Zen and the Art of Systems Thinking
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”

“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.”

“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.”

Knowledge-about-Systems

• A “whole” consisting of interacting “parts.”

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

• 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.
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.
Boundaries

• Every system is delineated by its spatial and temporal boundaries, surrounded and influenced by its environment, described by its structure and purpose and expressed in its functioning.

• A distinction made by an observer which marks the difference between an entity he takes to be a system and its environment.

• Where do you set the boundaries? At what level?

~~ Wikipedia explanation of System

~~ Checkland, P. 1999. Systems Thinking, Systems Practice (page 312)
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
“The Brute ... That Shouted Love... At the Heart of the Atom.”

Incredible Hulk Vol 1 #140 (June 1971), Marvel Comics.
https://youtu.be/0fKBhvDjuy0
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

https://youtu.be/c0En-_BVbGc
“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

**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*

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**Classical Period**

384 – 322 BC

**ARISTOTLE**

~ 350BC

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Zen and the Art of Systems Thinking
The Triumph of Reductionism

How humans tried to understand the universe

"... 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
The Triumph of Reductionism

How humans tried to understand the universe

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

- **Heliocentric model of universe**
- **Father of empirical experimentation**
- **Rational methodology, reductionism**

**INDUSTRIAL REVOLUTION**

Technology allows world growth

- **1 Billion World Population in Billions**
- **7 Billion World Population in Billions**

1455 Gutenberg printing Press
1608 Telescope Invented
1665 First Scientific Journal
1768 – 1771 Encyclopedia Britannica
1791 US Bill of Rights
1842 Industrial Revolution
1861 Technology

Renaissance
Reformation
Modern Era
Industrial Revolution
WW I
WW II

SE Scholar
Systems Engineering Explained
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

Zen and the Art of Systems Thinking
The need for Systems understanding

How humans tried to understand the universe better


**General System Theory**


**Operational Research**


**Cybernetics**

1926 – Jan Smuts, *Holism and Evolution*


**Systems Thinking**


**Holons**


**System Dynamics**

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

**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."


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.”

Any Questions for the SE Scholar?
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  - 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!
References

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  • Newton, I. (1687) *Philosophiae naturalis principia mathematica* (Mathematical Principles of Natural Philosophy)
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