INDUSTRIAL ENGINEERING

Lesson 2
System: The Focal Point of IE

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Synopsis

This chapter briefs the system theory, components of system, and types of system. At the end of this chapter, system thinking theory will also be discussed.

Expected Outcome

1. Understand the focal point of Industrial Engineering discipline.
2. Describe components of system.
3. Explain types of system.
4. Understand the concepts constituting the system theory.
5. Apply system thinking in problem solving and decision making to improve production system.

What is the focal point of IE?

System

Combinations of elements which interact one another (directly or indirectly) to achieve some goals.

Components of a System

Elements

Individual components that collectively make up the system

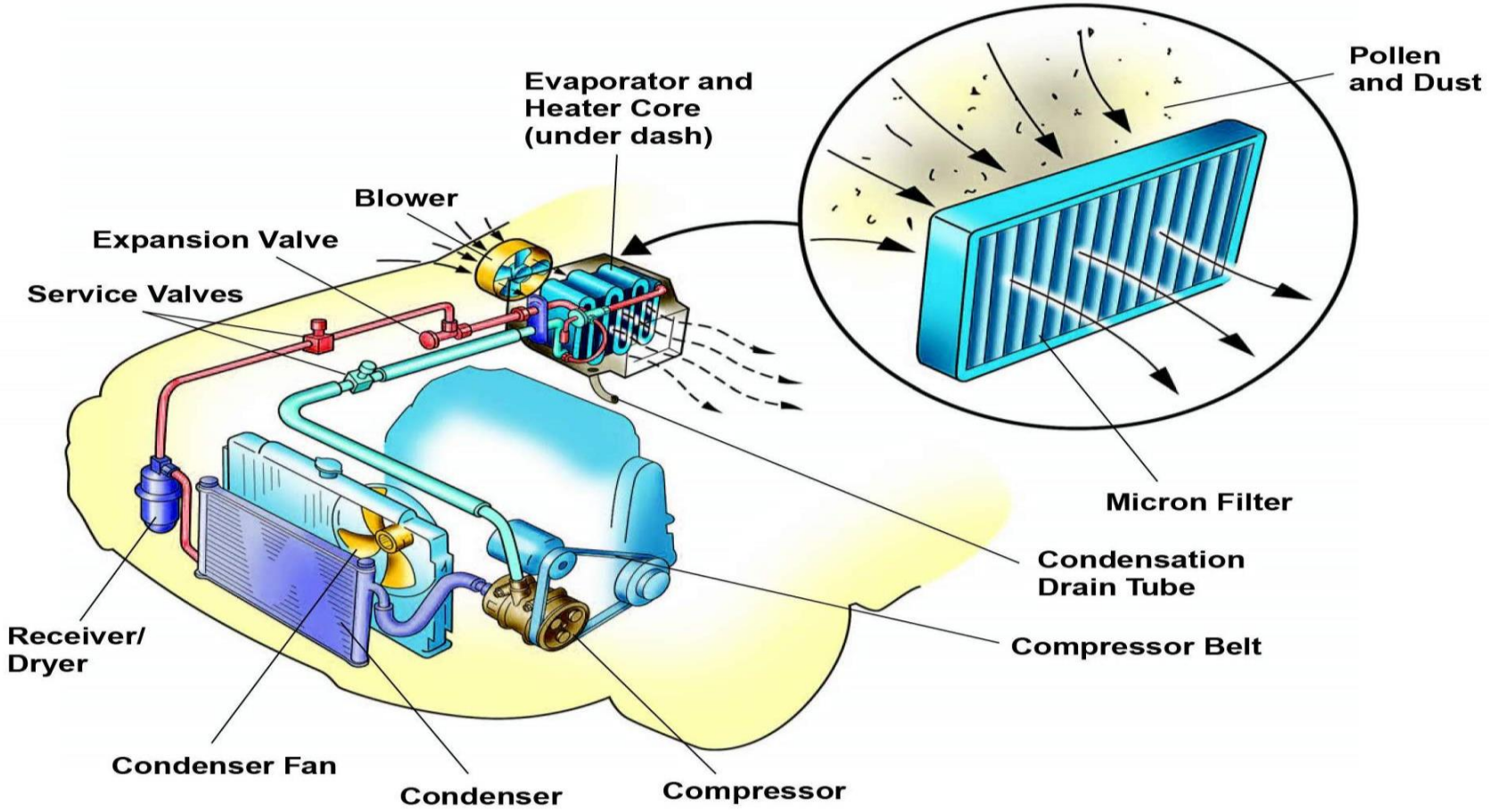
Interaction

Relationship among the elements

Purpose

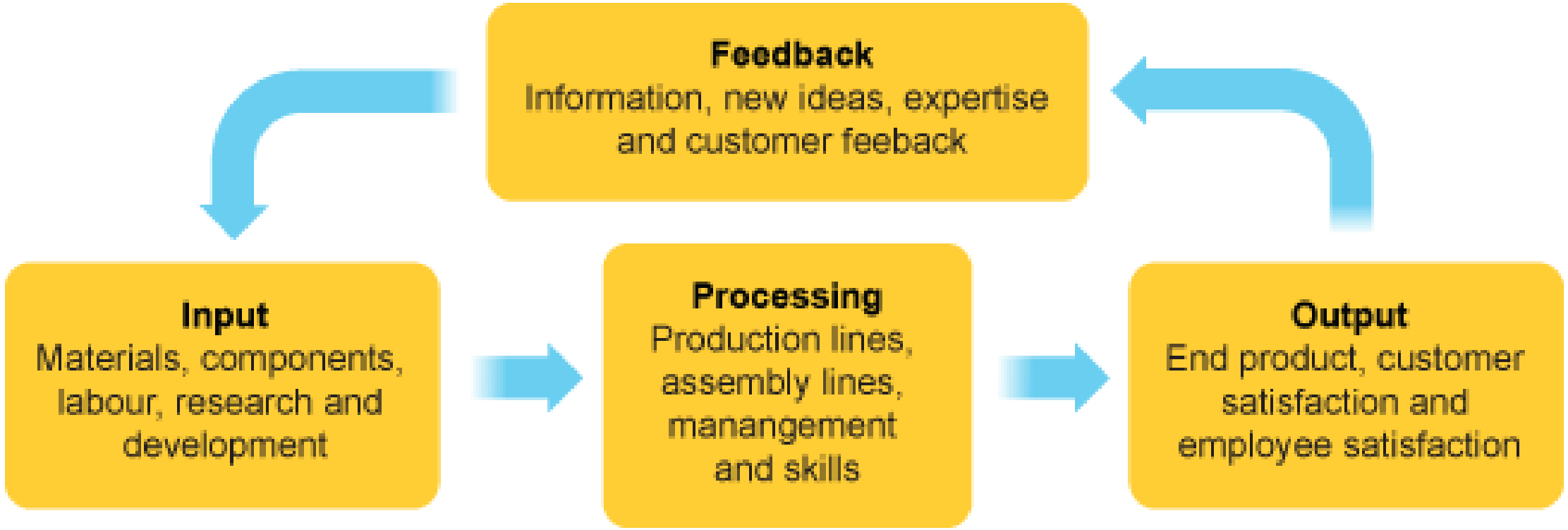
The desired state or outcome, which the system is attempting to achieve

Example (1): Air conditioning system



Source: http://www.andersonclark.co.uk/

Example (2): Production system



Source: http://www.bbc.co.uk

Other examples of system

- Production system of a factory
- Information system of a business firm
- Computer system of an airlines company
- Circulatory system of the human body
- Nervous system of the human body

Types of System

Natural system
Exists as a result of natural processes

Man-made system
Something that was created by humans

Static system
Has structure but no related activity

Dynamic system
Involves time-varying behavior

Physical system
Involves physically existing components

Abstract system
Symbols represent the system components

Open system
Interacts with its environment

Closed system
Isolated from its environment

Open-loop vs Closed-loop System

Open-loop system

Closed-loop system

Open-loop vs Closed-loop System

Open-loop system

Characteristics:

✓Past action has no influence on future action.

✓No own-control mechanism.

✓Output = f (input), but Input ≠ f (output).

Examples:

- Toaster-doesn't know whether it burned the toast
- Watch-not self-correcting
- Auto without driver

Open-loop vs Closed-loop System

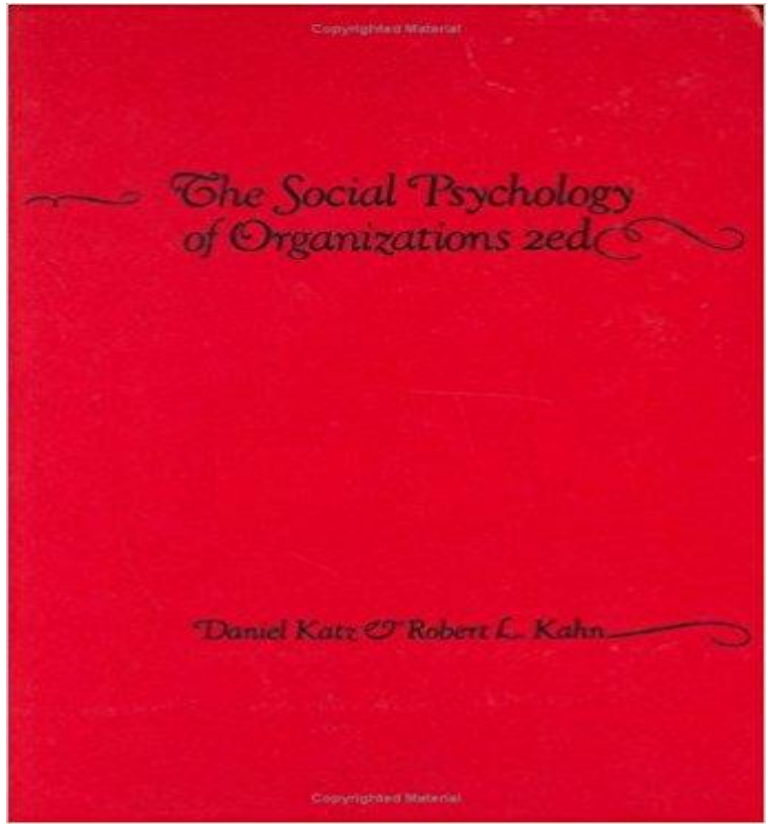
Closed-loop system

Characteristics:

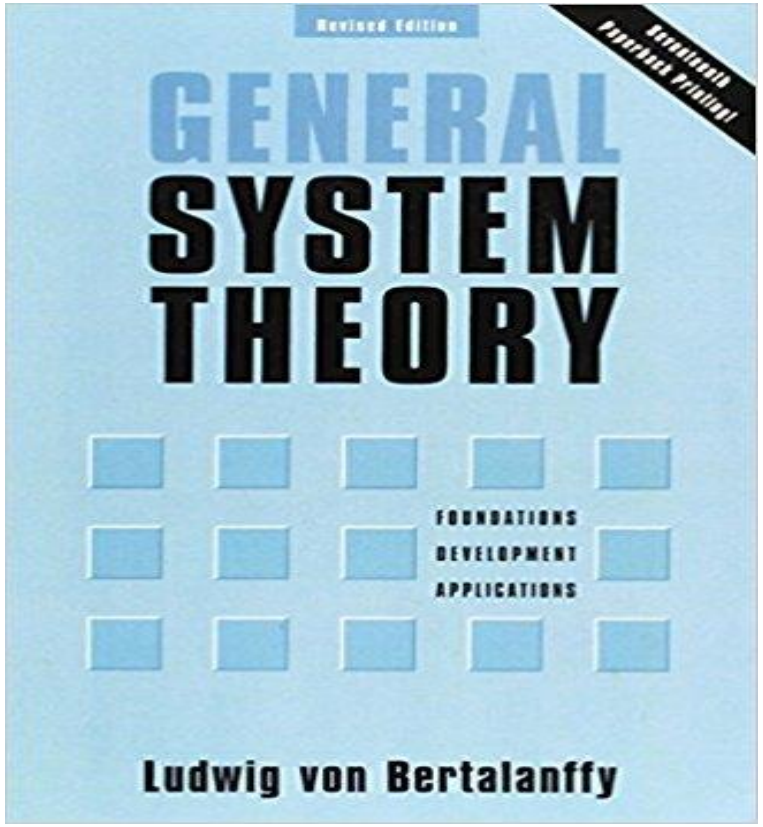
- ✓Results of past action influence future action.
- ✓Senses its performance & automatically makes adjustment.
- ✓Output = f (input), and Input = f (output).

Examples:

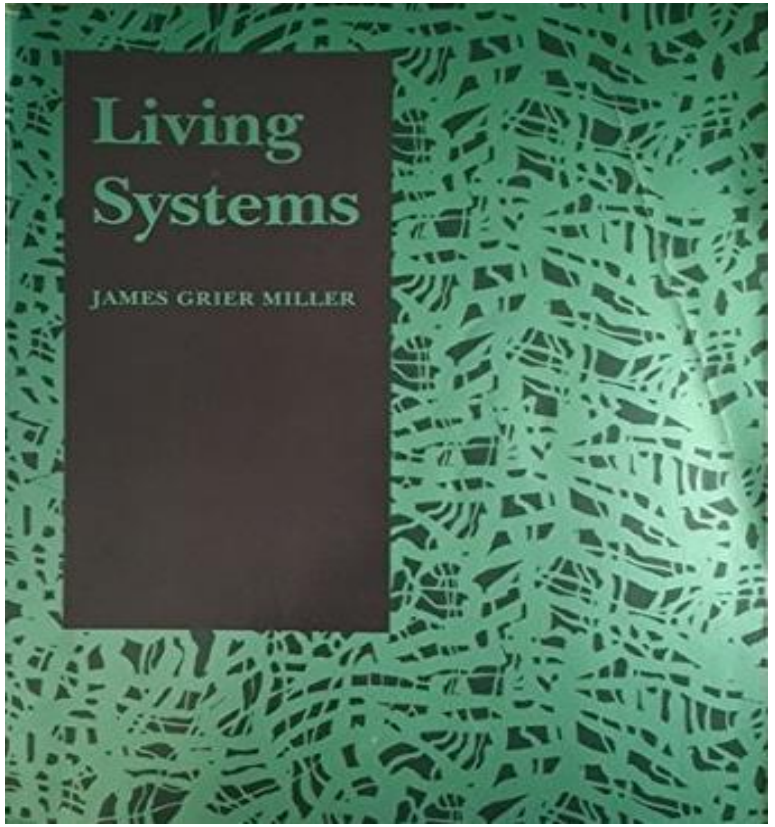
- Toaster & operator-adjust the desired darkness
- Watch & owner-adjust time to standard
- Auto with driver



Source: http://home.isr.umich.edu



Source: https://www.amazon.com



Source: https://www.amazon.ca

Katz & Kahn (1966), von Bertalanffy (1968) & Miller (1971) established

the foundation of System Theory

System as an alternative perspective

Classical management approach

Dominated by a view of organizations as machines

Goal:
Wanted efficiency, productivity, & control

Focus:
one right way

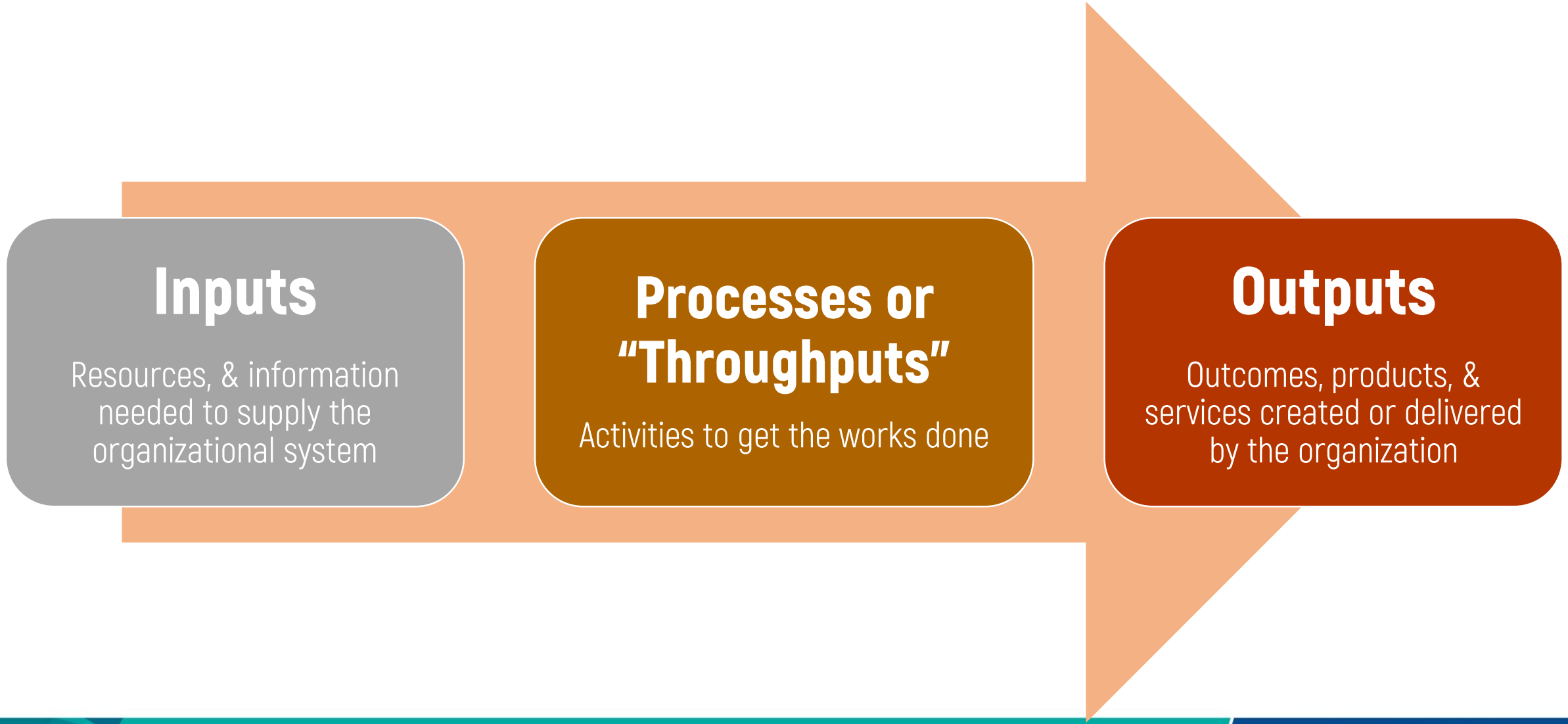
A system approach

Looks at the whole organism

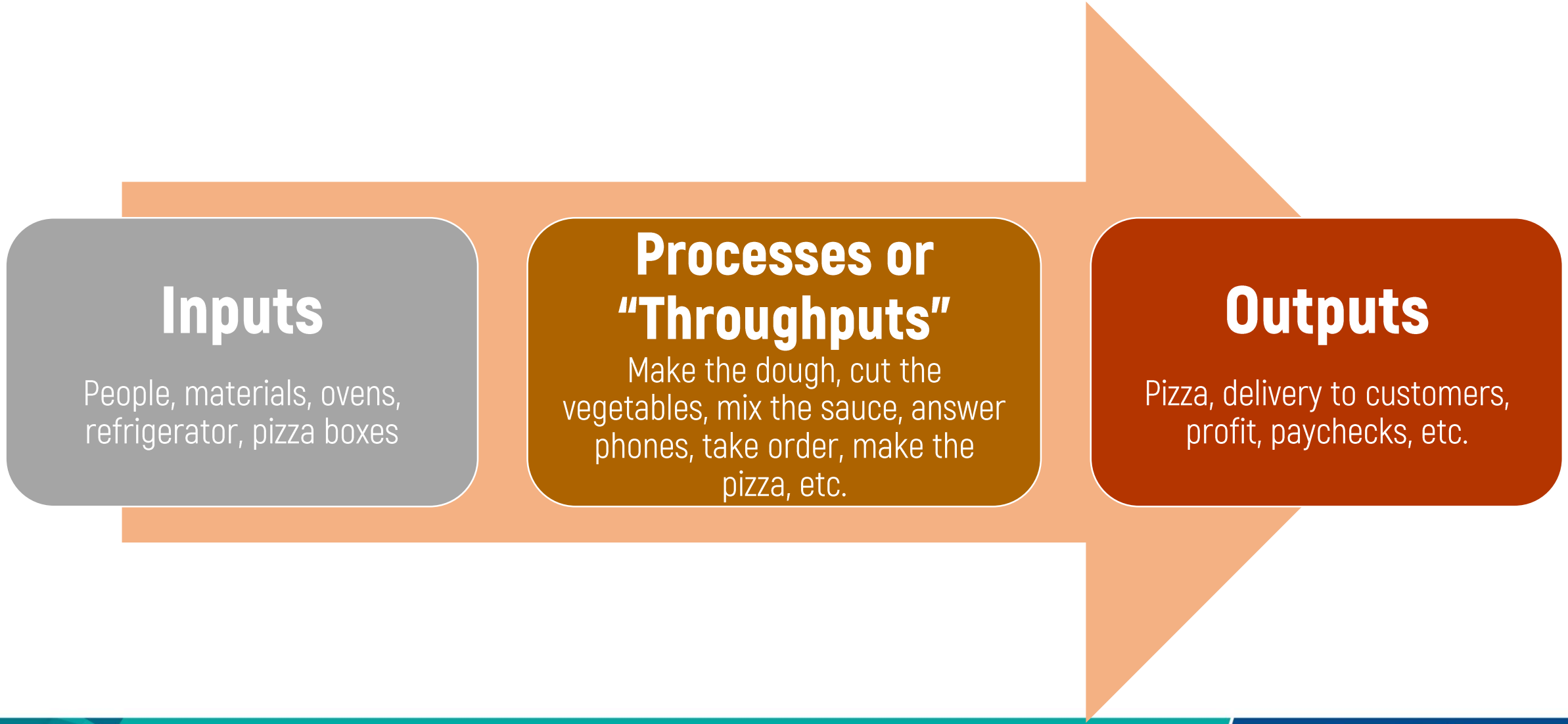
Goal:
Describe and explain how organizations work

Focus:
Multiple ways to accomplish various goals

Organizational System



Organizational System



Organization is an Open System

It is open to its environment

Exchange with environment is essential for the health of the system.

Holism

A system should be viewed as a whole, not as collection of separate pieces.

A system is greater than the sum of the parts.

Those parts are interdependent & interact through mutual feedback processes.

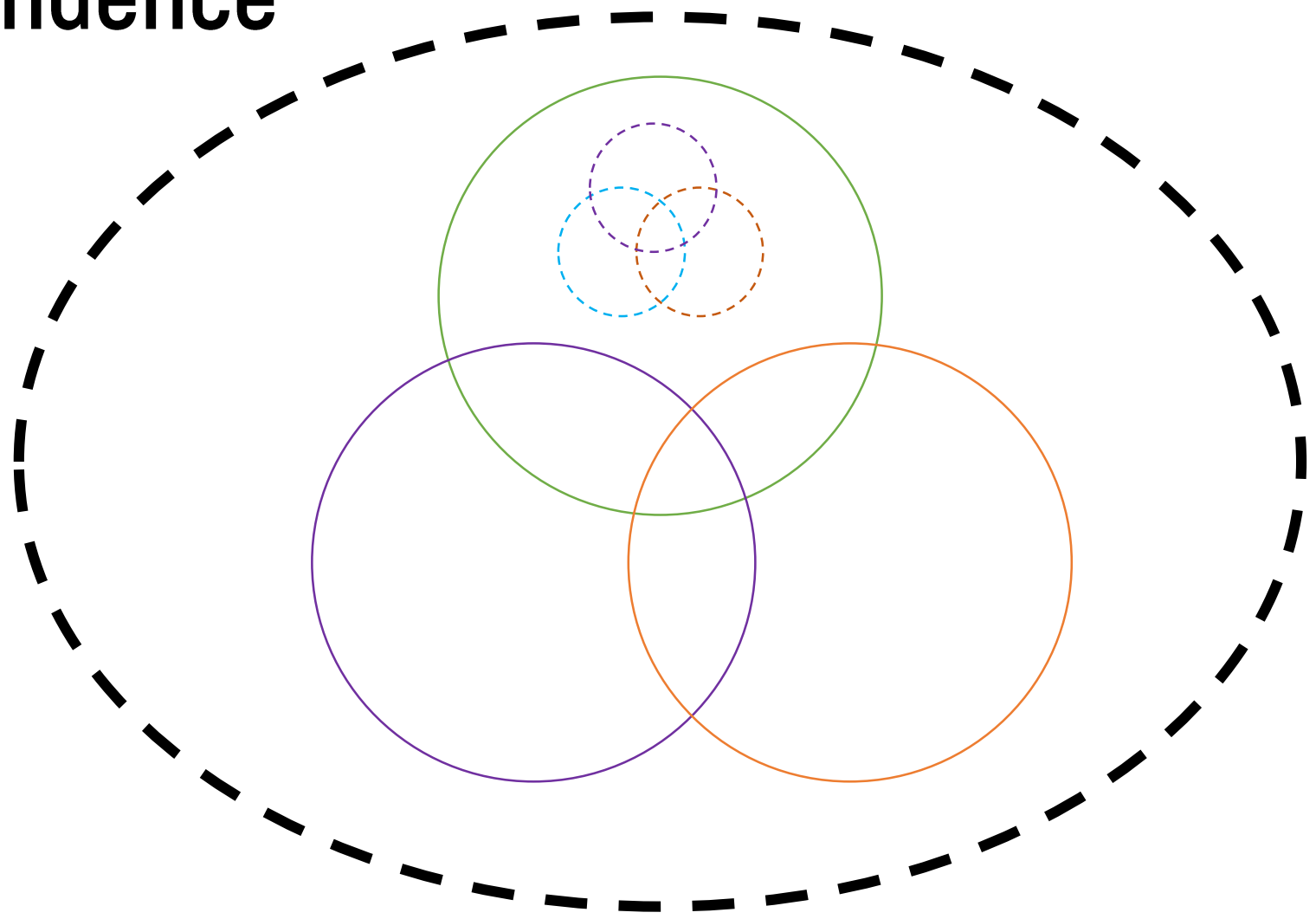
Interdependence

An organization is in an interconnected relationship with environment.

The subparts are interrelated, not isolated.

Changes to one part, directly or indirectly, influence the others.

Interdependence



System & sub-systems

Goals

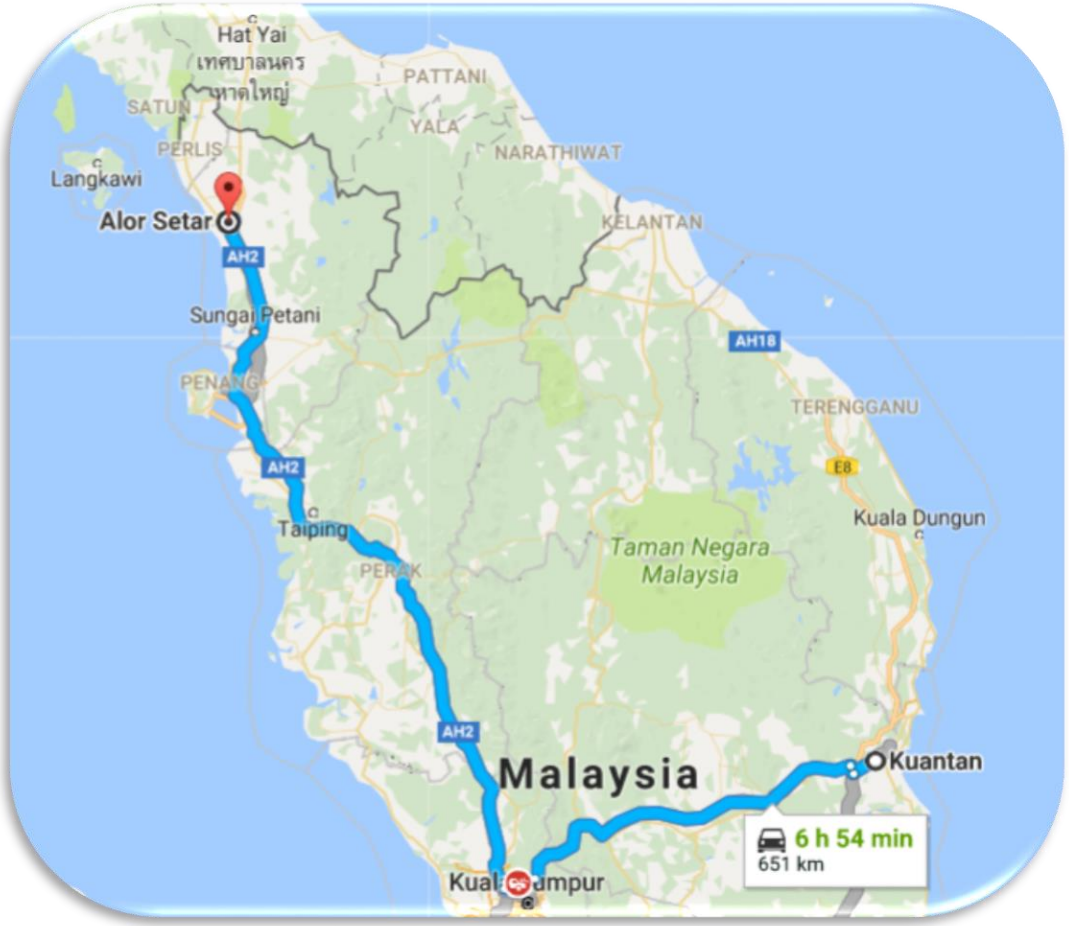
Goals in a system are contingent & negotiated.

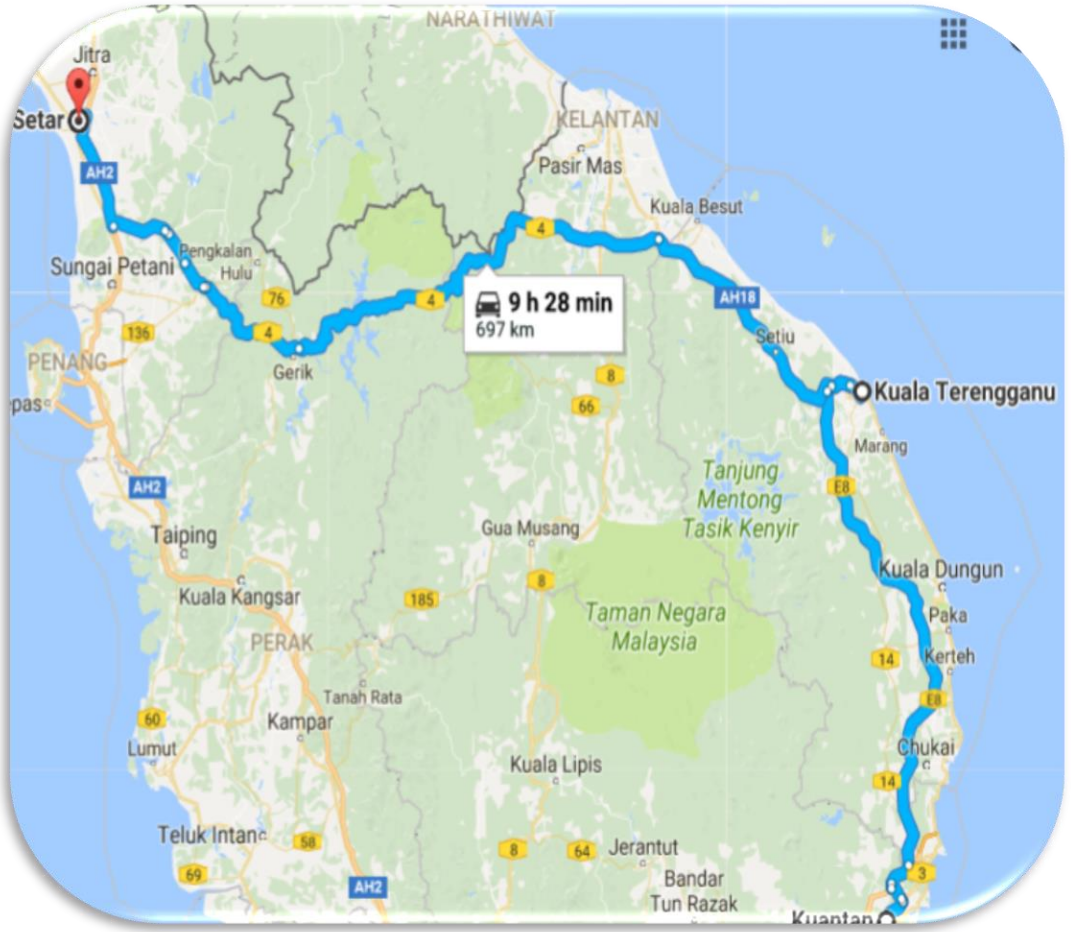
Equifinality

✓ There is no the best way to organize

✓ All ways of organizing are not equally effective.

Goals





Source: https://www.google.com/maps

Feedback

Reactions to a product, a person's performance of a task, etc., used as a basis for improvement.

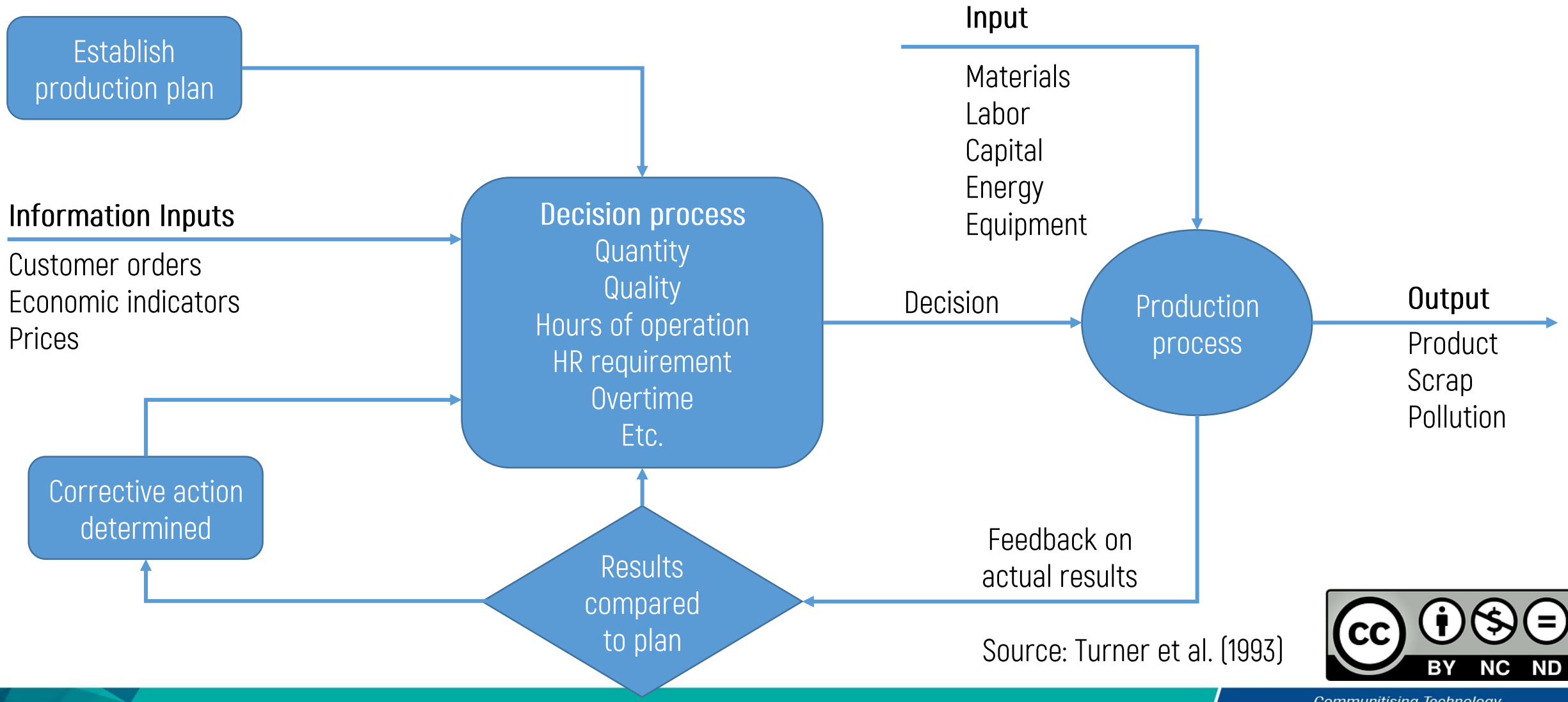
Positive feedback:

Grows the system in desired way to amplify & enhance the system's current processes

Negative feedback:

Seeks to correct or reduce deviations in the system's processes to re-establish a steady course back in the direction of the system's goals.

Feedback-Control System for Production



Source: Turner et al. (1993)

System Boundary

An interface which separates the system & its internal components from its environment/external entities.

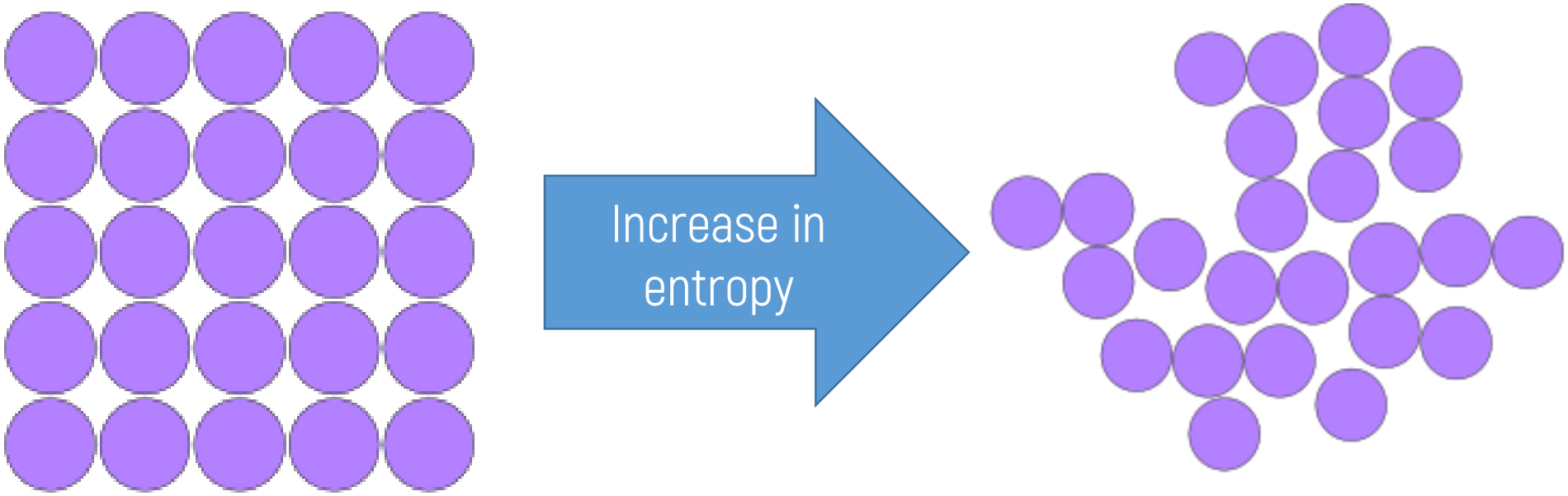
Any element or system that does not interact with the system of interest lies outside the system.

Entropy

The level of disorder or decline into disorder in a system.

Systems tend to run down, get worse, and move toward disorganization.

Balance: Energy, resources, and information coming into the system help to reach equilibrium.



Low entropy

High entropy

Source: https://masteroftheuniverseweb.wordpress.com

Two Types of Thinking

Traditional Thinking

- Focuses on the individual pieces

System Thinking

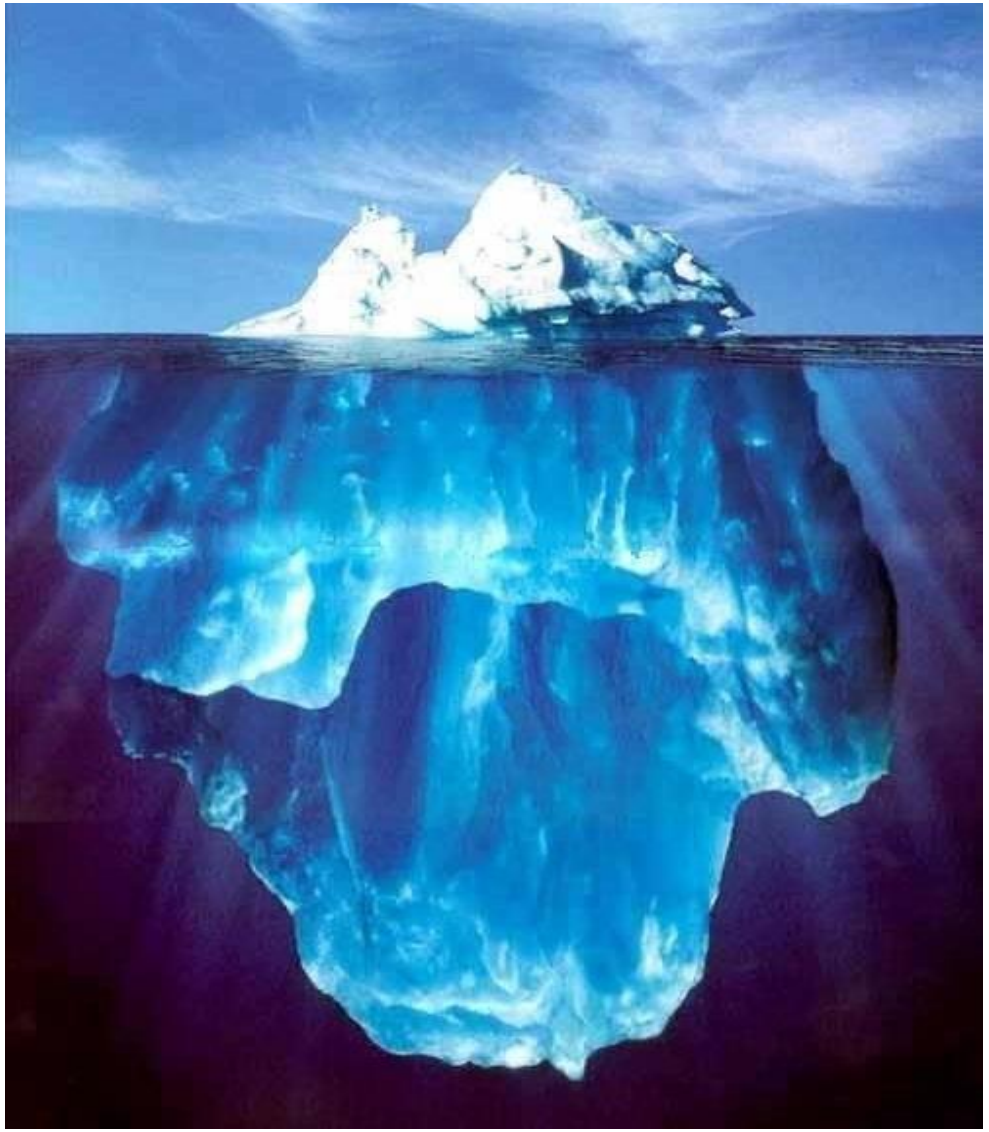
- Focuses on how the things interact with other elements

System Thinking

Concerns with an understanding of a system by examining the linkages & interactions among the system components.

Origin of System Thinking

1. System is composed of interrelated elements
2. Cause & effect among the components
3. The components may work together

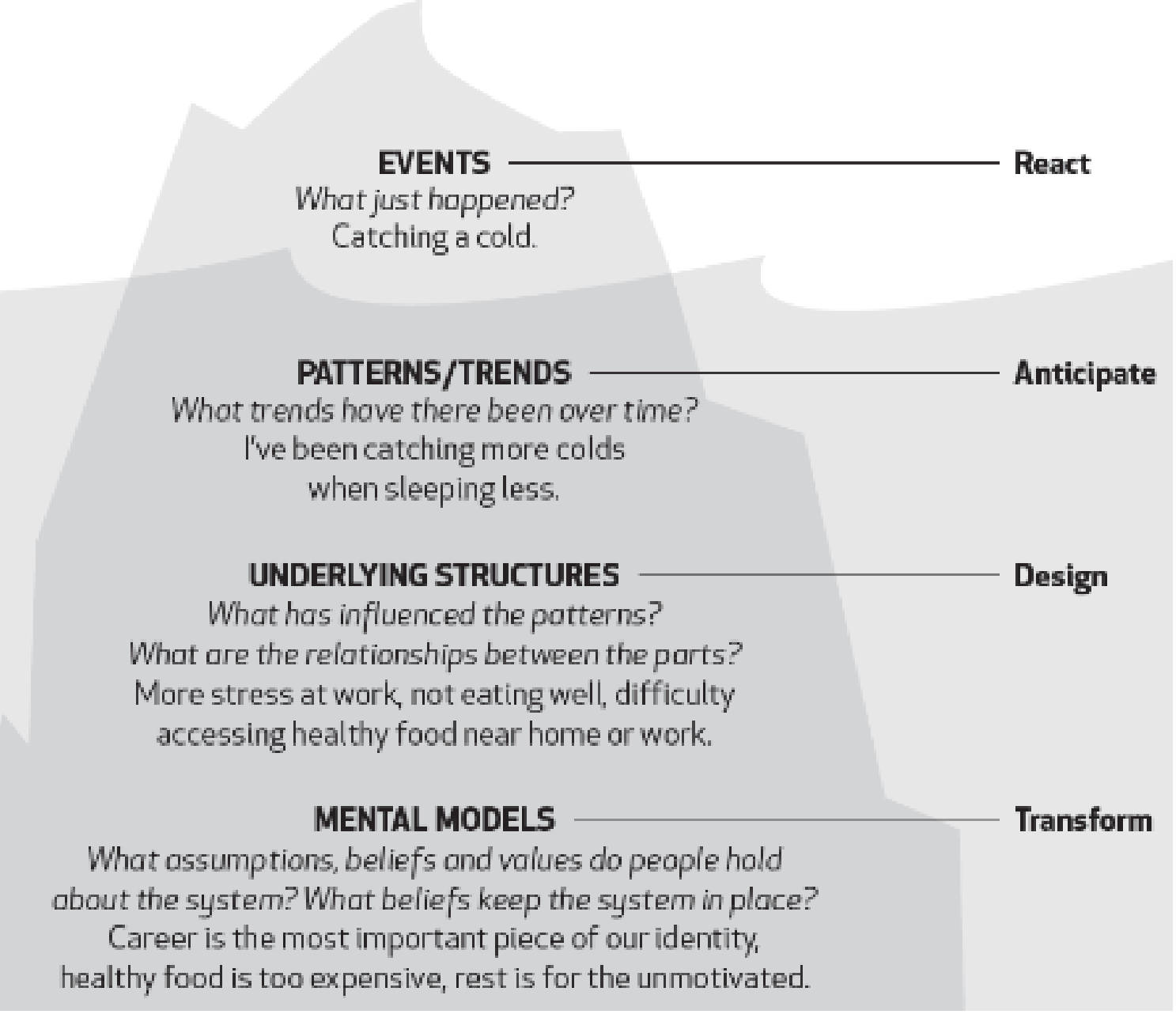


Source: https://vimby.com

System Thinking Iceberg

A tool/model to guide systemic thinking through discovering patterns of behaviour, supporting structures, & mental models that underlie a particular event.

System Thinking Iceberg



Source: https://www.nwei.org/iceberg/

The importance of System Thinking

- ✓ Important in developing a deeper understanding regarding the phenomena.
- ✓ System thinking represents a more comprehensive way of conceiving experience.
- ✓ Helps to explain complexity in a more comprehensive way.

System Thinking Habits of Mind

- ✓ Seeking to understand the bigger picture
- ✓ Seeing patterns/trends in the system
- ✓ Recognizing how a system's structure causes its behavior
- ✓ Identifying cause & effect relationships
- ✓ Surfacing & testing assumptions
- ✓ Finding where unintended consequences might arise
- ✓ Finding leverage points to change a system
- ✓ Resisting making quick conclusions.

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Greene, J. (2013). *Industrial Engineering: Theory, Practice & Application: Business and Production Management, Productivity and Capacity*. South Caroline, USA: Jackson Productivity Research Inc.

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Turner, W. C., Mize, J. H., Case, K. E., & Nazemtz, J. W. (1993). *Introduction to Industrial and Systems Engineering*. New Jersey: Prentice Hall.

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