禅 ZEN & the art of systems thinking

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INCOSE-CC Presentation

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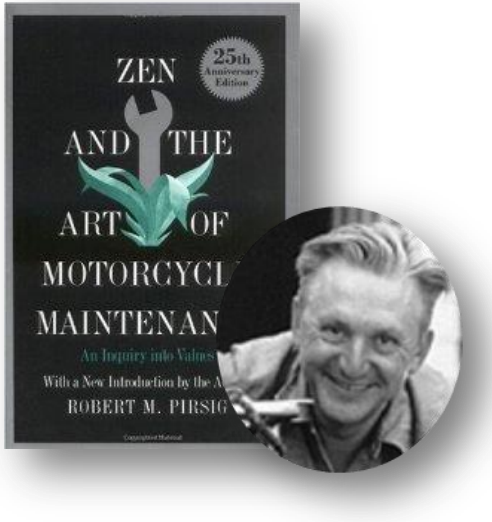
Objective

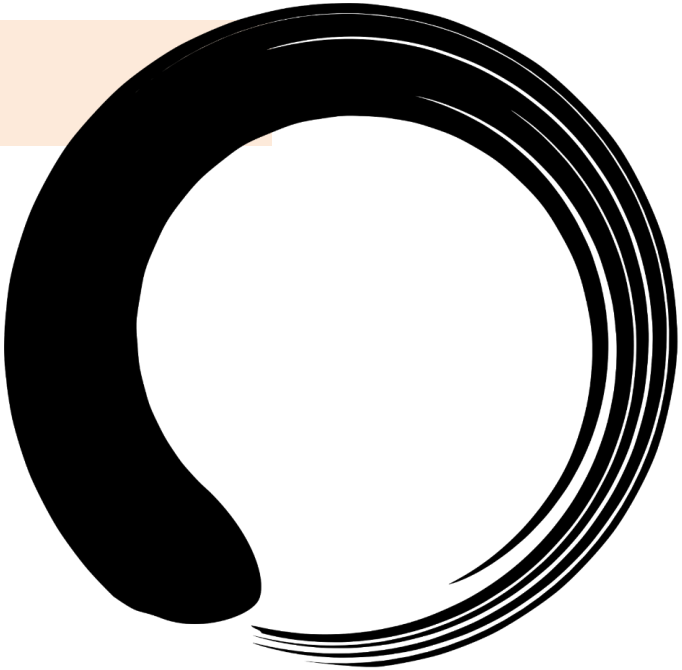
- Examine the context of the Systems Thinking paradigm by exploring its history and philosophy, as well as its intersection with Systems Science and Systems Engineering.
- "... should in no way be associated with that great body of factual information relating to orthodox Zen Buddhist practice. It's not very factual on ~~motorcycles~~ Systems Thinking, either."

~ Pirsig, R. M. (1974). *Zen and the art of motorcycle maintenance*



Why Zen?

- In Zen, there are no categories; nothing can be separated.
- Everything is interconnected. Even us.
- The entire Cosmos is influenced by our actions and our attitudes.



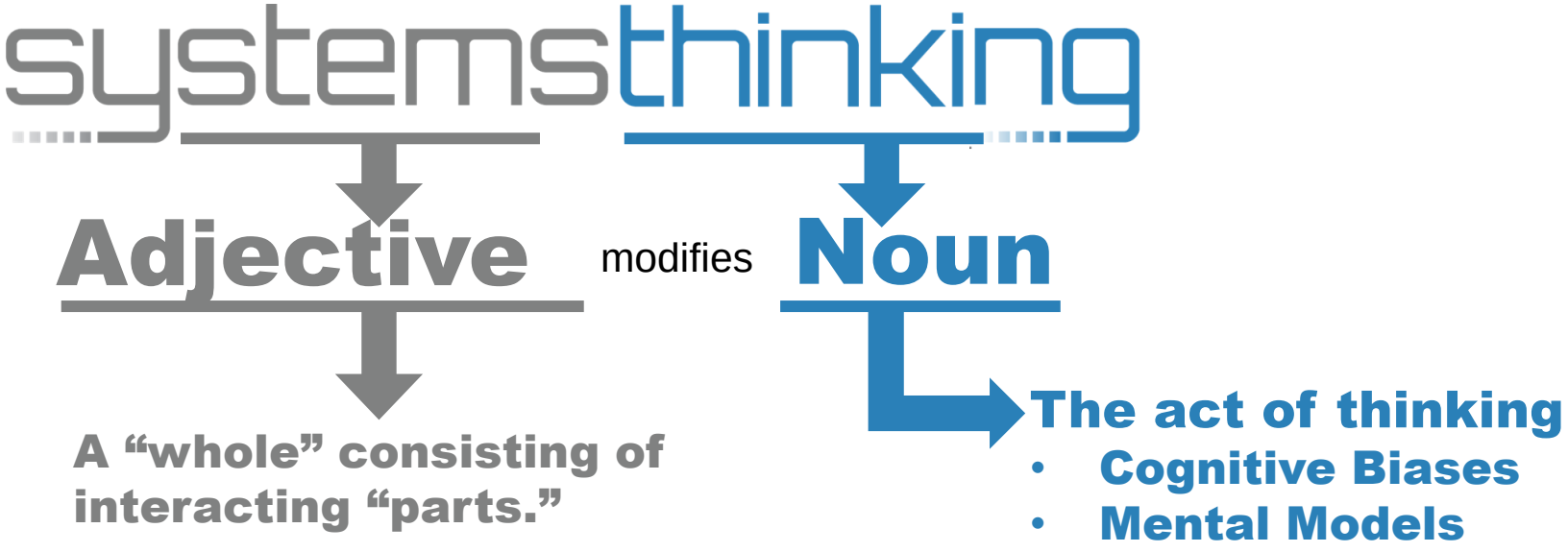
“We must stop acting as though nature were organized into disciplines in the same way that universities are”

Ackoff R.L. 1960. Systems, organizations and interdisciplinary research. General Systems Yearbook 5: 1–8

Analysis

- "Since the turn of the century (the 20th century, that is), the accepted approach to dealing with increasing complexity is to try to *reduce* it into manageable "bites" and address them in isolation. This approach is referred to as **analysis**. We analyze a complex situation or issue by trying to break it down into component pieces and consider each in isolation from the others. This kind of thinking has its roots in analytic geometry, where one basic axiom is that *the whole is equal to the sum of its parts*. Think about that for a moment. The underlying assumption behind this conclusion is that all of the parts are essentially independent of one another."

  ~ Dettmer, H. William. "*An Introduction to the Systems Approach*"



"Systems thinking is not a science; it is a conceptual ability, an orientation, and a framework. However, systems thinking is informed by *knowledge-about-systems*."

~ Cabrera, D., & Cabrera, L. (2015). *Systems thinking made simple: New hope for solving wicked problems*. .

Knowledge-about-Systems

- A "whole" consisting of interacting "parts."

  ~ von Bertalanffy, L. (1968). *General System Theory: Foundations, Development, Applications.*

- A combination of interacting elements organized to achieve one or more stated purposes

  ~ ISO/IEC/IEEE 15288:2015 *Systems and software engineering -- System life cycle processes*

- Systems are Holons of patterns at one or more scales of conceptualization. The patterns can be distinguished as the substance, the structure, and the dynamics of the system.

  ~ Kuras, M. (2006). 'Complex-system engineering'. http://cs.calstatela.edu/wiki/images/c/c5/Kuras.pdf

Let's play a game:

Is it System? or
Is it a Collection of Parts?

System or Collection of Parts?

- Football Team

System or Collection of Parts?

- Toaster

System or Collection of Parts?

- Kitchen

System or Collection of Parts?

- Marriage

System or Collection of Parts?

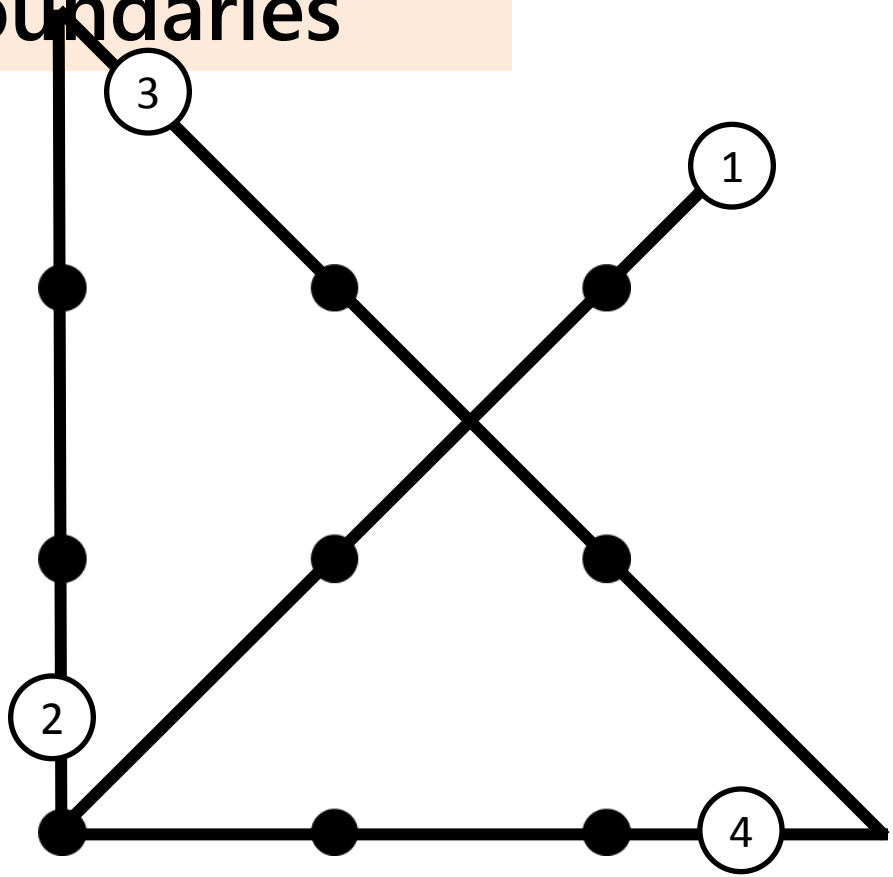
- Tools in a Toolbox

Defining Characteristics of Systems

- Systems have Purpose
- All parts must be present (for a system to carry out its purpose.)
- The order and arrangement of the parts affect performance
- Feedback helps the system maintain stability
- All Systems have a **boundary** and operate within an environment.

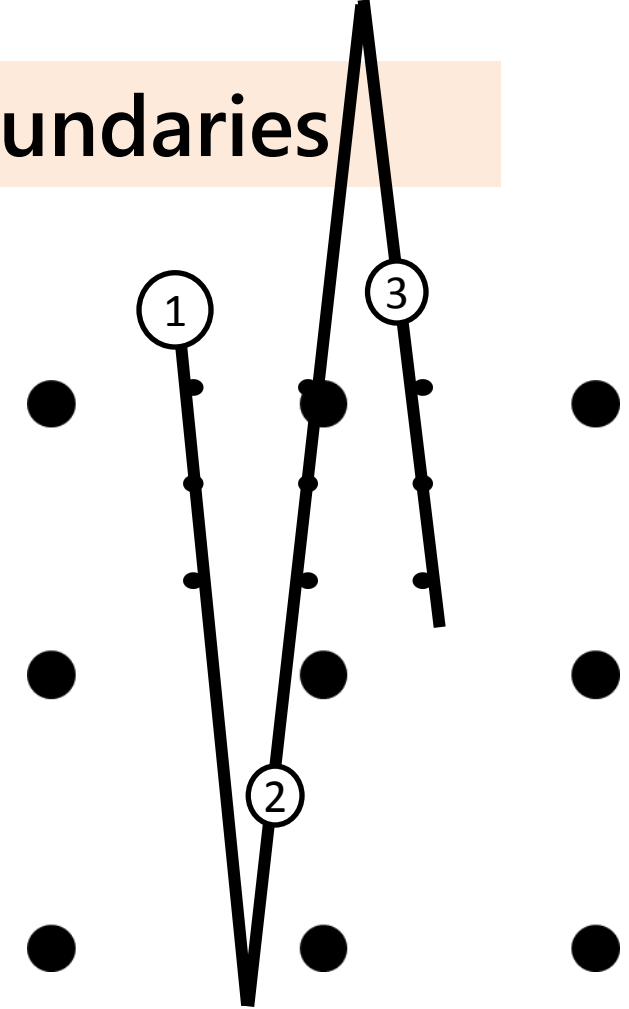
The challenge: Setting Boundaries

- 9 Dots
- One Rule:
  Interconnect the dots by drawing **four** straight lines through the nine dots without retracing and without lifting your pen.



The challenge: Setting Boundaries

- 9 Dots
- One Rule:
  Interconnect the dots by drawing ~~**four**~~ three straight lines through the nine dots without retracing and without lifting your pen.



The challenge: Setting Boundaries

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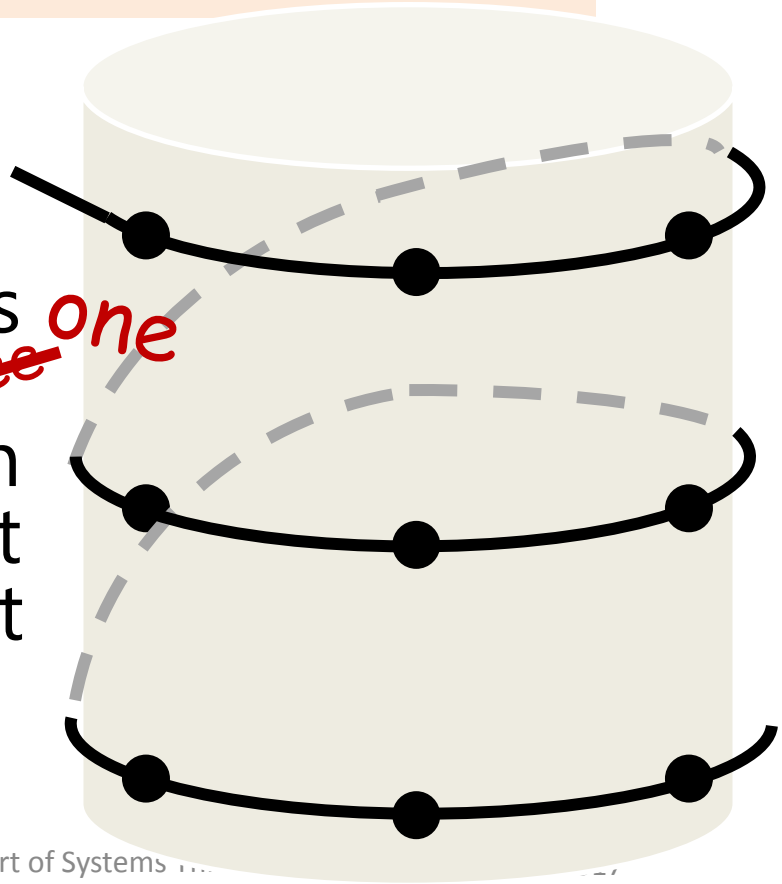


Boundaries at the Micro Level

The moment one gives close attention to anything, even a blade of grass, it becomes a mysterious, awesome, indescribably magnificent world in itself.

~ Henry Miller

Boundaries at the Micro Level

"The Brute ... That Shouted Love... At the Heart of the Atom."

Incredible Hulk Vol 1 #140 (June 1971), Marvel Comics.

Boundaries at the Macro

Impact of the fourth dimension

System or Collection of Parts?

- A piece of Art in NY Park
  - 36 foot high structure of aluminum and magnesium slab bolted together

New York City's prominent 1974 outdoor sculpture, 3000 A.D. by Terry Fugate-Wilcox where the piece's various aluminum and magnesium slabs will join themselves into one continuous alloy block around the year 3000. With time all boundaries disappear.

Impact of the fourth dimension

System or Collection of Parts?

- Bowl of Fruit

Name and Classify everything

How humans tried to understand the universe

"Now out of the ground the Lord God had formed every beast of the field and every bird of the heavens and brought them to the man to see what he would call them. And whatever the man called every living creature, that was its name."

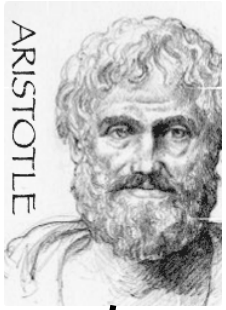
~ 1445 B.C [Genesis 2:19-20]

Once the whole is divided, the parts need names.
There are already enough names.
One must know when to stop.
Knowing when to stop averts trouble.

~ 500BC [The Tao Te Ching]

Name and Classify everything

How humans tried to understand the universe



~ 350BC

Aristotle showed this hierarchical tendency when he

- Classified animals into different types based on physical characteristics;
- Reduced the Rhetoric technique into a rational system
  1. particular proofs and topics
  2. common proofs.

"Aristotle was tremendously satisfied with this neat little stunt of **naming and classifying everything**. His world began and ended with this stunt."

~ Pirsig, R. M. (1974). *Zen and the art of motorcycle maintenance*

384 – 322 BC

The Triumph of Reductionism

How humans tried to understand the universe

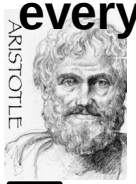
Reductionism

Name and Classify everything

"… divide all the difficulties under examination into as many parts as possible, and as many as were required to solve them in the best way."

~~ Descartes, René (1637)

An essential part of the Scientific Method



384 – 322 BC

1596-1650

1643 - 1727

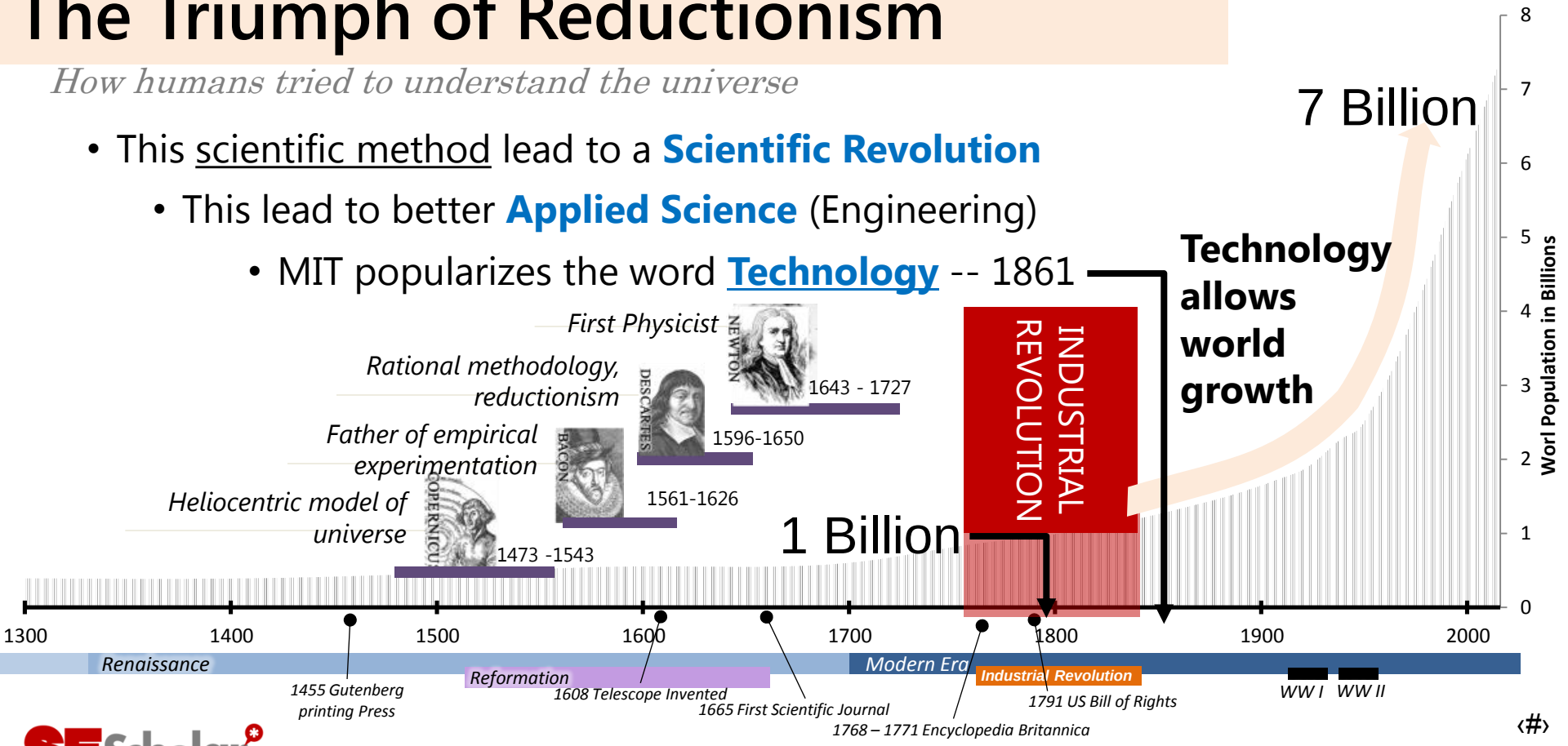
1561-1626

1473 -1543

The Triumph of Reductionism

How humans tried to understand the universe

- This <u>scientific method</u> lead to a **Scientific Revolution**
  - This lead to better **Applied Science** (Engineering)
    - MIT popularizes the word **Technology** -- 1861



Limitations in Reductionism

How humans misunderstand the universe

- "From a very early age we are taught to break apart problems, to fragment the world. This apparently makes complex tasks and subjects more manageable, but we pay a hidden, enormous price. We no longer see the consequences of our actions; we lose our intrinsic sense of connection to a larger whole. When we then try to "see the big picture," we try to reassemble the fragments in our minds, to list and organize all the pieces …. after a while we give up trying to see the whole altogether."

~ Senge, P.M. (1990). *The Fifth Discipline*

The price of reductionism is NOT seeing the overall system!

Limitations in Reductionism

How humans misunderstand the universe

- **It basically ignores Complexity**
  - The whole idea of Reductionism is to reduce complexity – but this doesn't mean complexity isn't still there.

    "If you understand, things are just as they are... If you do not understand, things are just as they are..."

    ~ Anonymous Zen Quote

- **We can't study Emergence with Reductionism**
  - The concept of emergence is based on characteristics that the whole demonstrates and can not be attributed to the components.

    "An appeal to emergence is thus a way to describe the need to go to the macro level and its unique dynamics, laws, and properties in order to explain more adequately what is going on."

    ~ Jeffrey Goldstein

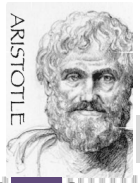
The need for Systems understanding

How humans tried to understand the universe better

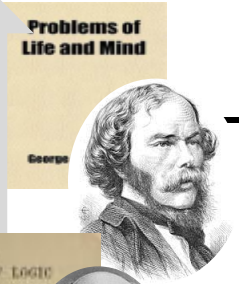
- Aristotle observed the fact that **system properties will manifest only when components interact** with one another. These system level properties are different than the individual component level properties.

"the whole is greater than the sum of the parts"

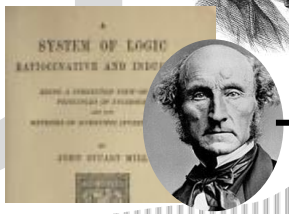
~ Metaphysics Book H 1045a 8-10



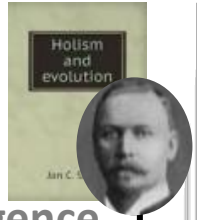
1875 - George Henry Lewes *Problems of Life and Mind.* "the emergent … cannot be reduced either to their sum or their difference."



1843 - John Stuart Mill *System of Logic*
"… no mere summing up of the separate actions of those elements will ever amount to the action of the living body itself."



1926 – Jan Smuts *Holism and Evolution*



Concept of Emergence

World Population in Billions

0 1 2 3 4 5 6 7 8

-500 -400 -300 -200 -100 0 100 200 300 400 500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000

Classical Period | BC | AD | *The Middle Ages* | *Renaissance* | *Modern Era*

476 Fall of Rome

Reformation

Industrial Revolution

The need for Systems understanding

How humans tried to understand the universe better

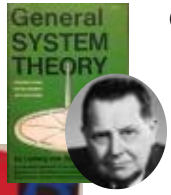
1926 – Jan Smuts
Holism and Evolution

1948 - Wiener N.. *Cybernetics or Control and Communication in the Animal and the Machine.*

Cybernetics

1950 - Churchman, Ackoff, and Arnoff, *Introduction to Operations Research.*

Operational Research

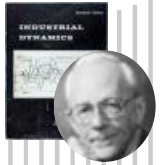


1951 - Ludwig Von Bertalanffy, *General System Theory: A New Approach to Unity of Science.*

General System Theory

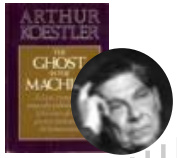
1961 - Jay W. Forrester, *Industrial Dynamics.*

System Dynamics

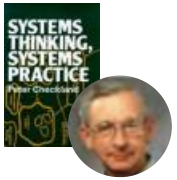


1967 - Arthur Koestler. *The Ghost in the Machine*

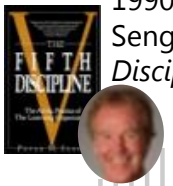
Holons



1981 – Peter Checkland, *Systems Thinking, Systems Practice.*



1990 - Peter M. Senge, *The Fifth Discipline*



Systems Thinking

Modern Era

1900 1905 1910 1915 1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015

WW I *WW II*

Worl Population in Billions

0 1 2 3 4 5 6 7 8

Systems Science

The Oxymoron

Systems – holistic view to comprehend phenomena

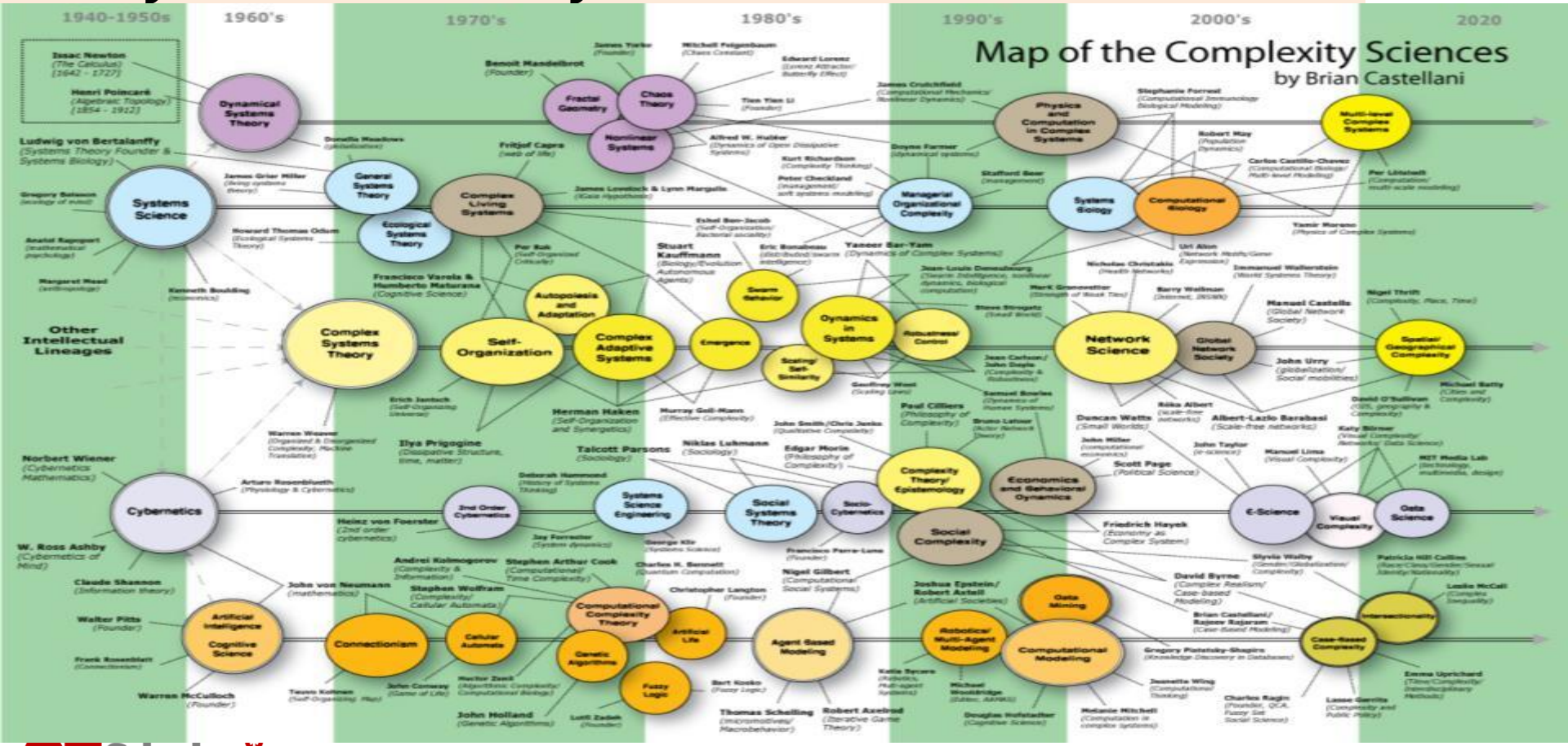
- *Synthesis* – refers to a combination of two or more entities that together form something new

Science – reductionist view to comprehend phenomena

- *Analysis* – the process of breaking a complex topic or substance into smaller parts in order to gain a better understanding of it.

A new paradigm - that changes the framework of analysis to an approach of one of synthesis

Many and various systems theories



It's not one or the other!

- "**The good systems scientist or philosopher is both reductionist and holist.** Consider the care with which he considers the detailed structure of a system: the meticulous attention he gives to establishing the proper relations between the objects; the methodical way in which he builds his whole model from these parts, having, of course, first defined the boundaries of the whole system; the agonies he goes through as he tries to establish the validity of the model. **This is good hypothetical-deductionist science, and it is good reductionism and holism.**"

~ M'pherson, P. K. "A Perspective on Systems Science and Systems Philosophy." *Futures* 6.3 (1974): 219-39.

A good Systems Thinker will use both!

Conclusion

- Why Systems Thinking?
  - Attacking problems from a Systems Perspective is a reaction to the ineffectiveness of Scientific Reductionism.
- Use both frameworks
  - Use all the tools from System Science and Traditional Science
- Systems Science is new and young – give it time

"[A] Shift of Mind [is going] from seeing parts to seeing wholes, from seeing people as helpless reactors to seeing them as active participants in shaping their reality, from reacting to the present to creating the future."

~ Senge, P.M. 1990, 2006. The Fifth Discipline: *The Art and Practice of the Learning Organization*. New York, Doubleday/Currency (p. 69)


Any Questions for the
SEScholar

Paul Martin, *ESEP, CTT+*

- **Manager Technical Training** for Northrop Grumman Corporation
- **Certificates**:
  - International Council on Systems Engineering (INCOSE) Expert Systems Engineering Professional (ESEP);
  - CompTIA Certified Classroom Trainer (CTT+),
- **Adjunct Professor in the UMBC** College of Engineering and Information Technology, Systems Engineering Graduate Programs
  - ENEE 663 -System Implementation, Integration, and Test
  - ENEE 667 - Advanced Systems Engineering Processes.
- Owner of **SE Scholar**, LLC – *a company dedicated to helping Systems Engineers get their INCOSE SEP certification. Our goal is to reach all Systems Engineers with affordable, high quality instruction no matter where they live and work!*

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Systems Engineering Explained

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