examination
    3. Analysis should begin by looking at the easiest part first, followed by the next hardest and then the next so as to work one's way from easiest to hardest during examination
    4. Conclusions and enumeration should be kept very general and broad-based so as not to omit anything.

    DesCartes's thinking divided the human experience into two parts: the mind, which should operate like a machine, calculated and precise; and the soul, the domain of which belonged to the heavens.

- Systems Thinking as an Alternative to Traditional Thought

  -Based on the premise that groups of interacting, independent parts are all linked together by exchanges of energy, matter and/or other binding forcing. This interdependence of parts is a diagnostic property of systems as a whole. Essential to systems is the concept of emergence, the notion that the whole is greater than the sum of its parts, or that emerging properties come out or emerge from the whole that don't exist in individual components. Examples of systems out of which things emerge:

  -Thicket of aspen trees (habitat, carbon sequestration)

-Community gardens (friendship, community growth)
-Distributed Computing (increased computing value to all users)
-Automobiles (speed, performance)

- Systems and Chaos

-Chaos is defined as the underlying connectedness that exists in apparently random events. It focuses on hidden patterns, nuances, the sensitivity of things and the rules of how the unpredictable leads to the new.
-Chaos, by nature, can lead to order and is therefore a good thing.
For example: we will always learn from unforeseen accidents or mistakes
-As a result of this chaos, systems tend to self-organize, preserving their internal equilibrium while retaining a measure of openness to the external world.
Characteristics of chaotic systems:
-dynamic with self organization (order through chaos as described above)
-small things can have huge consequences (eg, one car accident creates huge problems on freeways during rush hour; a first encounter with a future spouse)
-coupled negative and positive feedback loops
-openness and bifurcation
-creative, cooperative, sharing
-non-linear and diverse
-simple, complex, dialectical
dialectical vs. duality: the notion that interaction is communal (dialectical), open and interactive rather than of a divided nature (duality), right/wrong, or one-way.
For example: discussion (duality) vs. dialogue (dialectic).
-synchronicity (eg, you're thinking of something and then it actually happens)
-fractal (patterns of subdivided chaos)

- Effects of Chaos

Chaotic events can have extremely large impacts.
-events of September 11, 2001 have led to worldwide changes in foreign policy
-malaria outbreak in Borneo led to dramatic public health policies and sometimes outrageous political action (Operation Cat Drop)
These results are often unexpected because of unseen underlying interconnectedness.
-Technical failures or negative environmental impacts occur when engineers fail to examine and understand the big picture.

- Composition of a System

  Systems are composed of various parts, each interrelated and with its own purpose within that system. These parts may conflict with, or complement, each other. This is contrary to Cartesian thinking which does not recognize such interrelationship. DesCartes would view the world as a huge machine, with each part doing its own thing independent of others. This type of thinking is dangerous in that it leads one to think that these parts can be controlled, or managed, for benefit.

- Important Deduction

  The world is not what we (especially engineers) have been trained to think it is. The Cartesian system is obsolete!

- Types of Systems

  Isolated – system boundaries to the import and export of mass and energy (eg, a laboratory experiment)
  Closed – system boundaries are closed to the import and export of mass but not energy (eg, earth)
  Open – system boundaries are open to the exchange of both mass and energy with its surroundings (life)
  Simple – systems with only a few variables, components, or parts
  Complex – systems with many variables, all sensitive and subject to a changing dynamic equilibrium (eg, the weather)

- What Makes a System?

  -Its underlying parts form a system, not a heap or pile (eg, remove a grain of sand from a pile of sand (a heap) and the pile of sand is still a pile of sand; remove a species from the earth (a system) and the equilibrium of the system is affected)
  -The whole is greater than the sum of its parts
  -There is an interconnected purpose of each underlying part
  -Causes and effects are circular in nature, not linear
  -Chaos in the system leads to order (eg, learning, change, evolution)

- Early Systems Thinkers

  -Greeks 2000 years ago
  -Native American cultures

- Global View

  A global view of systems thinking would incorporate the following:
  -see the world around us as a whole instead of just snapshots
  -see multiple levels of perspective rather than a cause/effect interaction
  -see the dynamic changing nature of life including time domains and delays associated with that dynamic (eg, oscillating

temperatures in a London shower with poor response to changes in temperature dials)
-recognize that we (humans) are part of and inside the system and that perspective changing everything (ie, systems are sensitive to both physical and temporal perspectives)
-challenge our own assumptions and mental models

- Not Systems Thinking
  Scientific analysis which breaks down components into manageable pieces for examination and manipulation

- Examples of Complex Systems with Feedback Loops
  Cold war arms race
  -many complex political interrelationships (especially between the US and USSR), sensitivity and reactive delays (eg, buildup of arms vs. counter-buildup – an example of a positive feedback loop which if left unchecked, would destroy the system), negative feedback loops (Soviet government went defunct)
  French Revolution
  -positive feedback (interactions with fledgling United States bolstered political relations and future outlook for France), negative feedback (exhaustion of funds during U.S. revolution curtailed investment in France and led to overthrow and restructure of French government)

- The Powers of Ten
  Short movie to reinforce the ideas of perspective and humility and belonging
  -when we examine the universe as a whole, we begin to realize there is a lot that we as humans do not understand or even begin to understand.
  -when we examine some portion of the universe, we can always step back or forward and find ourselves in a new realm of perspective in which is present a multitude of aspects different from our those in our previous view