







## A Practical Guide to Implementing Complex Systems Governance Concepts on Projects

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### Old Dominion University

Located in Norfolk, Virginia, USA



- Established 1930, 26,000+ students from 106 countries, 795 Full-time faculty, 166 degree programs (Bachelor's to Doctoral), 124K+ graduates
- Home to the National Centers for System of Systems Engineering (NCSOSE) – focused on system science based engineering of technologies to improve complex system performance

**Complex System Governance**  
Mastering Complexity by Design

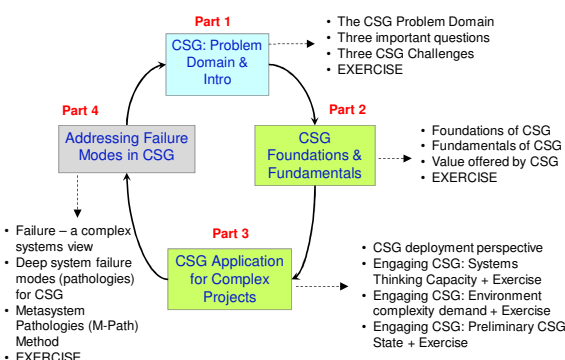
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Purpose:  
Provide a **hands-on experience** for Project Management (PM) professionals for **application of Complex System Governance (CSG)** concepts.

Objectives:

- Examine the nature and implications of the **complex problem domain** facing PM professionals.
- Explore **CSG** as a systems-based response to better deal with **increasingly complex projects**.
- Apply **CSG methods** to discover 'deep system' failure modes in design, execution, or development of projects.
- Determine **feasible strategic responses** to preclude or mitigate **CSG failure** modes in complex projects.

### Big Picture for this Masterclass



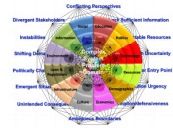
- Part 1: CSG: Problem Domain & Intro**
  - The CSG Problem Domain
  - Three important questions
  - Three CSG Challenges
  - EXERCISE
- Part 2: CSG Foundations & Fundamentals**
  - Foundations of CSG
  - Fundamentals of CSG
  - Value offered by CSG
  - EXERCISE
- Part 3: CSG Application for Complex Projects**
  - CSG deployment perspective
  - Engaging CSG: Systems Thinking Capacity + Exercise
  - Engaging CSG: Environment complexity demand + Exercise
  - Engaging CSG: Preliminary CSG State + Exercise
- Part 4: Addressing Failure Modes in CSG**
  - Failure – a complex systems view
  - Deep system failure modes (pathologies) for CSG
  - Metasystem Pathologies (M-Path) Method
  - EXERCISE

#### Workshop Schedule (9:00 – 5:00):


9:00 – 9:15	Kickoff and Introductions
9:15 – 10:30	<b>P1</b> CSG: <b>Problem Domain &amp; Introduction</b> Exercise in Complex Problem Domain
10:30 – 11:00	Morning Tea
11:00 – 12:30	<b>P2</b> <b>CSG Foundations and Fundamentals</b> Exercise in CSG
12:30 – 1:30	Lunch Break
1:30 – 3:00	<b>P3</b> <b>CSG Application</b> for Complex Projects with Exercise in action
3:00 – 3:30	Afternoon Tea
3:30 – 5:00	<b>P4</b> <b>Addressing Failure Modes</b> in CSG Exercise in CSG Failure Modes Workshop Closeout

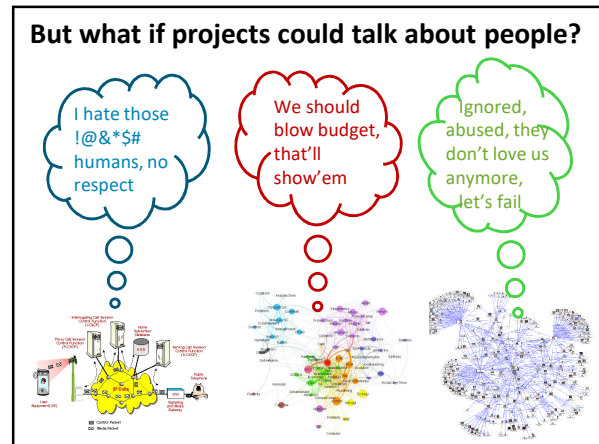
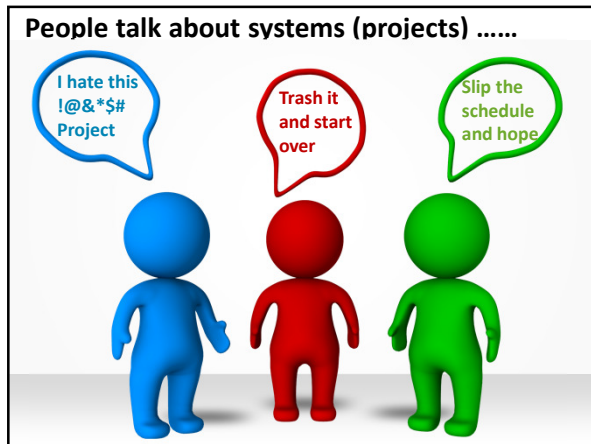
## Part 1: Problem Domain & Complex System Governance Introduction

**Problem Domain**

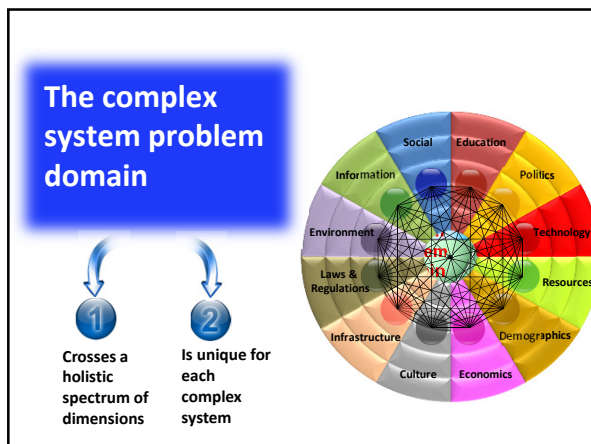
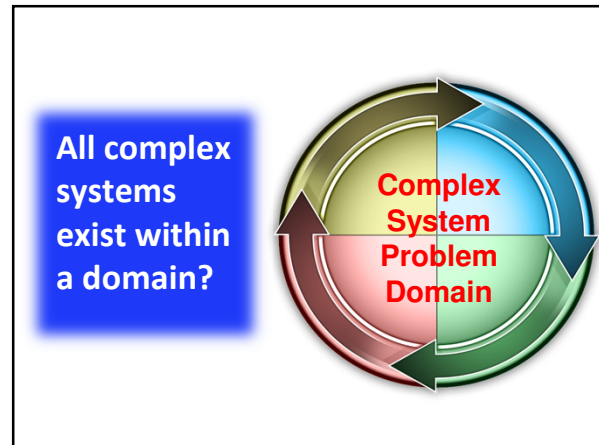


**Response**



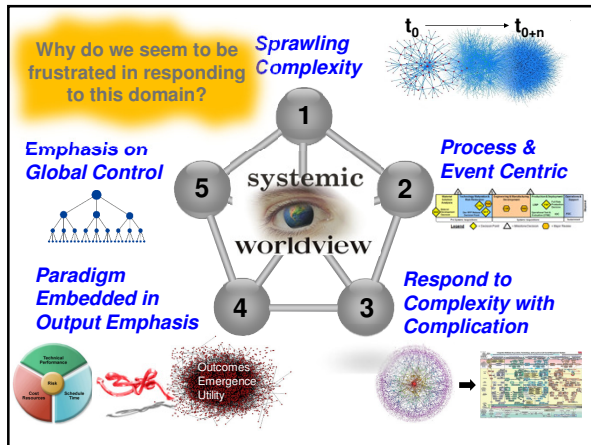
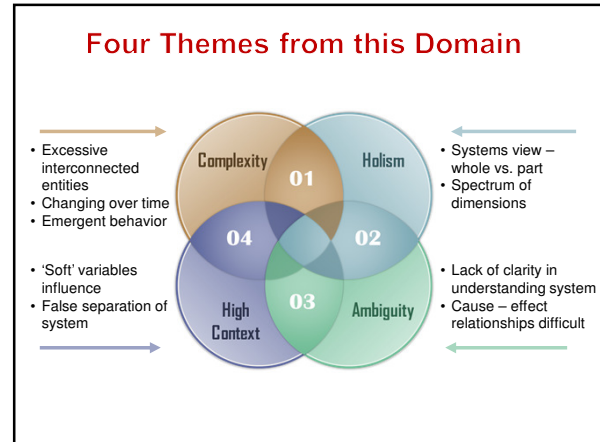
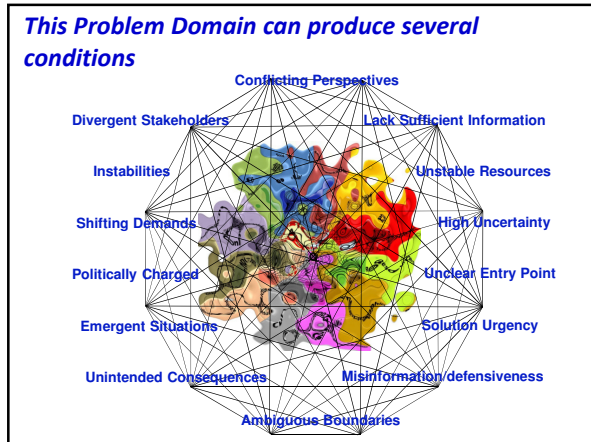


**The Problem Domain**



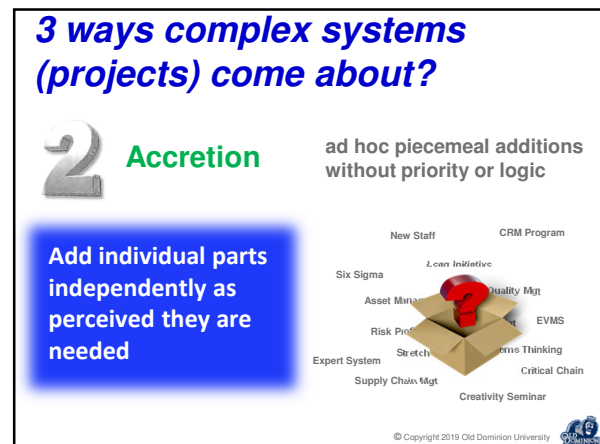
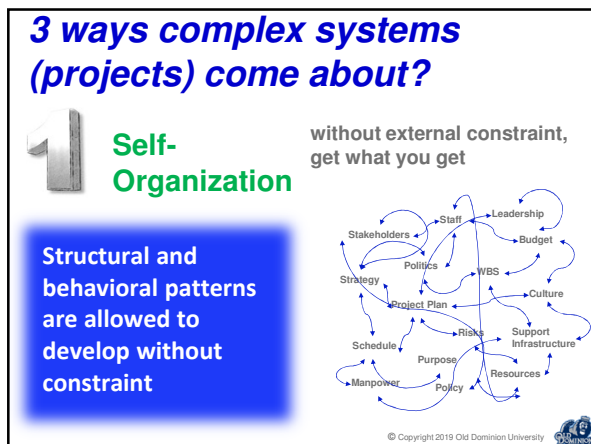
It's a little bit more complex than that

Ouch!! That's going to make a mark!



**Three important, but often forgotten questions about systems (projects)**

- 1. How did this come about?**
- 2. What do we do with systems?**
- 3. How do they fail?**



### 3 ways complex systems (projects) come about?

**3 Purposeful Design**

Deliberate, holistic with specific aims and logic

Intentionally adding elements in priority and knowledge of the whole

**System View**

Lean Initiative	Portfolio Mgt
New Staff	CRM Program
Six Sigma	Quality Mgt
Asset Management	E VMS
Risk Profile	

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### There are only three fundamental things WE do with systems – all three drive performance

Design by 'accretion', 'self-organization', or 'purposeful'

Modifying the system (structure) to accommodate shifts in systems, context, or environment

Accounting for 'emergence' and 'increasing system knowledge incorporation'

### Three Areas We Fail Systems

Can cross the 'holistic' spectrum – Tech, Org, Mgt, Hum, Soc, Pol, Political, Inf

**Failures of Design**

**Failures of Execution**

**Failures of Development**

**System Failure**

**Design**  
Design by 'accretion', 'self-organization', or 'purposeful'

**Development**  
Modifying the system (structure) to accommodate shifts in systems, context, or environment

**Execution**  
Accounting for 'emergence' and 'increasing system knowledge incorporation'

### All this failure ---- who is responsible?

1 Design

2 Execution

3 Development (redesign)

By us

Performance

Value Judgment (by us)

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## Complex System Governance: 3 Challenges for a Different Response

**Problem Domain** → **CSG Response**

**Complex System Governance**  
Mastering Complexity by Design

### Complex System Governance – 3 Challenges

- ✓ Versus Management
- ✓ Long (evolutionary) view
- ✓ Steering – Outcome - Trajectory
- ✓ Complete Spectrum
- ✓ System – Context – Environment
- ✓ Purposeful
- ✓ Whole vs. Part
- ✓ Complexity Map – Act - Measure

### Complex System Governance

Design, execution, and evolution [development] of the [nine] metasystem functions necessary to provide control, communication, coordination, and integration of a complex system  
(Keating, et al. 2014)

**9 Interrelated Metasystem Functions performed by all complex systems**

*Produces*

Integration, Control, Coordination, Communication, System Viability

Keating, C.B., Kalina, P.F., & Bradley, J. M. (2014). Complex system governance: concept, challenges, and emerging research. *International Journal of System of Systems Engineering*, 5(3), 263-288.

### Part 1: 5 Take Aways

- 1 Our problem domain is increasingly: complex, ambiguous, holistic, contextual
- 2 Systems come about by self-organization, accretion, or purposeful design
- 3 We design, execute, and develop systems - they produce what they produce - NMNL
- 4 Systems performance degrades or fails in design, execution, or development
- 5 CSG response enhances design, execution, and development of system viability functions

### Part 1: EXERCISE

**CSG problem domain:** This exercise explores the nature of complex problem domains and challenges participants to make an assessment of a problem domain they face.

### Part 2: Complex System Governance: Foundations and Fundamentals

1. Foundations of CSG
2. Fundamentals of CSG
3. Value offered by CSG

### CSG in a Nutshell

*We can do better with our complex systems*

**Complex System Governance**

System Governance, Management Cybernetics, Systems Theory

**Field Intersection**

Focused on direction, oversight, and accountability

Focused on communication and control

Focused on integration and coordination

### Breaking Down CSG

Design, execution, and evolution [development] of the [nine] metasystem functions necessary to provide control, communication, coordination, and integration of a complex system

(Keating, et al. 2014)

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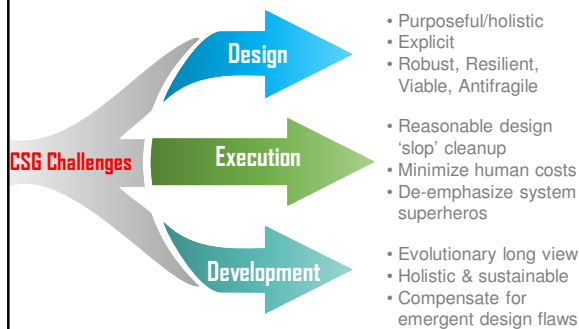
### Going Deeper: Breaking Down CSG

1 Design, execution, and evolution [development] of the [nine] metasystem functions necessary to provide control, communication, coordination, and integration of a complex system

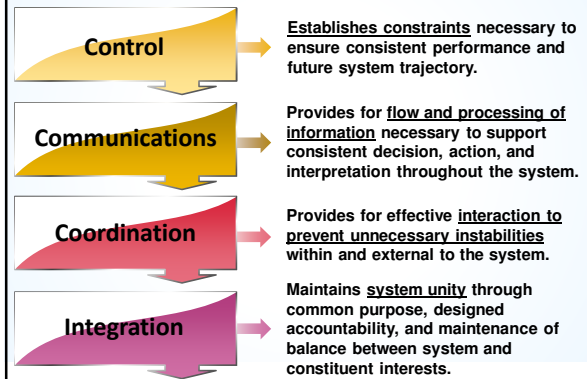
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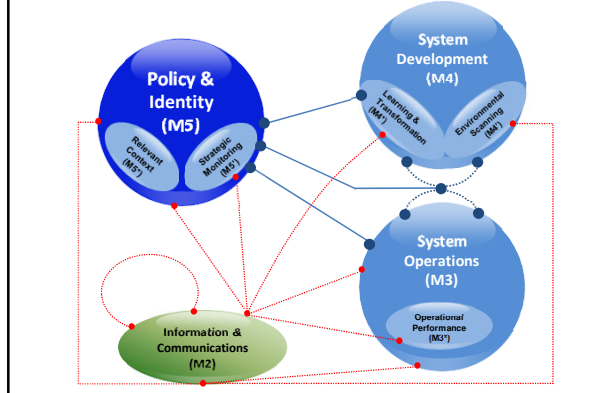
### 3 Great CSG Challenges for Improving System Performance



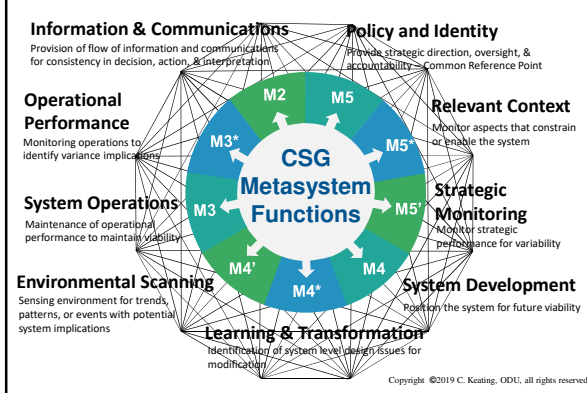
### CSG Provides

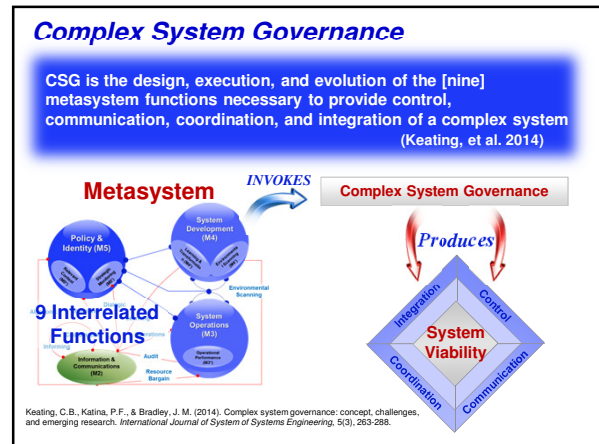
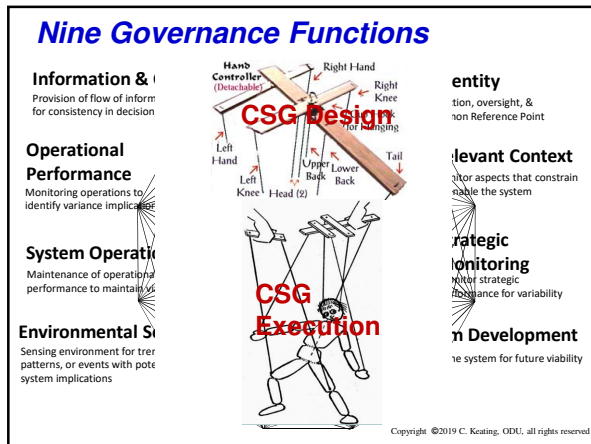


### Nine Essential Governance Functions




### Nine Governance Functions





## CSG in Five Fundamental Points



**All systems are subject to the laws of systems**

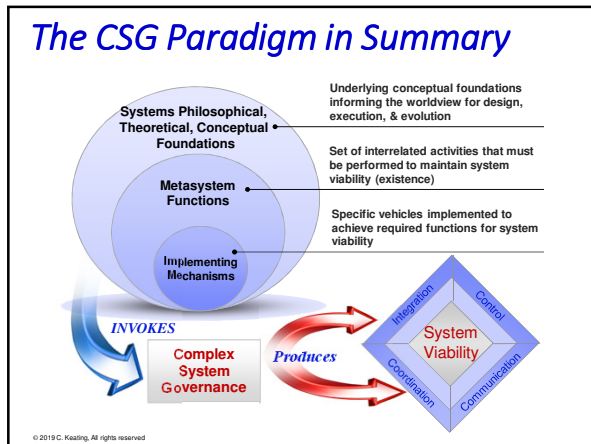
### Physics Laws in the Cartoon World


### Systems (principles) Laws in the Real World

Unlike cartoons, real world Systems conform to principles that:

1. Don't sleep, are always there & on
2. Apply equally without bias or value judgments
3. Make no allowances for ignorance
4. Have real consequences for violations


**All viable systems execute essential governance functions via mechanisms that determine system performance.**




 Governance functions can experience pathologies in their performance.

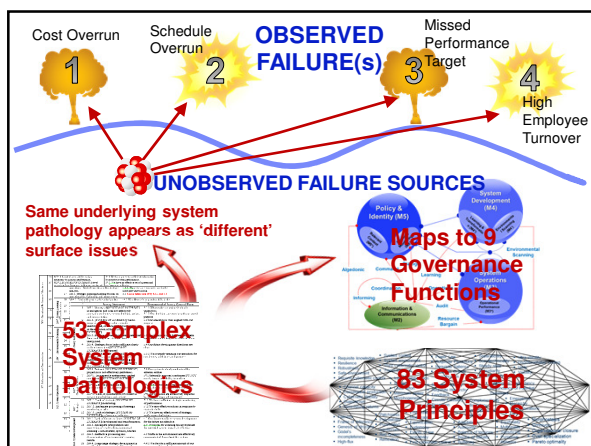
### PATHOLOGY


“circumstance, condition, factor, or pattern that acts to limit system performance, or lessen system viability, such that the likelihood of a system achieving performance expectation is reduced” (Keating and Katina, 2012, p. 253)

**EXAMPLE**  
M2.11. Introduction of uncoordinated system changes resulting in **excessive** oscillation.

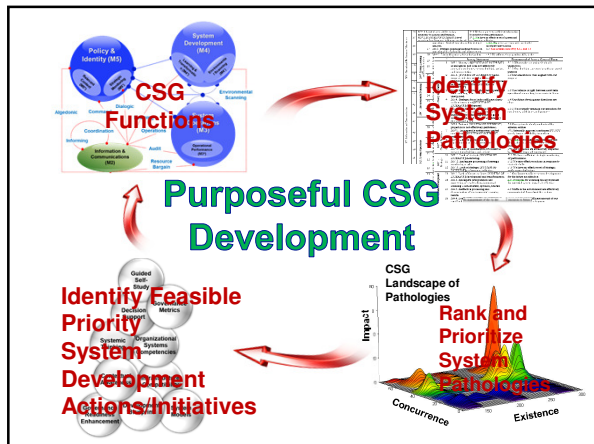
Keating, C. B., & Katina, P. F. (2012). Prevalence of pathologies in systems of systems. International Journal of System of Systems Engineering, 3(3-4), 243-267.

 Pathologies linked to ‘violation’ of one or more system principles



 System performance can be enhanced through purposeful development of governance functions & addressing their pathologies





# Value Offered by CSG Development

### Complex System Governance - Value

CSG value accrues through rigorous examination of system performance across workforce, organizational, support infrastructure, & environment levels

**Several CSG value adding benefits include:**

- Rigorous self-study & mapping of target organization (system) governance, support infrastructure, environment, & performance
- Basis in advanced 'state of knowledge' for dealing with complexity
- Enhance workforce capacity & organizational capabilities for (holistic) systems thinking
- Identify 'deep system' performance constraints & feasible development strategy/priorities
- Strategic development initiative mapping & assessment of contribution & integrated fit

**CSG Provides Value on Multiple Levels**

### What CSG is NOT!

- Magic
- Easy
- Prescriptive
- "Systemtopia"

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## Part 2: 5 Take Aways

- CSG is focused on design, execution, and development of 9 system functions
- CSG functions provide communications, control, integration, and coordination
- Pathologies act to degrade system performance
- Value accrues from CSG self-study to address 'deep system' deficiencies
- In addition to system, CSG develops: workforce, organization, support infrastructure, & environment

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## Part 2: EXERCISE

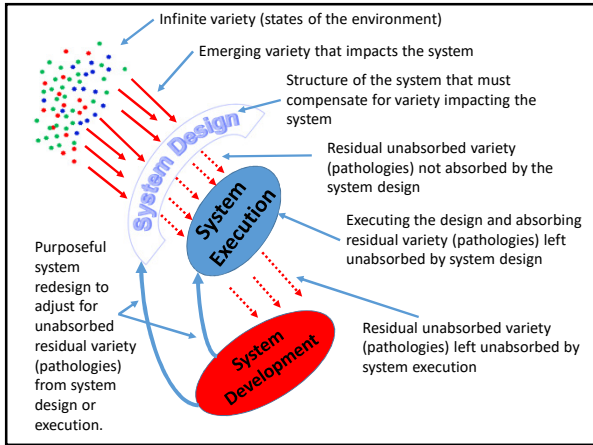
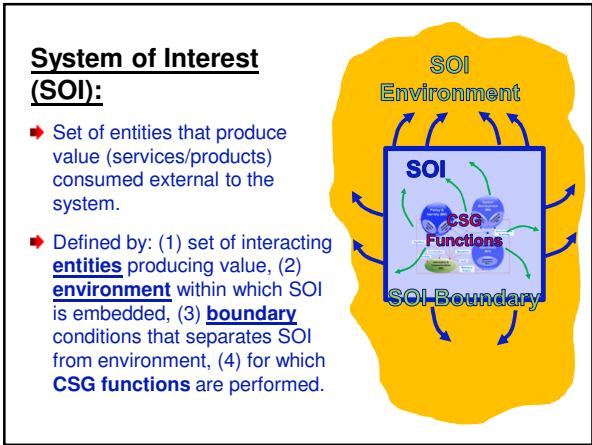
A 14-Point assessment that indicates the potential need for engagement in more purposeful CSG development.

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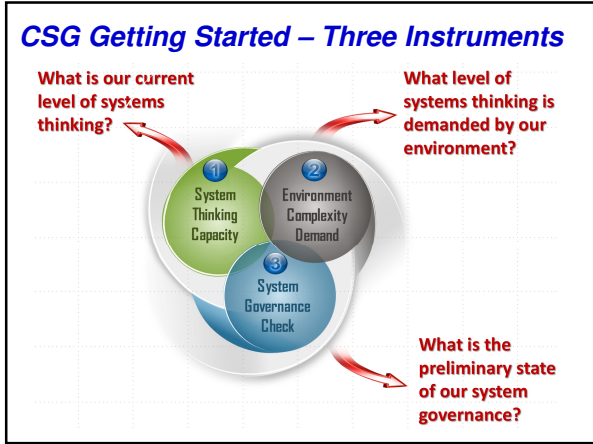
## Part 3: CSG Application for Complex Projects

1. CSG Deployment Perspective
2. Preparing for CSG Application

## CSG Deployment Perspective




## Preparing for CSG Application



# 1 Systems Thinking Capacity

Represents the preference for engaging complexities we encounter as we navigate complex systems and environments.



- A slice of our total worldview
- Frames how we interpret and make sense of all that we encounter
- Influences our thinking, decisions, actions, and interpretations
- Determines our 'systemic' preference for engaging our world

## Part 3: EXERCISE 3a

This exercise provides an indicator of 'your' Systems Thinking Capacity

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**From 39 Survey Questions** ➔ **Example**

2. Do you prefer to work with

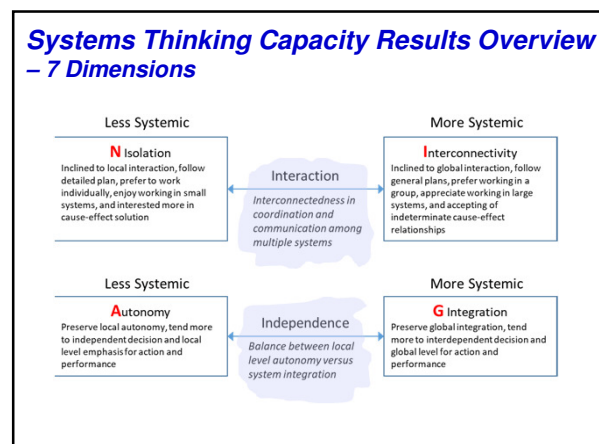
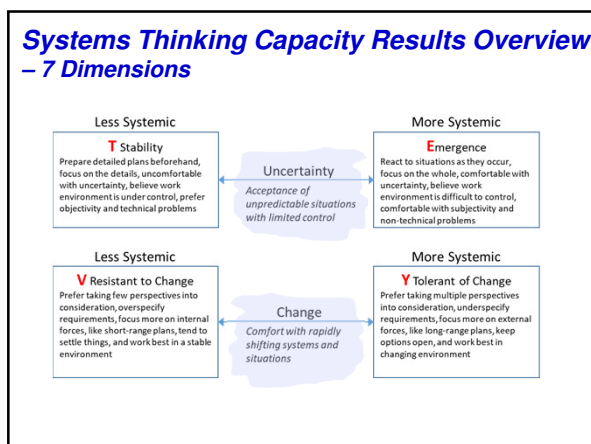
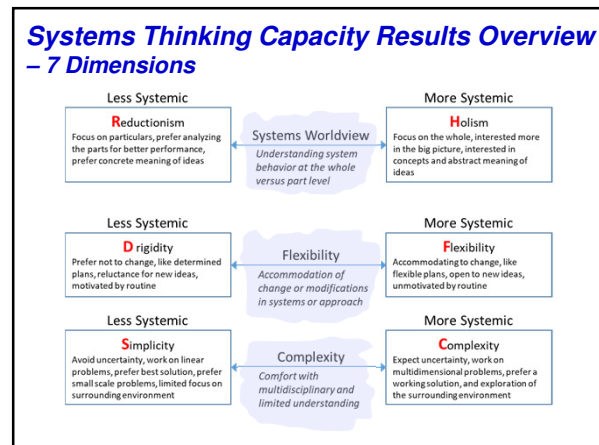
- a. few systems or people
- b. many systems or people

### 7 Dimensions of Systems Thinking

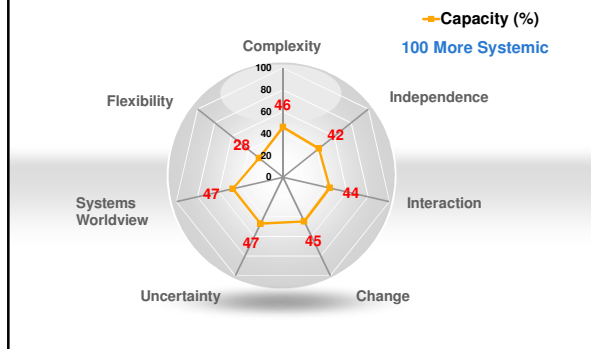
1. Complexity
2. Integration
3. Interaction
4. Change
5. Uncertainty
6. Systems Worldview
7. Flexibility

Identifies

Identifies

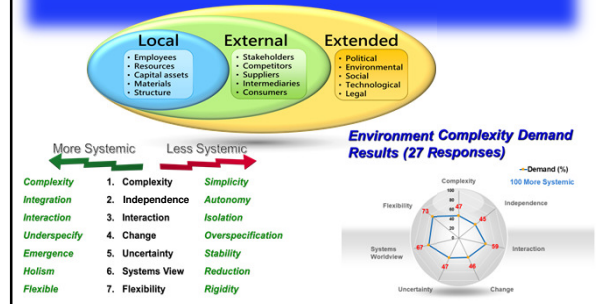


### Systems Thinking Capacity Results Overview (29 responses)



### 2 Environment Complexity Demand

Represents the degree of complexity perceived to exist in the environment for a system of interest.



### Part 3: EXERCISE 3b

Assess the Environment Complexity Demand for a selected system of interest

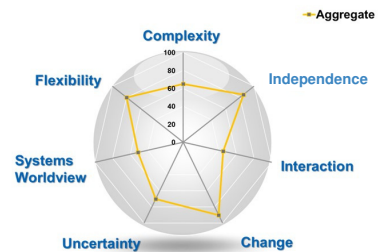
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### From 43 Survey Questions

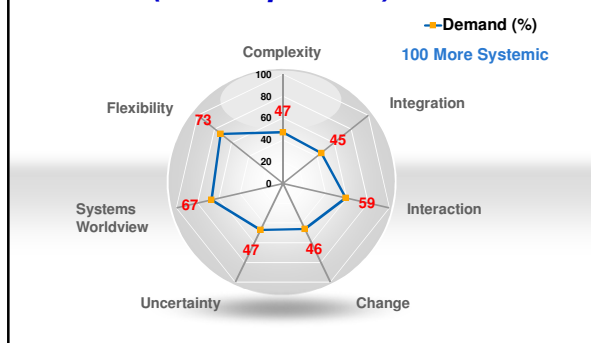
#### Example

- 1. Our working environment is MORE:
  - a. predictable
  - b. unpredictable

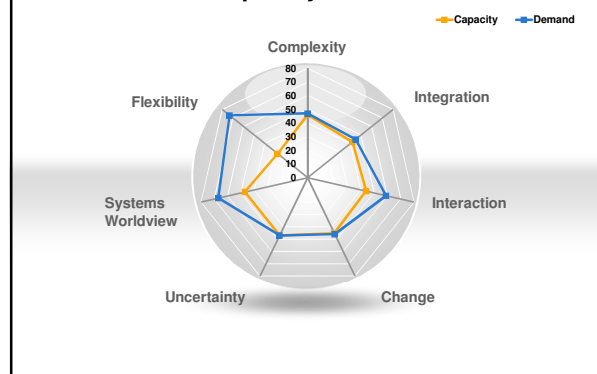
7 Dimensions Provide Systems Thinking Demand for the Environment

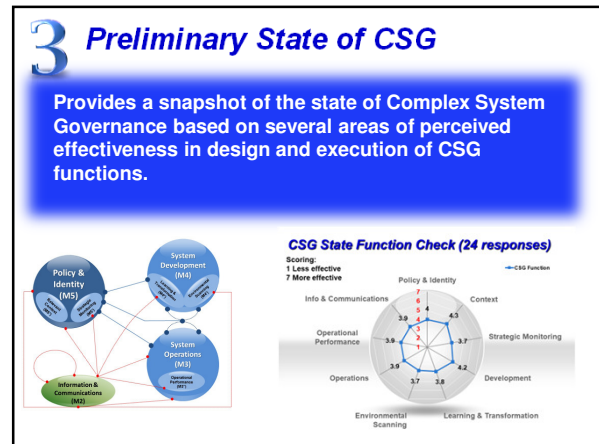
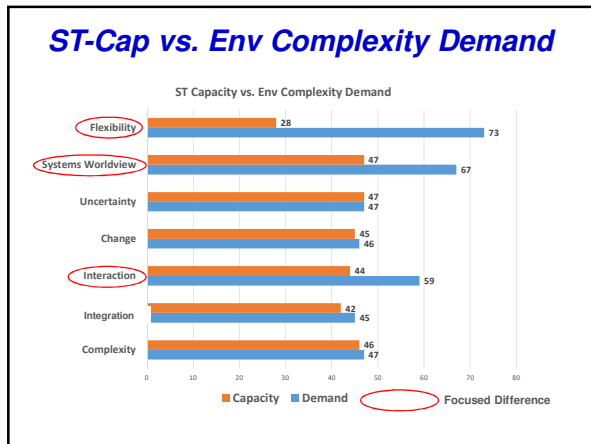


### Environment Complexity Demand Results (27 Responses)



### Composite Systems Thinking Capacity and Environment Complexity Demand

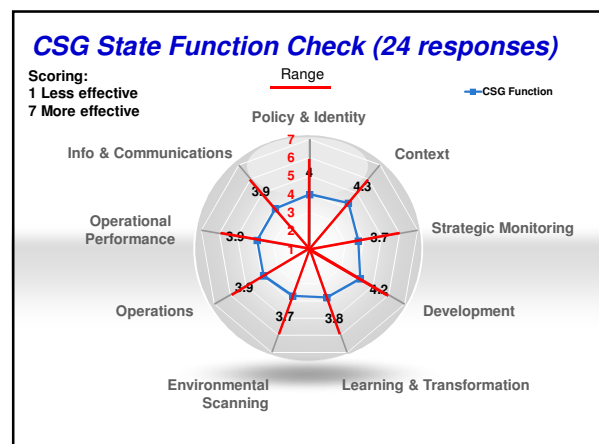
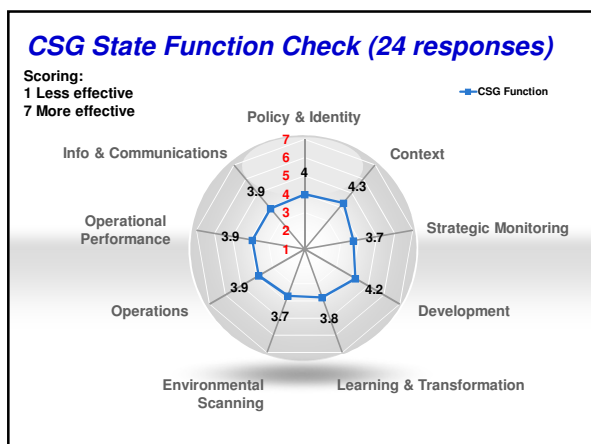
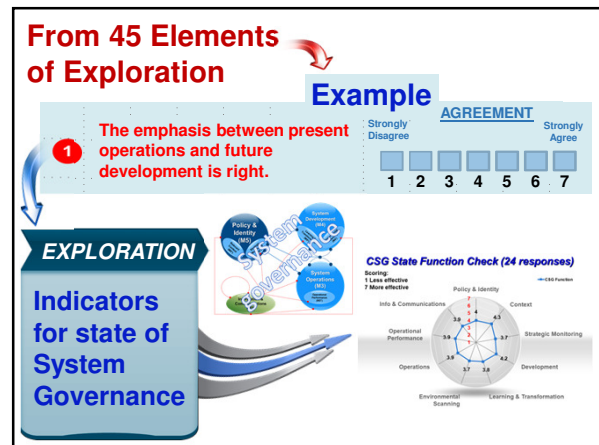




## Part 3: EXERCISE 3c

Provides an assessment of the effectiveness of the 9 metasystem functions to establish a Preliminary State of CSG

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### Part 3: 5 Take Aways

- 1 Application of CSG requires a 'system of interest' be determined (project/program/entity)
- 2 Understanding Systems Thinking Capacity is essential for engagement of CSG
- 3 Assessing the complexity demand of the environment is necessary for engaging CSG
- 4 Systems Thinking Capacity must equal or exceed environment complexity demand
- 5 CSG state indicates the perceived level of governance effectiveness



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### Part 4: Addressing Failure Modes (pathologies) in CSG

1. Failure – a systems view
2. Deep system failure modes (pathologies)
3. Metasystem Pathologies (M-Path) Method
4. EXERCISE

## Failure – a Complex System Governance View

### What is failure?

failure [feyl-yer]\*  
noun

1. an act or instance of failing or proving unsuccessful, lack of success
2. nonperformance of something due, required, or expected
3. a subnormal quantity or quality; an insufficiency
4. deterioration or decay, especially of vigor, strength, etc.
5. becoming insolvent or bankrupt
6. a person or thing that proves unsuccessful

We intuitively understand failure in a general sense

### 45 Synonyms for Failure\*

bankruptcy	misstep	downfall	misadventure	washout
breakdown	abortion	fiasco	miscarriage	wreck
collapse	bomb	flip	nonperformance	false step
decline	botch	frustration	overthrow	face-past
default	blunder	implosion	ruin	flash in the pan
deficiency	bluff	inadequacy	rupture	lead balloon
deterioration	checkmate	lemon	stalemate	non-success
falling	decay	loser	stoppage	sinking ship
loss	deficit	mess	turkey	total loss

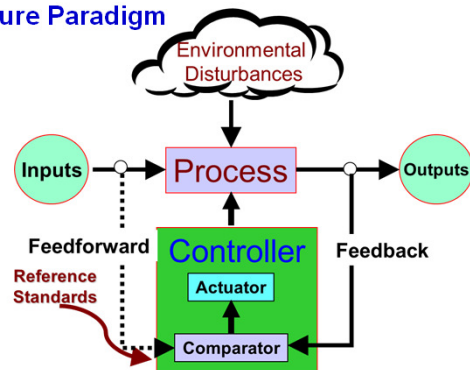
\*definitions and synonyms from dictionary.com

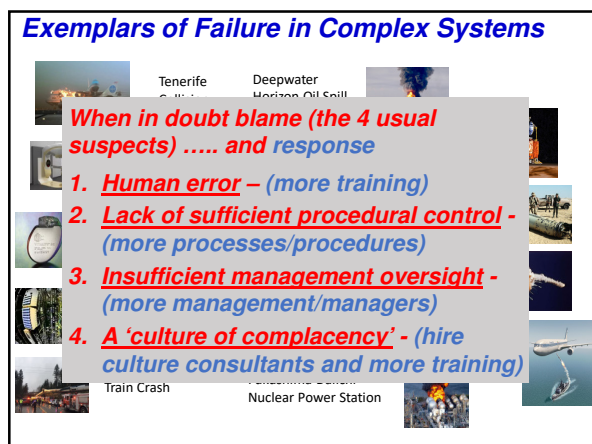
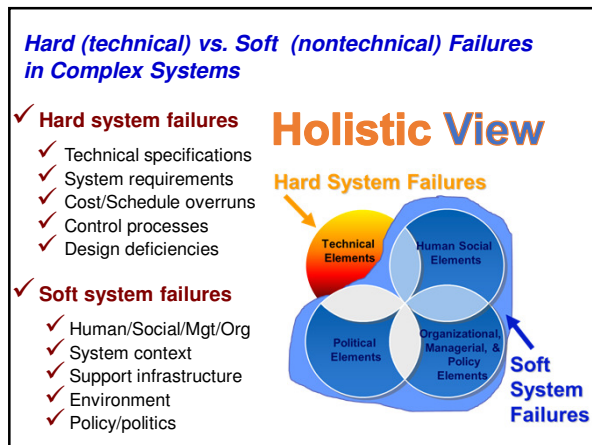
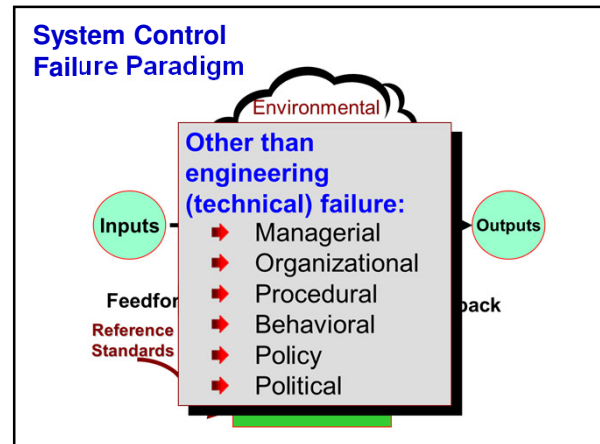
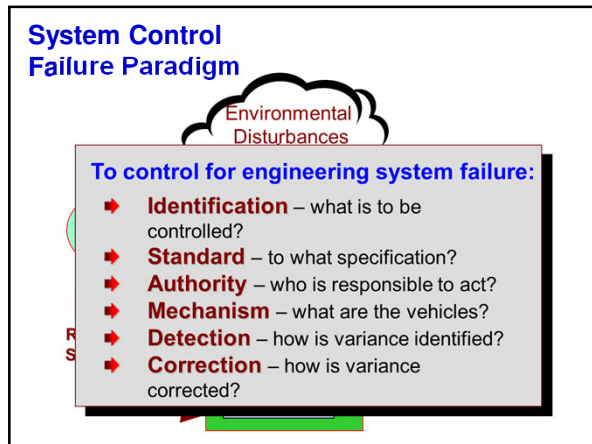
### Complex System Failure: Perspective

- **Loss of ability** to satisfactorily achieve intended function (fracture or deterioration) within domain
- State of condition of **not meeting** or **unacceptably deviating** from specified or implied performance requirements
- **Event** that renders a system **no longer capable of operation**
- **Degradation** that lessens viability (continued existence)
- A matter of **interpretation & perception** for complex systems



### System Control Failure Paradigm





## Deep System Failure Modes for CSG – Metasystem Pathologies

**RECALL System Pathologies – a source of unobserved failure modes**

**System Pathology**

“circumstance, condition, factor, or pattern that acts to limit system performance, or lessen system viability, such that the likelihood of a system achieving performance expectation is reduced” (Keating and Katina, 2012, p. 253)

**EXAMPLE**  
**M2.11. Introduction of uncoordinated system changes resulting in excessive oscillation.**

Keating, C. B., & Katina, P. F. (2012). Prevalence of pathologies in systems of systems. *International Journal of System of Systems Engineering*, 3(3-4), 243-267.

**Deep System Failure: Perspective**

- Directly observable: objective, verifiable (e.g. cost, sch, perf)
- Symptomatic surface
- Deviate from requirements or expectations
- Not directly observable: subjective, difficult to verify
- Contribute to failure
- Difficult attribution of cause-effect
- Produce observed failures

**Pathologies**

**Metasystem Pathologies (M-Path) Method**

**The M-Path Method - Identification and response to system pathologies [failure modes]**

**PHASE 1** Identification of Failure Modes

**PHASE 2** Analysis of Failure Modes

**PHASE 3** Exploration of Failure Modes

**PHASE 4** Systemic Implementation

**PHASE 5** Follow-up for impact

Complex System of Interest

Discovery and analysis of pathologies impacting system performance

Determine the movement for pathologies

Identification of feasible (technology, infrastructure, cultural) strategic actions and activities to improve pathologies

Implementation of feasible actions and evaluation

Katina, Potingapilimbe (2016), 'Metasystem pathologies (M-Path) method: phases and procedures', *Journal of Management Development*, Vol. 35 Iss 10 pp. 1267- 1301

**M-Path Identification**

**M-Path Identification (of 53 CSG Function Failure Modes)**

1. Each of 53 pathologies are assessed for 'existence' and 'impact'

**53 Complex System Pathologies Linked to Nine Functions**



### M-Path Identification (of 53 CSG Function Failure Modes)

2. Pathologies are represented in preparation for analysis

The heatmap plots Impact (Y-axis: Extreme, Very High, High, Moderate, Low, Very Low, Negligible) against Existence (X-axis: Strongly Disagree, Disagree, Somewhat Disagree, Undecided, Somewhat Agree, Agree, Strongly Agree). A blue circle highlights a cluster of high-impact, high-existence pathologies.

## M-Path Analysis

### M-Path Analysis

1. Examine nature and implications of the unique 'landscape' of pathologies

2. Enumeration of the composite results to capture: **CENTROID, VARIABILITY, RANKINGS**

The heatmap shows the distribution of 53 pathologies. Below it, a diagram titled 'Pathologies Mapped' shows a network of pathologies, and a bar chart titled 'Pathologies Ranked' shows their relative frequencies.

## M-Path Exploration

### M-Path Exploration

1. Investigate (group) meaning of pathologies, including disparities in perspectives – FACE Validation and Triangulation

2. Identify implications for **ACTIONABLE AND FEASIBLE RESPONSES**

3. Map existing and planned initiatives to pathologies

The heatmap shows the distribution of 53 pathologies. Below it, a diagram titled 'Pathologies Mapped' shows a network of pathologies, and a bar chart titled 'Pathologies Ranked' shows their relative frequencies.

### CSG Development Across 5 different levels

The diagram shows a central 'CSG Dev' sphere connected to five levels of development. Example actions/activities are listed for each level:

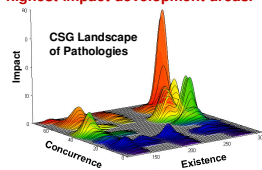
- Practitioner:**
  - Systems Thinking Training
  - Individual Self-Study in CSG
  - On-line Education in CSG
- Organizational:**
  - Development Workshops
  - Environmental Scanning
  - Metrics Development
- Support Infrastructure:**
  - Infrastructure Compatibility
  - Adjust Spt Infrastructure
  - Install new Spt Infrastructure
- Context:**
  - Contextual Analysis
  - Stakeholder Mapping
  - Competencies Development
- System:**
  - Mapping/Modeling CSG
  - Initiatives Assessment
  - Strategic CSG Development

# M-Path Systemic Implementation


### M-Path Systemic Implementation

1. Responsive strategies deployed for targeted system development
2. Understand the relationship to ongoing and planned initiatives for system development
3. Seek to PURPOSEFULLY influence the CSG landscape.

**CSG Landscape Map to identify highest impact development areas.**



**Complex System Governance Profile**




→

# M-Path Follow-up for Impact


### M-Path Follow-up

1. Examination of the effectiveness of the system development initiatives – has the state of CSG shifted
2. 'Adjustment' of initiatives, priorities, and system development resource investments


**Complex System Governance Profile**



**Complex System Governance Development Across 5 different levels**



→

- ## Part 4: 5 Take Aways
1. Failure in systems results in degradation in performance or loss of ability to perform mission
  2. System failures can be technical or nontechnical across a spectrum of dimensions
  3. Pathologies are 'deep system' deficiencies in functions that and degrade system performance
  4. M-Path is a 5-phased approach to rigorously examine CSG pathologies
  5. CSG and M-Path provide a new and novel look at system development effectiveness
- 
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## Part 4: EXERCISE

**Metasystem Pathologies (M-Path)  
Method: Phases 1 – 2 for a selected system of interest**

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## Master Class Closeout

1. 2-Minute Essay
2. 3 Major Themes of Class – Exploiting CSG
3. Challenges to deployment of CSG

## 2 Minute Essay

**What are your most significant insights from today's Masterclass?**

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## 3 Major Themes from the Masterclass for Exploiting CSG

### Three Major Themes for Exploiting CSG

systemic  
worldview

1

**Engage problem domain differently** - a 'systemic worldview' provides new language to support different thinking, decision, action, and interpretation. **EXCEED DEMAND.**

CSG Landscape of Pathologies

2

**Purposefully develop CSG functions** - All systems perform CSG functions – but usually without purposeful design, execution, or development. **GUIDED SELF STUDY**

CSG Landscape of Pathologies

3

**M-Path for 'Deep system' pathologies** - critical to developing system robustness, resilience, viability, and sustainability. **FOCUSED RESOURCES/INITIATIVES.**

## Challenges for Deployment of CSG – 8R Framework

### 8R Framework to Engage System Development (including CSG)

Or 8 ways to fail miserably in application of CSG

**Rigidity**  
Flexibility in design and execution of system development effort

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

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

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

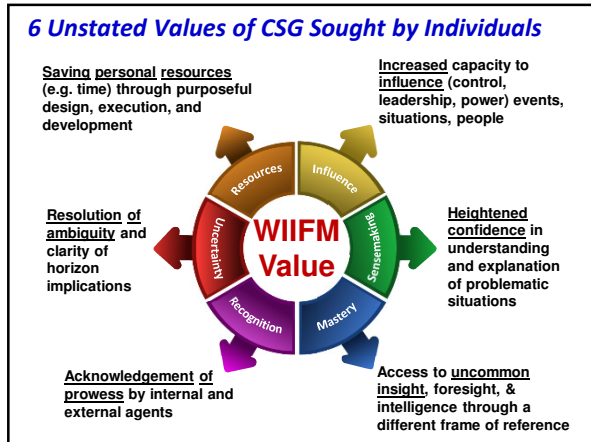
**Relevance**  
Recognition of need, measurable value, comprehensive nature, and relationship to other development efforts

**Realism**  
Consistency between expectations and feasible system development activities


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

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

Pyno, J.C., Keating, C.B., Katina, P.F. and Bradley, J.M. (2018) 'Systemic intervention methods supporting complex system governance initiatives', *Int. J. System of Systems Engineering*, Vol. 8, No. 3, pp.285-309.



## Questions, Contact and Follow-up Information



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