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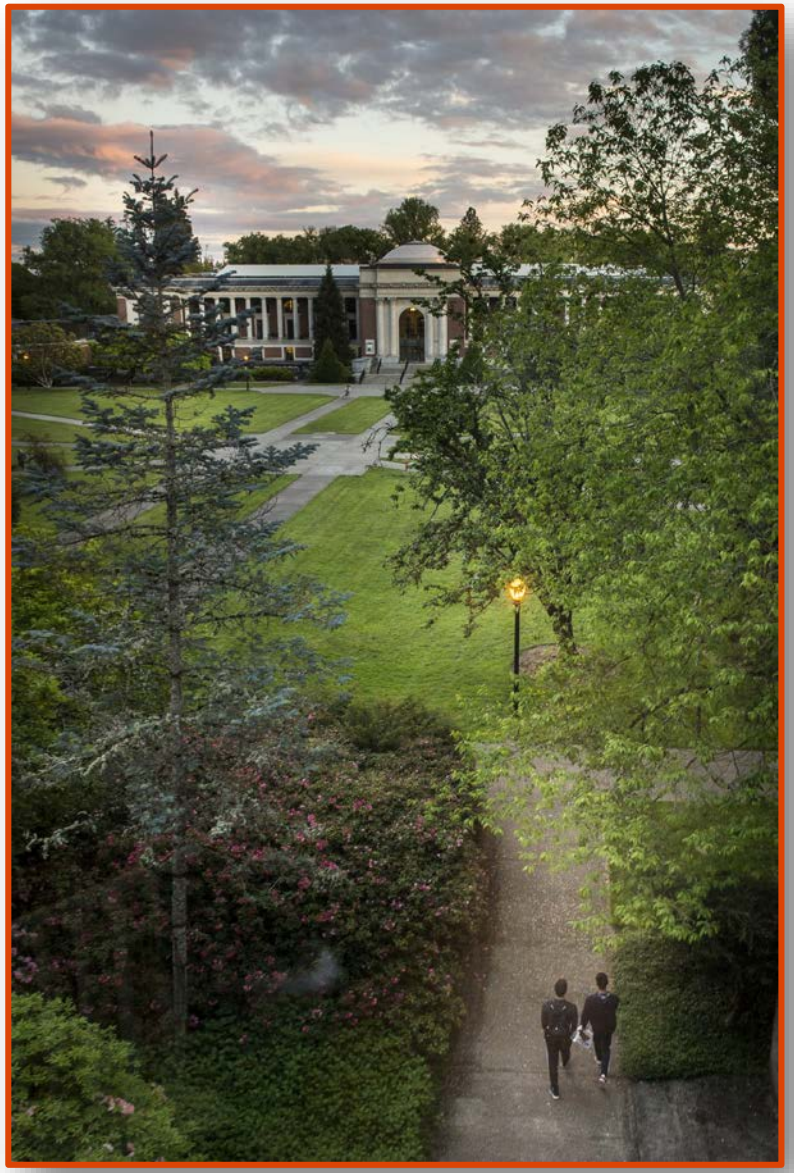
The Human Activity System: Emergence from Purpose, Boundaries, Relationships, and Context



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17th Annual Conference on Systems Engineering Research (CSER)

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Agenda

SE Challenge
Human Activity System
Specialized Principles

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SE Challenge

Human Activity System

Specialized Principles

Challenges in Systems Engineering

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- Systems engineering is a human activity that:
  - engineers complex systems;

Challenges in Systems Engineering

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- Systems engineering is a human activity that:
  - engineers complex systems;
  - realizes complex systems;

Challenges in Systems Engineering

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- Systems engineering is a human activity that:
  - engineers complex systems;
  - realizes complex systems;
  - manages complex engineered systems.
- Human activity systems, therefore, are central in SE.

Challenges 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.
  - Yet, there is still a need to further understand how systems engineers think about what they do.
- This presents the opportunity to develop a more specialized set of principles that can shed some light into how to design, realize, and manage human activity systems within a SE context.

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SE Challenge

Human Activity System

Specialized Principles

Key Insight

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- A human activity system feeds from and influences culture.
  - This is supported by the three general systems science principles proposed by Rousseau (2018):
    1. Conservation of Properties
    2. Universal Interdependence
    3. Complexity Dominance

Rousseau, D. (2018). Three general systems principles and their derivation: Insights from the philosophy of science applied to systems concepts. In Disciplinary convergence in systems engineering research (pp. 665-681). Springer, Cham.

Principle 1 – Conservation of Properties

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- Emergent properties are exactly paid for by submerged ones.
  - This principle is relevant for human activity systems because:
    - It captures the relationship between a human activity system's emergent processes, behaviors, structures, and/or meanings and its parts' submergence of their interactions, capabilities and boundaries, as the stability of the emerging system is achieved.

Principle 2 – Universal Interdependence

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- System properties represent an exact balance between bottom-up emergence and outside-in submergence.
  - This principle is relevant for human activity systems because:
    - The second principle acknowledges that human activity systems are part of higher domain systems that influence the potential the system of interest possess.
    - This means that when designing human activity systems we need to account for two explanatory arrows:
      - one (going from the parts towards the boundary) for the bottom-up emergence
      - one (coming from the environment towards the boundary) for outside-in submergence

Principle 3 – Complexity Dominance

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- The impact of submergence on a part is proportional to the complexity differential between the part and the whole .
  - This principle is relevant for human activity systems because:
    - Establishes that a system's potential and what is subtracted by the higher-order system are not always equivalent.
    - In addition to the explanatory arrows that explain emergence/submergence internally and contextually (as in Universal Interdependence), these arrows can differ in size (power) due to complexity differentials between system and higher-order system.
      - The complexity differentials can be of kind or degree.

Bottomline

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- Human activity systems emerge from individuals coming together and suppressing certain behaviors that do not match a team environment;
  - the same behaviors are again expressed as soon as individuals leave a team environment.
- The higher-order system also influences the potentials of teams
  - e.g. site regulations, organizational culture, etc.
  - however, human activity systems can exert considerable influence on their environments if their behavior, capability, and structure are capable of overcoming the subtracting influences from the higher-order system.

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SE Challenge

Human Activity System

Specialized Principles

Human Activity Systems Concepts

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General Inquiry Component	Information Component Questions	Human Activity Systems Concepts
Ontology of human activity systems	What are human activity systems? How can we recognize a Human activity system?	Boundaries, relationships, process, context, perspective (weltanschauung), concrete, conceptual, parts, structure, emergence, interdependence.
Metaphysics of human activity systems	What is the nature of a human activity system? What makes a system a human activity system?	Concrete, abstract, emergent properties and meanings, submergence, interdependence, entropy.
Cosmology of human activity systems	How do human activity systems arise and evolve? How are human activity systems organized? How do they change?	Physical systems, sapient systems, socio-technical systems, conceptual systems, systems of systems,, goal seeking, transitions (transformation), self-organization, evolution, homoerhesic, homeostatic.
Axiology of human activity systems	Why are human systems important to systems engineering practice? What makes a good human activity system?	Effective, efficient, efficacious, ecological, robust, resilient, agile, evolvable, coherent, productivity, external compatibility.
Praxeology of human activity systems	What is the purpose of a human activity system? How is its purpose achieved?	Concrete purposes: survival, competition, evolution, transformation, innovation, learning. Conceptual purposes (meanings): persuasion, motivation, anticipation,
Epistemology of human activity systems	How do we know a human activity system is successful? How can we obtain knowledge about human activity systems?	Model and principles; isomorphisms, system analysis, measure of success.

Human Activity System - Definition

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- According to Sillitto, a system is

> *"a persistent region of low entropy (= high organisation) in physical or conceptual space-time."*

- In systems engineering practice engineers deal on a daily basis with a special kind of conceptual system
  - we form teams and interact with colleagues while belonging and acting within the culture of an organization.

Human Activity System - Definition

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- Successful human activity systems are:
  - Stable systems with low entropy that maintain a tractable progress trajectory to achieve their goals (purpose).
    - 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.

Human Activity System - Definition

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- Human activity systems have interrelationships between concrete and conceptual parts that exhibit persistent structures, processes and meanings.
  - Parts interrelations are determined by the kind, capability, and structure of the human activity system.
  - And because the explanatory arrows point both ways, the kind, capability, and structure of the system are influenced by the parts interactions depending on their degree of concreteness vs. degree of abstraction.

Human Activity System - Definition

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- Relevant principles for kind, capability, and structure:
  - Human activity systems have parts
    - The parts can be conceptual and concrete
    - The parts interrelate to produce persistent structures, processes, and meanings
    - The parts interrelations are conditioned by the kind, capability, and structure of the human activity system

Concrete parts: People, computers, software, furniture, whiteboards, etc.
Conceptual parts: Beliefs, theories, perceived value of work, organizational culture, camaraderie, etc.

Persistent structures: computer vs. user interaction, user interfaces, office layout, furniture, etc.
Persistent processes: communication, design process followed, decision making process, regulations, etc.
Persistent meanings: perceived value of work, organizational culture, team camaraderie, theoretical foundations used, etc.

System kind: in-person, interdisciplinary, multimedia environment (computer, whiteboards, etc.)
System capability: level of expertise, technical knowledge, technology available, etc.
Parts interrelations: social and concrete networks and communication channels

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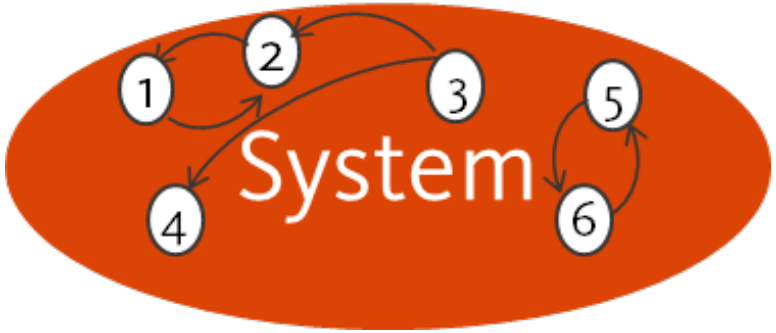

Human Activity System - Purpose

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- Systems can exist to have meanings, functions and/or purposes
- 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. Delimiting a system's capability and structure, and
    3. Acting as a subtracting agent to the potential emergence.

Human Activity System - Purpose

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- Relevant principles for purposeful human activity systems:
  - Human activity systems exist to fulfill a purpose or a set of purposes
    - Human activity systems possess inherent causal powers to fulfill their purpose
    - The human activity system design is commensurate with its purpose
    - Human activity systems are aware of their purposes, and pursue them intentionally

Purpose: design a multipurpose and modular high-tech widget.

Causal powers: technology, knowledge, and design decision authority are present.

Commensurability of purpose: Experienced engineers possess sufficient experience to make design decisions; technology provided assist decision making.

Purpose awareness: purpose of team is communicated clearly and acknowledged by team.

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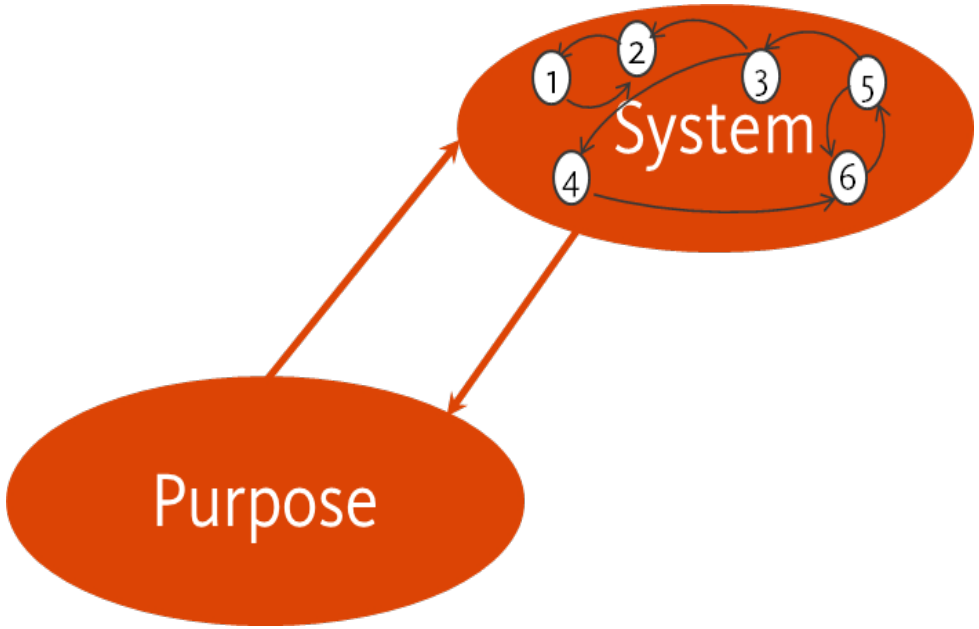

Human Activity System - Boundaries

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- Thinking about *open* and *closed* systems is useful when conceptualizing real life systems because it offers conceptual tools to assist SE endeavors.
- The notion of systems openness – or closedness – is particularly useful when human activity systems are of concern, as human activity systems don't operate in isolation, they occur within macrosystems, and information exchanges within and between them need to be considered in their design.

Human Activity System - Boundaries

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- Relevant principles for determining system boundaries:
  - A system mediates its interactions with its environment through its boundary
    - A system submerges to its environment
    - A system influences its environment

Concrete boundaries: beyond people involved; servers hosting software and data, office walls.

Conceptual boundaries: repository of knowledge, organization team belongingness, etc.

Submergence: team members focus on task and role at hand. Other roles and tasks are formally suspended while working with team.

Environment: if modifications to decision making processes are found, experience engineers can enact changes in organizational procedures and regulations.

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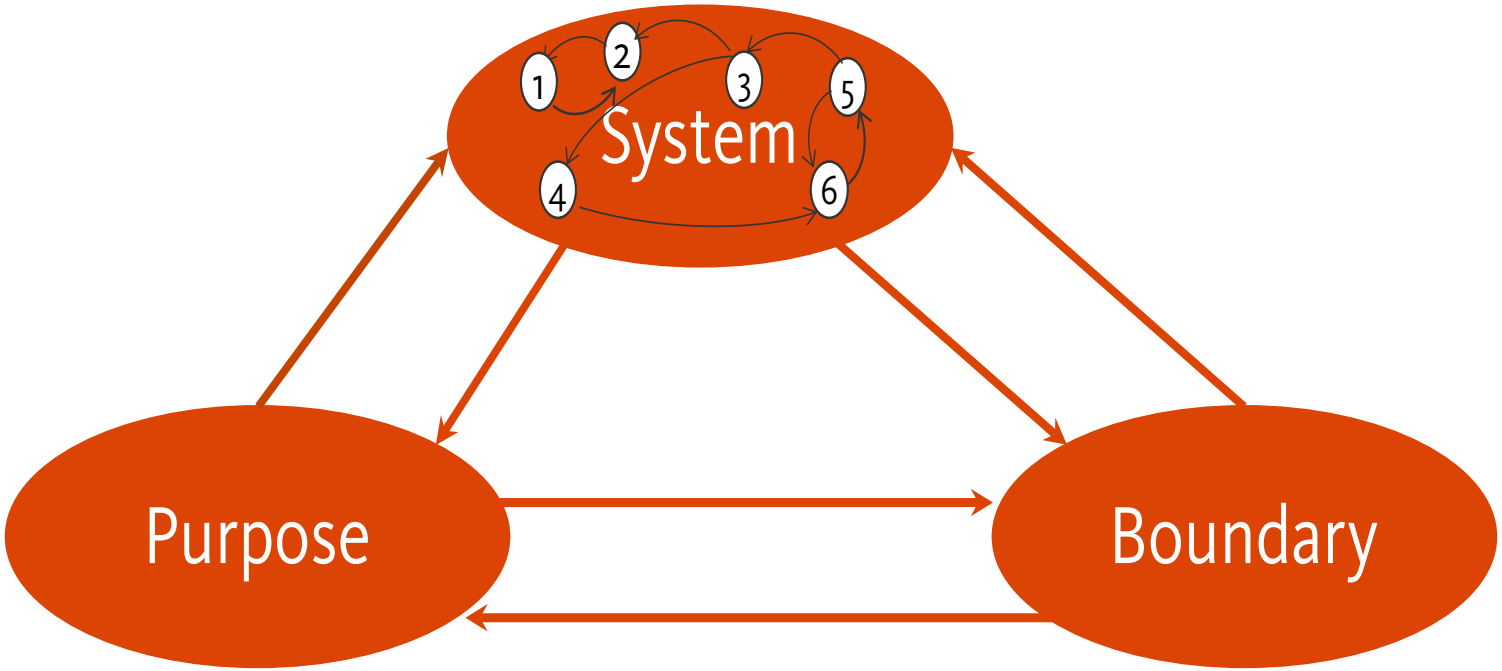

Human Activity System - Relationships

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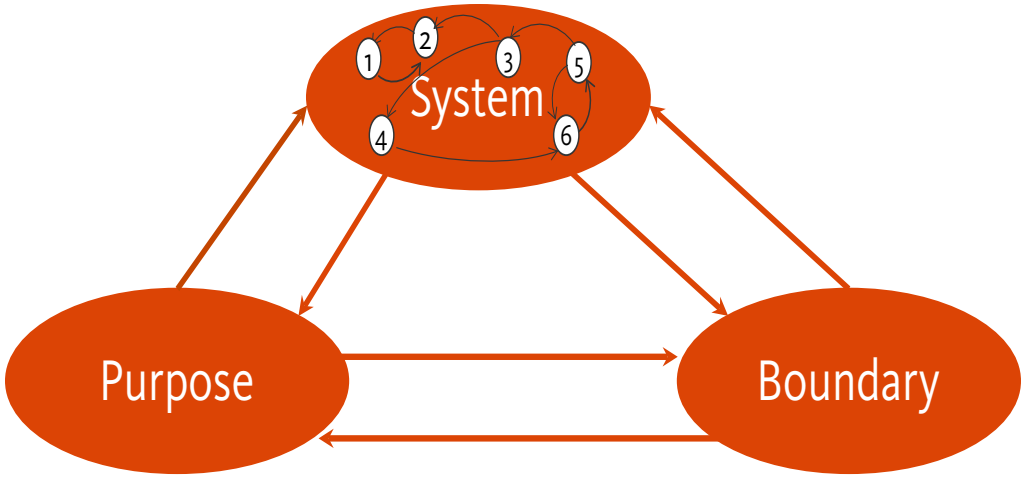
- In addition to there being a two-way relationship potential between the parts of the system and its purpose and between the boundary and the parts of the system,
  - there is a two-way relationship between the human activity purpose and the boundary.
  - In an activity system, its parts (e.g. humans, machines, software) interrelate among themselves, but also with the purpose and boundary.



Human Activity System - Relationships

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- The relationships between system, purpose and boundary give rise to a system's structure but are also delimited by the parts capabilities and the environment they are embedded in.
- Therefore, the kind and magnitude of the relationships need to be commensurate with the human activity system's purpose, boundaries and capabilities of the system and its parts.

Human Activity System - Relationships

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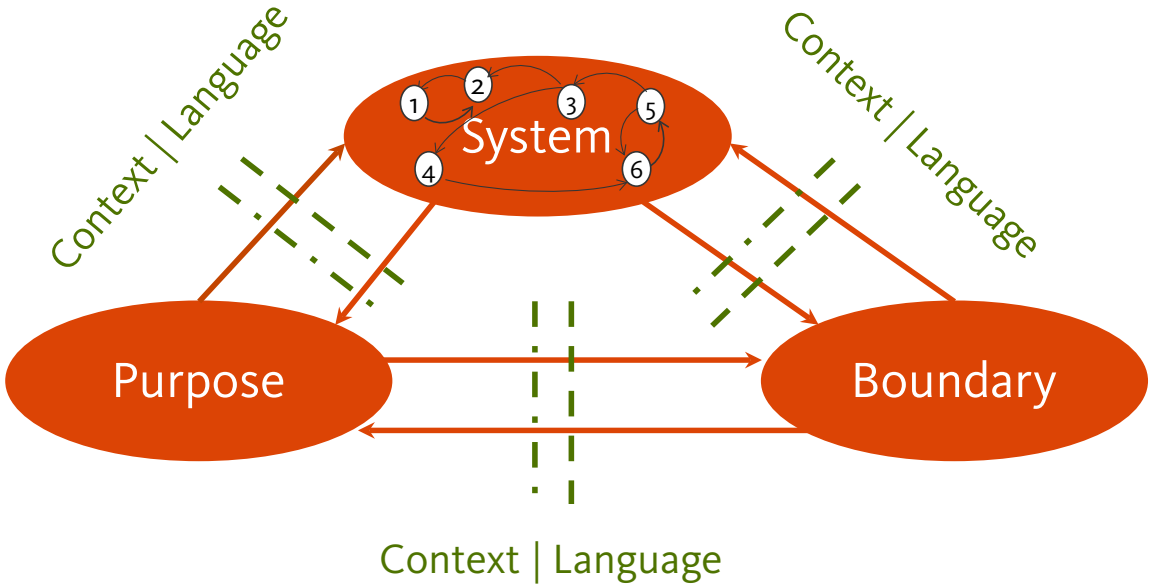
- The meaning of a human activity system can be different to different stakeholders depending on their interpretation of the context and their language proficiency level.
  - Vickers states that the context determines the morality of the purposeful activity
    - Thus, having an impact on the two-way explanatory arrows by determining the magnitude of the influence that purpose has on the parts of the system and vice-versa



Human Activity System-Relationships

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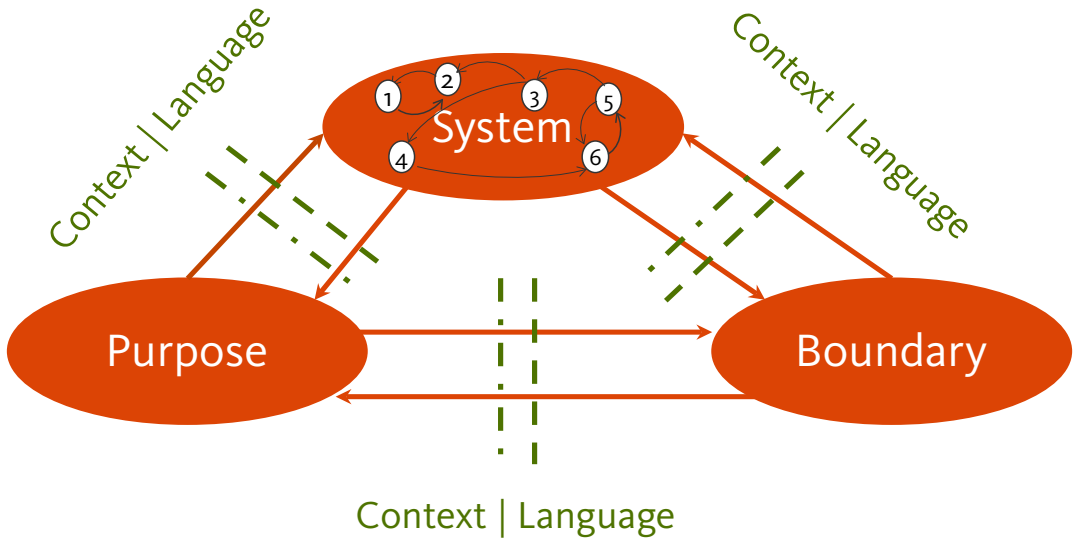
- A similar process happens between the parts of the system and the boundary and between the purpose and the boundary.
  - The degree in which the language adopted to control information flow within the human activity system is understood by all the parts of the system affects the nature of the two-way relationships
    - In other words, when there is no unified technical knowledge, terms might be related to different concepts and even definitions by different stakeholders.



Human Activity System - Relationships

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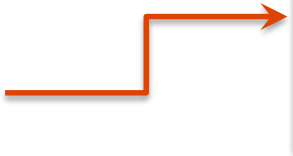
- Relevant principles for defining system relationships:
  - Context and language modulate the relationships in a human activity system
    - The magnitude and kind of the two-way relationships between the parts of the system, purpose, and boundary vary according to the context



Context: The organizational structure is a loosely-coupled organic network, where each team possesses freedom and flexibility to organize and disband.

    - The magnitude and kind of the two-way relationships between the parts of the system, purpose, and boundary are attenuated by the language used

Language: being a transdisciplinary team, team members are not accustomed to each other's technical terminology, complicating effectiveness of interrelations between members, their boundaries, and pursue of purpose.

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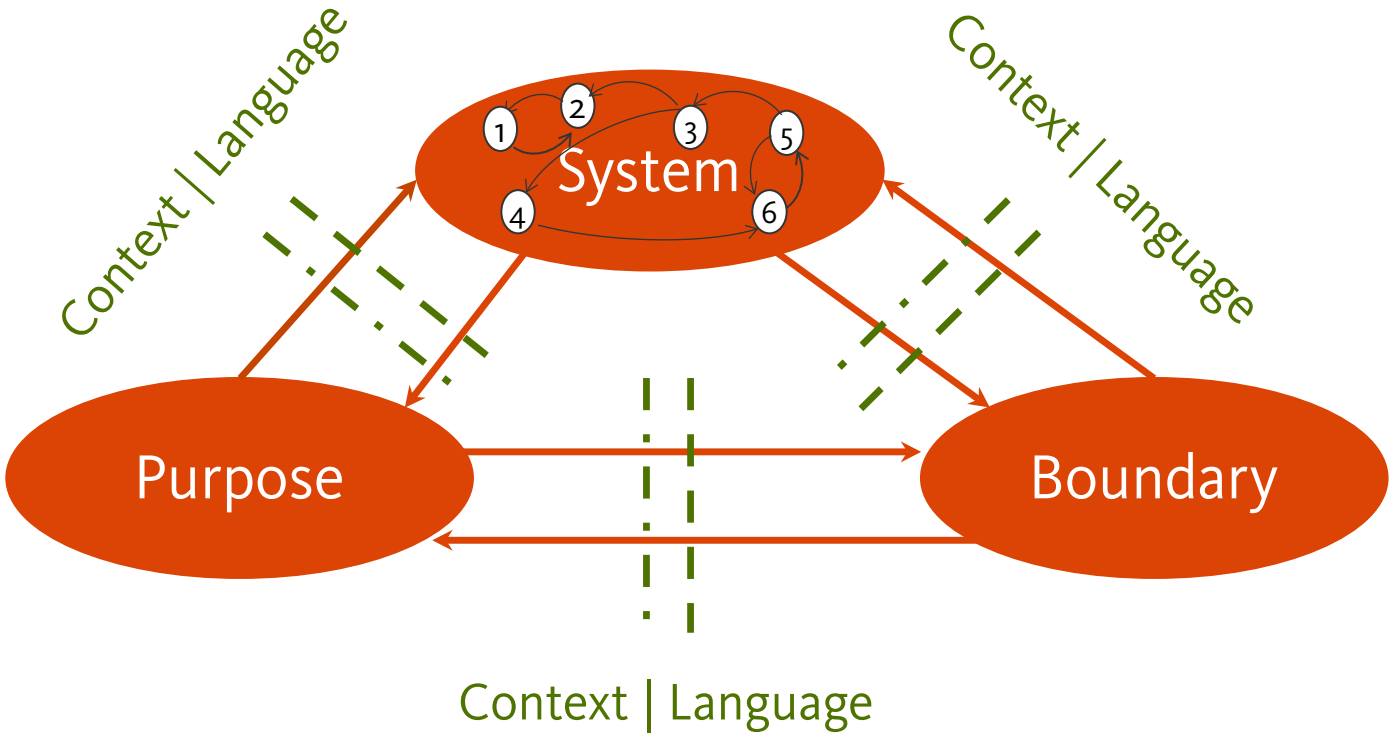

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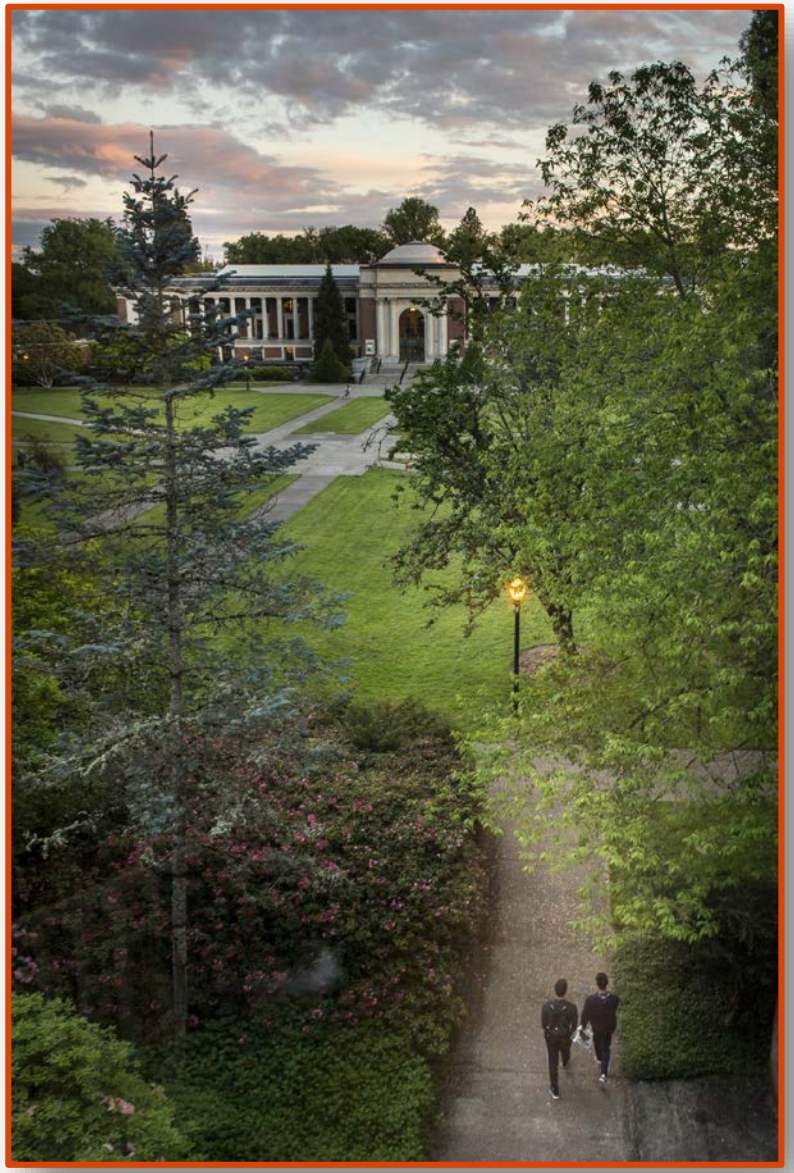

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