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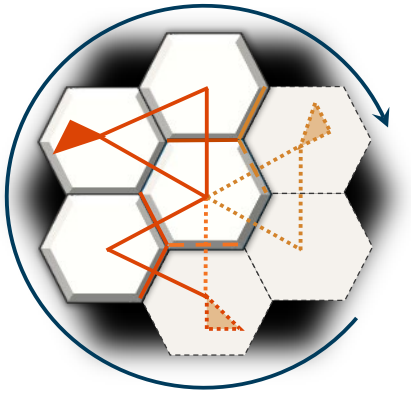
COLLEGE OF ENGINEERING | School of Mechanical, Industrial, and Manufacturing Engineering

Purposeful Human Activity Systems

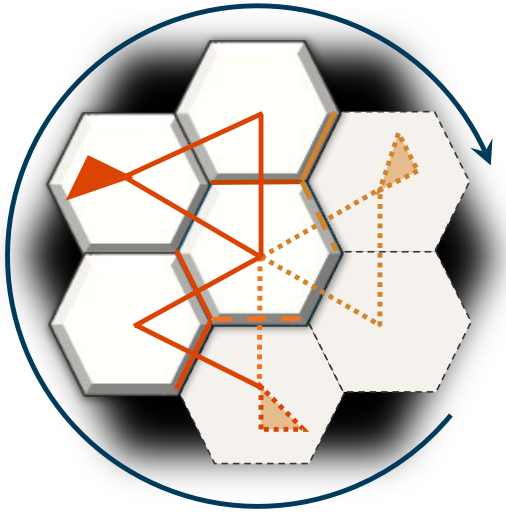


Javier Calvo-Amodio, Ph.D.

Associate Professor of Industrial Engineering

Systems Science Working Group Chair

Oregon State University
College of Engineering



CaRSEM

Change and Reliable Systems Engineering and Management

AGENDA

Systems Engineering and Systems Science

What is a Purposeful Human Activity System?

Example of Application

INCOSE

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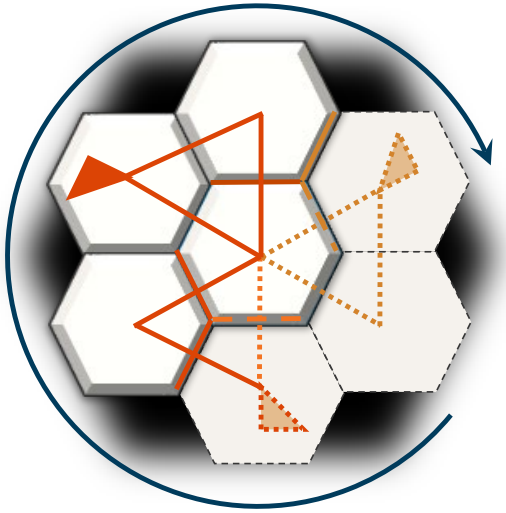

CaRSEM

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Systems Science as a Foundation for SE

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- SE's identity and distinctive capability derives from its use of *Systems Science*
  - ...but *Systems Science* itself has challenges: it is fragmented, uneven in maturity, non-standardized terminology, and has major theoretical gaps
- *Systems Science* is currently comprised of two well-developed *movements* that are somewhat disjunct:
  - Complexity science
  - Systems research

Systems Science as a Foundation for SE

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Complexity Science

- ✓ Deals with phenomena difficult to describe but eventually easy to explain
- ✓ Highly scientific and widely used, but can be considered as largely reductionistic

Starling murmuration

- Complex to describe
- Simple to explain

Systems Research

- ✓ Deals with phenomena easy to describe but increasingly difficult to explain
- ✓ Largely holistic but not widely used and mostly grounded in heuristics

Vandalism

- Simple to describe
- Complex to explain

Vision for the Future of SysSci & SE as Disciplines

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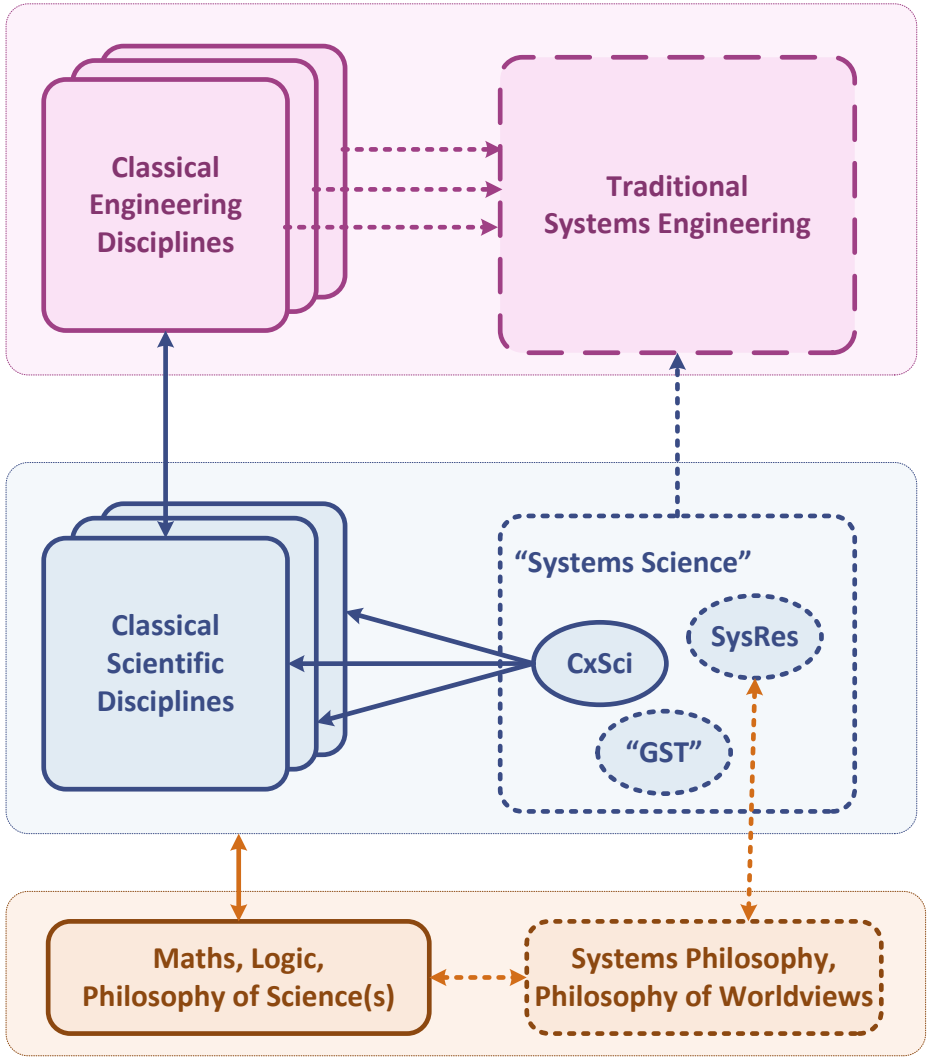
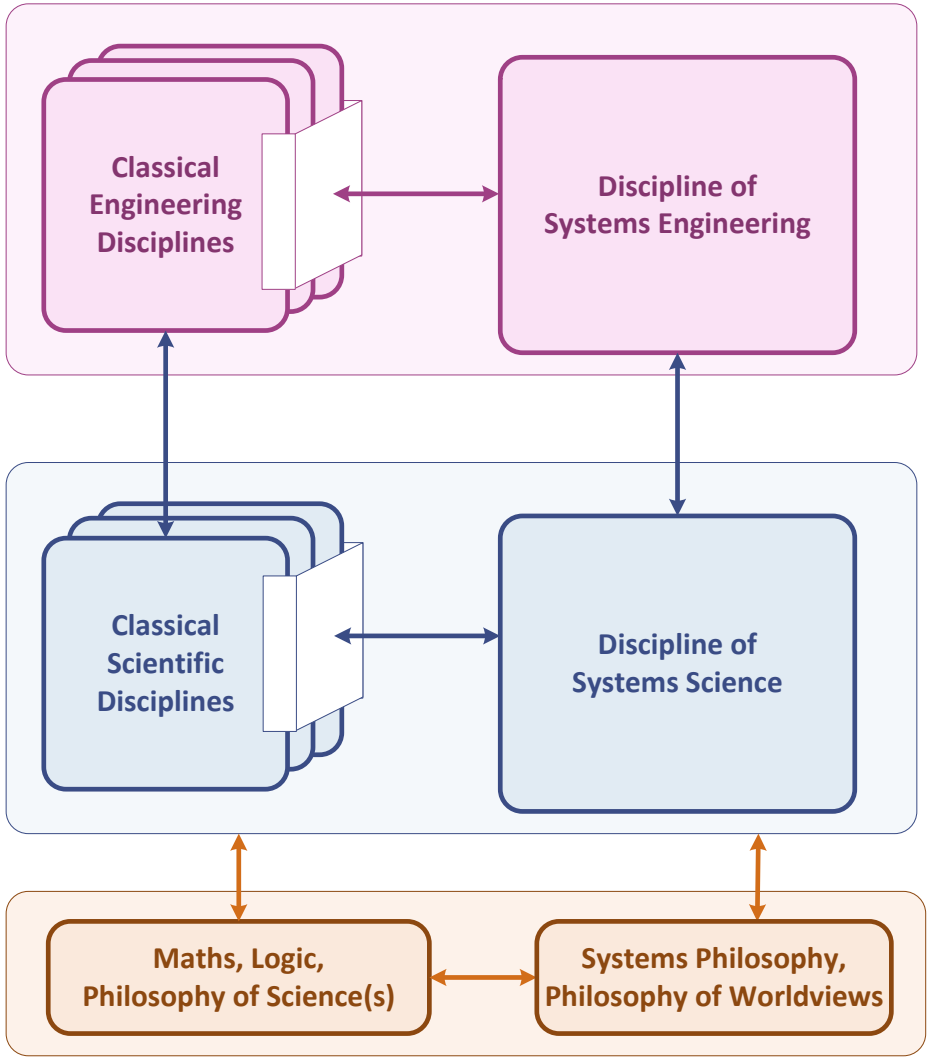
Today:



SF4SE

Scientific Foundations for Systems Engineering

Future:



A Particular Challenge in Systems Engineering

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- In SE, emphasis is placed on what systems engineers do: design, realize, and manage systems.
  - As a community, we are developing scientific principles to enhance SE practice (FuSEo.
  - Yet, there is still a need to further understand how systems engineers think about systems engineering activity.
- This presents, from a researcher's perspective, the opportunity to develop a specialized set of principles that can shed some light into how to design, realize, and manage human activity systems within a SE context.
- → A Purposeful Human Activity System is needed

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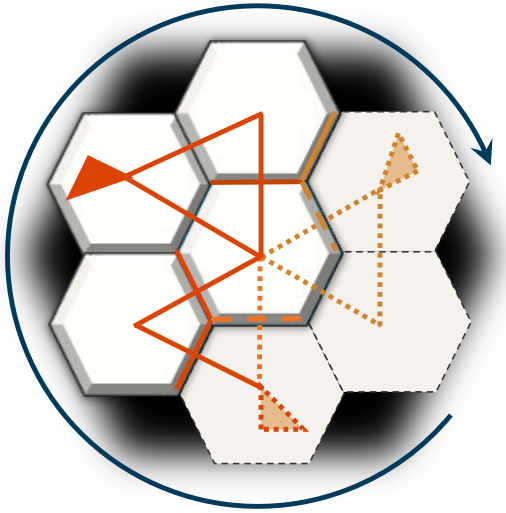

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Systems Engineering and Systems Science

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Rationale for systems research in human activity in SE

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- There is a need to develop foundational knowledge in management of human activity in organizations
- New definition of Systems Engineering *(will be in SEBoK)*
  - Systems Engineering is a transdisciplinary and integrative approach to enable the successful realization, use, and retirement of engineered systems, using systems principles and concepts, and scientific, technological, and ***management methods***.

Rationale for systems research in human activity in SE

Oregon State University College of Engineering

- We are systems engineers, so let's think of our organizations as systems.
- The INCOSE Fellows propose the following system definitions:
  - General: *A system is a persistent region of low entropy (= high organisation) in physical or conceptual space-time.*
  - Specialized: *A system is an arrangement of parts or elements that together exhibit behavior or meaning that the individual constituents do not.*

Rationale for systems research in human activity in SE

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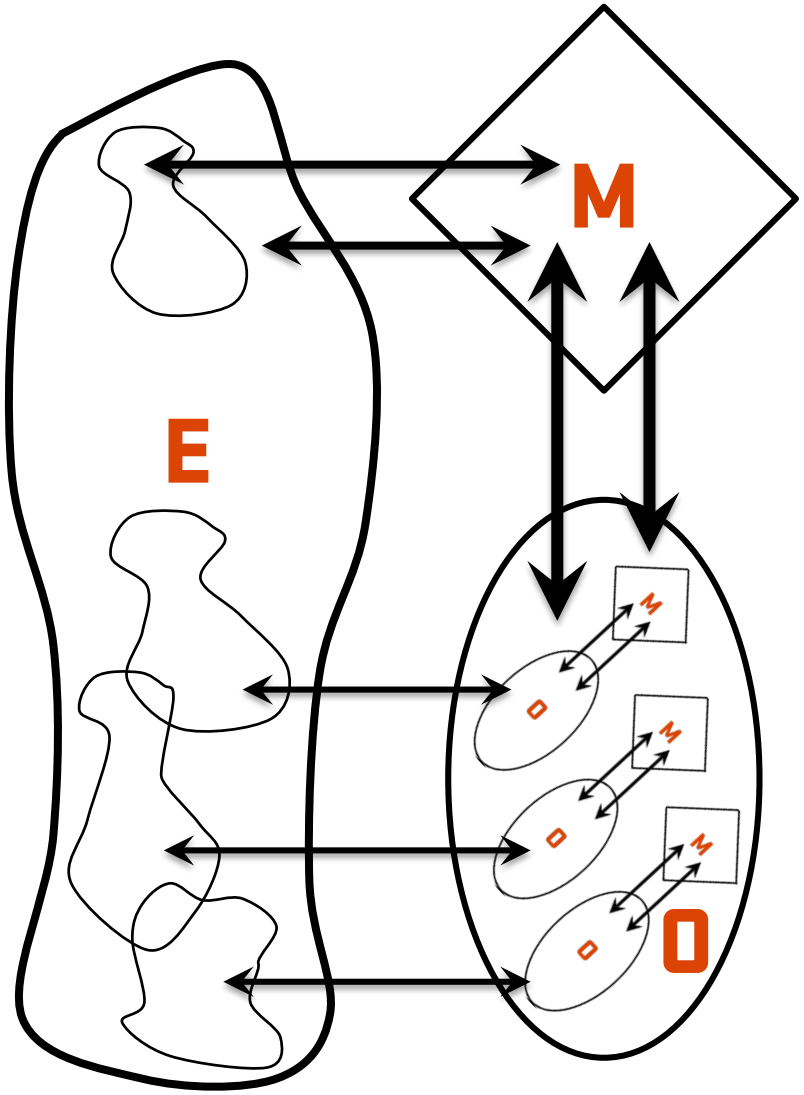
- In systems engineering practice we deal in a daily basis with a special kind of systems:
  - we form teams and interact with colleagues while belonging and acting within the culture of an organization
- Therefore, we need to design organizations as physical and conceptual systems; for that we need:
  - a control system,
  - autonomy and flexibility for operational units,
  - enable organizational learning,
  - create sense of belonging, ownership, and accountability with purpose

Theoretical Framework – Control, Autonomy, Flexibility

- Approach Based on Three Elements of an Organization
  - The Operation - **O**
  - The Metasystem - **M**
  - The Environment – **E**
- Based on Viable System Model
  - Developed by Stafford Beer
  - Based on cybernetic management



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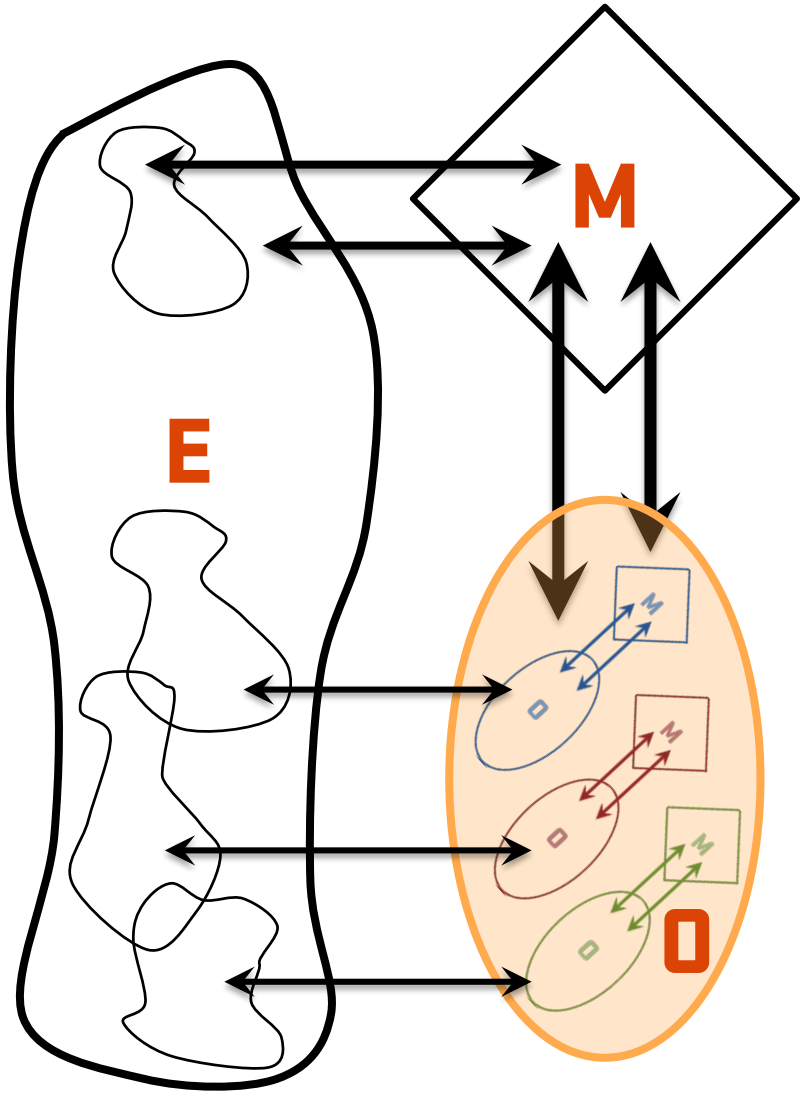
Theoretical Framework – Control, Autonomy, Flexibility

- ***The Operation***: the primary activities the organization performs; these are found in departments, units, etc.



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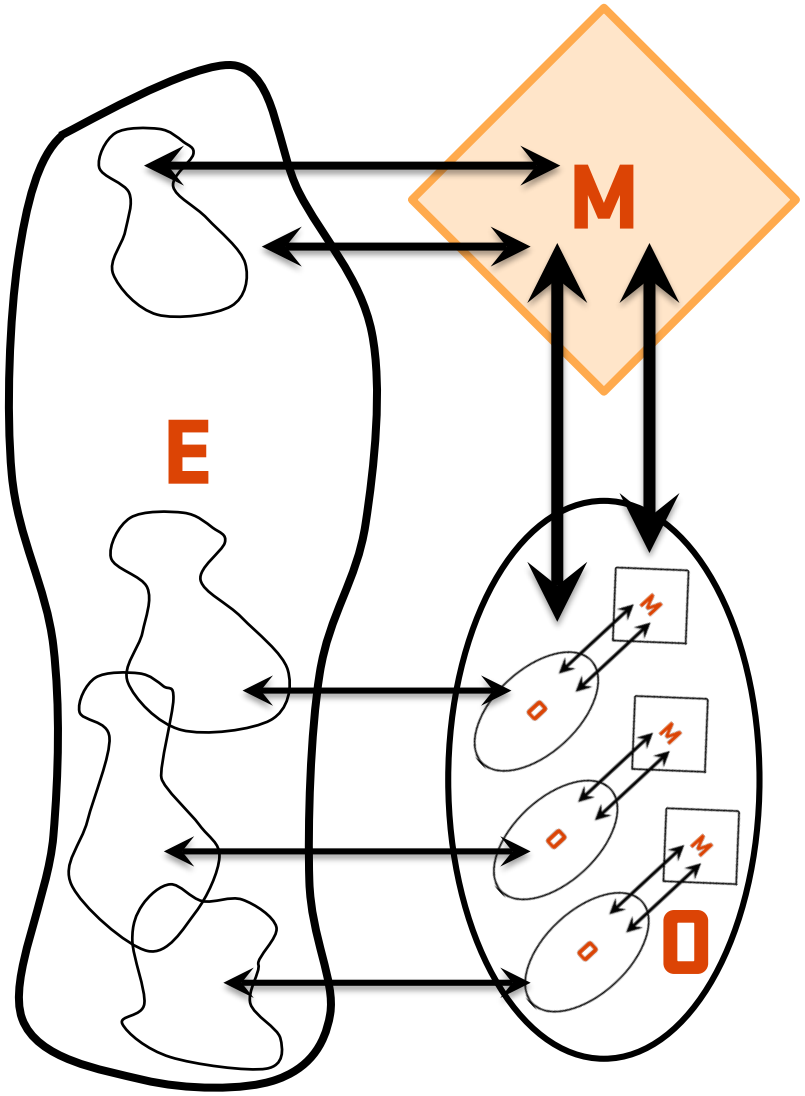
Theoretical Framework – Control, Autonomy, Flexibility

- ***The Operation***: the primary activities the organization performs; these are found in departments, units, etc.
- ***The Meta-system*** *(logically over & above)*: designed to ensure all the parts of the operation cohere into a single, harmonious, integrated whole; think of organizational policies, system architecture, etc.



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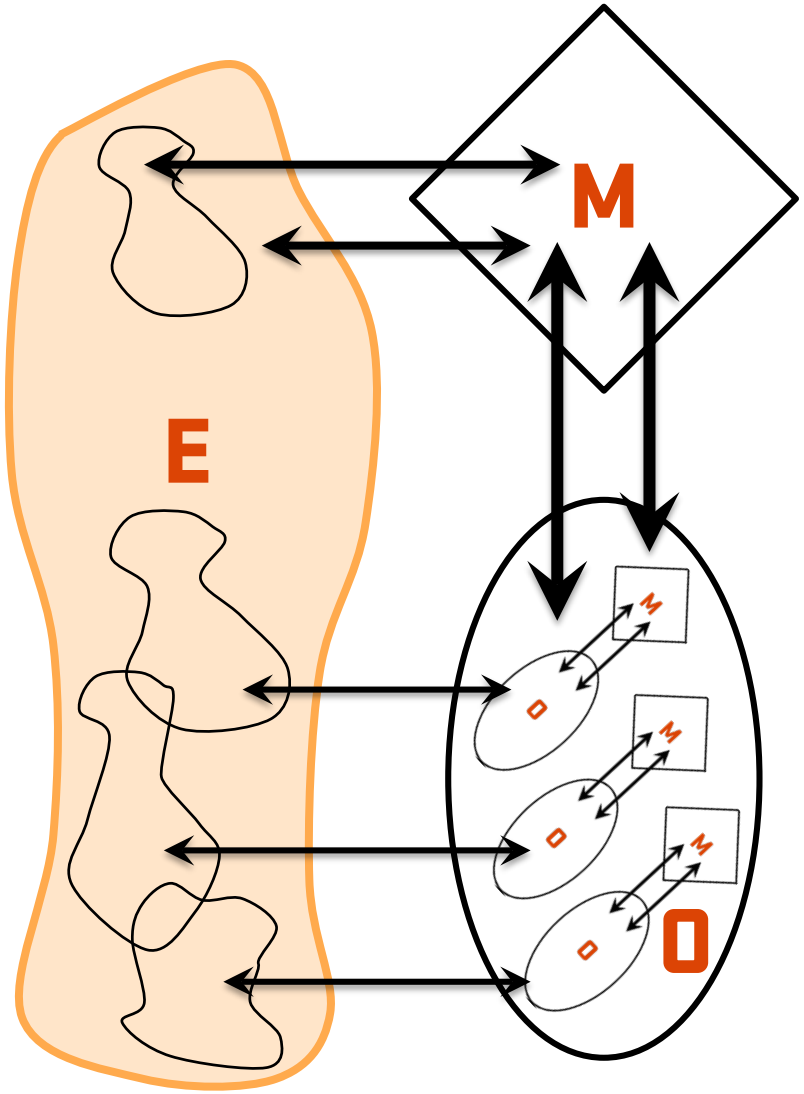
Theoretical Framework – Control, Autonomy, Flexibility

- ***The Operation***: the primary activities the organization performs; these are found in departments, units, etc.
- ***The Meta-system***: (logically *over & above*) designed to ensure all the parts of the operation cohere into a single, harmonious, integrated whole; think of organizational policies, system architecture, etc.
- ***The Environment:*** Those parts of the outside world which affect or are effected by the system; think customers, suppliers, congress, etc.



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Theoretical Framework – Control, Autonomy, Flexibility

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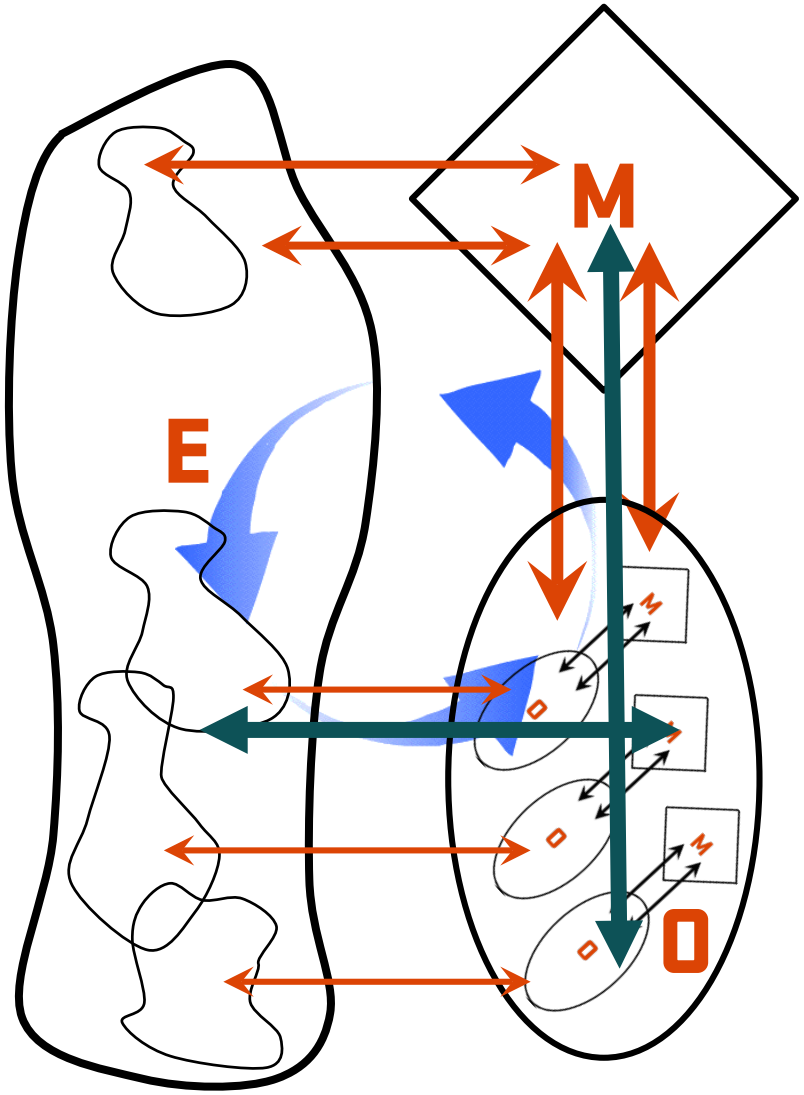
- The three elements are all interacting to determine:
  - Organizational control through centralization of managerial and operational processes to maintain system coherence.
  - Operational independence to maximize autonomy and flexibility to react to environmental changes.
- The goal is to maximize autonomy while maintaining system coherence.



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Theoretical Framework

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- Ok, this takes care of the control and concrete/physical parts of an organization, but:
  - what are we controlling?
  - how do we handle the human part of the equation?

Theoretical Framework – Human Activity System

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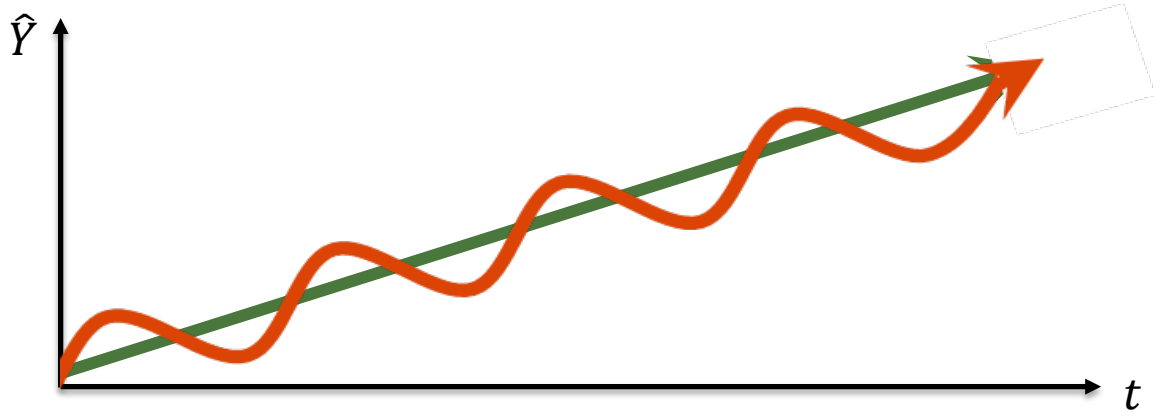
- Successful human activity systems are:
  - Stable systems with low entropy that maintain a tractable progress trajectory to achieve their goals.
    - Human activity systems maintain *homeorhesic* control towards fulfilling their purpose while maintaining a *homeostatic* state when
      1. their purpose is well understood by its parts (humans) and
      2. the causal powers needed to conduct purposeful activities are present.



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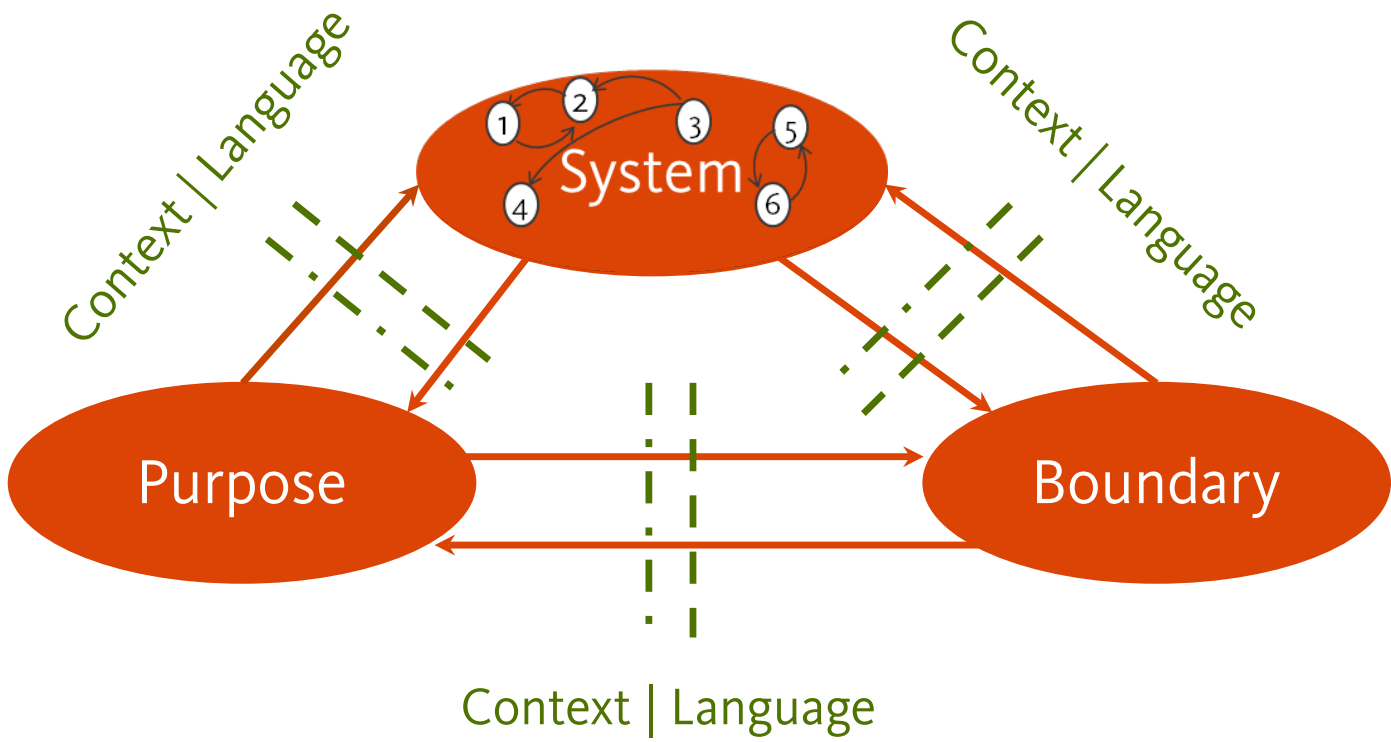
Theoretical Framework – Human Activity System

Oregon State University College of Engineering

- Human activity systems have interrelationships between *concrete* and *conceptual* parts that exhibit persistent *behaviors, structures, processes* and *meanings*.
  - Parts interrelations are determined by the kind, capability, and structure of the human activity system.
  - System performance is dependent on boundary, purpose, context and language.



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Theoretical Framework – Human Activity System

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- It can be distilled from the words of Deming that:
  1. We manage what we can control.
  2. We control what we can measure.
  3. We measure what we understand.
- To ***understand*** what we do and its impact in the larger organization it is necessary to identify key activities that best depict how we do things
  - For instance, telling the story about how are we doing as an organization is best answered through the performance of key activities.

Theoretical Framework – Purposeful Human Activity System

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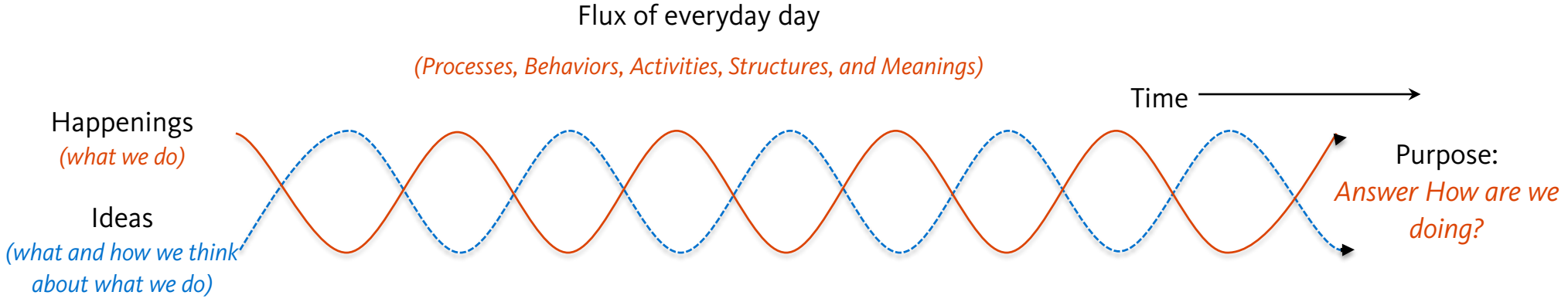
- Human activity systems are a special kind of system that is aware of its purpose and intentionally pursues its purpose.
  - Having a purpose influences what the human activity system is capable of by
    1. Guiding behavior and resource allocation,
    2. Determining a system's capability through its designed processes, behavior, structure, and meaning,
    3. Delimiting the potential emergence of unwanted properties.



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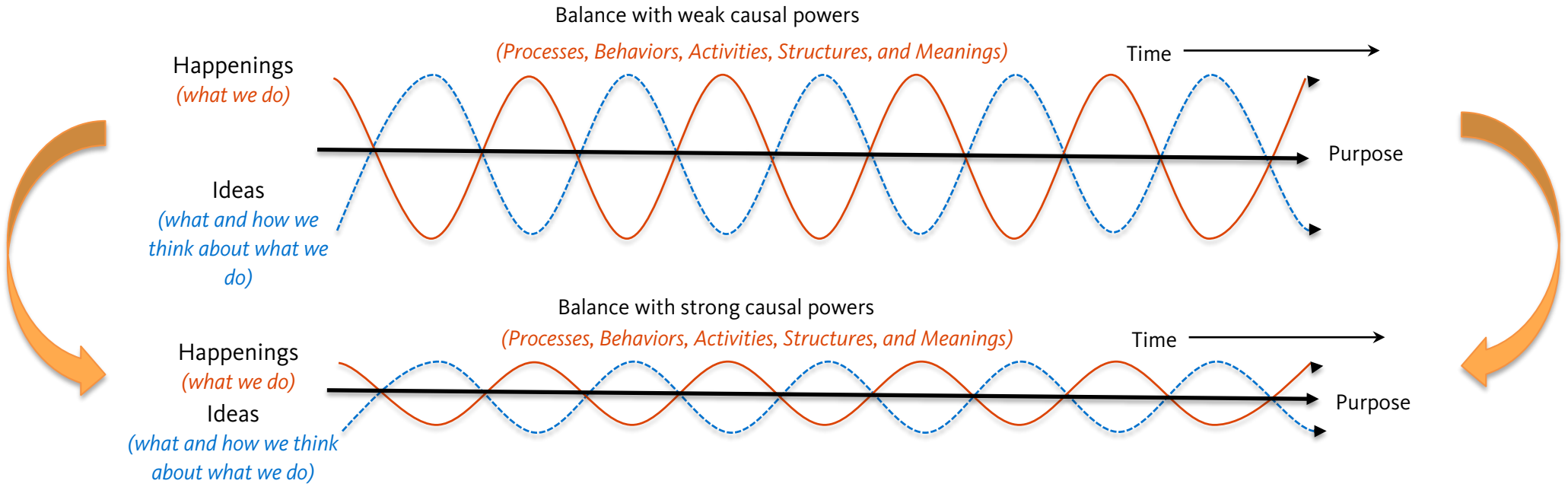
Theoretical Framework – Integration of Control and Human Activity System

Oregon State University College of Engineering

- There must be an inherent balance between ideas and happenings that regulate how any purposeful human activity system operates.
  - A stable trajectory *(homeorhesic control and homeostatic state)* is crucial to enable continuous improvement, adaptability, flexibility, autonomy, etc. *(this is done by design)*



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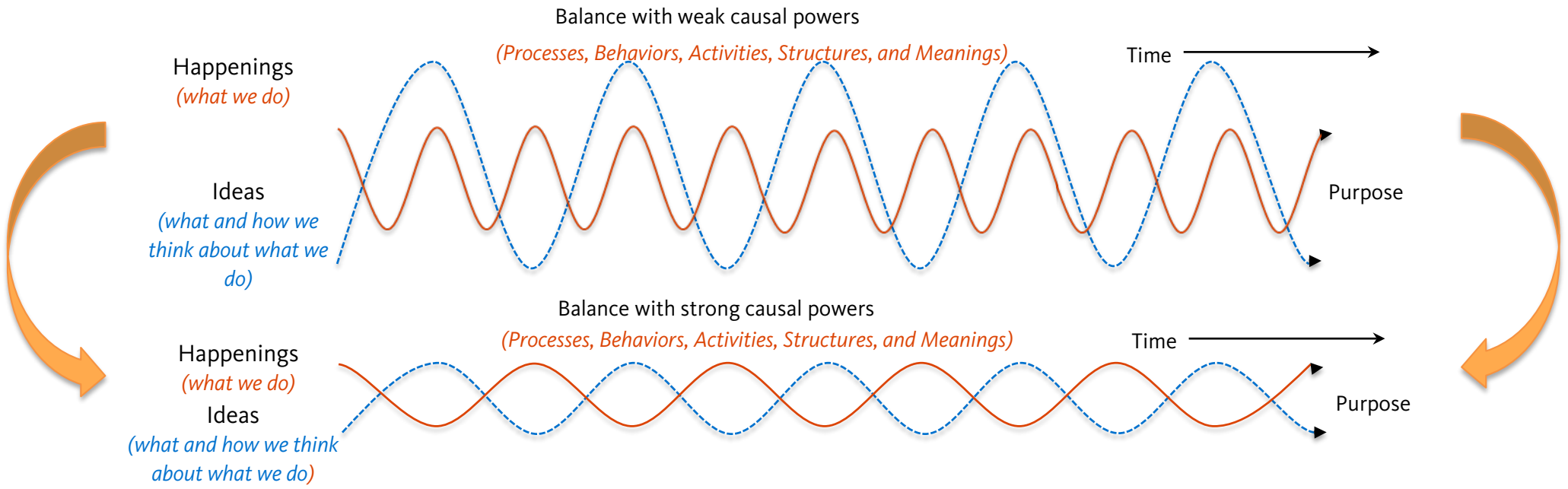

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Theoretical Framework – Integration of Control and Human Activity System

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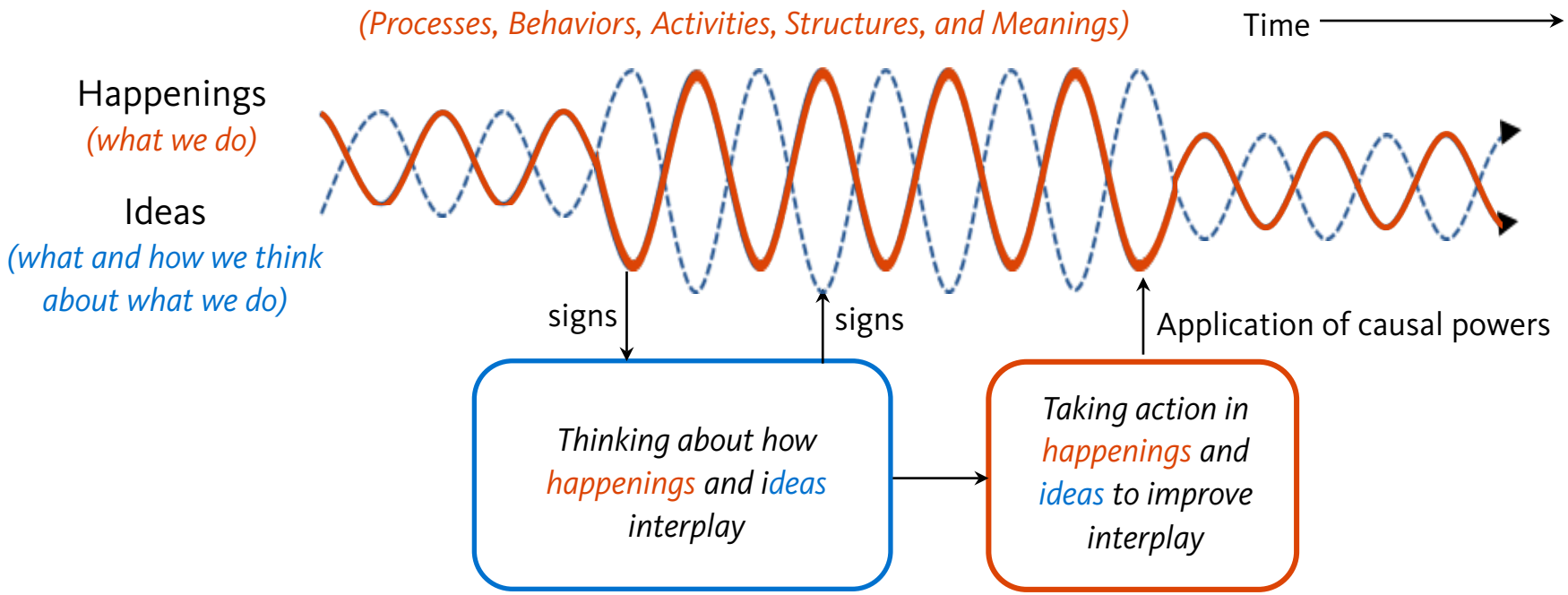
- We use metrics (signs) to identify when the balance is altered, both in improvement and degradation of functionality



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Theoretical Framework – Integration of Control and Human Activity System

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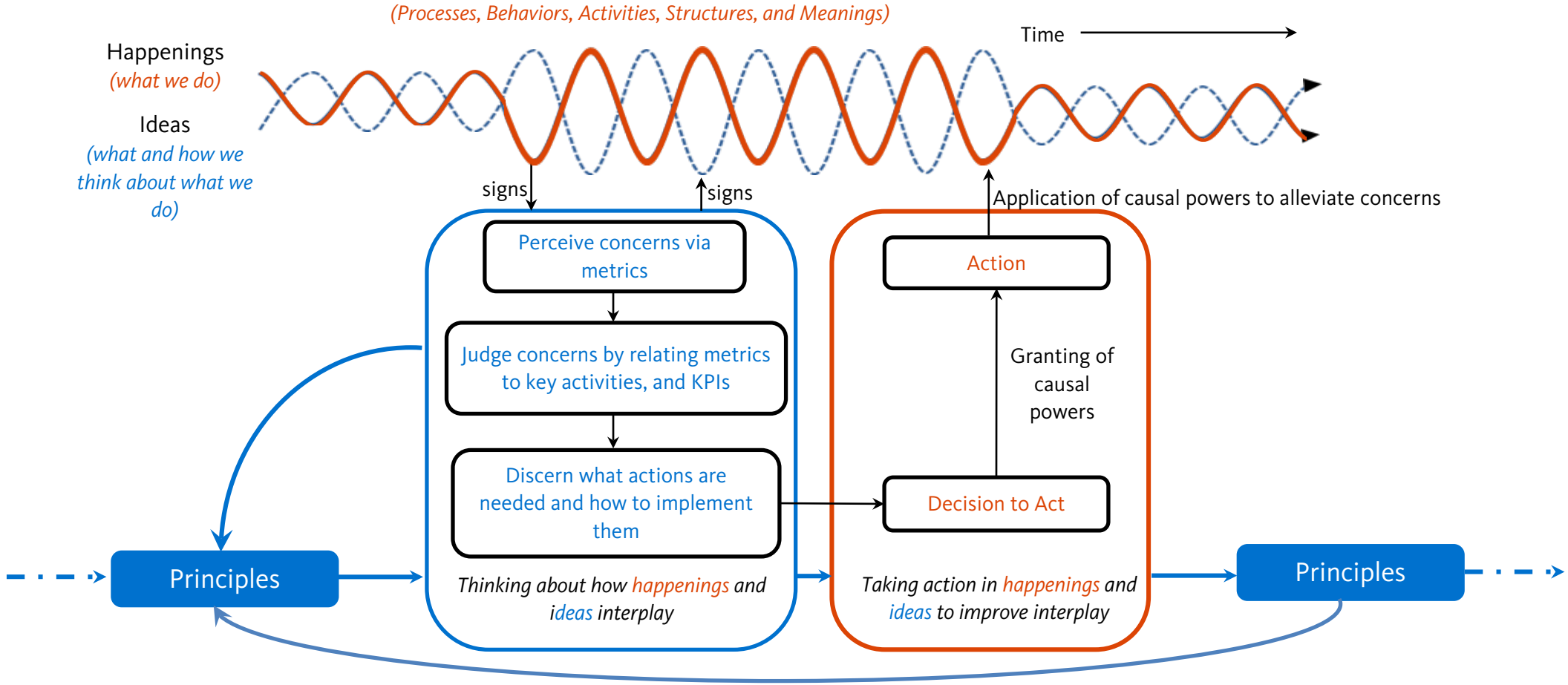
- Integration of Principles, KPIs, key activities, and Metrics



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Theoretical Framework – Integration of Control and Human Activity System

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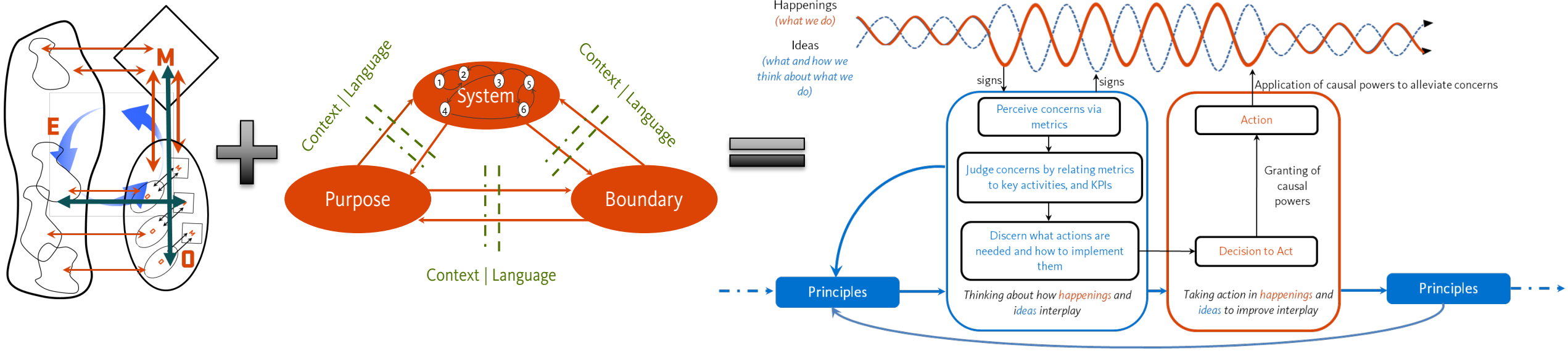
- A Purposeful Human Activity System:



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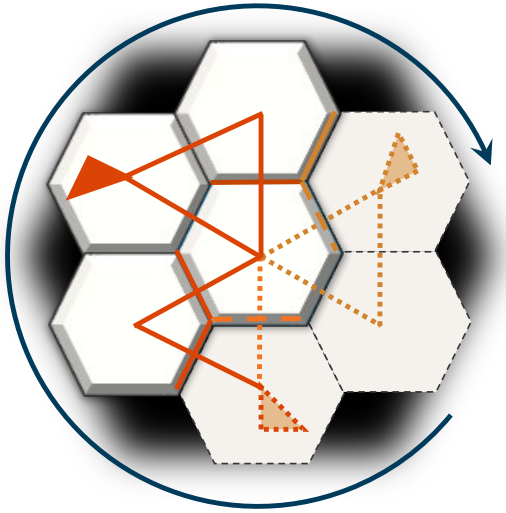

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Example of Application

INCOSE

Example: OSU's Division of Finance and Administration

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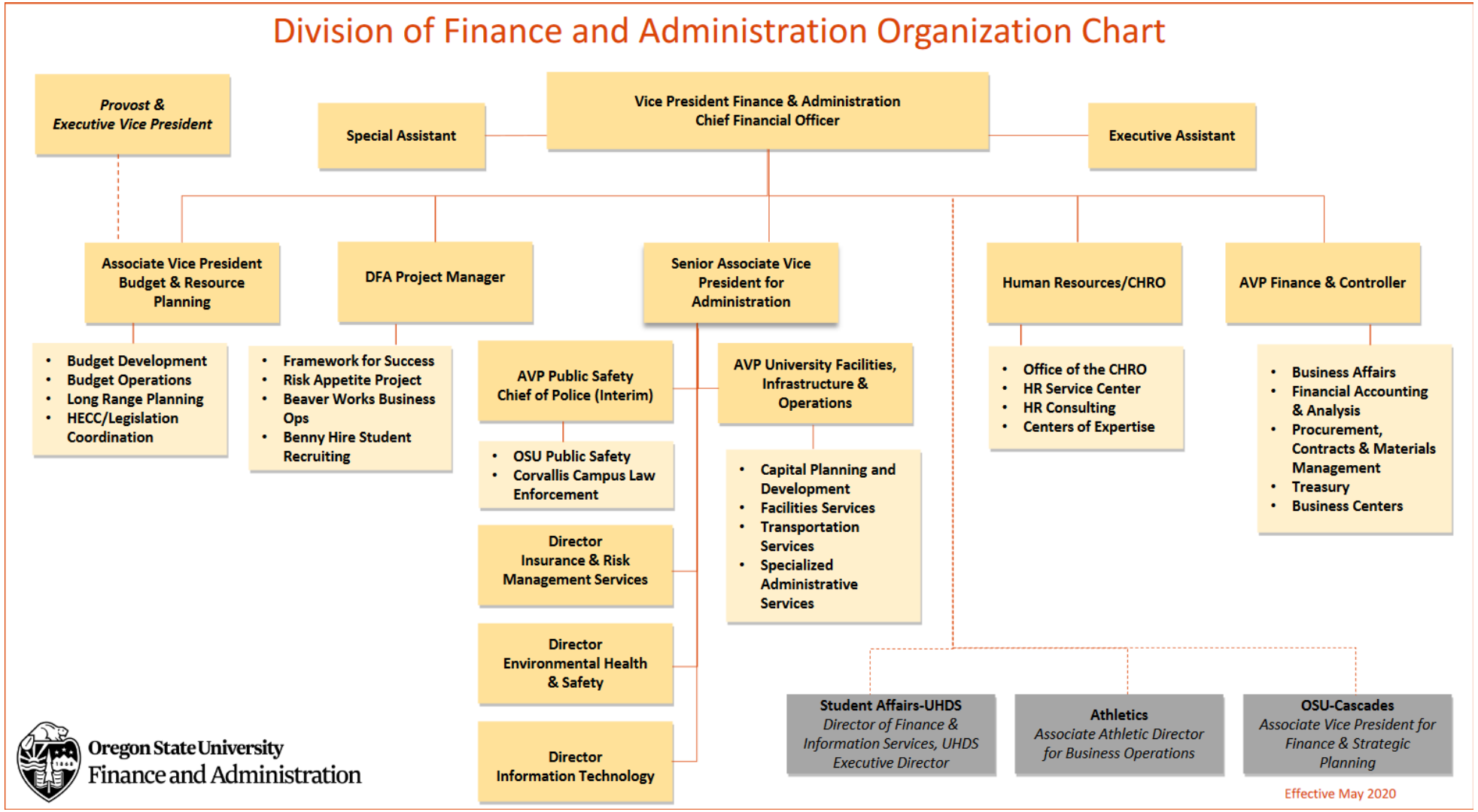

Example: OSU's Division of Finance and Administration

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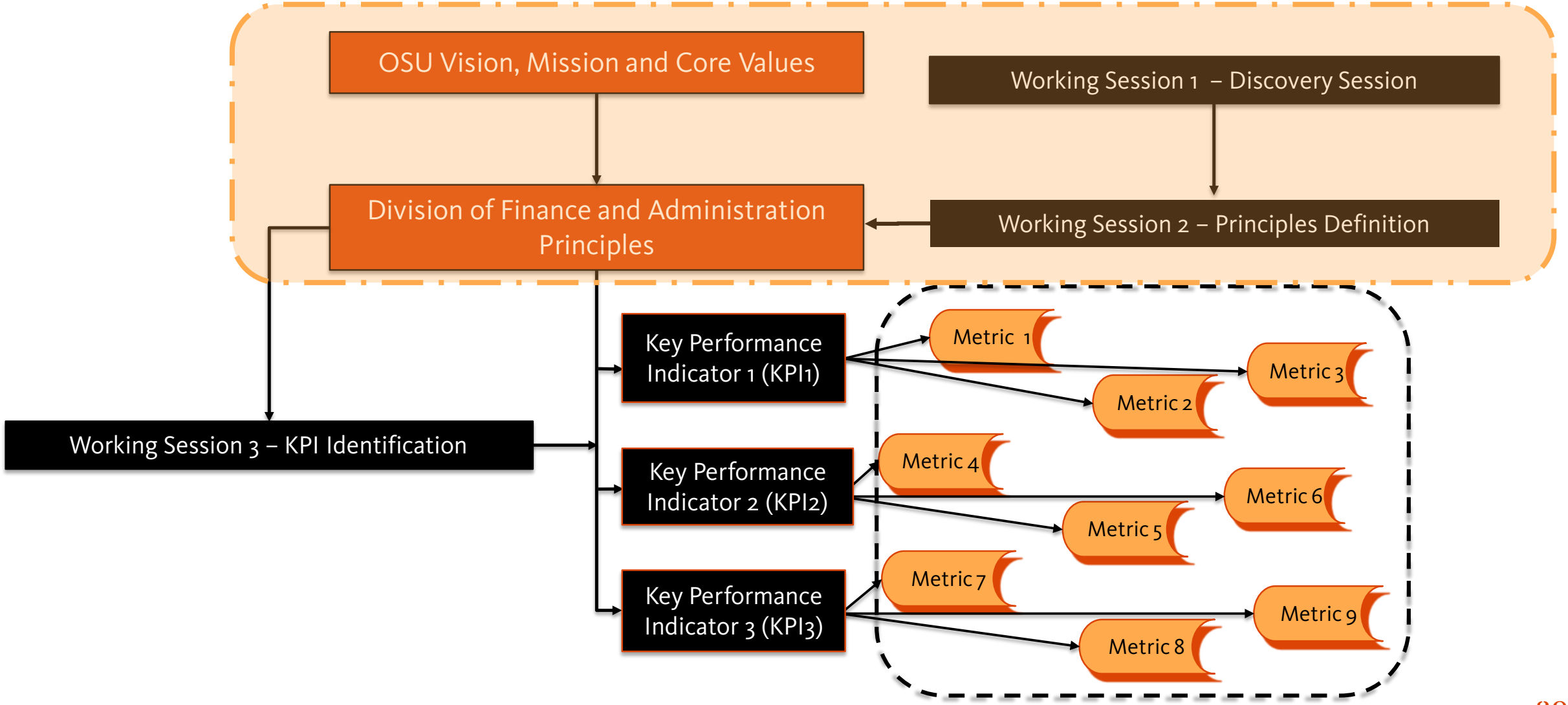

Application of PHAS - Framework

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OSU Vision, Mission, and Core Values

↓

Division of Finance and Administration Principles

OSU Core Values

Accountability	Diversity	Integrity	Respect	Social Responsibility

- ***Structured and inclusive decision-making*** generates effective results.
- ***Clear and transparent communication*** conveys and confirms intent and respect for all stakeholders.
- **Process consistency, balanced with flexibility,** improves efficiency and effectiveness.
- ***Community safety and respect for all its members*** embodies our core values, and enables our mission.
- ***Active stewardship of resources*** ensures the long-term success of the university.
- ***Assessing and managing risk*** balances innovation and compliance
- ***Clearly defined and integrated policies, standards and processes that remove institutional bias, coupled with appropriately delegated authority,*** empowers employees and improves the satisfaction of all stakeholders

Accountability	Diversity	Integrity	Respect	Social Responsibility

Example: OSU's Division of Finance and Administration

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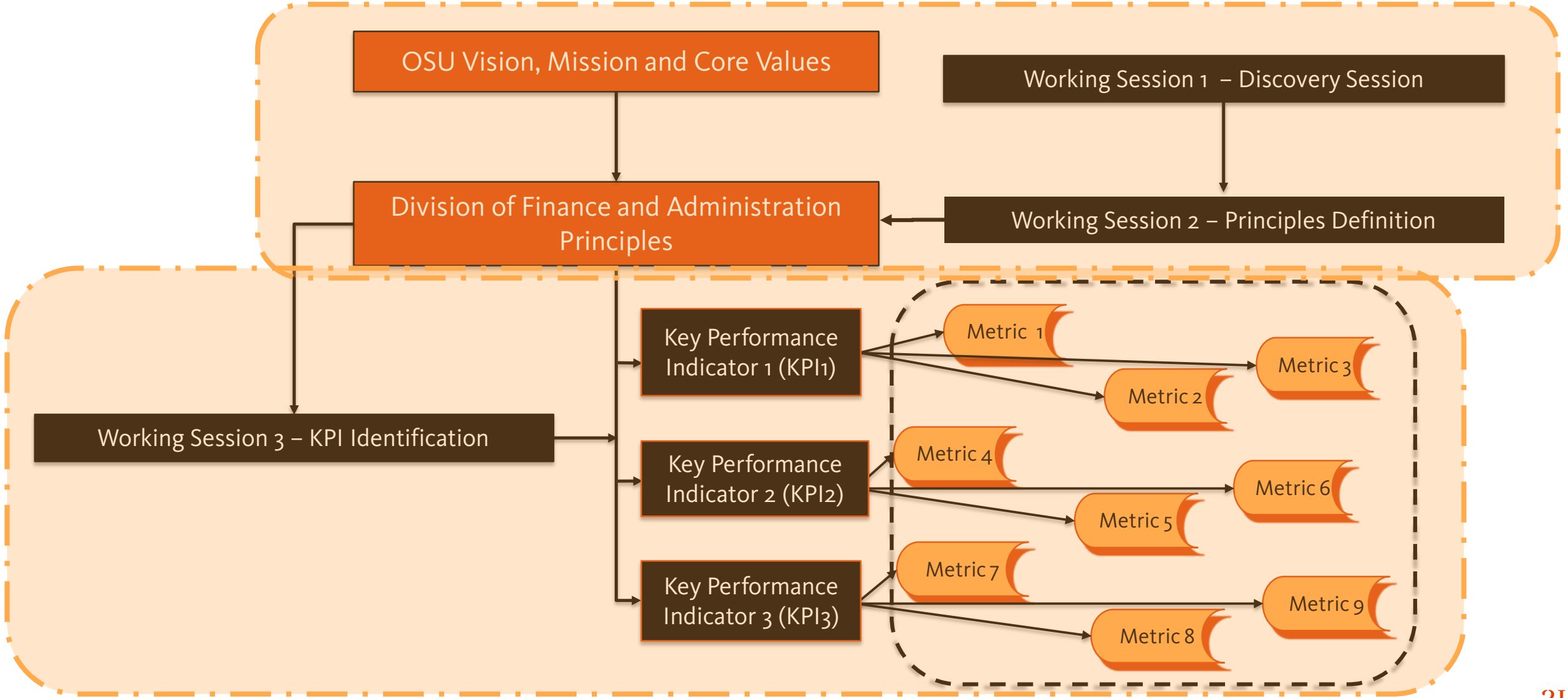
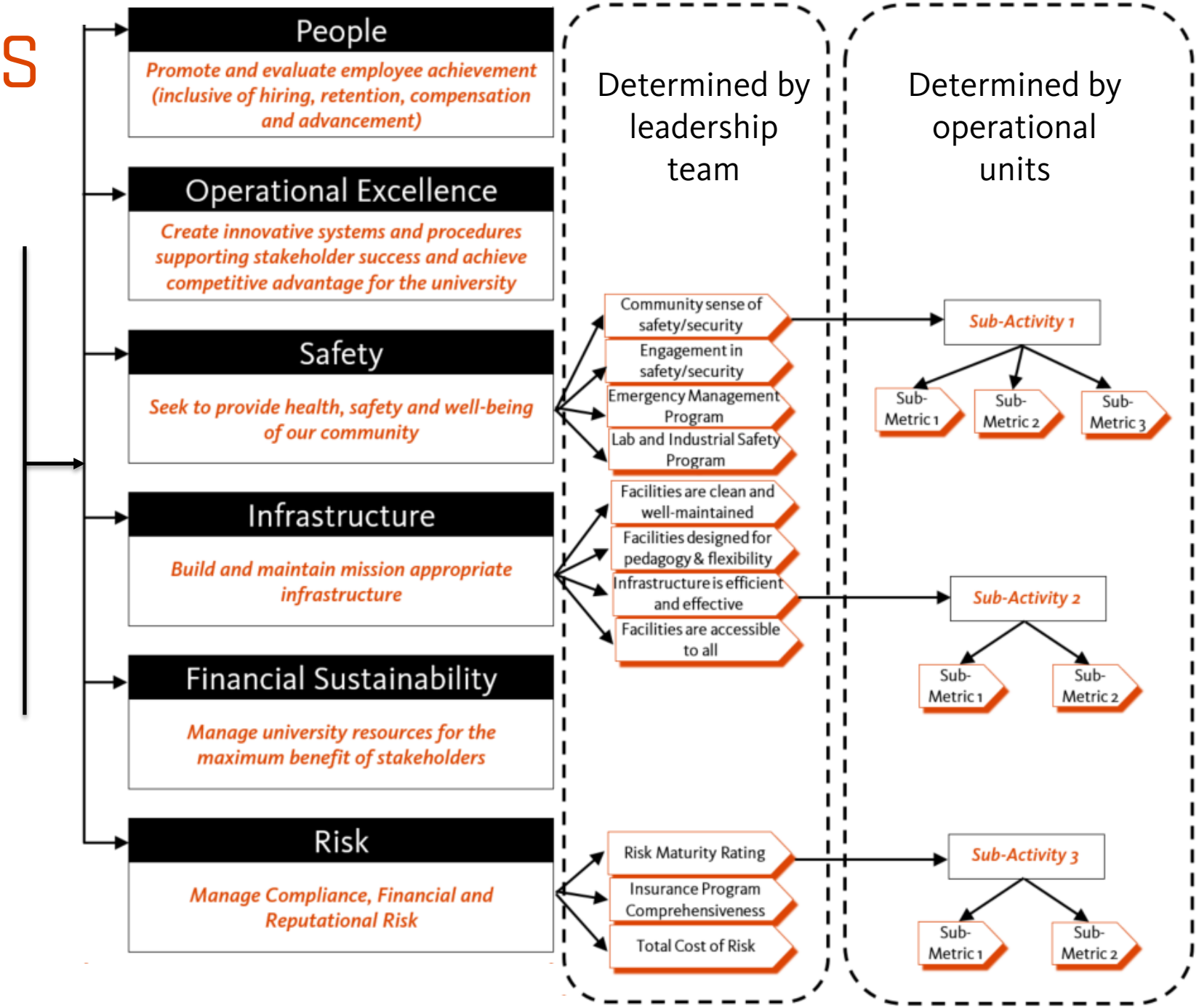


Application of PHAS - Framework

- Mission, Vision, and core values along with *principles* inform how *KPIs*, *key activities*, and performance *metrics* are developed, interpreted, and acted upon.



How and why does the Framework for Purposeful Human Activity Systems Work?

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- Integration of principles, KPIs, key activities, and metrics.

Structured and inclusive decision-making generates effective results.
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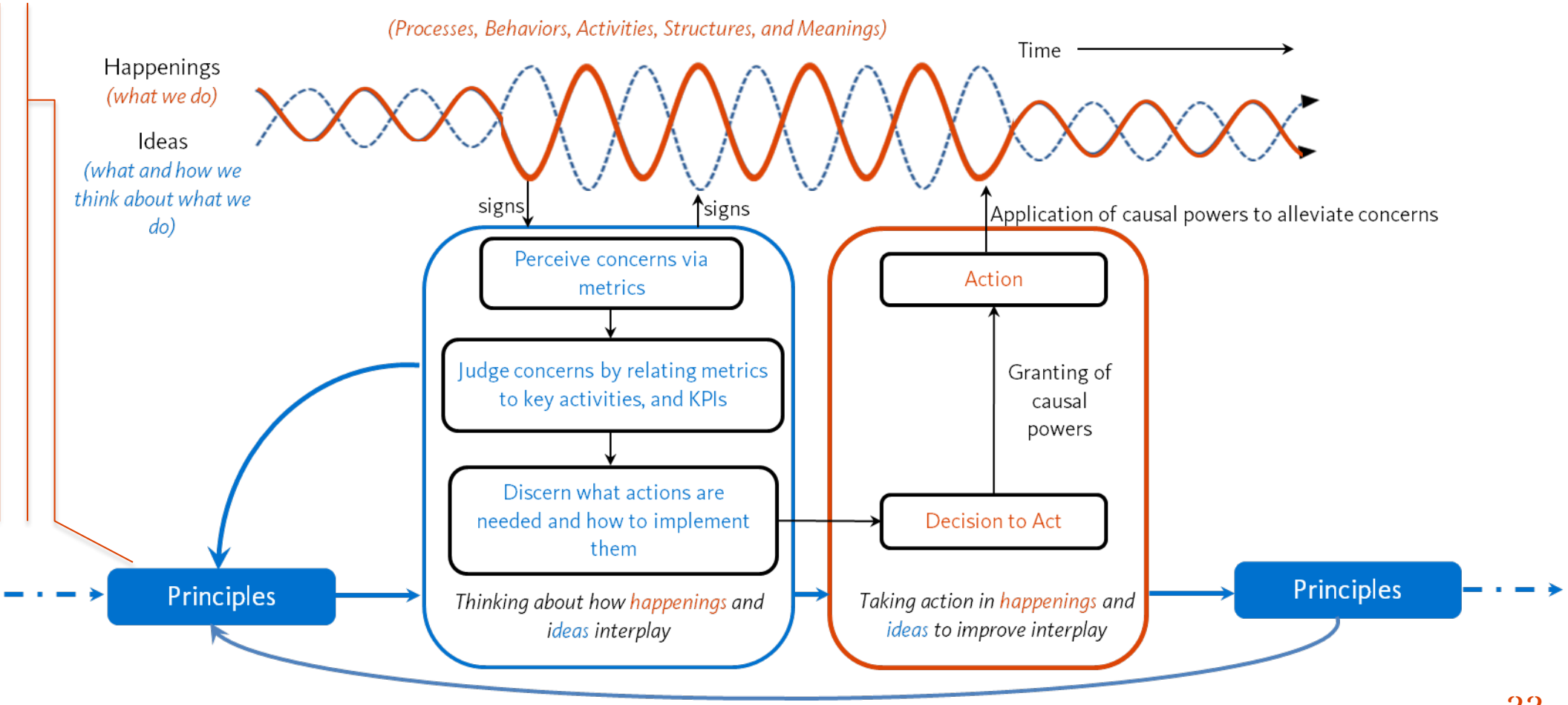

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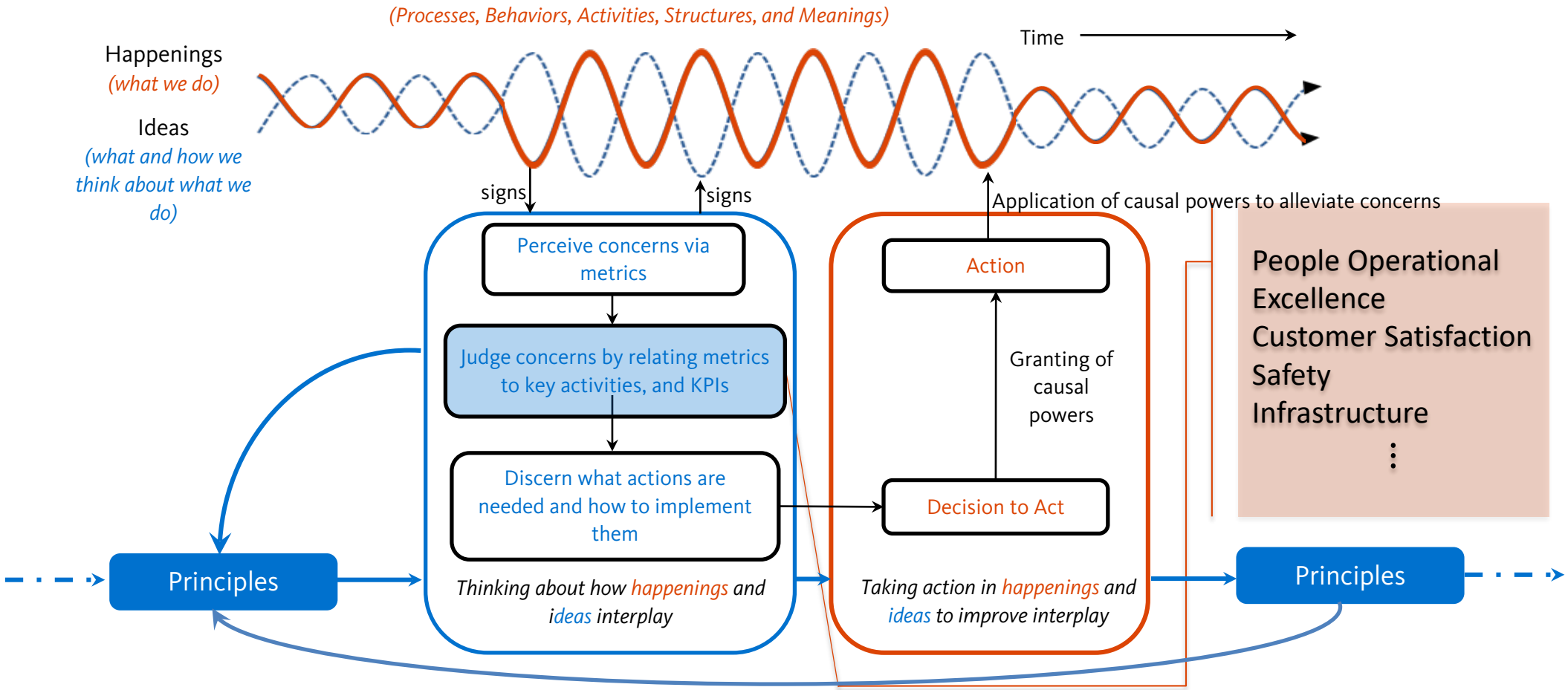

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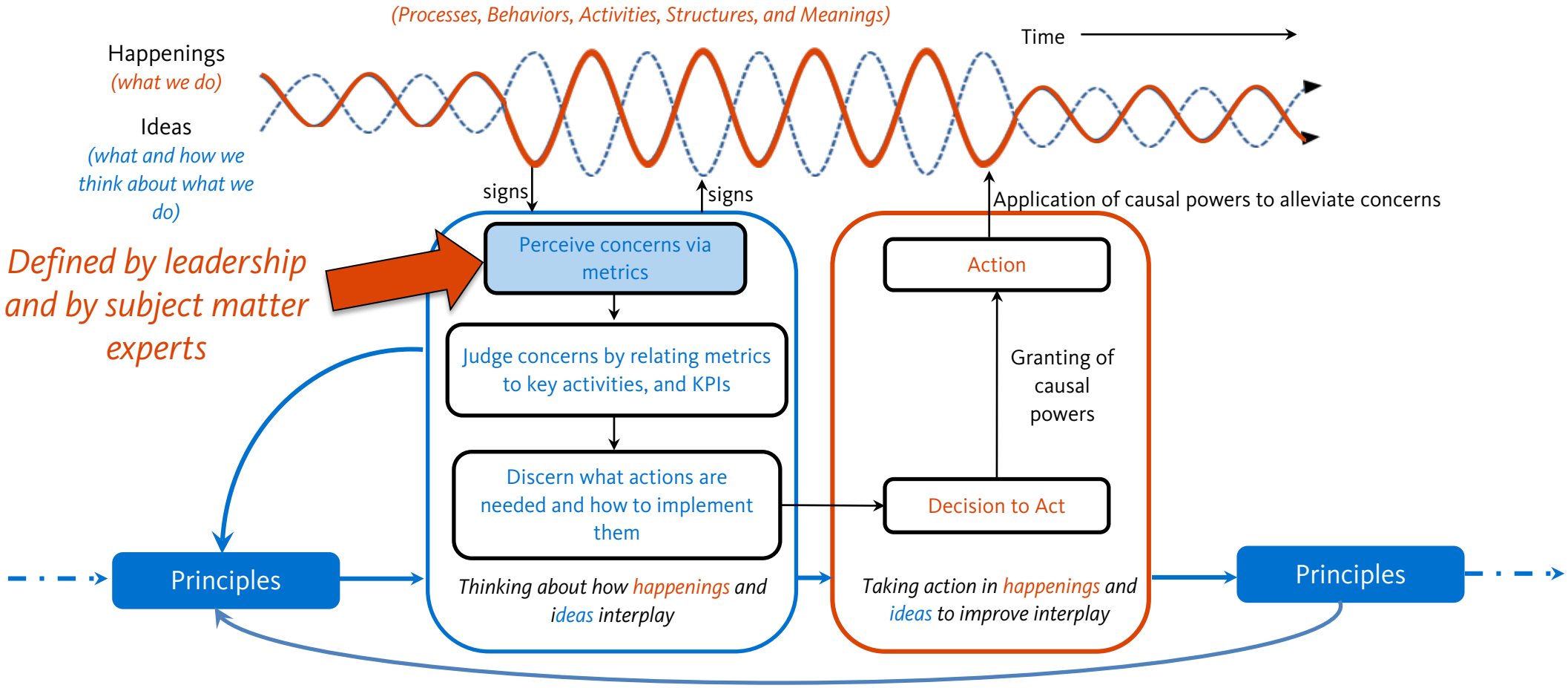
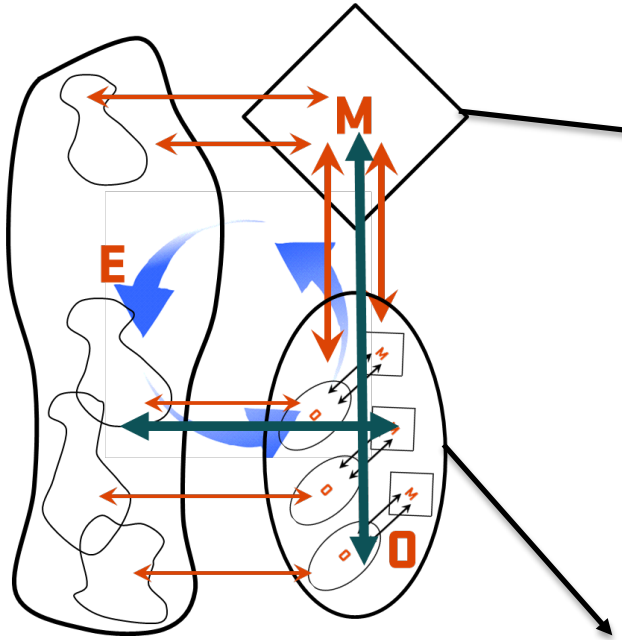
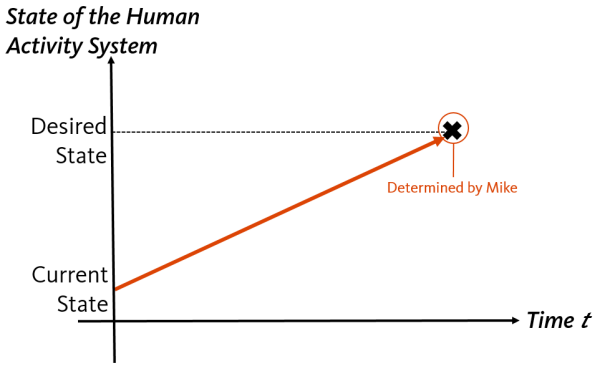


For Each KPI:



Overarching Key Activity

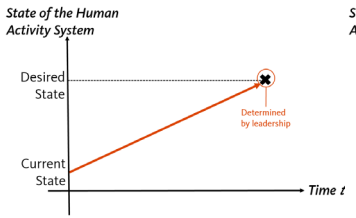
DFA-Wide Metric(s)



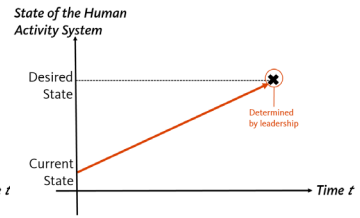
Leadership Council Level

Sub-Activity 1

Sub-Metric 1

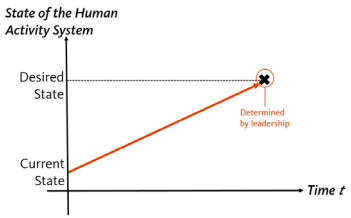


Sub-Metric 2



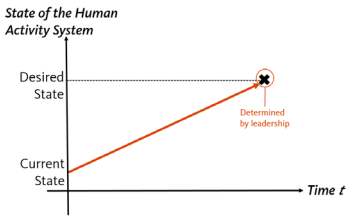
Sub-Activity 2

Sub-Metric 1

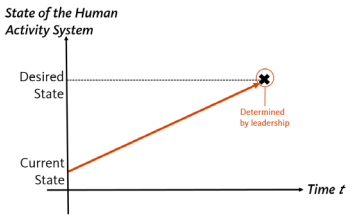


Sub-Activity 3

Sub-Metric 1



Sub-Metric 2



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Unit Level

For Each KPI:

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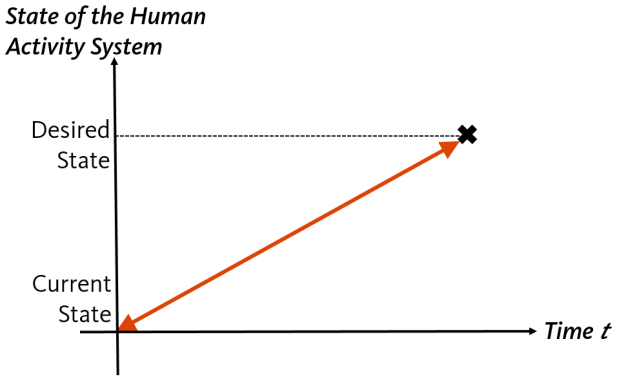
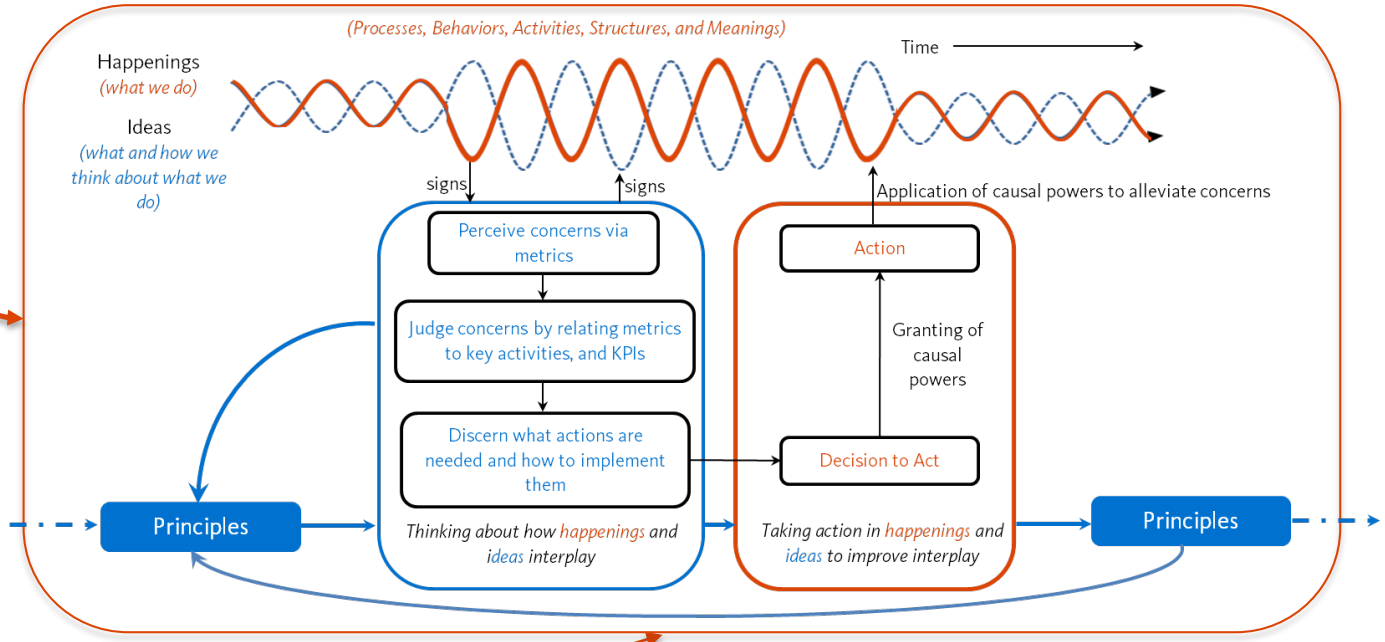
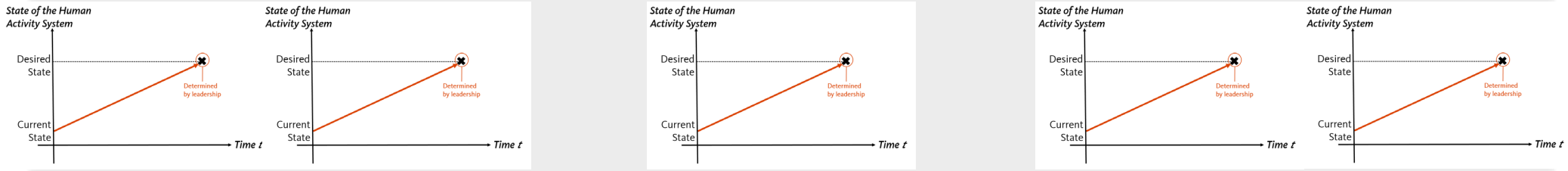
Overarching Key Activity

DFA-Wide Metric(s)





Sub-Metric 1 **Sub-Metric 2** **Sub-Metric 1** **Sub-Metric 1** **Sub-Metric 2**



For Each KPI:

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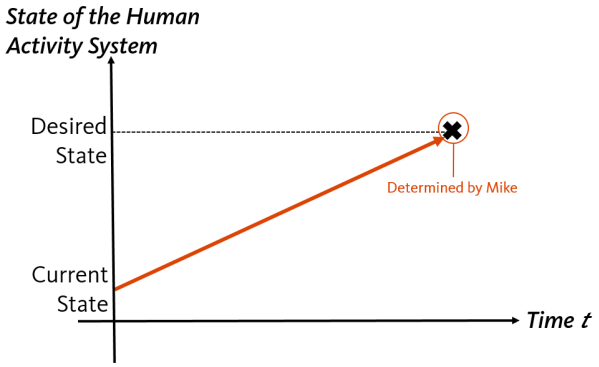
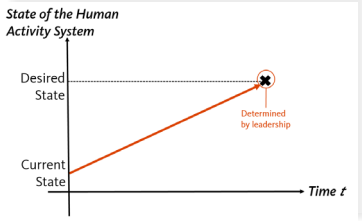
Overarching Key Activity

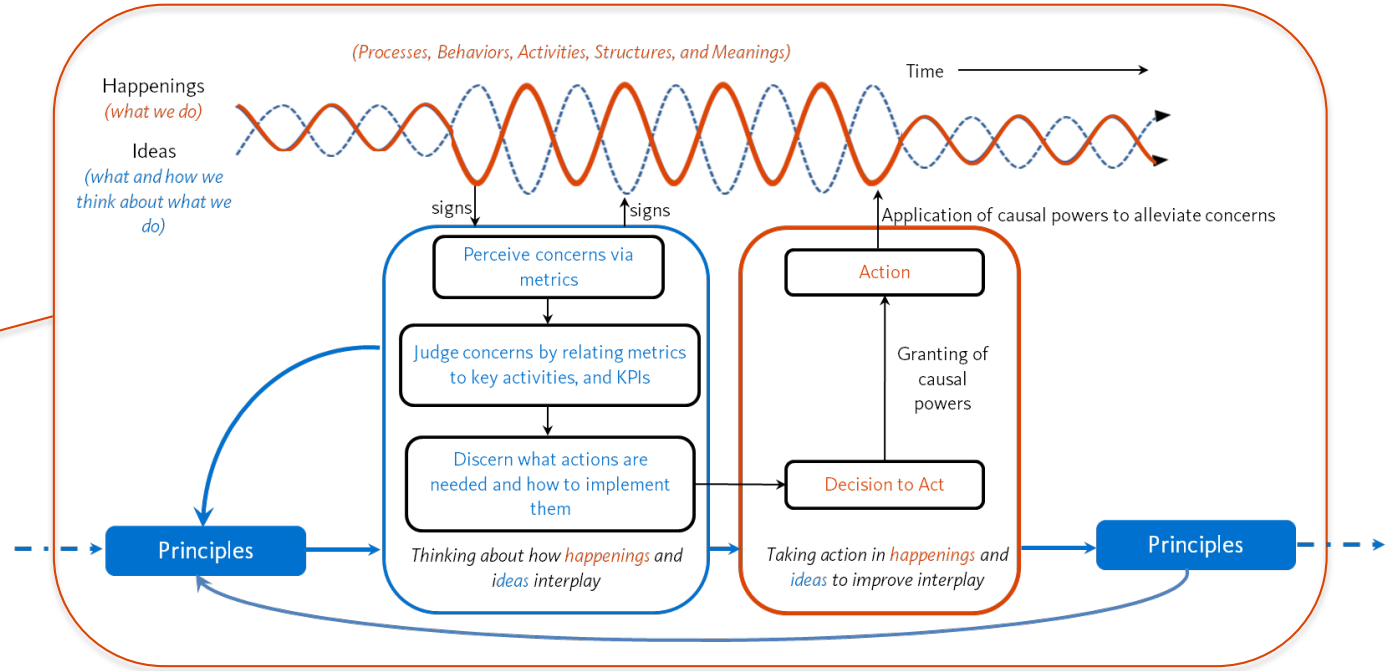
DFA-Wide Metric(s)



Sub-Activity 1

Sub-Metric 1





For KPI People:

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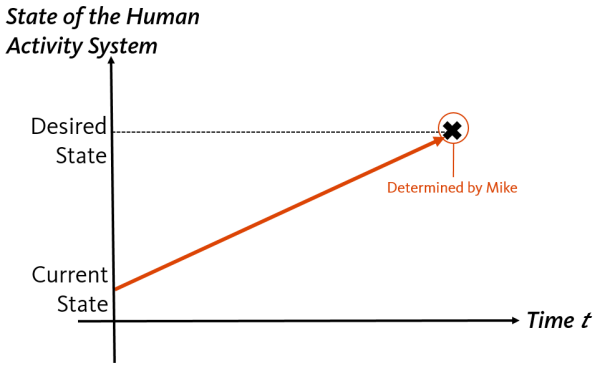
Promote and evaluate employee achievement

Training (frequency and relevance)



Leadership Council Level

Human Resources

Budget and Resource Planning

Risk Management

Promote and administer training policies

Resource allocation for training

Evaluation of risk mitigation through training

• • •

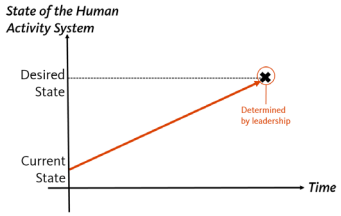
Outreach Percentage

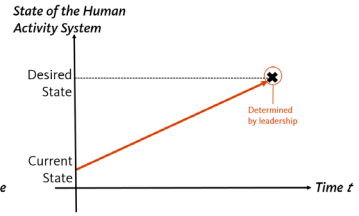
Policy Compliance Percentage

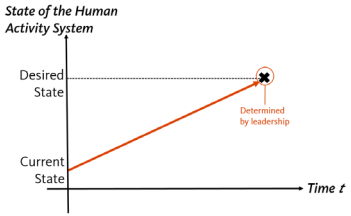
Frequency and relevance

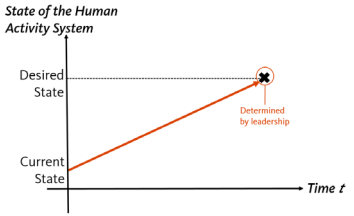
Effectiveness of training

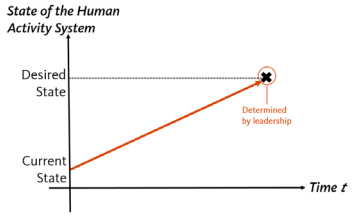
Risk potential











Unit Level

Normalization of metrics is necessary

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Change in System	Metric Level	While Improving	When Degradation Occurs
Evolution happens here *(We learn new things and how to do better things)*	Excels	Continued accomplished performance, evolution is possible	
	Accomplished	Meets activity's performance goal	Goals need revision, principles, KPIs, IT solutions may need revising
Adaptiveness happens here *(We learn how to do what we do differently and better)*	Emerging	Continue Operational Excellence, stabilize new process(es) in activity	Failed to stabilize new process(es) – new processes too rigid or not appropriate to meet activity's performance goal
	Developing	Operational Excellence required to improve activity's performance	Training not effective, Principles and KPIs not understood, metrics do not provide insights into activity's performance

A Purpose

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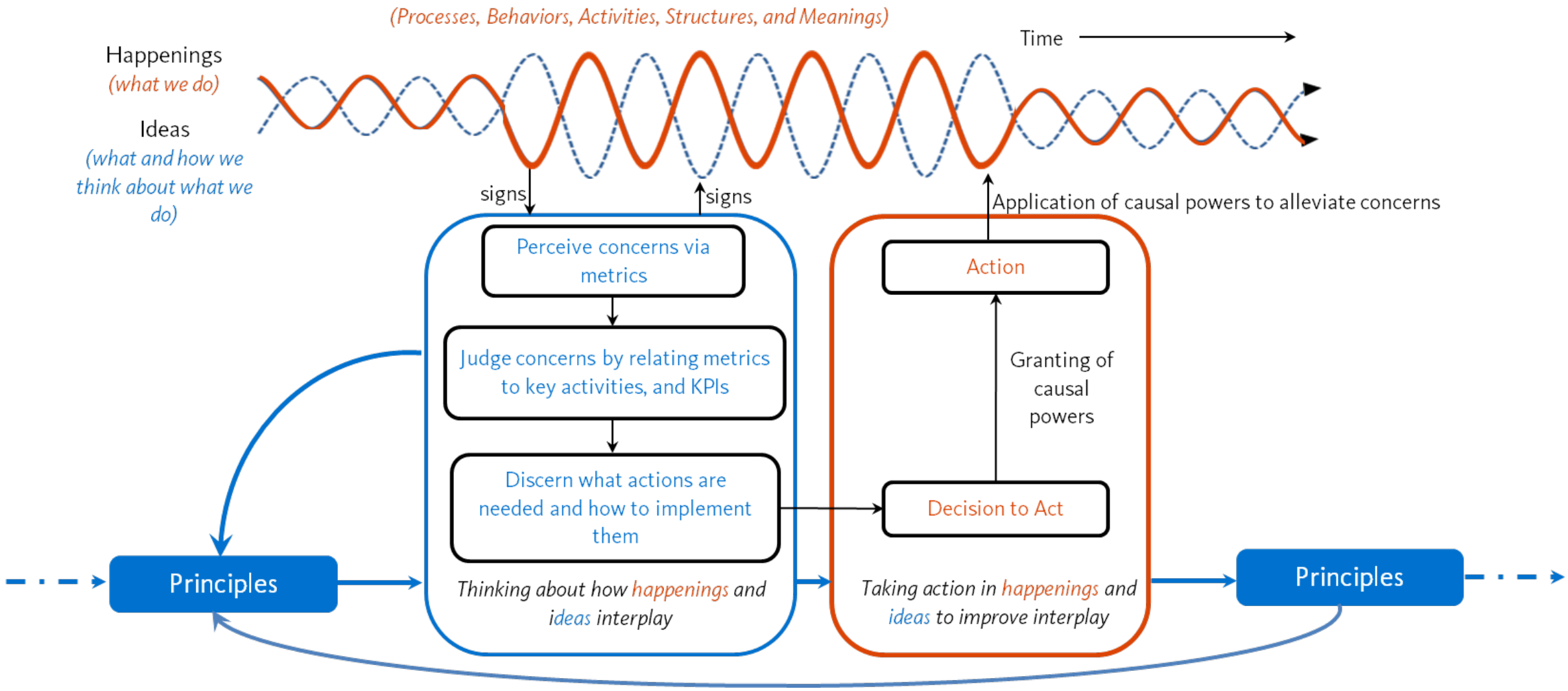

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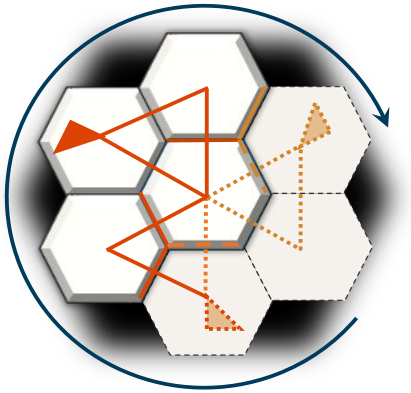
Systemic design of PHAS is possible by using key activities to balance control and autonomy



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Associate Professor of Industrial Engineering

Systems Science Working Group Chair