For good or ill, ideas guide our economic, social and cultural development.
Ideas and History

“We must torture nature to reveal her secrets’

- Francis Bacon (1561 - 1626 )

“God said to them, ‘Be fruitful and multiply, and fill the earth and subdue it; and have dominion over the fish of the sea and over the birds of the air and over every living thing that moves upon the earth.’”

- Genesis 1:28
Platonic Idealism

Plato’s philosophy is referred to as Idealism.

Idealism is the claim that reality is based in ideas.

A chair is a chair insofar as it participates in the *idea* of “chair”. Plato calls these ideas “the forms”. (τὸ εἴδος)
Platonism is Dead, Long Live Platonism

Plato’s ideas largely disappear from view from the end of the Greek era through the Middle Ages.

But then they come back, specifically Idealism, during the Renaissance, but they come back in a new form...
Galileo - (1564 - 1642)

Birth of Modern Physics

1638 – Two New Sciences - Galileo develops an interpretation of physical being that shows it can successfully be studied mathematically (mechanics).

“[The universe] cannot be read until we have learnt the language and become familiar with the characters in which it is written. It is written in mathematical language, and the letters are triangles, circles and other geometrical figures, without which means it is humanly impossible to comprehend a single word.”

Opere II Saggiatore, 1633
Descartes – (1596 – 1650)  
Birth of Modern Philosophy

1644 – *Meditations* - Descartes proposes that logical reasoning is our highest faculty.

“I concluded that I might take as a general rule the principle that all things which we very clearly and obviously conceive are true: only observing, however, that there is some difficulty in rightly determining the objects which we distinctly conceive.”

*Discours de la Méthode*. 1637.
Cartesian Thinking

Rules for evaluating reality:

• Never accept anything for true that we do not clearly know to be such
• Divide each part of the difficulties under examination into as many parts as possible
• Begin with the simplest and easiest and then work step-by-step to the more complex
• Make enumeration so complete and reviews so general that it might be assured that nothing is omitted.

Descartes (1619)
What went wrong?

The concern we’ve considered: “Linear Thinking”

A concern we have not considered:

This Platonic and Cartesian framework for the world (all of being) necessarily restricts how we look at all things, ourselves, and the world.

Reductionism
Quantum Thinking

● Reality is not as objective as we may think
● Reality is in the eyes of the observer
● Our moment to moment observations are shaped up by our perceptions and belief system
● What we believe in, is what we get.
Quantum Thinking

“Reality is what we take to be true. What we take to be true is what we believe. What we believe is based upon our perceptions. What we perceive depends upon what we look for. What we look for depends on what we think. What we think depends on what we perceive. What we perceive determines what we believe. What we believe determines what we take to be true. What we take to be true is our reality”

Gary Zukav
Bohr’s Principle of Complementarity:
Things, events, etc. are always potentially present. They become present when we decide to look at them (quantum probability functions collapse). The problem is that once we decide to look at one aspect of something, the less we know about the other aspects.

Heisenberg Uncertainty Principle:
The simple process of observation changes what we perceive due to our own interaction. Reality depends on what we choose to measure, or more specifically, which set of lenses we choose to look through. Knowing is disrupting.
Reality

**Fiction**
- Cartesian
- Linear
- Predictable
- Independent parts
- Closed systems
- To be controlled

**Fact**
- Non-Cartesian
- Non-linear
- Chaotic
- Interconnectedness
- Open, Dissipative
- Emergence, Self-organization, Autopoiesis
Systems Thinking

Systems may be defined as groups of interacting, independent parts (agents, or subsystems, or lower hierarchies within the system under consideration) linked by exchanges of energy, matter, and/or information.

Interdependence of parts is a diagnostic property of systems.

In systems, the whole is greater than the sum of its parts (emergence)
What makes a system?

- The parts or components
- The relationship between the parts
- The purpose of the system (subsystems may have several purposes conflicting or not)

“Nothing is completely itself without everything else”

(T. Berry)
Types of Systems

- **Isolated**: boundaries closed to import or export of both mass and energy
- **Closed**: boundaries closed to import or export of mass, but not of energy
- **Open**: exchange of both mass and energy with surroundings

“When we try to pick up anything by itself, we find it is attached to everything in the universe” (John Muir)
Simple and Complex Systems

**Simple**: few variables involved with limited and easily understandable relationships that are displayed over a short time period

**Complex**: many variables, complex interactions between the variables. Characteristics: non-linearity, feed-back loop, discontinuities, sensitivity, dynamic equilibrium, emergent behavior, evolution, path-dependency, small changes here create big changes there (Edward Lorenz, 1979)
“Chaos” refers to an underlying connectedness that exists in apparently random events. Chaos science focuses on hidden patterns, nuance, the ‘sensitivity’ of things, and the ‘rules’ for how the unpredictable leads to the new”.

“Chaos theory tells us that systems tend to self-organize, preserving their internal equilibrium while retaining a measure of openness to the external world”

(J. Briggs and D. Peat)
Some characteristics of chaotic systems:
- Dynamic with self organization (order out of chaos)
- Small things can have huge consequences (subtle influences)
- Many coupled negative and positive feedback loops
- Openness and bifurcation
- Creative, cooperative, sharing
- Non-linear and diverse
- Simple, complex, dialectical
- Synchronicity
- Fractal (patterns of chaos)
A Global View of System Thinking

See the world around us in wholes instead of snapshots.
See and sense how the parts of systems work together.
See relationships between the elements from multiple levels of perspective rather than cause-effect chains (31).
Help understand the dynamic and changing nature of life including the effect of time and delays (34).
Help understand how one small event can influence another and unintended consequences (33).
Help understand that what we see happening around us depends on where we are in the system.
Challenges our own assumptions (mental models).

(Linda Sweeney, 2001)
NON-NATURAL SYSTEMS
(Built Environment - Anthrosphere)

- Cartesian
- Somewhat predictable
- Designed as closed systems
- Built to last

NATURAL SYSTEMS
(Biosphere- Hydrosphere-Geosphere – Atmosphere)

- Non-Cartesian
- Non-linear
- Coupled
- Chaotic
- Diverse
- Open
- Dissipative
- Changing
Nuclear Waste Repository

FROM: Figure 1.1, Industrial Ecology, Environmental Chemistry and Hazardous Waste, Stanley E. Manahan
Why Things Fail?

- **Slowness of human thinking.** We feel obliged to economize and simplify.
- **Slow speed in absorbing** new material. We don’t think about problems we don’t have.
- **Self protection.** We need to have things easier and under control to preserve our expectation of success.
- **Limited understanding of systems:** complexity, dynamics, mistaken hypotheses and ignorance.
What is NOT Systems Thinking?...

- It is NOT analysis
- Analyzing something involves breaking it down into bite-size, manageable pieces.
- Analysis works fine for: organizing your CD collection, or finding out exactly how your clock works, or examining a water molecule.
- Problems arise when we use analysis mindlessly!
- Systems are dynamic, and there are relationships
What is NOT Systems Thinking?

Detail complexity—simulations with thousands of variables and complex arrays of details can actually distract us from seeing patterns and interrelationships. Traditional approach in tools for forecasting, planning and business analysis

Dynamic complexity—Difficult to handle with traditional tools because of: subtle relationship between cause and effect, effects over time and space and interventions are not obvious. This is where the leverage lies

“As complexity arises, precise statements lose meaning and meaningful statements lose precision”

“Theory of mindful decision: when we are certain, we cease to pay attention
What is Systems Thinking?...

“Since relationships are the essence of the living world, one would do best… if one spoke a language of relationships to describe it. This is what stories do….

What is important in a story, what is true in it, is not the plot, the things, or the people in the story, but the relationships between them.”

Fritjof Capra
If You Give a Mouse a Cookie

Author: Laura Joffe Numeroff, illustrated by Felicia Bond
Publisher: HarperCollins, New York, 1985
Format: Picture book, fiction
Age Range: 3–7

Systems Thinking Concepts
Simple interconnectedness, circular feedback, unintended consequences, time horizons, solutions that create new problems

The Cat in the Hat Comes Back

Author: Dr. Seuss
Publisher: Random House, New York, 1958
Format: Picture book
Age Range: 4–8 (but open-ended possibilities for grown-ups, too!)

Systems Thinking Concepts
Simple interconnectedness, unintended consequences, the archetypal systems story of "Fixes That Fail"

The Old Ladies Who Liked Cats

Author: Carol Greene, pictures by Loretta Krupinski
Format: Picture book
Age Range: 9–12 (though this range seems too limited to me; I know readers younger than 9 who enjoy reading this book as well)

Systems Thinking Concepts
Simple interconnectedness, the impact of delays, unintended consequences, goal-seeking behaviors or equilibrium, how seemingly rational decision can have disastrous large-scale results

Zoom

Author: Istvan Banyai
Publisher: Viking Children's Books, New York, 1995
Format: Picture book, nonfiction
Age Range: All

Systems Thinking Concepts
Understanding the impact of our own perceptual filters, multiple levels of perspective, "nested systems," systems boundaries
ZOOM Exercise

- Look at the book, one page at a time, not skipping any pages. No peaking ahead!
- How do you describe the main points of the book?
- How do the main points apply to the following hypothetical “built environment” system?

The State of Colorado has decided to design and construct a new highway. It will extend through several counties, and through state parks, national parks, and national forest. The purpose is to bring more individuals from cities into the parks and outdoor areas of Colorado. The design and planning process is just beginning. Individuals from several different agencies and groups are attending a series of planning meetings.

(Feel free to analyze the “system” at any point in time, meaning its design phase, construction phase, operation phase, and beyond.)