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Sustainability: A Complex System Governance Perspective

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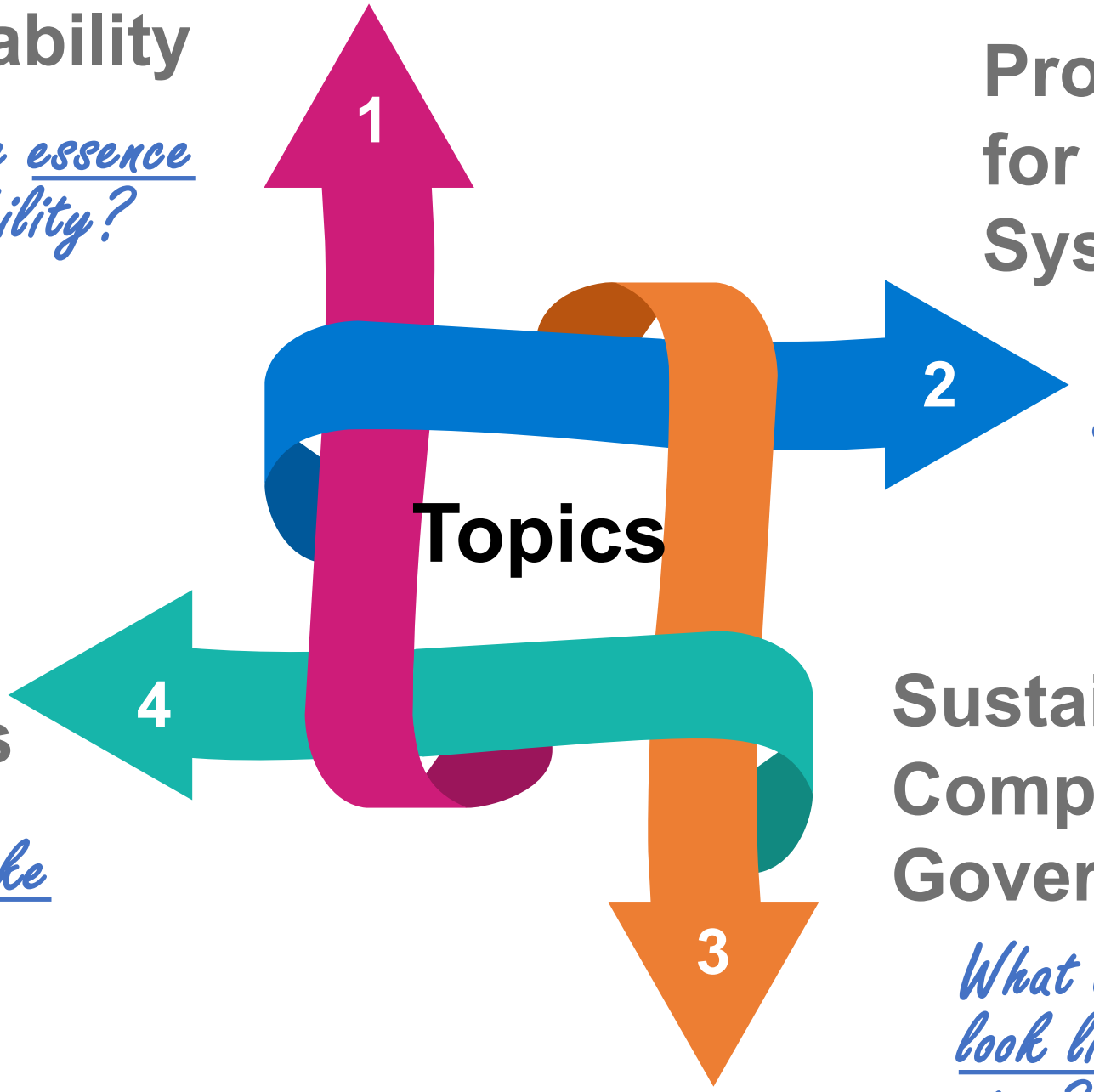
Sustainability

What is the essence of sustainability?



Problem Domain for Sustainable Systems

What must sustainable systems contend with?

Challenges and Directions

Where can CSG take sustainability?

Sustainability: A Complex System Governance View

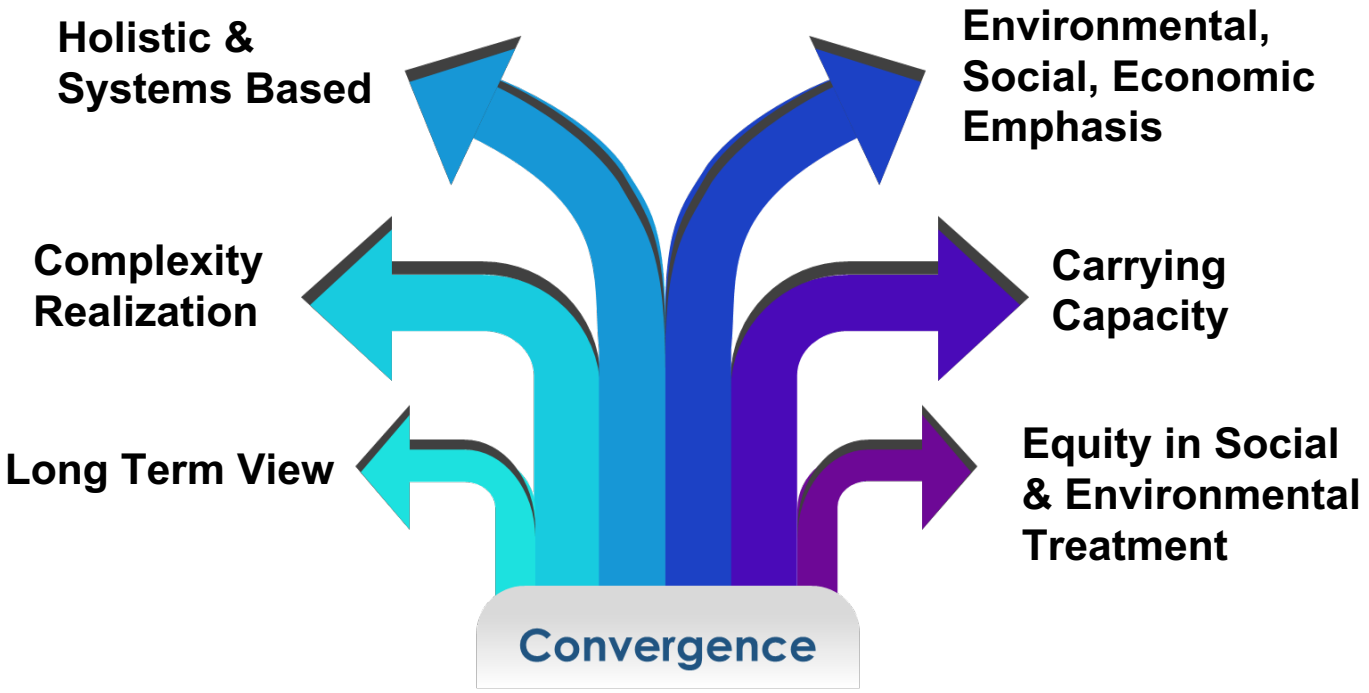
What does sustainability look like from a systems view?

Sustainability

What is Sustainability?

Sustainability: "meeting the needs of the present without compromising the ability of future generations to meet their own needs." (United Nations, 1987)

- Multitude of perspectives, definitions, and themes – 500 definitions as of 2012
- Fragmented viewpoints
- Strong concept, multiple perspectives, absence of Systems Theory formulation
- Some general convergence across the literature



What is System Sustainability for our present purposes?

Byproduct of an executed system design

System Sustainability: "an outcome-based product resulting from effective governance of an underlying system which produces sustainability." (Keating et al., 2023)

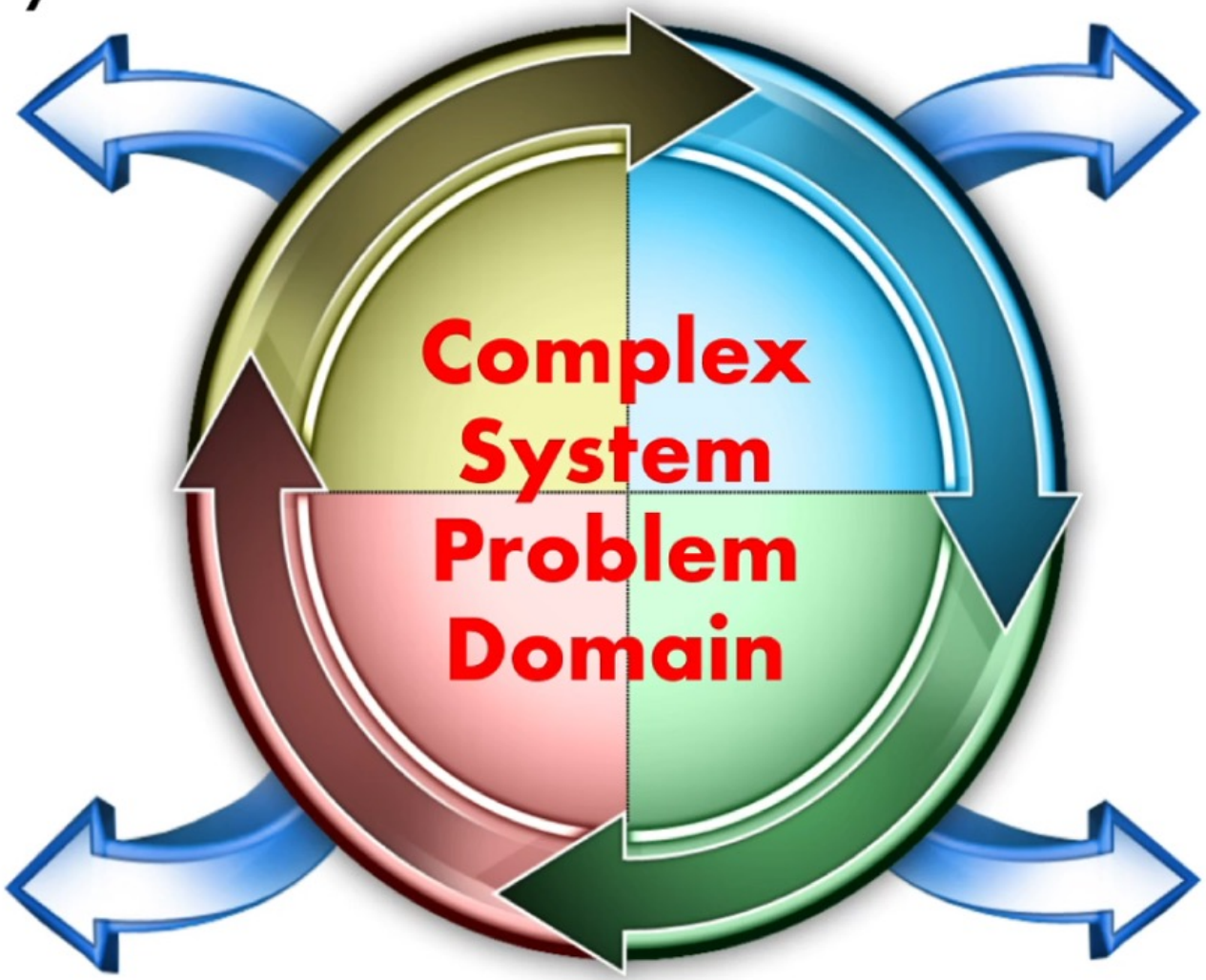
Provision of system direction, oversight, and accountability responsible for producing sustainability

Systems engineered product, where execution of system design produces and maintains sustainability over the system life cycle

Problem Domain for Sustainable Systems

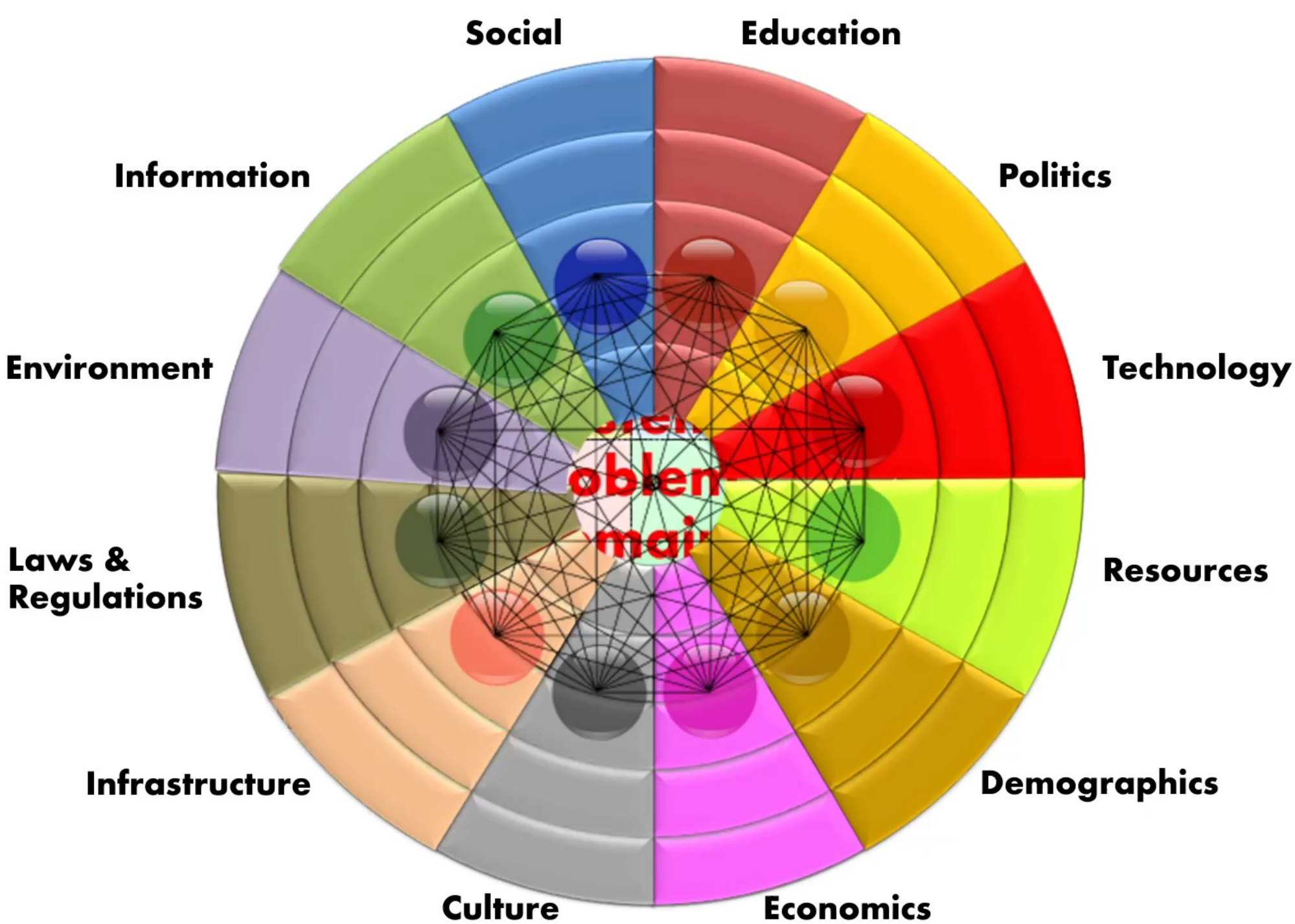
Extreme Uncertainty

Complexity



Holism

Ambiguity


Social
Education
Information
Politics
Environment
Technology
Laws &
Regulations
Resources
Infrastructure
Demographics
Culture
Economics

Conflicting Perspectives

Divergent Stakeholders

Instabilities

Shifting Demands

Politically Charged

Emergent Situations

Unintended Consequences

Lack Sufficient Information

Unstable Resources

High Uncertainty

Unclear Entry Point

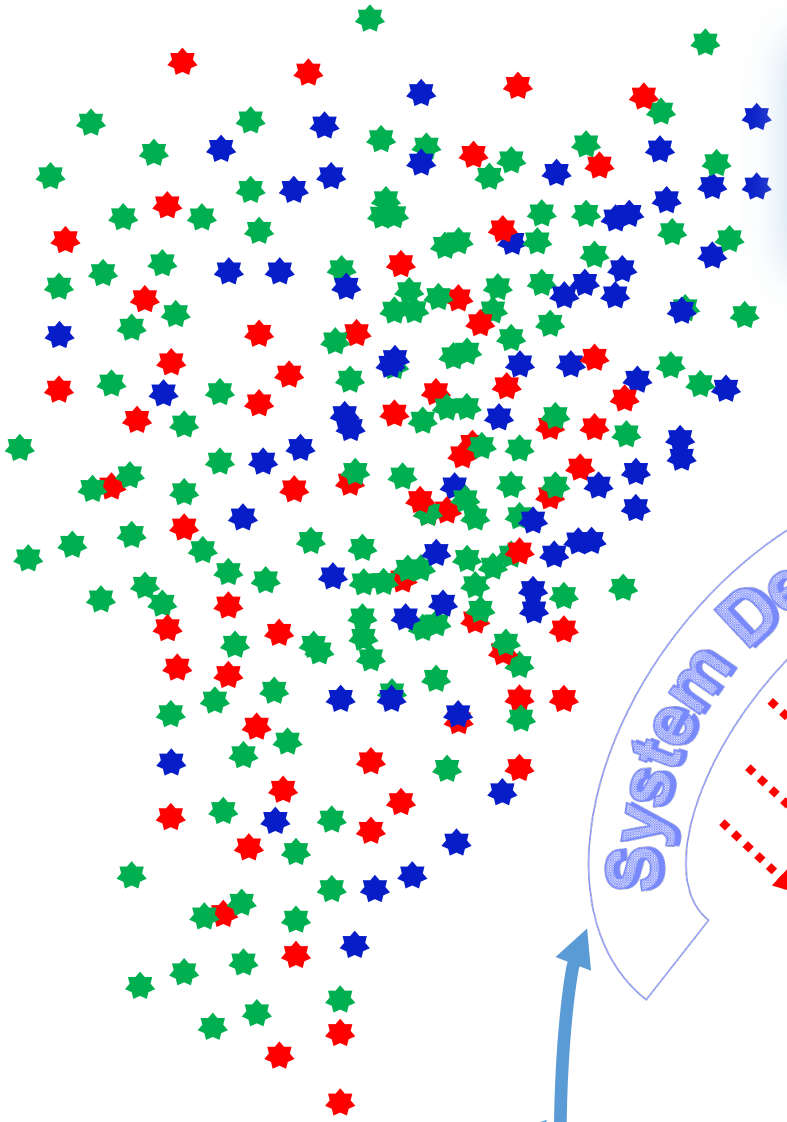
Solution Urgency

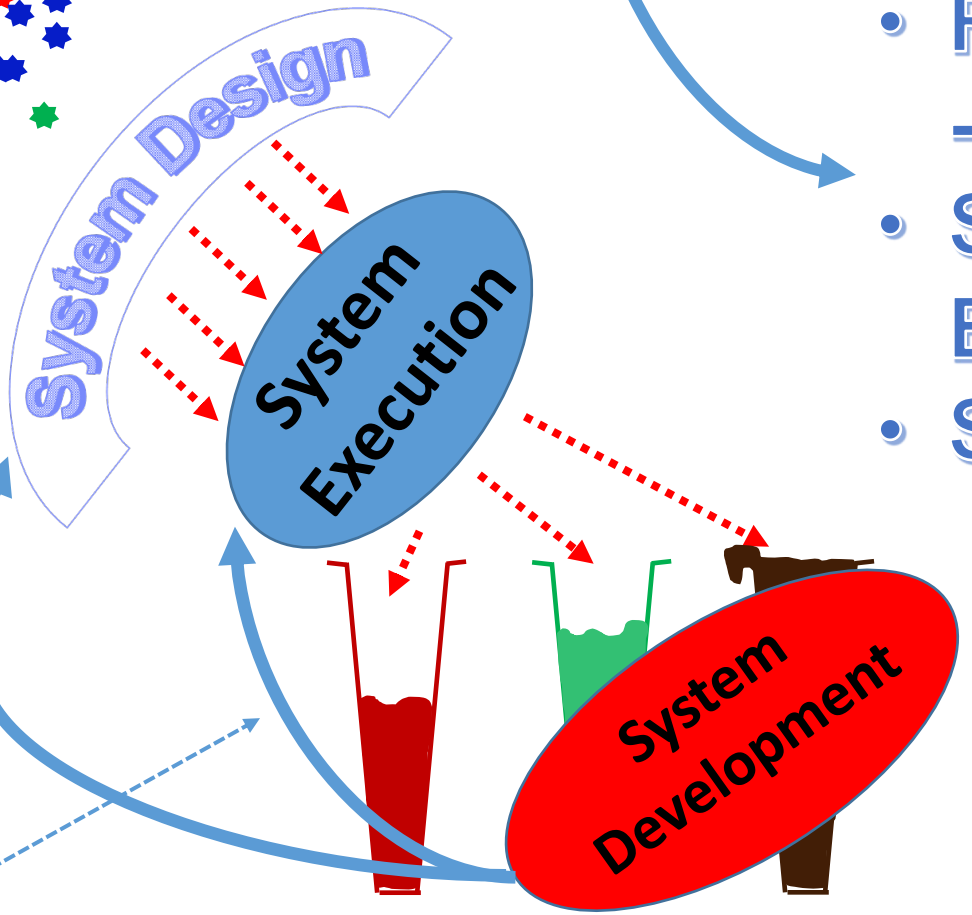
Misinformation/Defensiveness

Ambiguous Boundaries

Sustainability: A Complex System Governance View

Sustainability: A Systems View





- Viability
- Requisite Variety - Matching
- Systems Variety Engineering
- SE Product

Second order sustainability (double-loop) learning

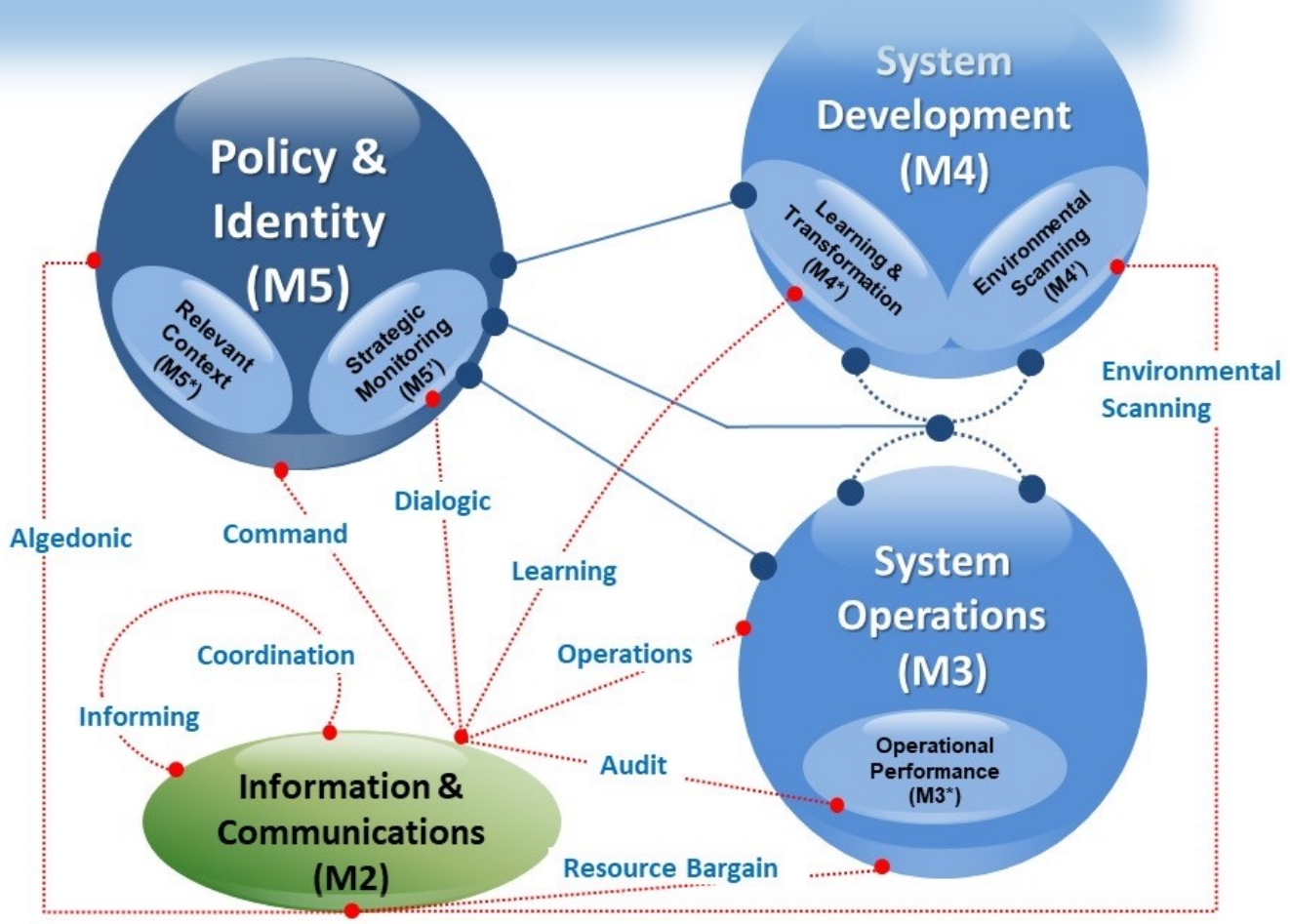
First order sustainability (single-loop) learning

Complex System Governance

*CSG – "the design, execution, and evolution of the [nine] metasystem functions necessary to provide control, communication, coordination, and integration of a complex system."

Perspectives:

- All systems perform nine interrelated functions and communication channels to maintain viability
- Functions are performed by mechanisms subject to Systems Theory propositions
- Violations of system propositions produce pathologies (aberrations from normal/healthy system conditions)
- System performance can be enhanced through purposeful development of system functions and addressing their pathologies



*Keating, C. B., & Katina, P. F. (2019). Complex system governance: Concept, utility, and challenges. *Systems Research and Behavioral Science*, 36(5), 687-705.

9 Metasystem Functions

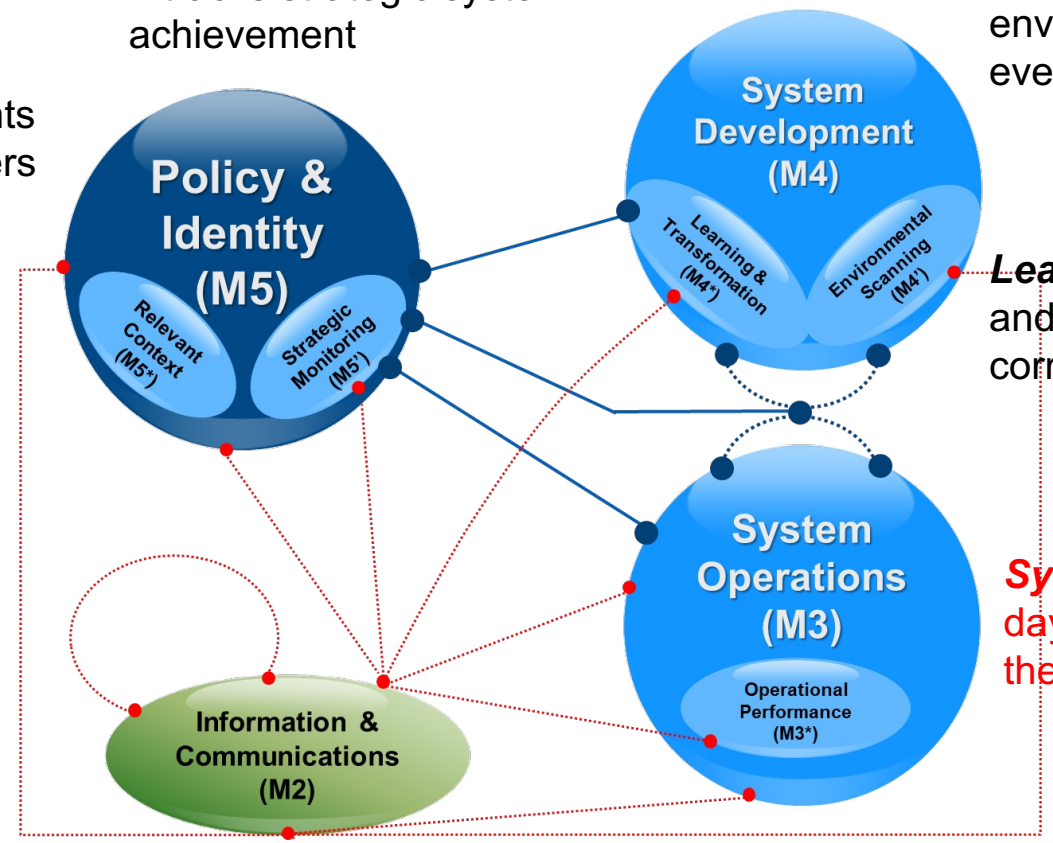
Policy and Identity –steering, direction and identity for the system

System Development – long range future development to ensure future viability

Strategic System Monitoring – tracks strategic system achievement

Environmental Scanning -- sensing the environment for trends, patterns, or events with system implications

System Context – accounts for 'soft' constraints/enablers



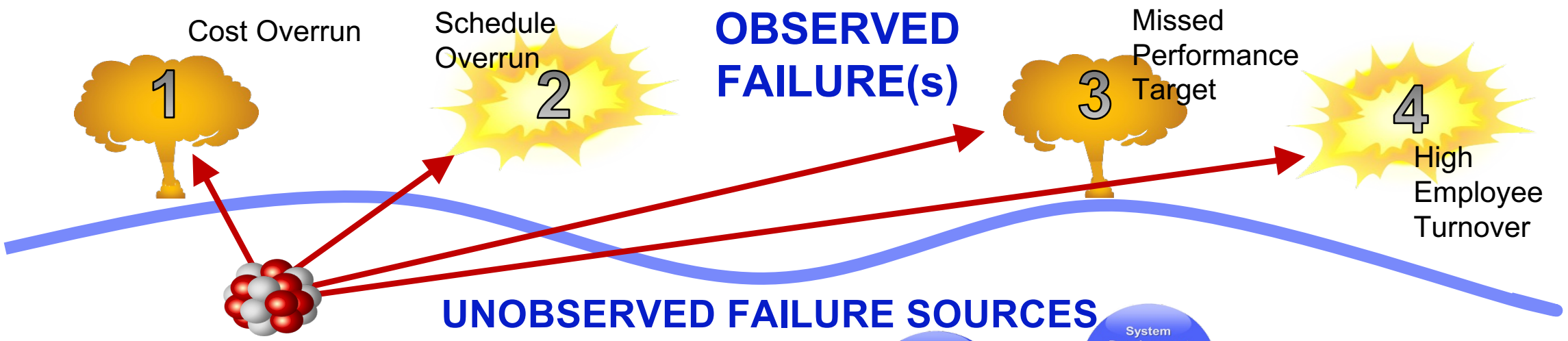
Learning and Transformation -- detection and correction of system design errors on correction of design errors

System Operations – day to day operation of the system

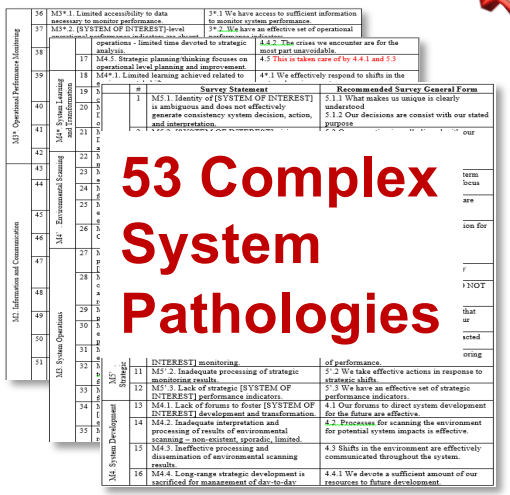
Information & Communications – flow and interpretation of information

Operational Performance –monitoring system performance to expectations

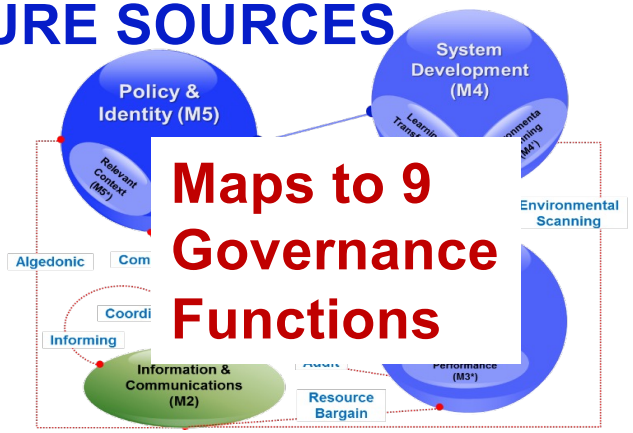
Complex System Governance - Relationships



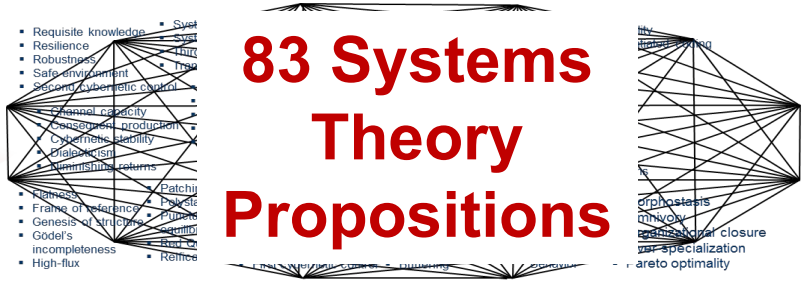
Same underlying system pathology appears as 'different' surface issues



53 Complex System Pathologies

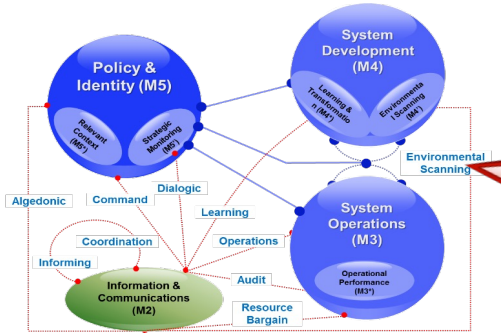


Maps to 9 Governance Functions



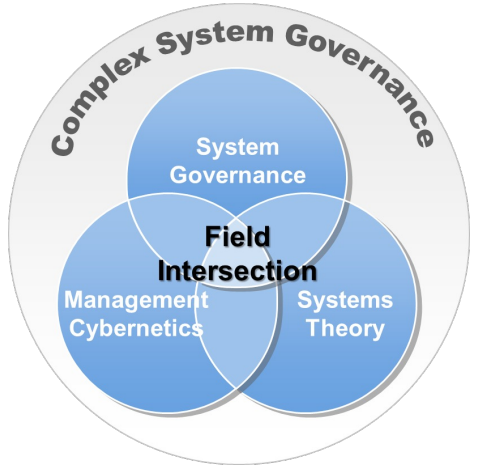
83 Systems Theory Propositions

Four CSG Contributions to Sustainability



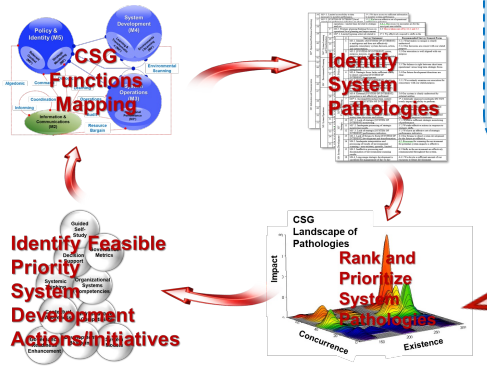
MODEL DRIVEN
Reference model defining functions and communication channels

THEORETICAL GROUNDING
Systems Theory as the conceptual foundation for sustainability



RIGOROUS APPROACH
Methodologically sound approach to design, execution, and development

DEVELOPMENT FOCUSED
Focused on purposeful engineering of sustainability as a product



Stage 1 – Initialization
Frames the current state of CSG, including the system of interest and context

Stage 2 – Development Mapping
Sets the priorities, feasibility, and capacity for CSG development expectations

Stage 3 – Development
Selects the activities, deployment design, and execution to improve state of CSG

Challenges and Directions

Challenges and Directions

Challenges

- Mindshift – Sustainability as a ‘systems engineered product’
- Overcoming fixation on short term, easy, and immediate
- Threat to the ‘Status Quo’
- Challenging the “In addition to” syndrome with rigorous self-study

Directions

- Making CSG Accessible for practitioners
- Building support tools, methods, and technologies
- Business case proposition – bottom line value
- Non-binary initiation development

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