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Systems Thinking Applied to Higher Education Curricula Development

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Overview

INTRODUCTION

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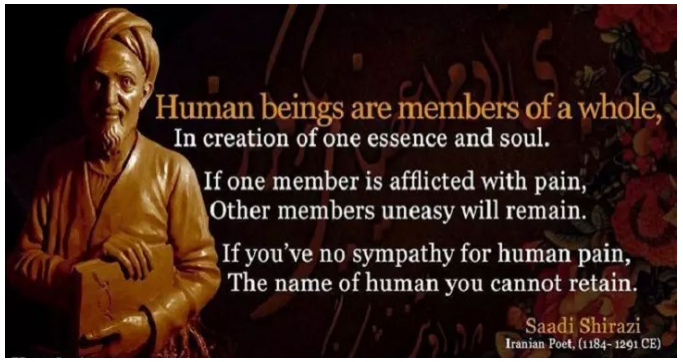
INTRODUCTION

"No man is an island entire of itself; every man is a piece of the continent, a part of the main"

Irish poet John Donne

"Human beings are members of a **whole**
In creation of one essence and soul
If one member is afflicted with pain
Other members uneasy will remain
If you have no sympathy for human pain
The name of human you cannot retain"



An Iranian Poet Saadi

Systems Thinking- What is it?

- Systems Thinking (ST) is a holistic approach to understanding and working with complexity in the real world.
- The fundamental aspect of System Thinking is to evaluate different behaviors of individual system elements in isolation and when they are integrated into a larger system and within a particular operating environment.
- ST evolved incrementally alongside specific “paradigm shifts”.
- These paradigm shifts demarcated discrete and substantive changes in systems science and system modeling capabilities.
- Some notable paradigm shifts include:
  - Reductionism to Holism, Linear to Nonlinear Dynamics, Static to Dynamic Systems, Piecemeal Solutions to Systemic Solutions, Linear Causality to Feedback Loops, etc.

Systems Thinking- What is it?

- The systems thinking traces its origin to the classical Greek philosophers.
- Pythagorean philosophical school believed that all matter is composed of four elements: earth, air, fire, and water
- Leucippus and Democritus taught that everything is reducible to discrete and indivisible Atomos.
- Later, Aristotle, in his Metaphysics, summarized the idea of holism in the statement that “the whole is more than the sum of its parts.”
- But Derek Cabrera, suggests the origin of the idea of systems thinking arose not from the ancient Greek philosophers but from Lao Tzu in the Tao Te Ching around 2600 years ago

Systems Thinking- What is it?

Assertion from the ancient world:

- The preceding thinkers asserted that:
  - The fundamental elements possess unique attributes in **themselves**
  - But when these elements are placed in **combination and integrated** with other elements,
    - The original individual elements lose some of their unique characteristics
- Thus, they each held to a nascent form of systems thinking in which the attributes and characteristics of lower-level elements change as they integrate into high-level and more complex entities.

The whole is more than the sum of its parts.

Systems Thinking- What is it?

Back to the modern time:

- In 1637, René Descartes introduced the idea of reductionism in Part V of his “Discourses on Method”.
- Descartes asserted that the world was like a **machine**, whose pieces could be taken apart and put back together in order to understand its underlying mechanisms and its larger picture.
  - Reductionism, in a philosophical context, is a theory that asserts that the entities or phenomena is reduced to the entities of sums of simpler or more fundamental things.
  - Reductionism focused on breaking down systems into their constituent parts for understanding.
  - Reductionism, or reductionist theory, is the idea that complicated behaviors and phenomena can be better explained by “reducing” them into small, simple pieces.
  - In the 1940s and 1950s, the reductionism idea dominated the traditional scientific method – **The machine age**

René Descartes, (born March 31, 1596, La Haye, Touraine, France—died February 11, 1650, Stockholm, Sweden),

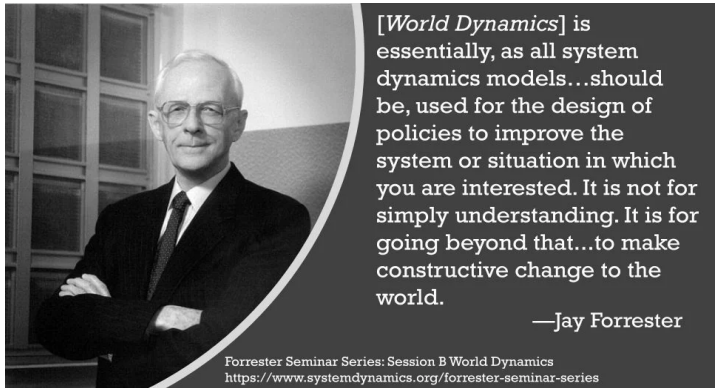
Verywell / Emily Roberts

Reductionism = Individual parts summing up the whole.

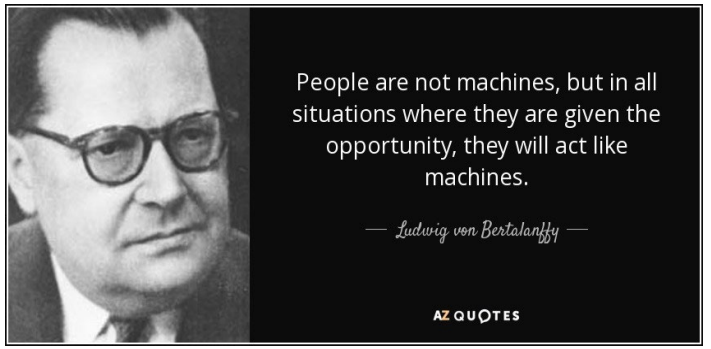
Systems Thinking- What is it?

Back to the modern time:

- Modern systems thinking formed in 1956 when Professor Jay Forrester founded the Systems Dynamic Group at MIT's Sloan School of Management.
- Current systems thinking was later formulated by Von Bertalanffy who in 1968 introduced the contemporary concept of system theory.
- More advanced understanding and application of systems thinking has since emerged as a multidisciplinary reaction to previous versions of reductionistic theory.
- Consequently, Systems thinking now used across different domains and disciplines including social sciences, engineering, management, organizational leadership, education, computer science and medicine.



July 14, 1918 – November 16, 2016



Karl Ludwig von Bertalanffy (19 September 1901 – 12 June 1972) was an Austrian biologist known as one of the founders of general systems theory (GST).

Both approaches have their merits and can be applied depending on the context and objectives of the analysis.

Systems Thinking- What is it?

The higher education systems

- The higher education environment consists of multiple systems with functions including teachers, learners, administrators, digital content, and learning goals/outcomes.
- The inherent complexity and interaction among these various educational system elements and functions makes this system a worthy candidate for consideration within a ST context.
- ST suggests a fruitful application in the curricula development aspects of the higher education system.
  - It focus on improving curricula flexibility and student outcomes,
  - It allows educators and administrators to see the interconnections and interdependencies between various elements of the system and their impact on each others

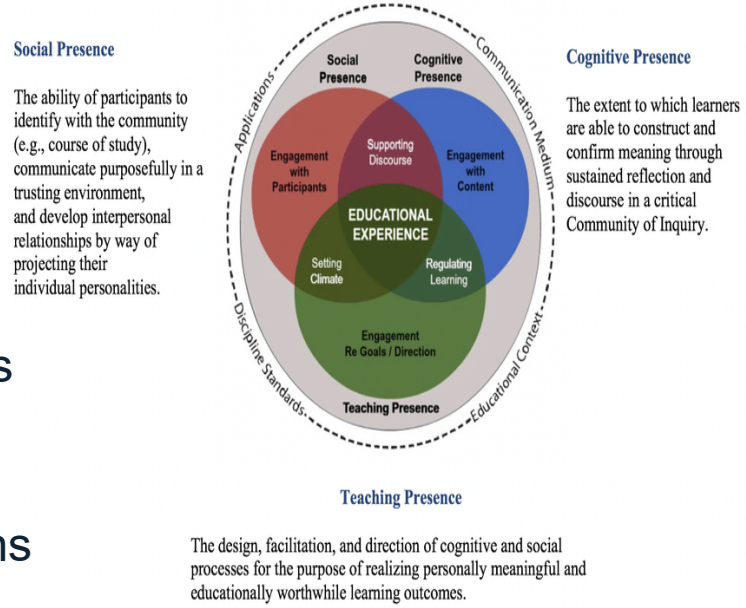


Figure - uploaded by Sarah Gauvreau

In this paper we contribute to the application of ST in the higher education system by a review of ST principles and their application to higher education curricula development

CURRENT LIMITATIONS IN HIGHER EDUCATION

The History

- The history of education is well rooted into the earliest forms of human socialization.
- Education emphasized the **transmission** of culture, values, and accumulated knowledge of a society.
- For thousands of years, education was performed in nonformal and informal means via:
- Both one-on-one student-tutor arrangements (especially among elites and the higher classes in each society)
- And teacher-students relationship (e.g., Plato's Academy, Aristotle's Lyceum, Islamic Madrasa).
- The current western educational system paradigm has its root in the comprehensive school system reform pioneered by Wolfgang Ratke and John Amos.
- It is heavily influenced by the mid-19th century Prussian educational structure (a model of mandatory education).

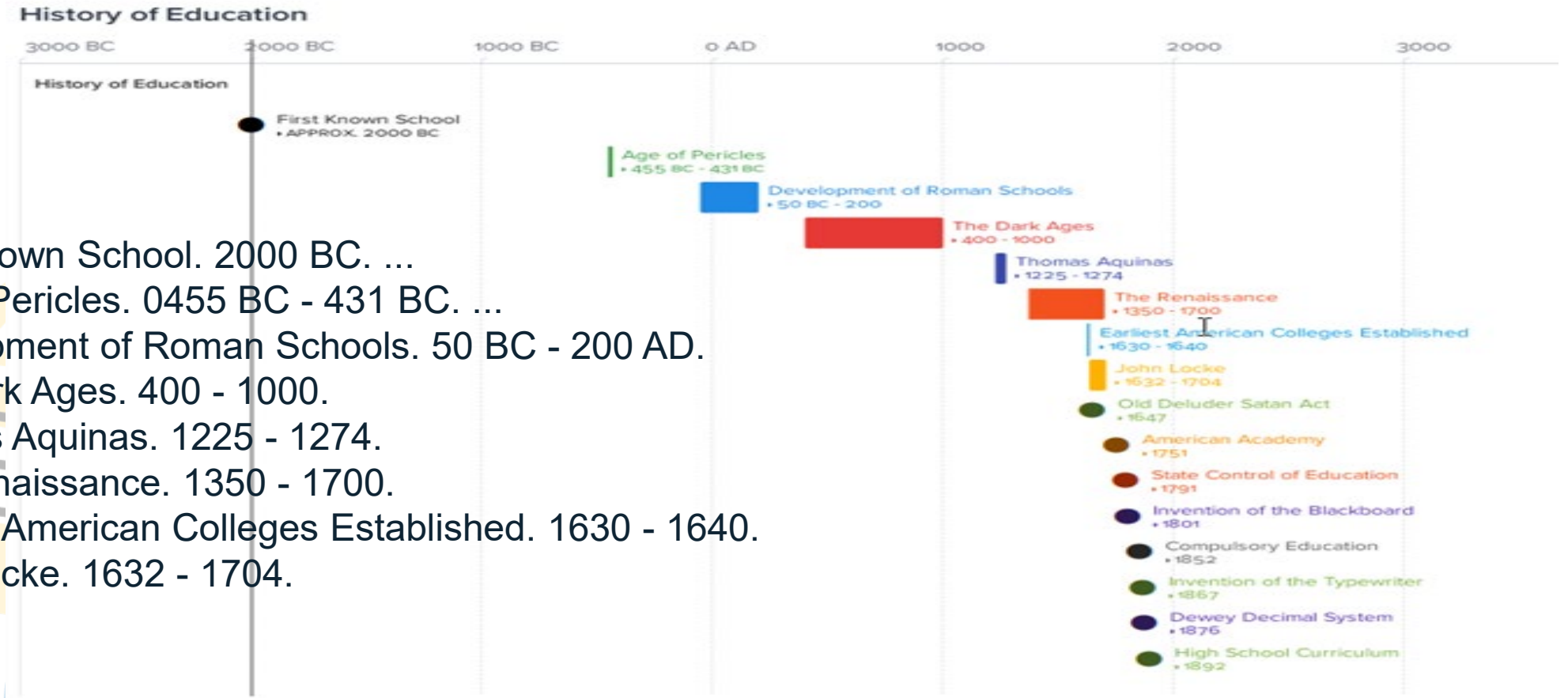
Plato's Academy (Akadimia Platonos)

Walking Around the Lyceum

Madrasah Muslim educational institution

CURRENT LIMITATIONS IN HIGHER EDUCATION

The History



- First Known School. 2000 BC. ...
- Age of Pericles. 0455 BC - 431 BC. ...
- Development of Roman Schools. 50 BC - 200 AD.
- The Dark Ages. 400 - 1000.
- Thomas Aquinas. 1225 - 1274.
- The Renaissance. 1350 - 1700.
- Earliest American Colleges Established. 1630 - 1640.
- John Locke. 1632 - 1704.

CURRENT LIMITATIONS IN HIGHER EDUCATION

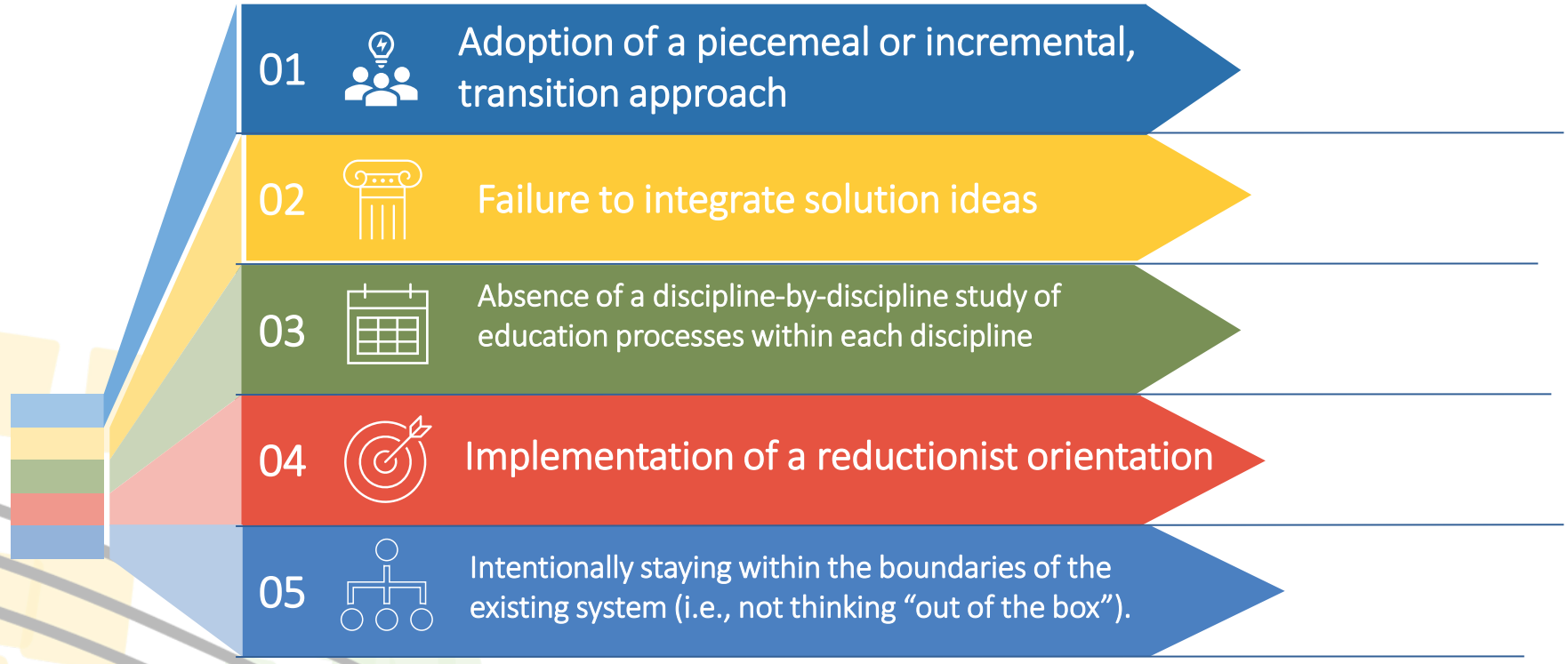
- The contemporary educational environment presents novel concerns not readily addressed by historical educational methodology.
- According to **World Economic Forum**, the four biggest challenges faced by the current higher education system are:

1. Increasing need for lifelong learning in a nonlinear world
2. Evolving needs and expectations of the "student-consumer",
3. Towards a "skills over degrees" model preference among younger generations as well as some employment field
4. Emerging technologies and business models, and

CURRENT LIMITATIONS IN HIGHER EDUCATION

❖ Banathy suggested five reasons for the failure of current approaches:

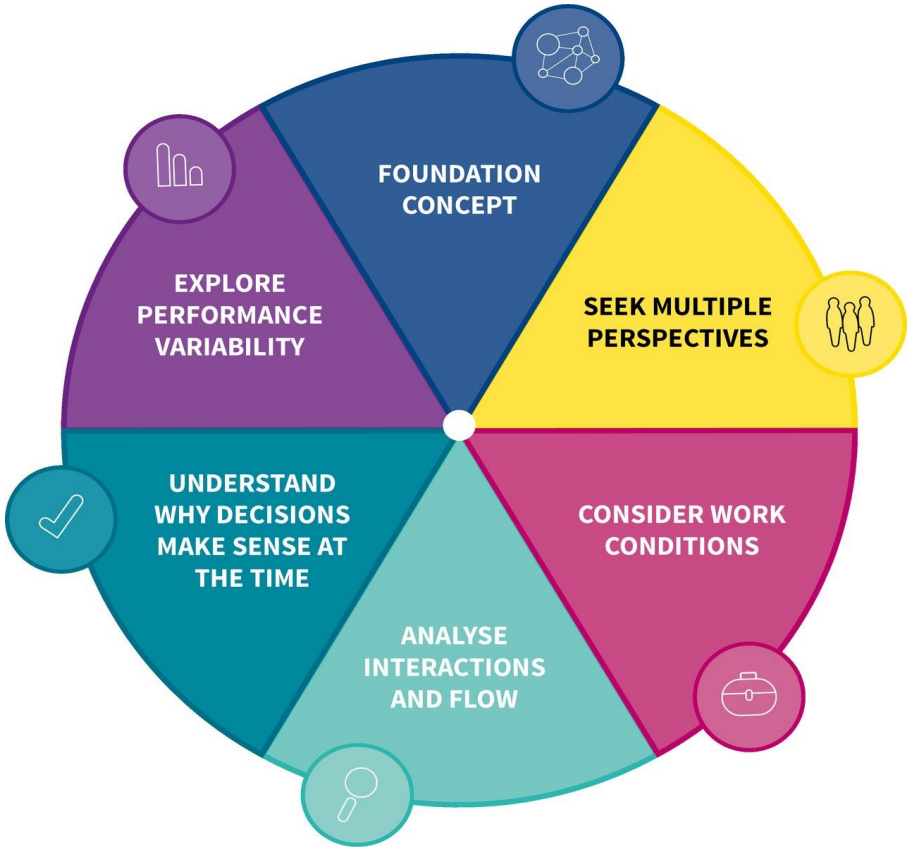
Reasons for the failure of current approaches



❖ In short, modern educational systems improperly emphasize the "parts" of the educational system instead of seeing the system from a "whole" perspective

SYSTEMS THINKING PRINCIPLES

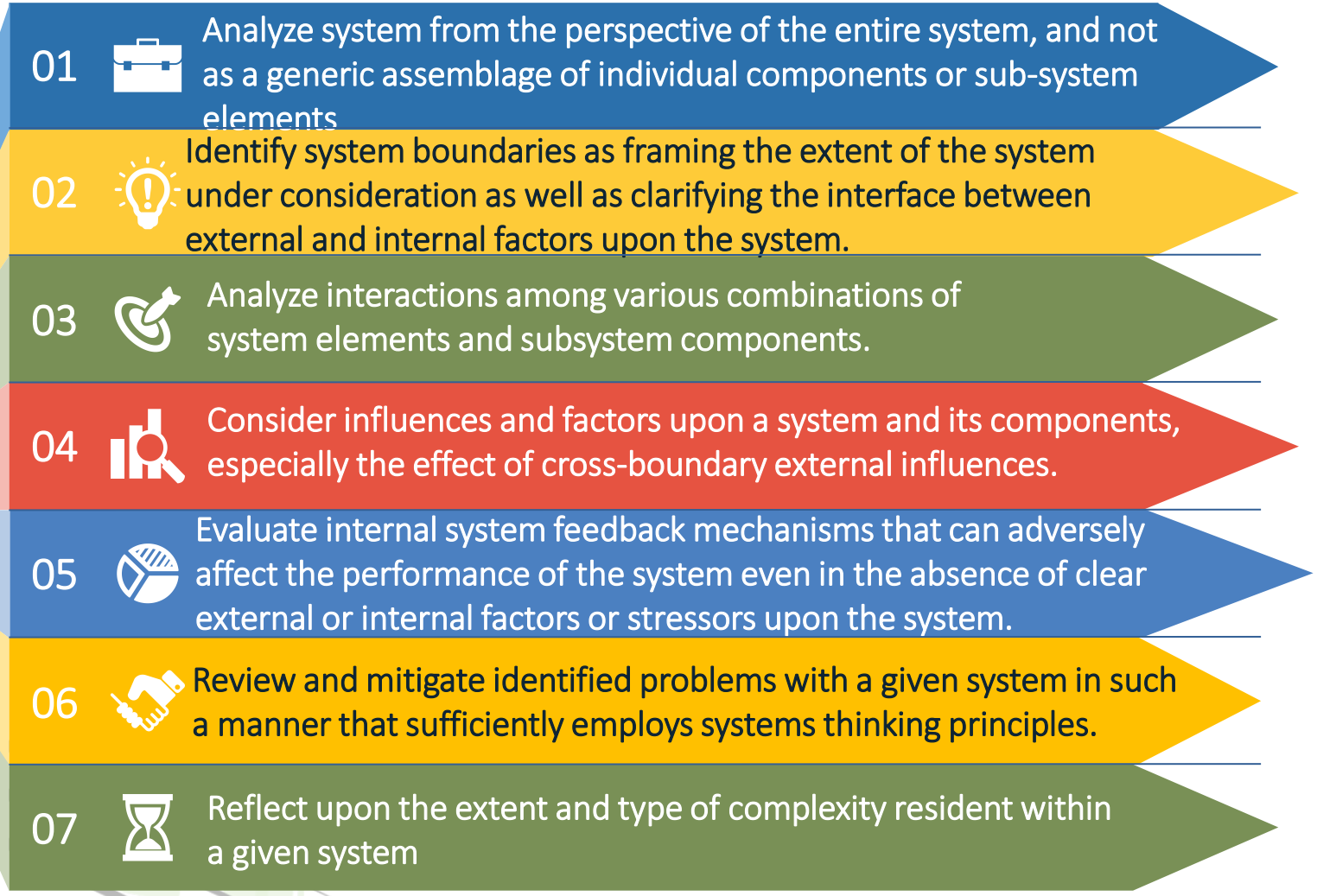
- Systems Thinking requires viewing a system as a whole rather than focusing on individual components or events.
- A whole is a web of interconnections that creates emerging patterns. Peter Senge
- An effective Systems thinking involves multi-perspective, participatory, and iterative approach.
- A systemic approach facilitate a suitable environment for creative policy and good decision making.



Development and application of 'systems thinking' principles for quality improvement, Duncan McNab, John McKay, Steven Shorrock, Sarah Luty, and Paul Bowie

SYSTEMS THINKING PRINCIPLES

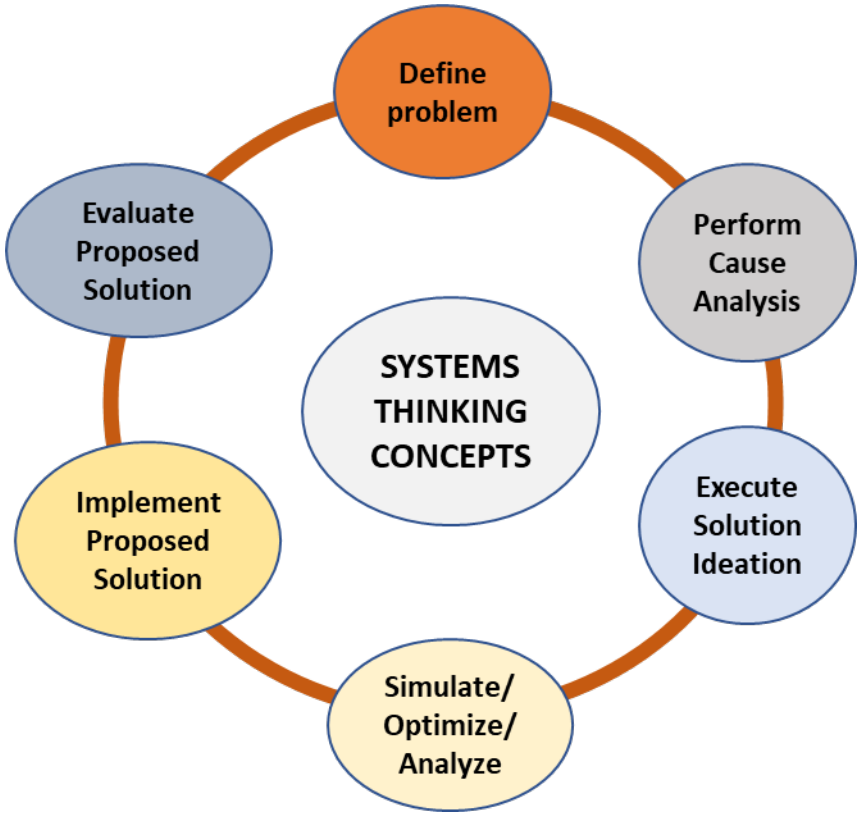
- Systems thinking covers a broad swath of concepts.
- Here are seven commonly accepted principles of systems thinking :



These principles may be fruitfully employed in a variety of systems including healthcare, human behavior, as well as more complex formally engineered systems

SYSTEMS THINKING PRINCIPLES

- A central focus of systems thinking is understanding the attributes of a **complete system** as related to the combined attributes of the component elements.
- We can leverage the insights from Cuff & Forstag to develop a process to evaluate issues within curricula development as shown in this Figure



LITERATURE REVIEW of SYSTEMS THINKING APPLICATIONS

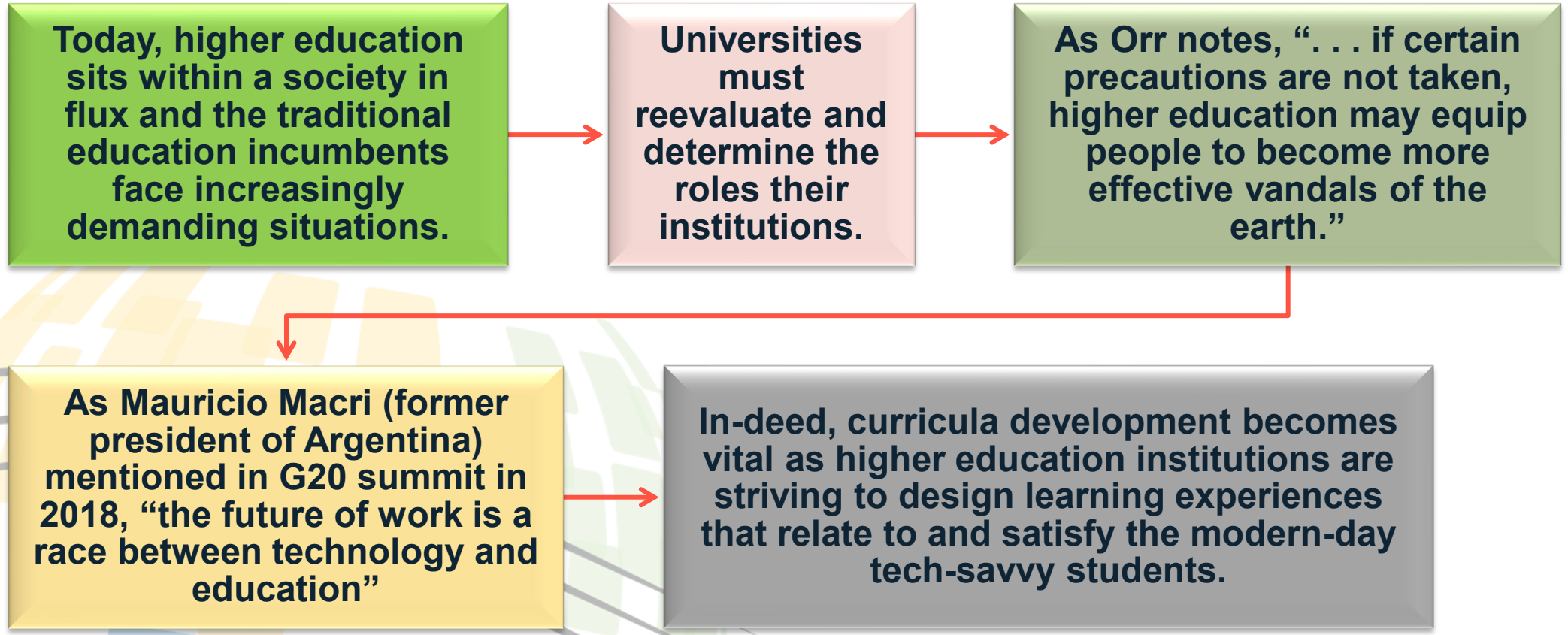
ST allow us to see how things interrelate with others, and better analyze and understand complex system behaviors.

ST applications span across different domains such as social science, mining industry, aviation systems, energy power systems, and curriculum design.

In additional ST has been recently employed in numerous areas within health organization, business and manufacturing, banking system, human performance, supply chain management, civil engineering applications, and project management.

Nevertheless, the use of ST principles within the field of higher education curricula development is very limited

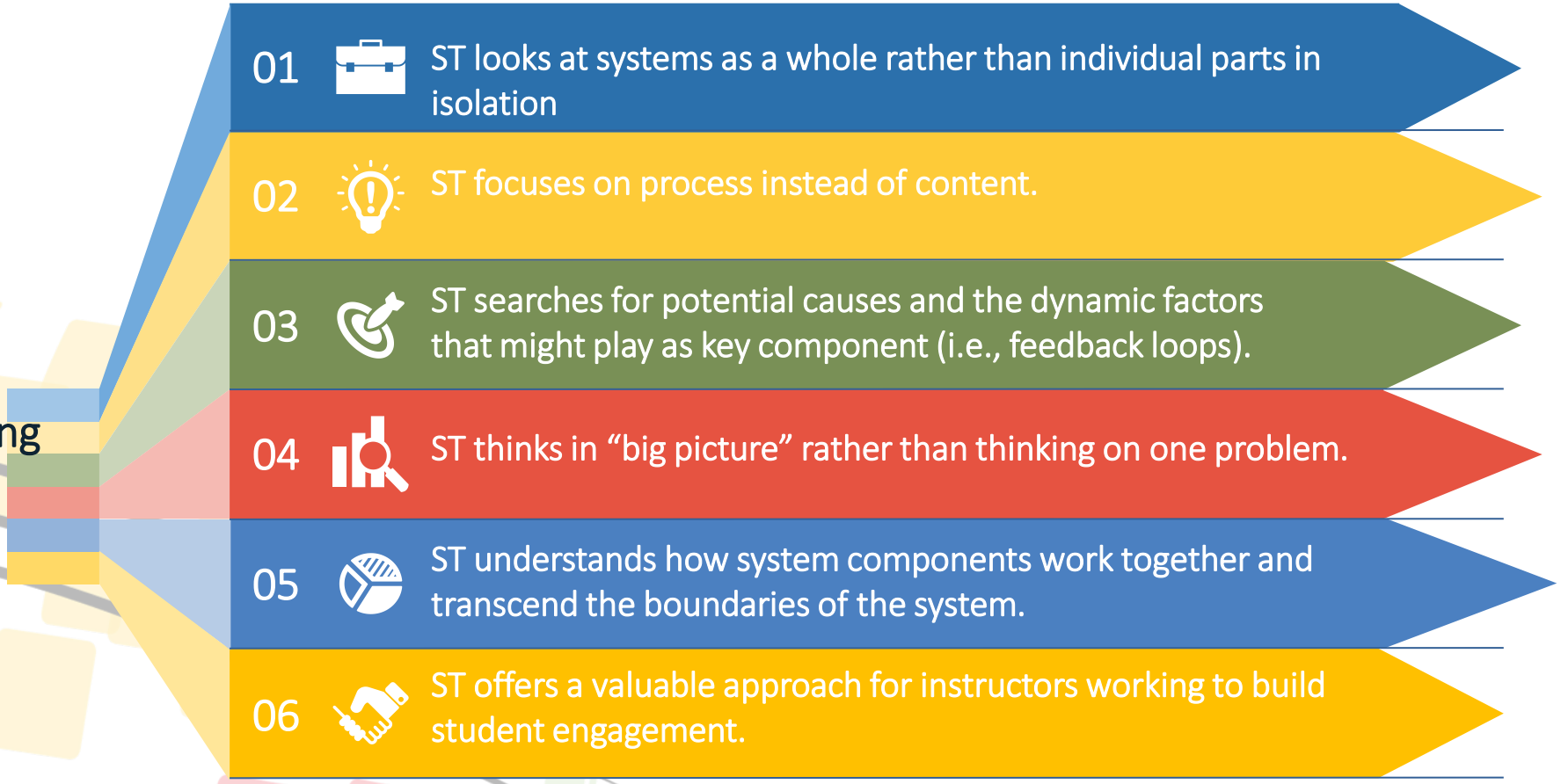
LITERATURE REVIEW of SYSTEMS THINKING APPLICATIONS



ST APPLICATIONS IN HIGHER EDUCATION

- Systems thinking approach produces an ability to see the whole beyond the parts and seeing the parts in the context of the whole.

- some specific reasons to incorporate systems thinking into higher education are:



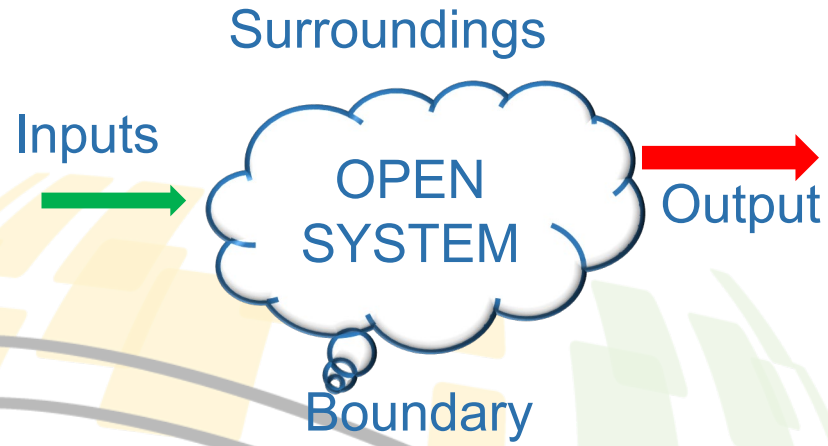
ST APPLICATIONS IN HIGHER EDUCATION

- Systems thinking approach is an ability to see the whole beyond the parts and seeing the parts in the context of the whole

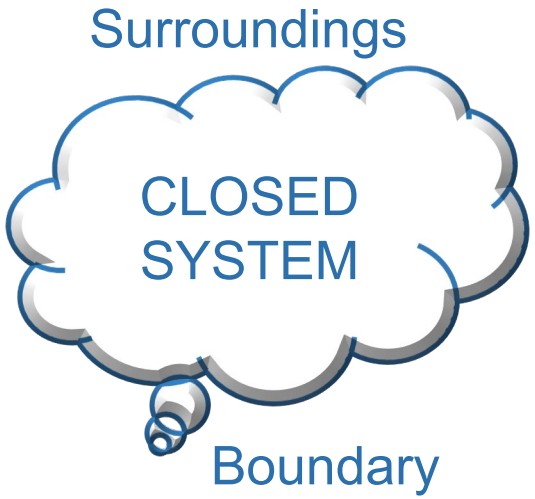
- some specific reasons to incorporate systems thinking into higher education are:

ST APPLICATIONS IN HIGHER EDUCATION

- Higher education institutions as a system



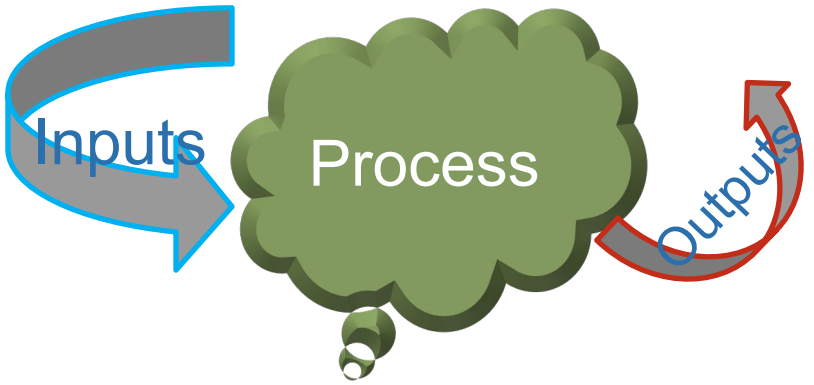
- Interacts with the surrounding environment
- Material may enter or leave and
- Therefore, a change in its components takes place continuously



- Material does not exchange with its surrounding

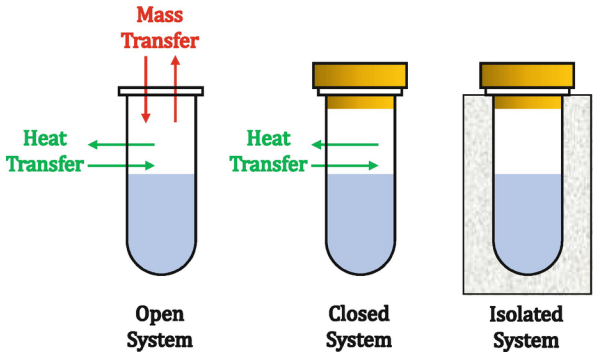
ST APPLICATIONS IN HIGHER EDUCATION

- **Dissanayake** described higher education institutions as an open system that consists of:
  - Inputs needed to run the education institution,
  - Outputs, and
  - Process to convert inputs into outputs
- The open system interacts with the surrounding environment through varied factors that impact higher education institutions.
- Specific key elements include social factors, technological factors, economic factors, and political factors, legal and ethical factors.



ST APPLICATIONS IN HIGHER EDUCATION

- **Von Bertalanffy**, one of the pioneers of systems thinking, distinguished between closed systems and open systems;
  - Closed systems are self-contained and do not interact with their environment
  - Open systems exchange matter, energy, and information with their surroundings, allowing for a continuous flow of inputs and outputs.
  - Many real-world systems are open and cannot be fully understood by focusing solely on their internal workings

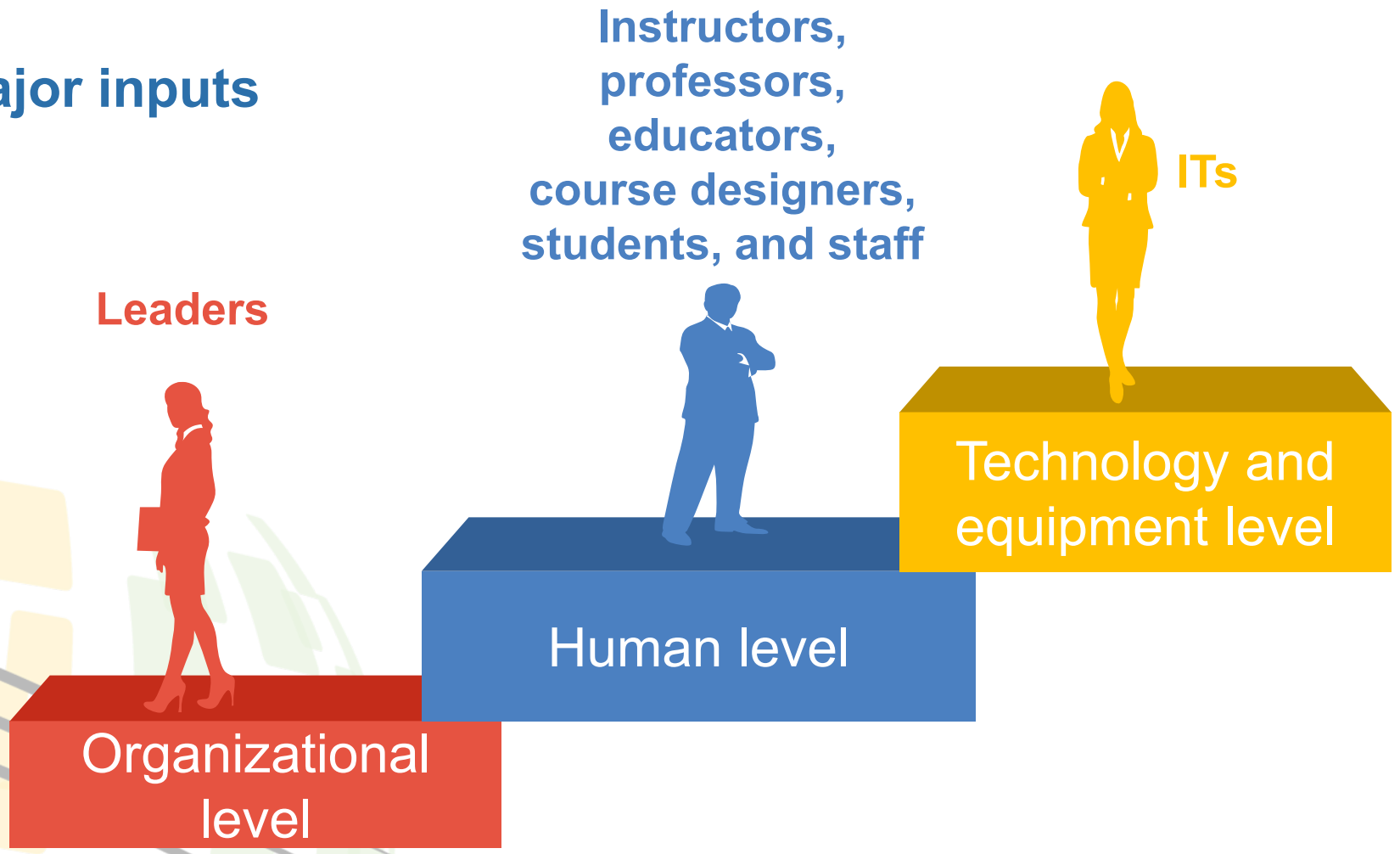


ST APPLICATIONS IN HIGHER EDUCATION

- **Higher education systems constantly interact with their environments;**
- **Curricula development is part of the education open system, which also shares the same inputs of the higher education system.**
- **Developing curriculum in the higher education system is complex and comprises key relationships among different elements in order to achieve learning outcomes**

ST APPLICATIONS IN HIGHER EDUCATION

- **Levels of the major inputs**



- **The major inputs needed to develop curricula are at the organizational level, human level, and technology and equipment level.**

There is a strong link between student achievement and associated educational system

ST APPLICATIONS IN HIGHER EDUCATION

Role of leadership

- During the course development, an effective leader should be able to identify the area of improvement; provide support to this course; motivate a further development;
- Leaders should promote partnership aligning support and resources and adapt to changing context in the process;
- Leaders ensure coordination and integration of service across campus, faculty, staff, and administrators.

ST APPLICATIONS IN HIGHER EDUCATION

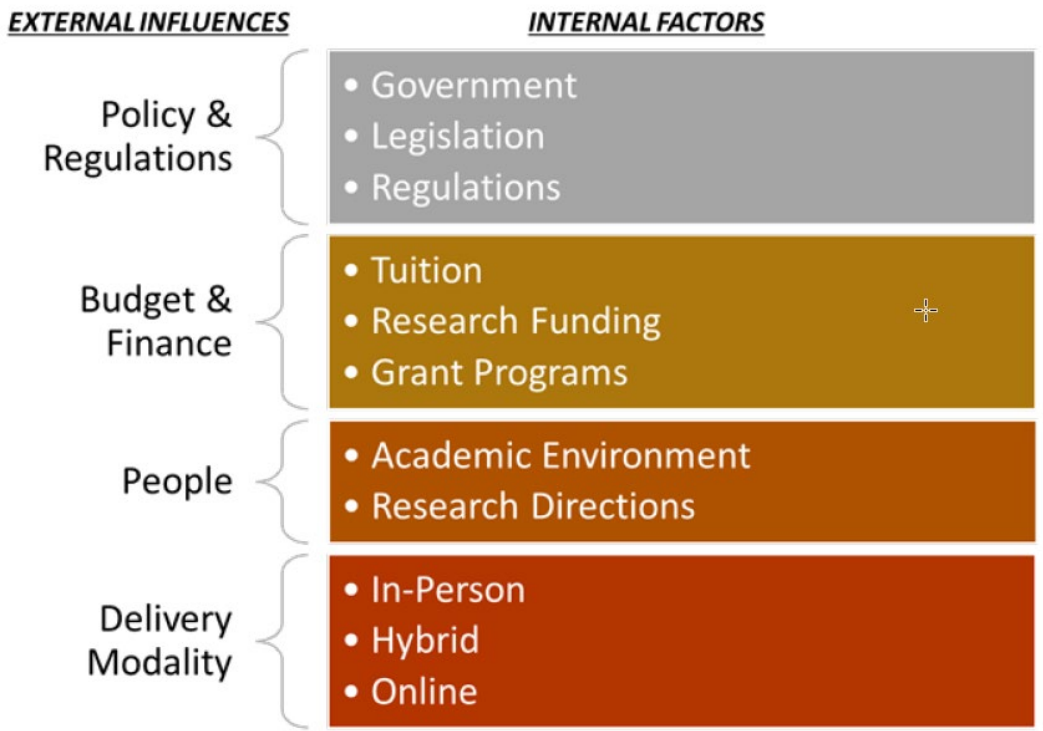
Role of leadership

- **Shukla** stated that educational leaders must comprise three valuable practices of systems thinking:
  1. Identify appropriate stakeholders and uncover values of group,
  2. Design framework for change and model feedback loops, and
  3. Engage all stakeholders and promote coordination of network align support and resources.

Besides leaders, instructors/professors/educators, and/or course designers should also be able to apply systems thinking to see a big picture during the curriculum development

ST APPLICATIONS IN HIGHER EDUCATION

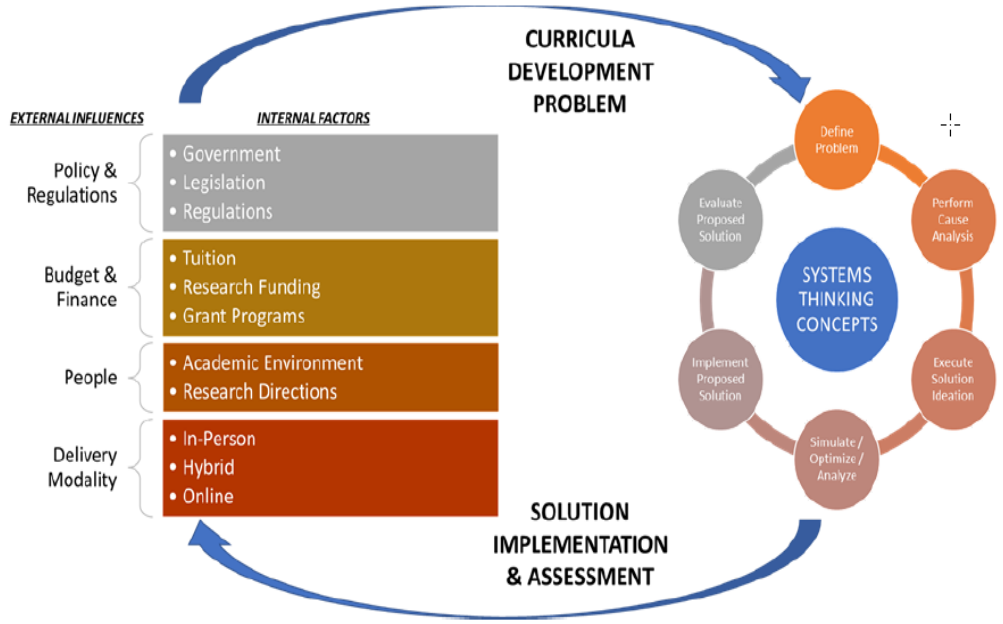
- **External influences and internal factors**



- Figure left shows a representative set of external influences and internal factors that can impact the curriculum development process.
- The consideration of these influences and factors forms the basis of treating education curriculum development as a complex system.

APPROACH TO APPLY SYSTEMS THINKING

- **Higher education curriculum development system**

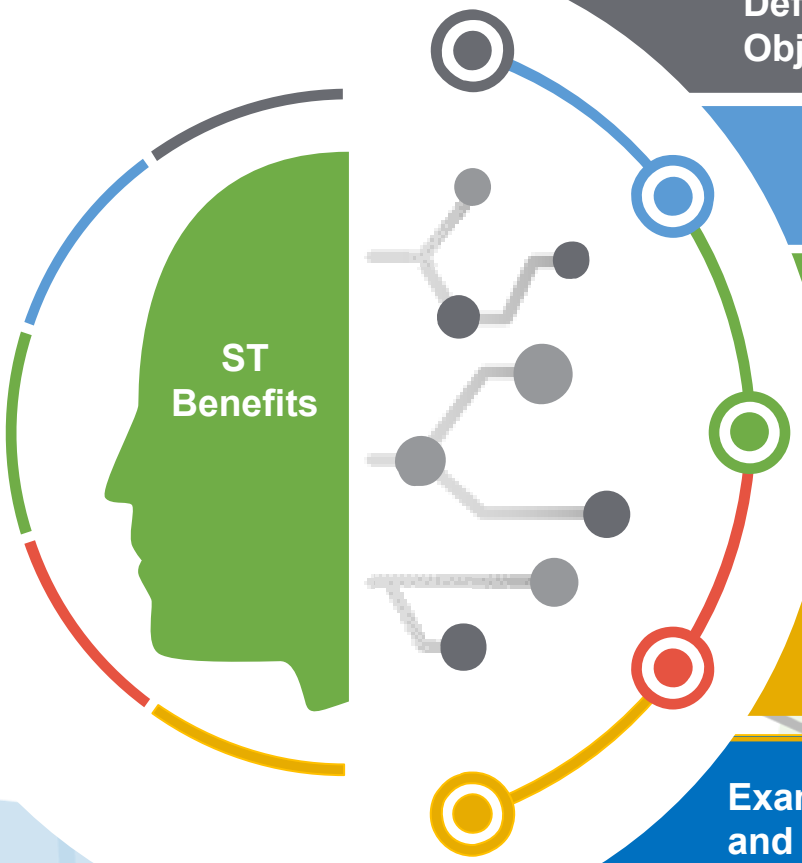


Iterative evaluation process of higher education with systems thinking principles

- Figure left is a representative example of a complex yet holistic higher education curriculum development system.
  - It addresses external factors and internal influences
  - Also provides for problem identification and an iterative process for evaluating such problems and implementing solutions within the broader scope of the system boundaries

BENEFITS OF APPLYING ST IN HIGHER EDUCATION

- Through collaborative teaching and interdisciplinary curriculum students will be able to see how fields of study demonstrate inter-connectedness and inter-dependence



Define Goals and Objectives?	Identifying the goals and objectives should be the first step in developing a curriculum..
Support Student Learning Outcomes	The systems thinking approach facilitates curriculum mapping across all the learning environments
Integrate and Interconnect	Consider different courses, topics, and skills that fit together for the creation of cohesive learning outcomes.
Implement Feedback Loop	The feedback loops have a significant impact on a curriculum's performance.
Forecast Long Term Prospective	The consideration of long-term impact of decisions is an essential part of ST.
Examine Larger Societal and Cultural Context	Intentional consideration and evaluation of the context in which the educational system operates will foster curricula design changes to satisfy the needs of students, stakeholders, and society as a whole.

FUTURE DEVELOPMENT

- A use case development: Appling ST principles in the development of the systems engineering curricula within Embry Riddle Aeronautical University
- Embry Riddle Aeronautical University –ERAU- as a complex System

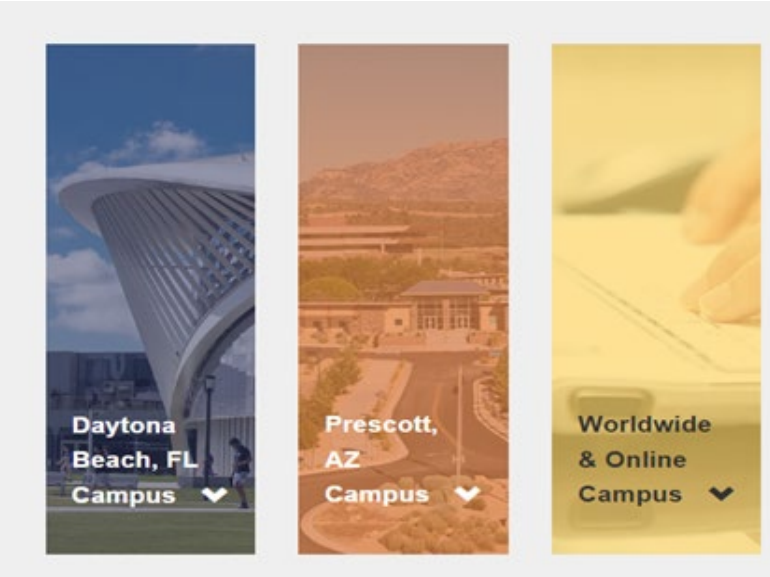
- Daytona Beach, Florida
- Prescott, Arizona
- Worldwide/Online
- Asia

- Applied Science
- Aviation
- Business
- Computer and Technology
- Engineering
- Security, Intelligence, and safety
- Space

FUTURE DEVELOPMENT

Overview

- Expand literature review
- Systems complexity
- External influences and internal factors
- Online VS in person classrooms
- Development of experiential use case to demonstrate ST principles in practice



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