Responding to Complex System Challenges for Project Management

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IDEA FUSION

EMSE
Engineering Management and Systems Engineering

NCSOSE
National Centers for System of Systems Engineering

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NCSOSE
National Centers for System of Systems Engineering

Located in Norfolk, Virginia, USA

- **Established 1930, 26,000+ students from 106 countries, 795 Full-time faculty**
- **Degree Programs: 70 undergraduate, 54 Masters, 42 doctoral**
- **Graduates: 124,000+ from 77 different countries**
- **Home to the National Centers for System of Systems Engineering (NCSOSE)** – *focused on system science based engineering of technologies to improve complex system performance*

NCSOSE

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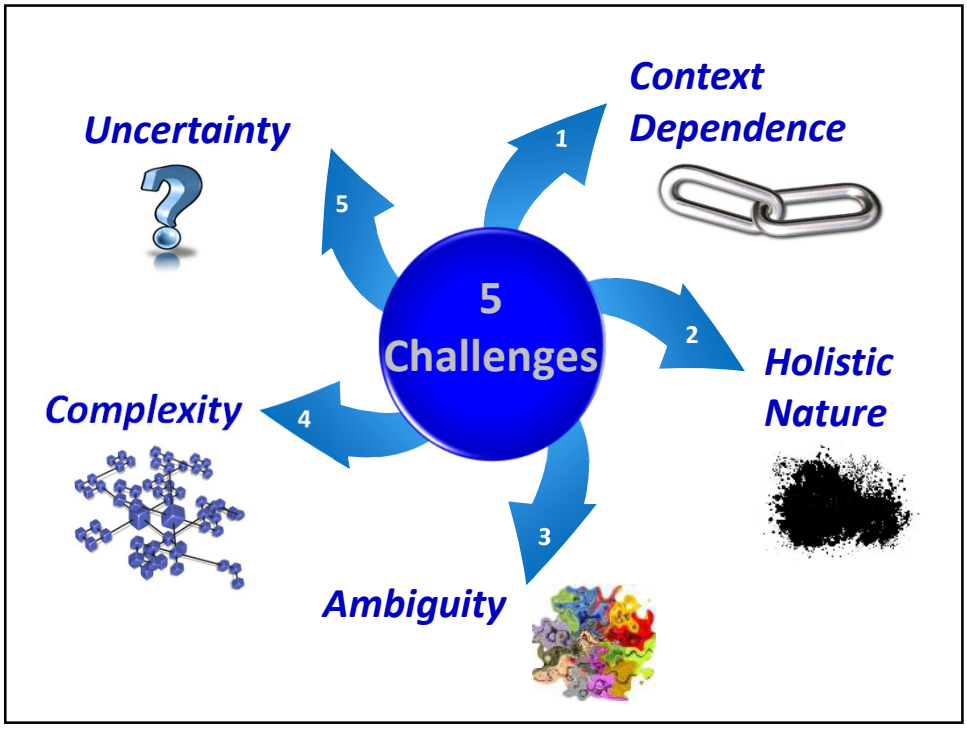
Topics

01 Challenges Facing PM

02 "Some" Systems Concepts to Help meet Challenges and Improve PM

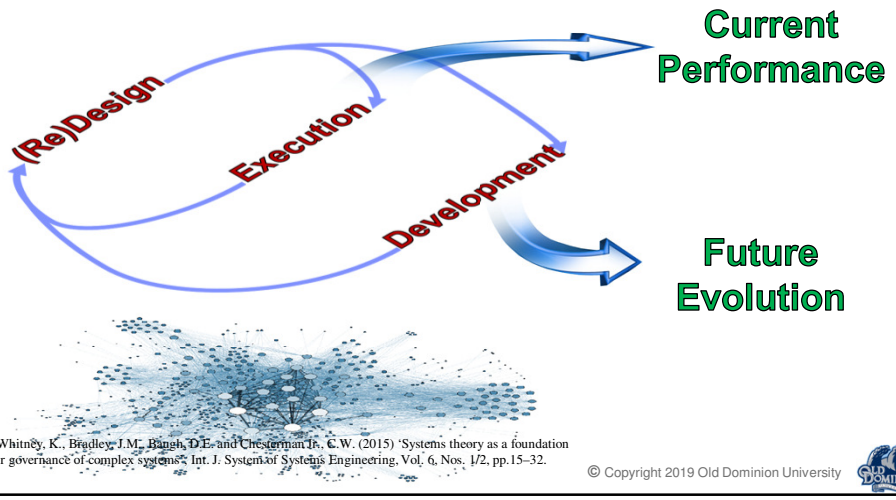
03 "Real" Considerations in Transforming PM Systems

Challenges Facing PM



7 Critical Systems Concepts for PM

*1. CONTROL – The process by means of which a whole entity retains its identity and/or performance under changing circumstances.**



*Whitney, K., Bradley, J.M., Baugh, D.E. and Chesterman Jr., C.W. (2015) 'Systems theory as a foundation for governance of complex systems', Int. J. System of Systems Engineering, Vol. 6, Nos. 1/2, pp.15–32.

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Control – what this means for PMs

- Control often gets a bad rap

- Paradox of control – to get control we must give up control

- Control is about balanced constraint – balance is dynamic, shifting, & subject to interpretation

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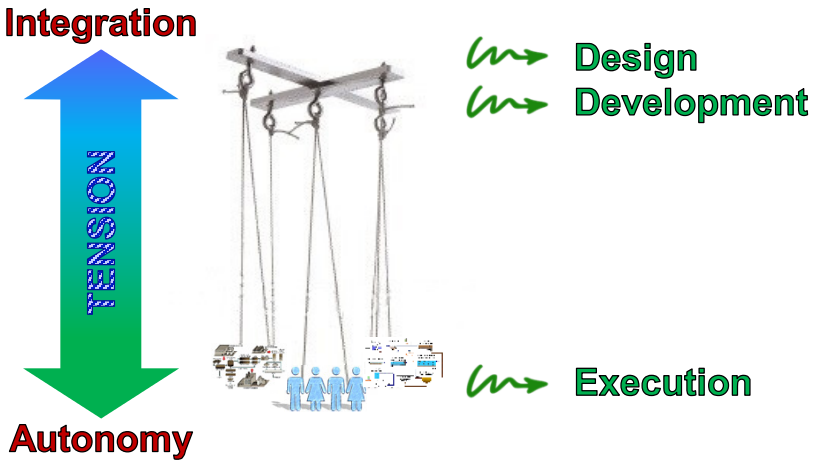
*2. MINIMAL CRITICAL SPECIFICATION – Only those constraints necessary to ensure performance should be invoked .**



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Minimal Critical Specification – what this means for PMs

- **Excess constraint wastes resources** – constraint is not free – it costs M5I (manpower, materials, money, methods, minutes, information)

- **Too little constraint impacts performance** – maintenance of performance requires sufficient constraint for integration
- **Constraint is not constant over time** – requires tradeoff to continual balance Autonomy and Integration

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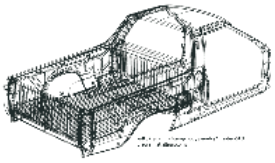
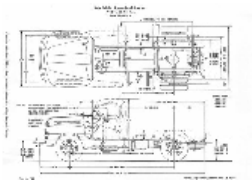
3. PURPOSIVE BEHAVIOR – in short 'the purpose of a system is what it does', not what it is designed, intended, or desired to do.*



a. The 'goals' for a system are user determined

b. A representation is not the system



*Rosenblueth, A., Wiener, N. and Bigelow, J. (1943) 'Behavior, purpose and telelogy', Philosophy of Science, Vol. 10, No. 1, pp.18–24.

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Purposive Behavior – what this means for PMs

- **Don't confuse design with performance** related, but not interchangeable

Designed ***Observed***

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- **Effective design must consider context** – there is no such thing as a context free system
- **Evolution** – maintenance of performance requires system development & evolution – faster than context change

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4. System Boundary

A constructed delineation of the separation of a system from that which exist outside the system.

Everything Else

The System

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Complex System Boundary – in a nutshell of 3 fundamentals points for PMs

- **Separates a system from its environment**, determining what is included and excluded – criteria answers inclusion question and serves purpose
- Is **arbitrary and dynamic** -- subject to value judgments and changes over time based on new knowledge, changing interpretations, or shifts in purposes
- Can be **tacit** (left undefined, ambiguous, and debatable) **or explicit** (defined, clear, and negotiable)

Careful with system boundary establishment & maintenance

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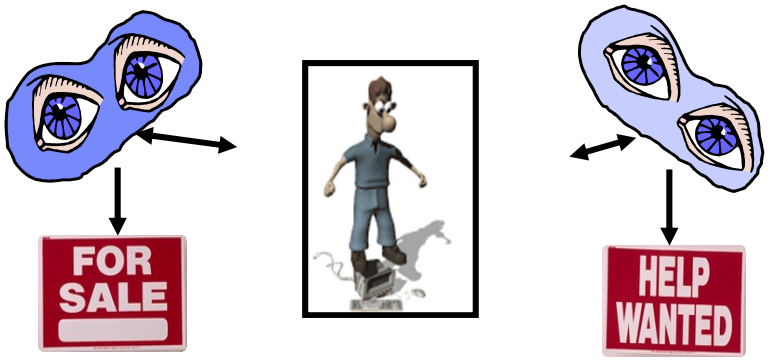
5. Complementarity

***Any two perspectives (or models) of a system will reveal truths about the system which are neither entirely independent nor entirely compatible**



*Bohr, N. (1928) "The Quantum Postulate and the Recent Development of Atomic Theory," Nature, 121 (3050), 580-590.

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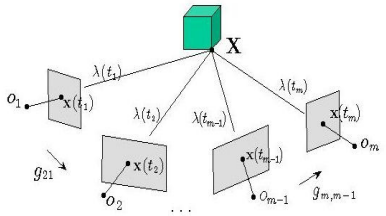
Complementrarity – what this means for PMs



- **All perspectives** of a system or problem are **correct and incorrect** – depending on their vantage point
- **Perspectives are incomplete** surface manifestations
- To challenge a perspective – **attack the assumptions, underlying logic, or inconsistent 'system' model**

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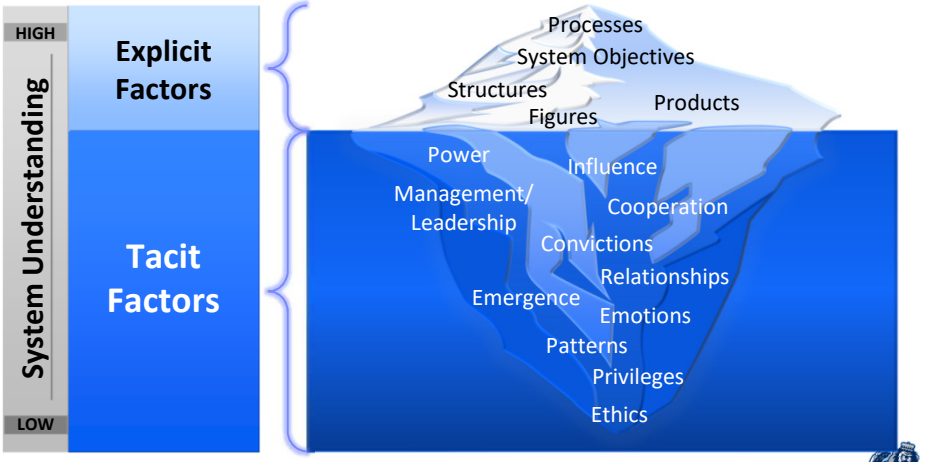
6. Incompressibility

We are not capable of complete knowledge of a complex system. The system is known only through its representation (model) – which is always incomplete.



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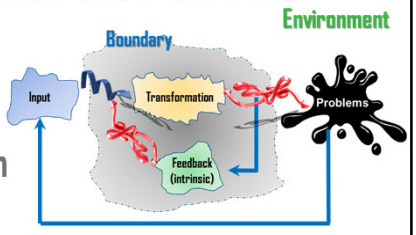
Incompressibility – what this means for PMs



- **Can't know everything** about a complex system – understanding & knowledge change over time
- **Representations are NOT systems** – all representations have 'abstraction' errors; system knowledge is fallible
- **Emergence** – behavior, structure, and performance emerge over time as a system operates

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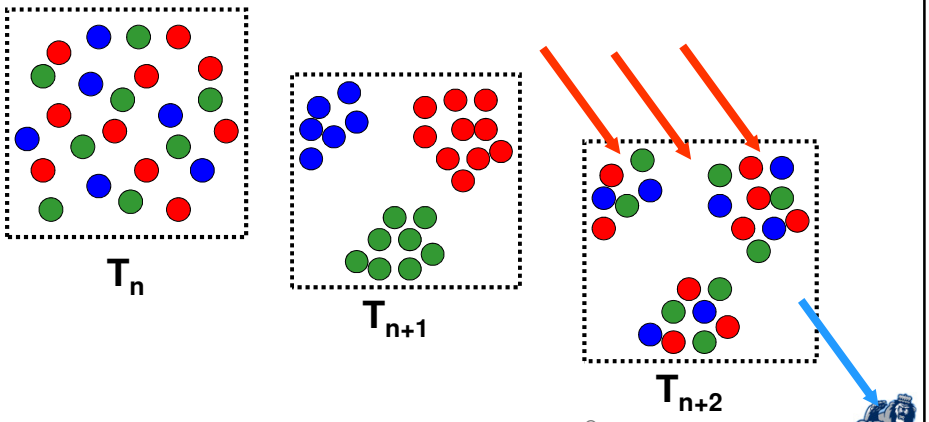
7. Self-organization

The structural and behavioral patterns (performance) of a complex system emerge as a result of interactions between entities within the system; subject to externally imposed constraints (energy).



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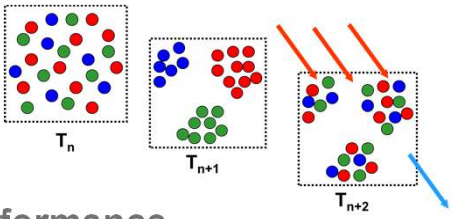
Self-organization – what this means for PMs



- **Left alone systems organize for lowest energy**
  – NOT maximum performance
- **Emergence is product of self-organization** – behavior, structure, and performance emerge over time as a system operates
- **Self-organization should be maximized** – 'by design' to maximize autonomy and preserve system level performance

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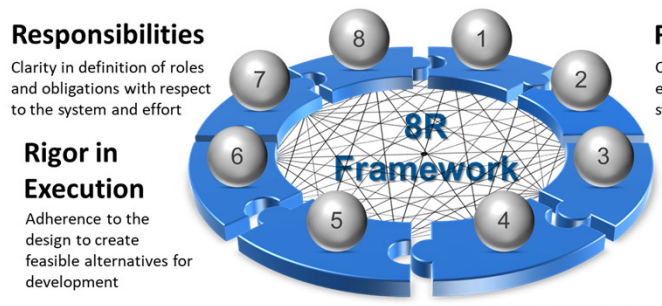
Considerations in Development of PM Systems

8R Framework to Engage System Development (including PM Systems)

Or 8 ways to fail miserably in development of PM systems



Rigidity
Flexibility in design and execution of system development effort

Relevance
Recognition of need, measurable value, comprehensive nature, and relationship to other development efforts

Responsibilities
Clarity in definition of roles and obligations with respect to the system and effort

Realism
Consistency between expectations and feasible system development activities

Rigor in Execution
Adherence to the design to create feasible alternatives for development

Resolve
Institutional will and commitment to the effort and system development sustainment

Resources
Provision for sufficient resources and access necessary to engage in the effort

Requisite Compatibility
Congruence in worldview, support infrastructure, approach, context, and risk-threat-reward balance

Pyne, J.C., Keating, C.B., Katina, P.F. and Bradley, J.M. (2019) 'Systemic intervention methods supporting complex system governance initiatives', *Int. J. System of Systems Engineering*, Vol. 8, No. 3, pp.285–309.

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