

SoSECIE Webinar

Welcome to the
2023 System of Systems Engineering Collaborators
Information Exchange (SoSECIE)



We will start at 11:00 AM Eastern Time

You can download today's presentation from the SoSECIE Website:

<https://mitre.tahoe.appsembler.com/blog>

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NDIA System of Systems SE Committee

- **Mission**

- To provide a forum where government, industry, and academia can share lessons learned, promote best practices, address issues, and advocate systems engineering for Systems of Systems (SoS)
- To identify successful strategies for applying systems engineering principles to systems engineering of SoS

- **Operating Practices**

- Face to face and virtual SoS Committee meetings are held in conjunction with NDIA SE Division meetings that occur in February, April, June, and August

NDIA SE Division SoS Committee Industry Chairs:

Mr. Rick Poel, Boeing

Ms. Jennie Horne, Raytheon

OSD Liaison:

Dr. Judith Dahmann, MITRE

Simple Rules of Engagement

- I have muted all participant lines for this introduction and the briefing.
- If you need to contact me during the briefing, send me an e-mail at sosecie@mitre.org.
- Download the presentation so you can follow along on your own
- We will hold all questions until the end:
 - I will start with questions submitted online via the CHAT window in Teams.
 - I will then take questions via voice in the Teams app; Please use the “raise hand” feature and wait to be called on.
 - Lastly, I will take questions via telephone dial in; Please state your name, organization, and question clearly.
- If a question requires more discussion, the speaker(s) contact info is in the brief.

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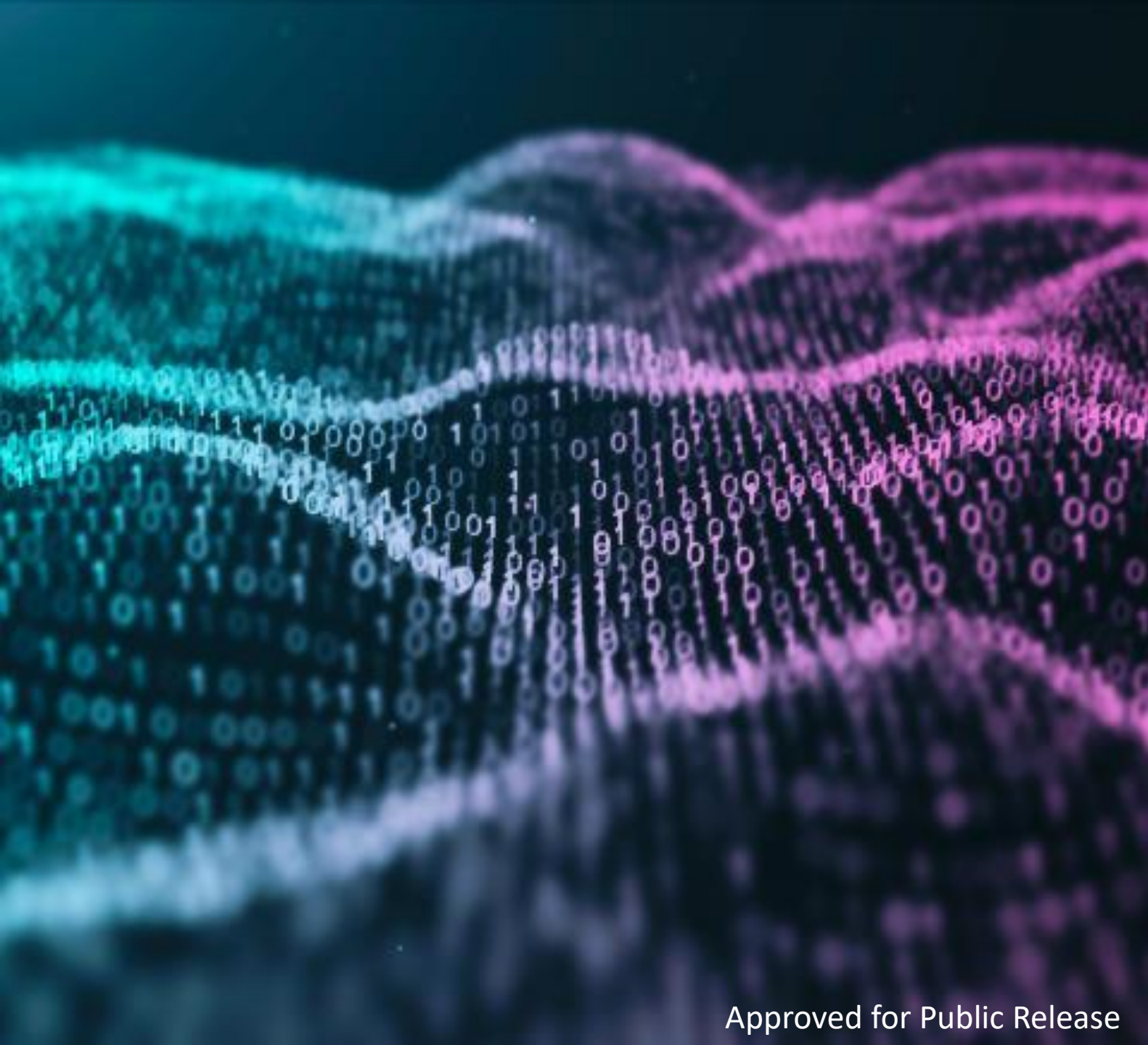
Next System of Systems Engineering Collaborators Information Exchange Webinar

Sponsored by MITRE and NDIA SE Division

January 24, 2023

Model-based Capability Planning and Enterprise Portfolio Management

Dr. James Martin



Mission Engineering and Complexity

SoS Engineering
Collaborators
Information Exchange

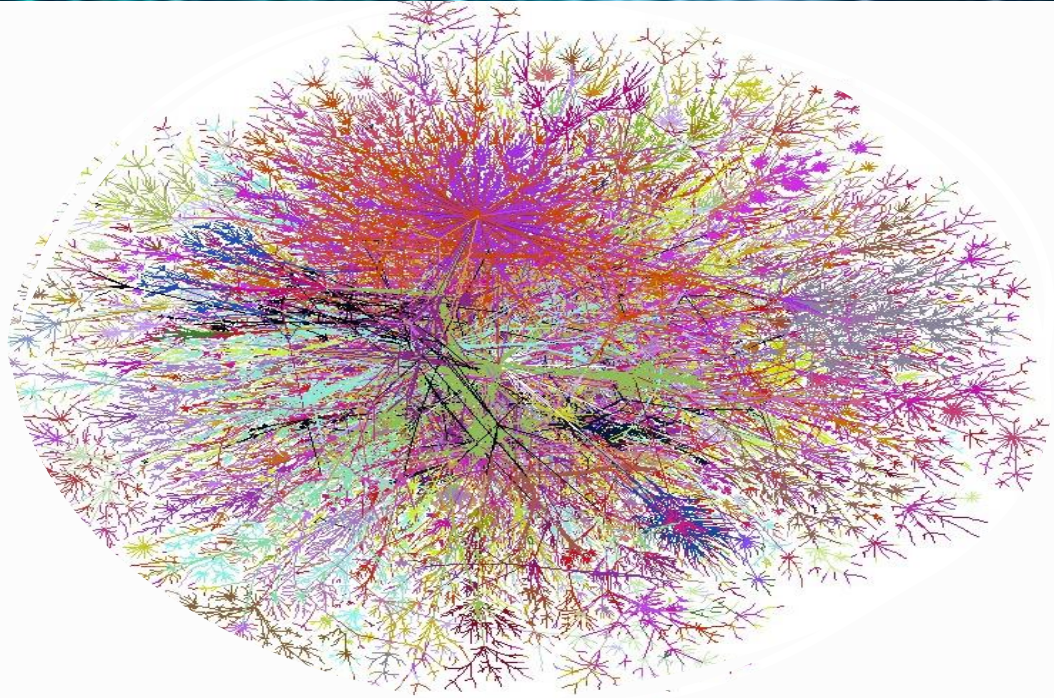
DR. JOHN POURDEHNAD

DAVE CHESEBROUGH



Agenda

- Complexity Thinking – Background and Applications
- Resilience
- Mission Engineering Context
- Relationship to Systems Engineering
- A Look Ahead
- Conclusion



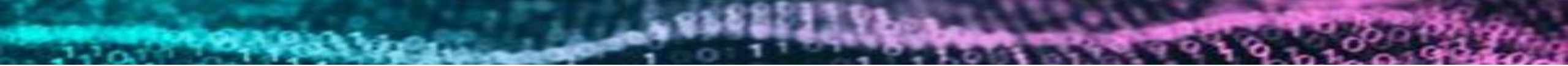
“What the hell is going on?”

Rising Complexity

“Managing a business today is fundamentally different than it was just 30 years ago. The most profound difference, we’ve come to believe, is the level of complexity people have to cope with.”

(Sargut & McGrath (2011) Harvard Business Review, Sept 2011)

- Complexity is more a way of thinking about the world than a new way of working with mathematical models.....It can help all of us address the challenges and opportunities we face in a new epoch of human history.

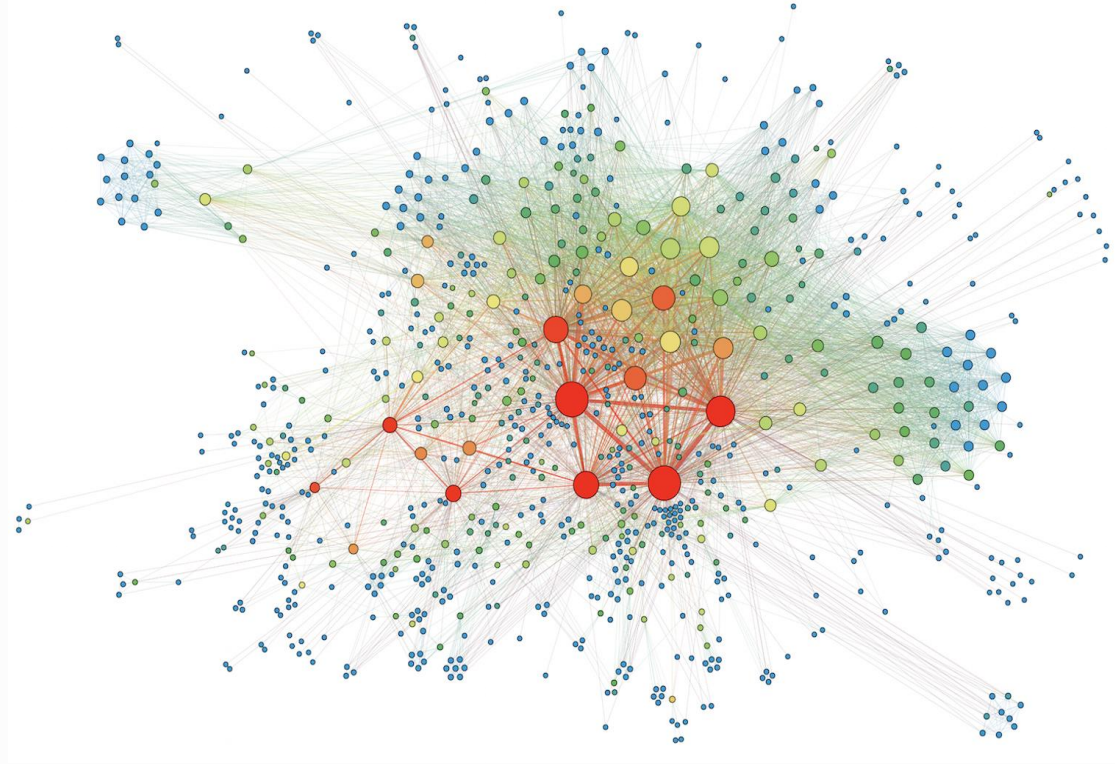


Applying Complexity Thinking to Large, highly Complex Organizations, Projects and Mega Programs

Complex Adaptive Systems

A complex adaptive system is a system that is complex in that it is a dynamic network of interactions, but the behavior of the ensemble may not be predictable according to the behavior of the components. [Wikipedia](#)

This is a way of thinking about and analyzing things by recognizing complexity, patterns and interrelationships rather than focusing on cause and effect.





Analogous learning is, quite simply, learning from situations and people that are different from your own but share similar attributes.



It entails exploring uncommon places for best practices, finding new ways of looking at the paradoxes of management and, most importantly, reinvigorating leaders.



The boundaries of analogous learning are set only by the degree of one's openness and curiosity.

Analogous Learning: Discovering Commonalities in the Most Uncommon Places

**Analogous Learning: Discovering
Commonalities in the Most Uncommon Places**
<https://tinyurl.com/cj4n4efu>

Lesson: Shinkansen bullet trains and the kingfisher bird

The Japanese Shinkansen bullet trains now move more passengers between metros than any rail in the world. But during development, their super speed caused them to exit the long, straight tunnels with a loud sonic boom. After several failed attempts at a solution, engineers knew they needed to think differently. So, they looked to the kingfisher bird. Studying its long, narrow beak and smooth ability to transition from air to water, they were able to implement the same design to allow the trains to enter and exit the tunnels quietly, saving millions in build costs.

Analogous Learning: Discovering Commonalities in the Most Uncommon Places
<https://tinyurl.com/cj4n4efu>





Turbulence in organizations:
New metaphor for
organizational research

**How do environmental turbulence and complexity
affect the appropriate formal design of
organizations?**

Proficiency

Ability to make effective decisions for improved performance in dynamic complexity is lacking!

Like pilots on the flight deck, executives and managers (people at the helm) are continuously making decisions. But unlike the pilots, they are rarely supported by systems that help them navigate the “permanent white water” in today’s environment.



A Leader's Framework for Decision Making

Harvard Business Review, 2007

by [David J. Snowden](#) and [Mary E. Boone](#)

[From the Magazine \(November 2007\)](#)

CYNEFIN[®]

weaving sense-making
into the fabric of
our world



DAVE SNOWDEN & FRIENDS

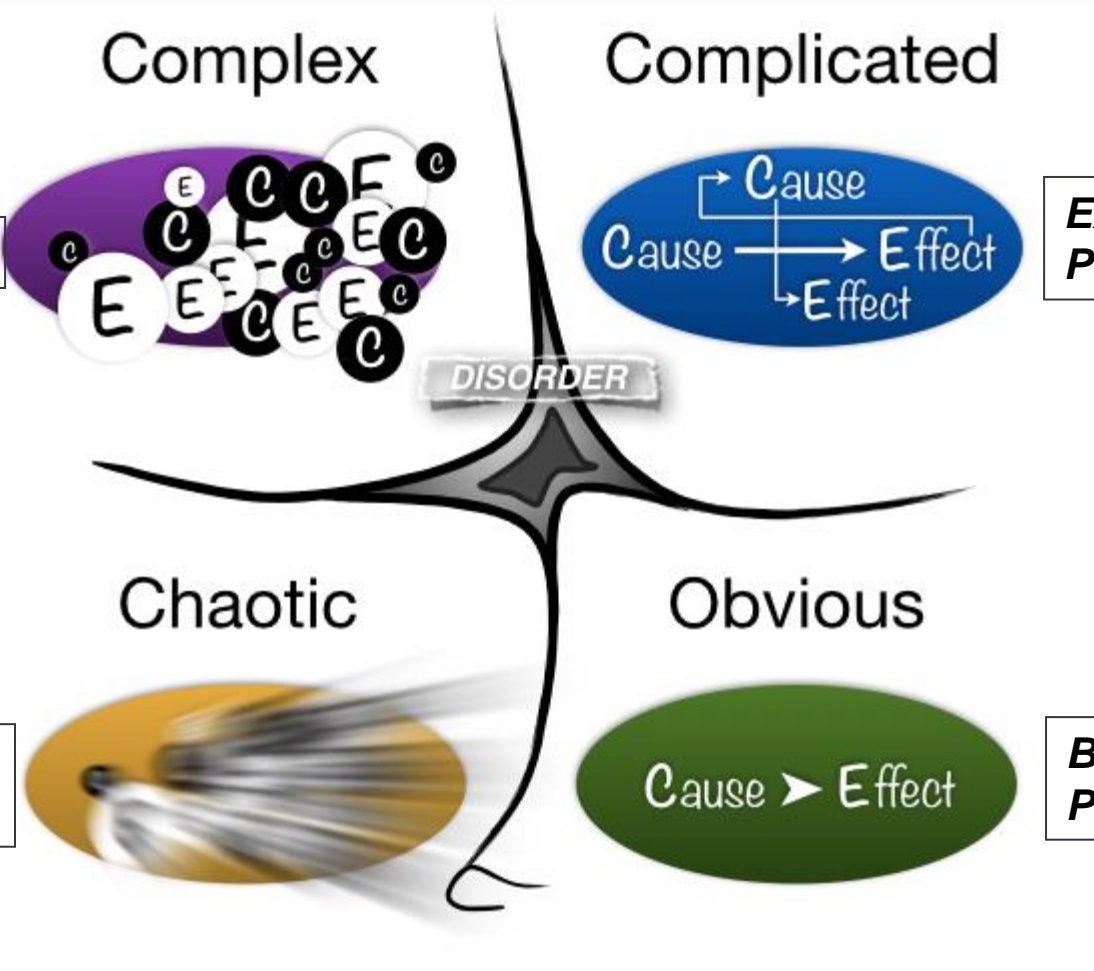
Illustrated by Sue Borchardt



“ We've moved from the age of enlightenment to the age of entanglement where sense-making aided by imagination is now more critical than ever. This book helps re-orient us to Dave's critical insights on complexity theory beautifully framed by his Cynefin Framework. ”

John Seely Brown

Emergence

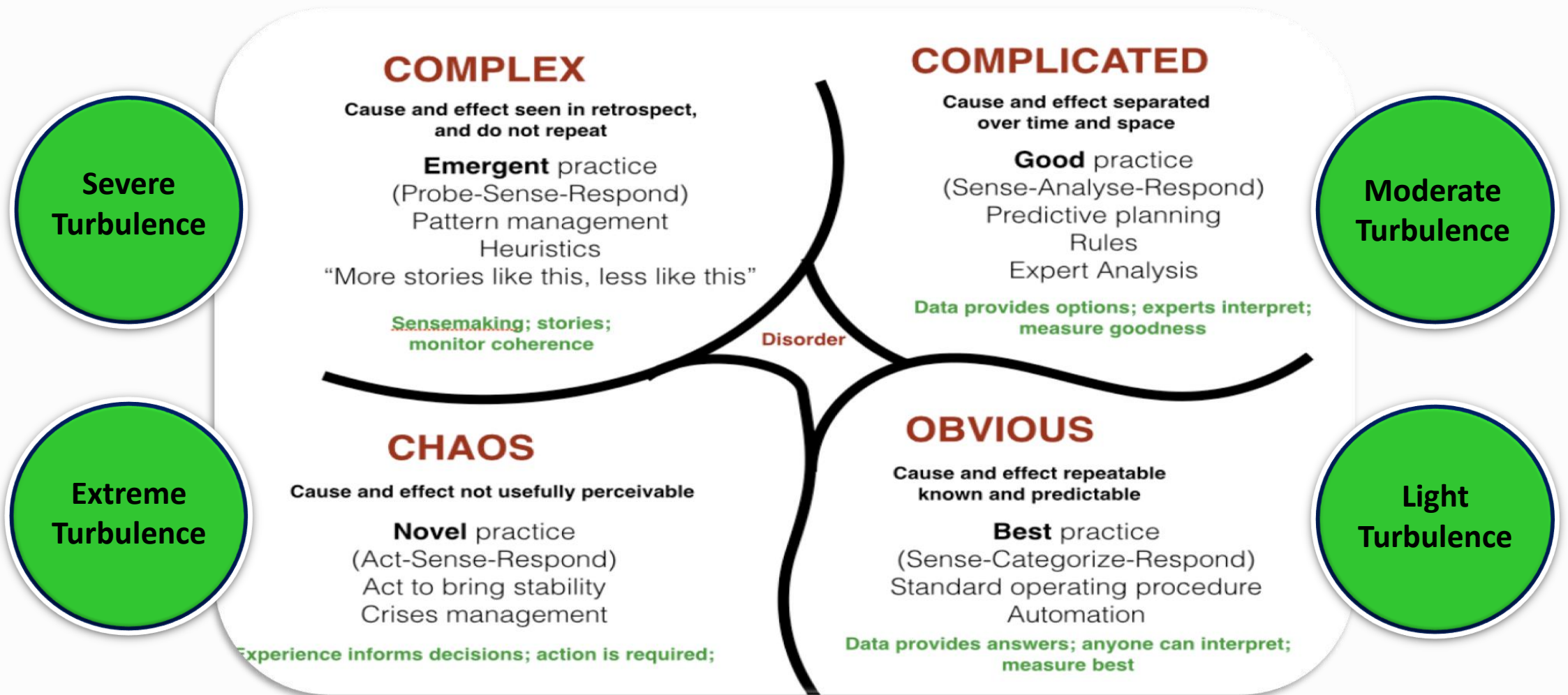


How to lead and make appropriate decisions



Sue Borchardt, borchardt cynefin fly-through_2021, <https://vimeo.com/640941172>

Four Levels of Turbulence in the Cynefin Framework

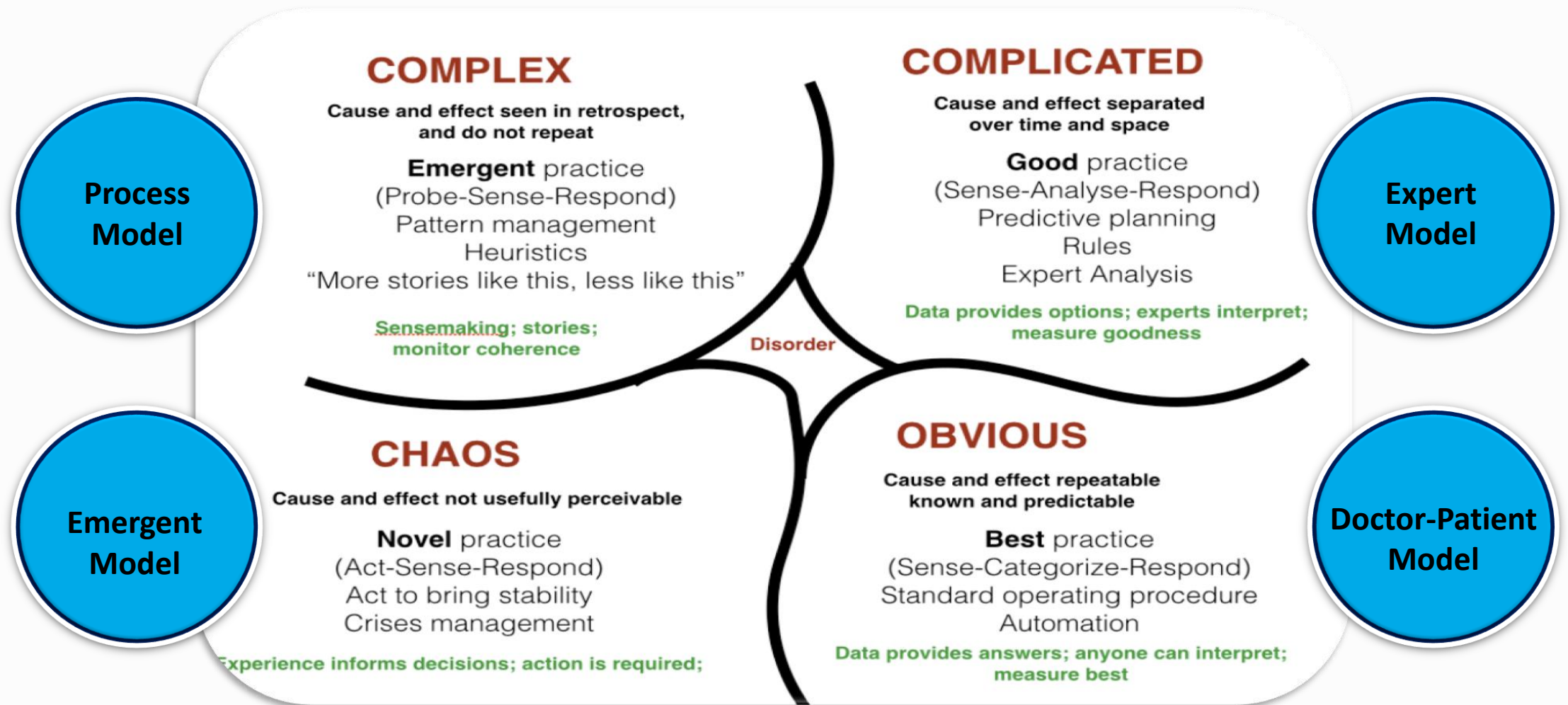


Need For *Diverse Thinking*



<http://bit.ly/WWjaXt>

Strategic Consulting Models in the Cynefin Framework



The Cynefin framework is a conceptual framework used to aid decision-making. Created in 1999 by Dave Snowden when he worked for IBM Global Services, it has been described as a "sense-making device". Cynefin is a Welsh word for habitat.

Complexity

Complexity: the myriad of possible ways that the variables in the internal and external environments of the system can interact.

- ✓ The complex whole: may exhibit properties that are not readily understood by understanding parts of the system. Complexity is manifested at the level of the system itself.
- ✓ The concept of emergence: what distinguishes a complex context from a complicated one is that some behaviors and patterns emerge in complex situations as a result of the pattern of relationships between the elements that creates a condition.
 - <https://medium.com/age-of-awareness/facing-complexity-means-befriending-uncertainty-and-ambiguity-46b7f576570>

Resilience

Resilience (n): The capacity to recover quickly from difficulties; toughness.

Both the ability to tap into a well of inner strength and a process of adapting in the face of adversity.



Ensuring resilience in the face of disruptions:

“the ability to successfully adapt and respond positively to difficulties or other adverse conditions.”

Resilience and Robustness

Resilience may be confused with robustness, but they are not the same.

“Resilience is more about how we go beyond that and how we continuously adapt to changing situations for which we may not necessarily have procedures.

“Robustness is more about how we respond to challenges when there are ways that were trained and skills and resources that were provided,” according to Shawn Pruchnicki, assistant professor at the Center for Aviation Studies at The Ohio State University.

In the aviation realm, it is when we are faced with unexpected events for which we do not have the likes of specific checklists that we can demonstrate our level of resilience.



Resilience

In the social realm, resilience is the process and outcome of successfully adapting to difficult or challenging life experiences, especially through mental, emotional, and behavioral flexibility and adjustment to external and internal demands.



Mission Engineering

the deliberate planning, analyzing, organizing, and integrating of current and emerging operational and system capabilities to achieve desired warfighting mission effects

The right thing, at the right place, at the right time

Mission

a duty assigned to an individual or unit

Mission Integration Management

the synchronization, management, and coordination of concepts, activities, technologies, requirements, programs, and budget plans to guide key decisions focused on the end-to-end mission.

MISSION ENGINEERING CONSUMERS

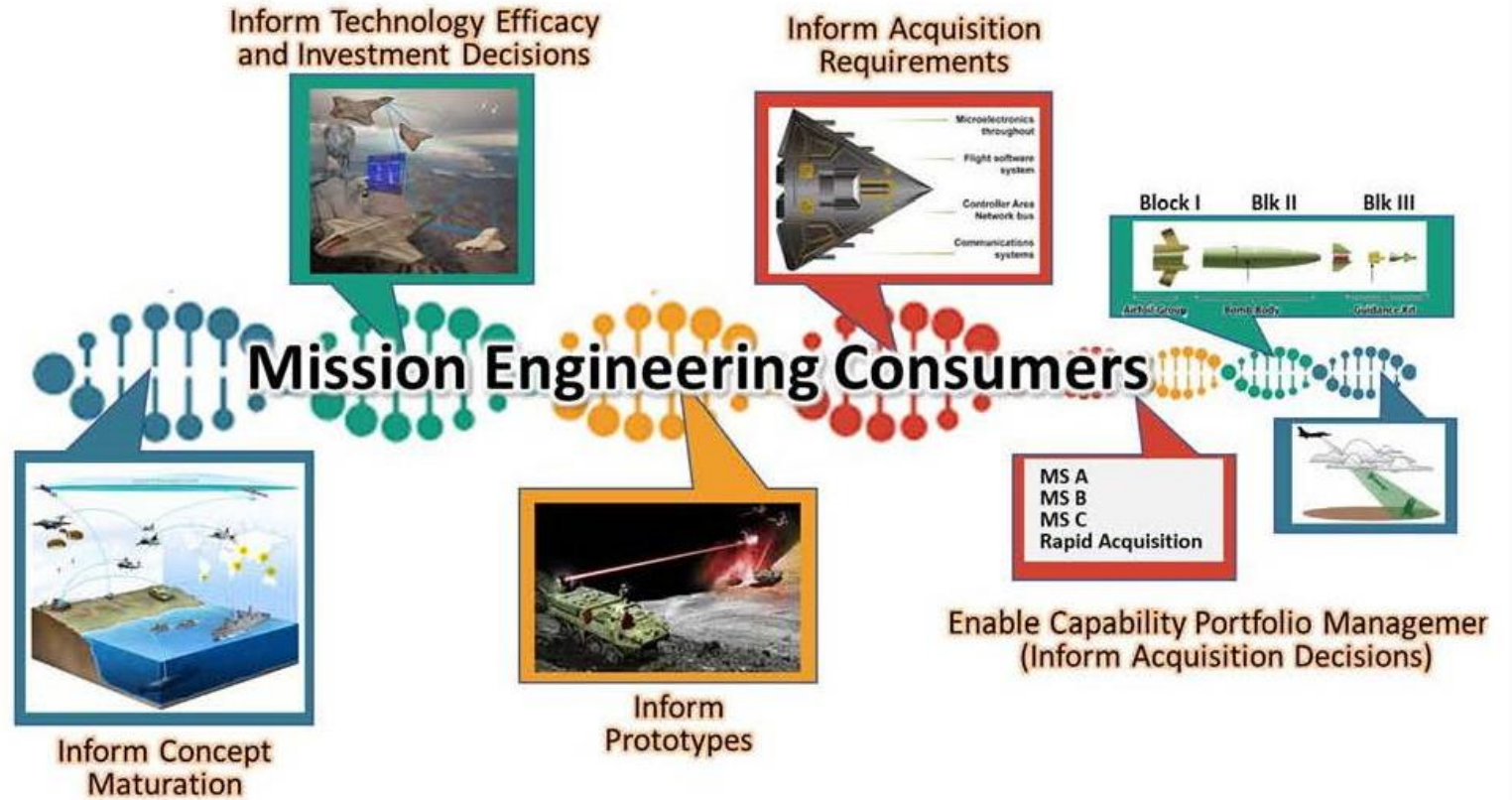


Figure 1-1. Consumers of Mission Engineering Outputs

Mission Engineering Guide, November 2020

“There are known knowns — there are things we know we know. We also know there are known unknowns — that is to say, we know there are some things we do not know. But there are also unknown unknowns, the ones we don’t know we don’t know.”

- Donald Rumsfeld, Secretary of Defense, February 2002



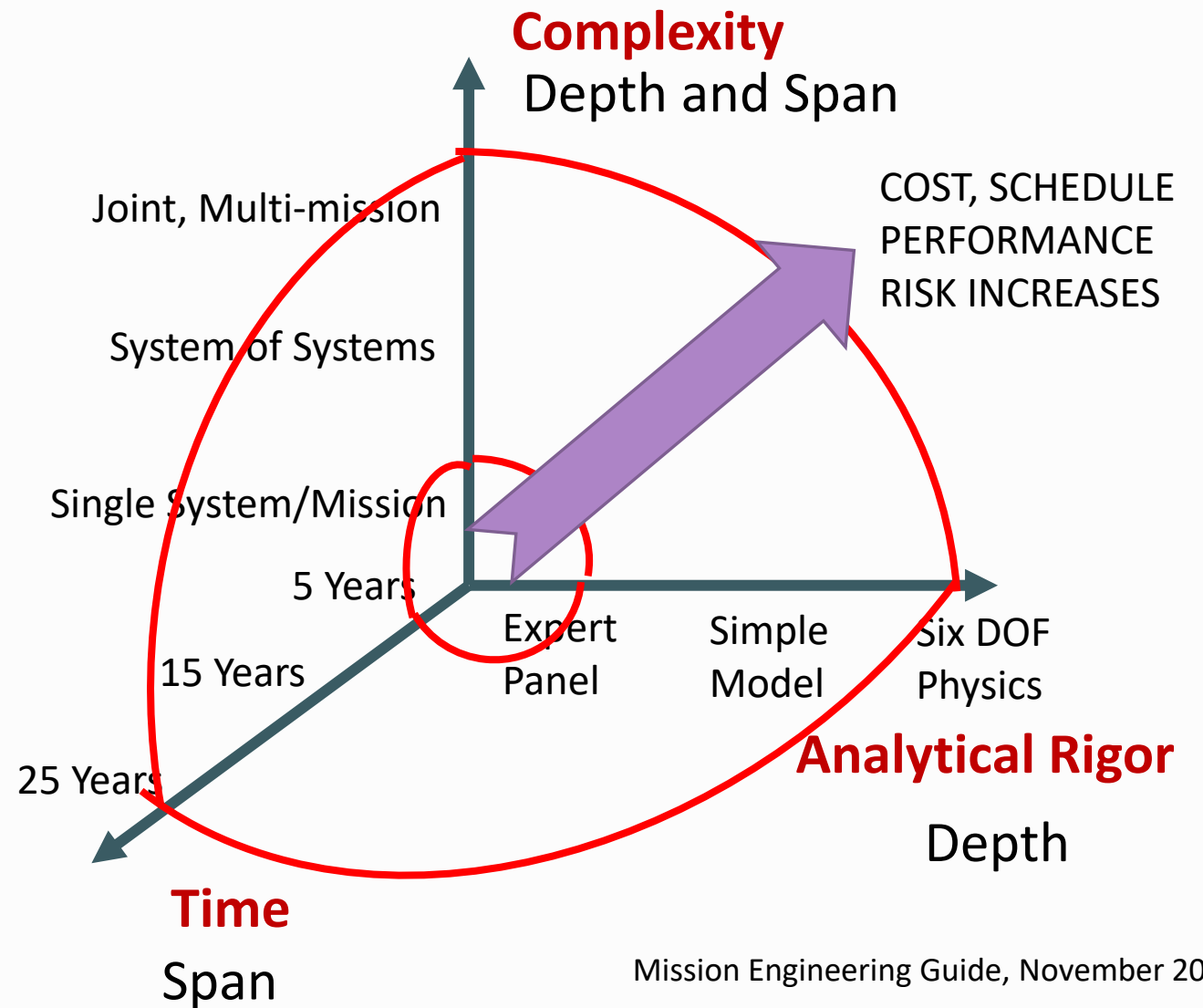
“The absence of evidence is not evidence of absence”

Mission Engineering Balance

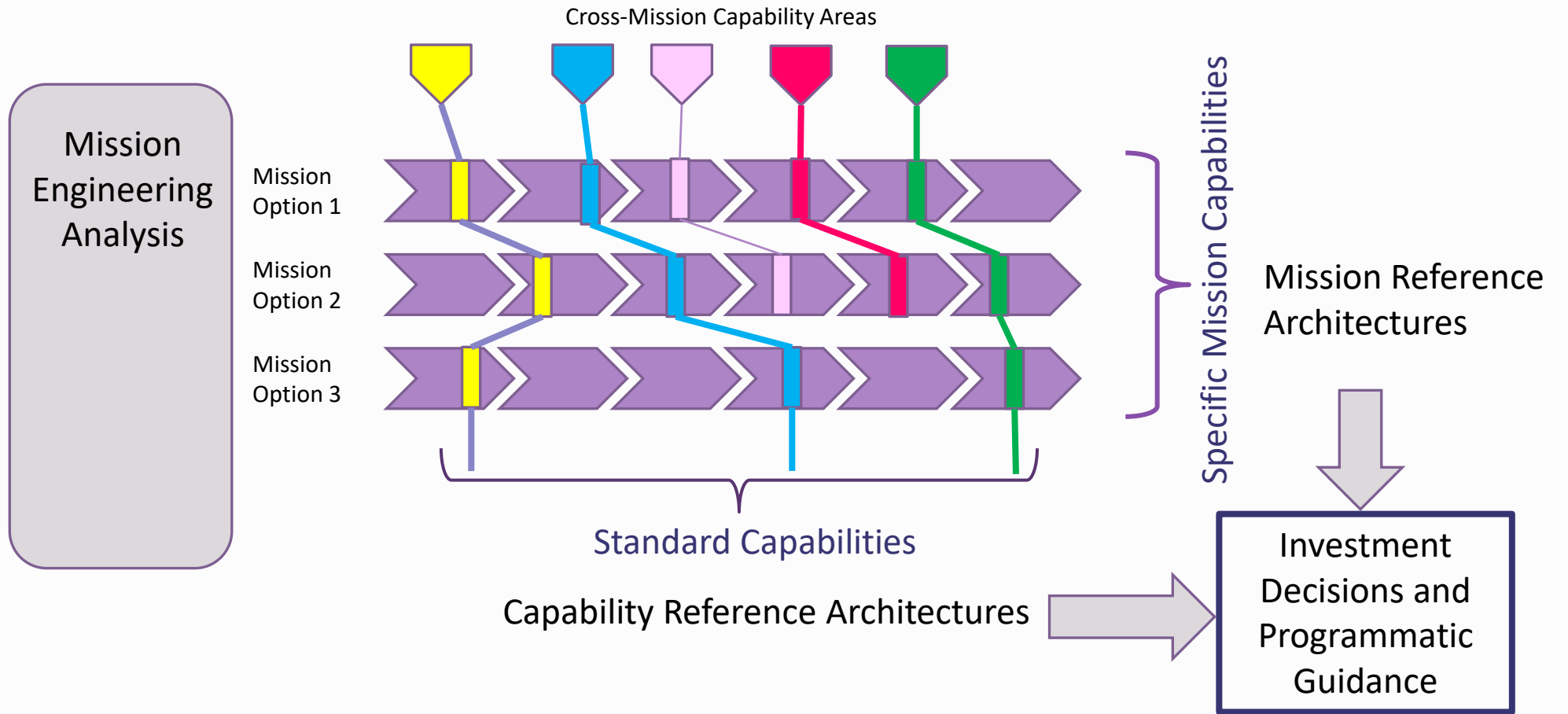
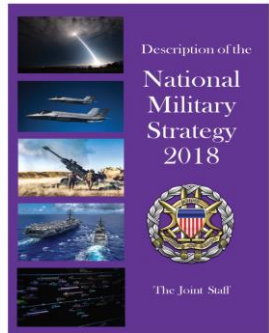
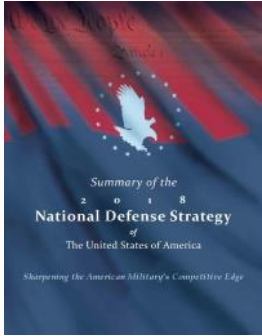
Overreach on any axis will impact

- Confidence in ME products
- Validity of analysis
- Availability of data

Three Axes of Mission Engineering



Strategy & Guidance



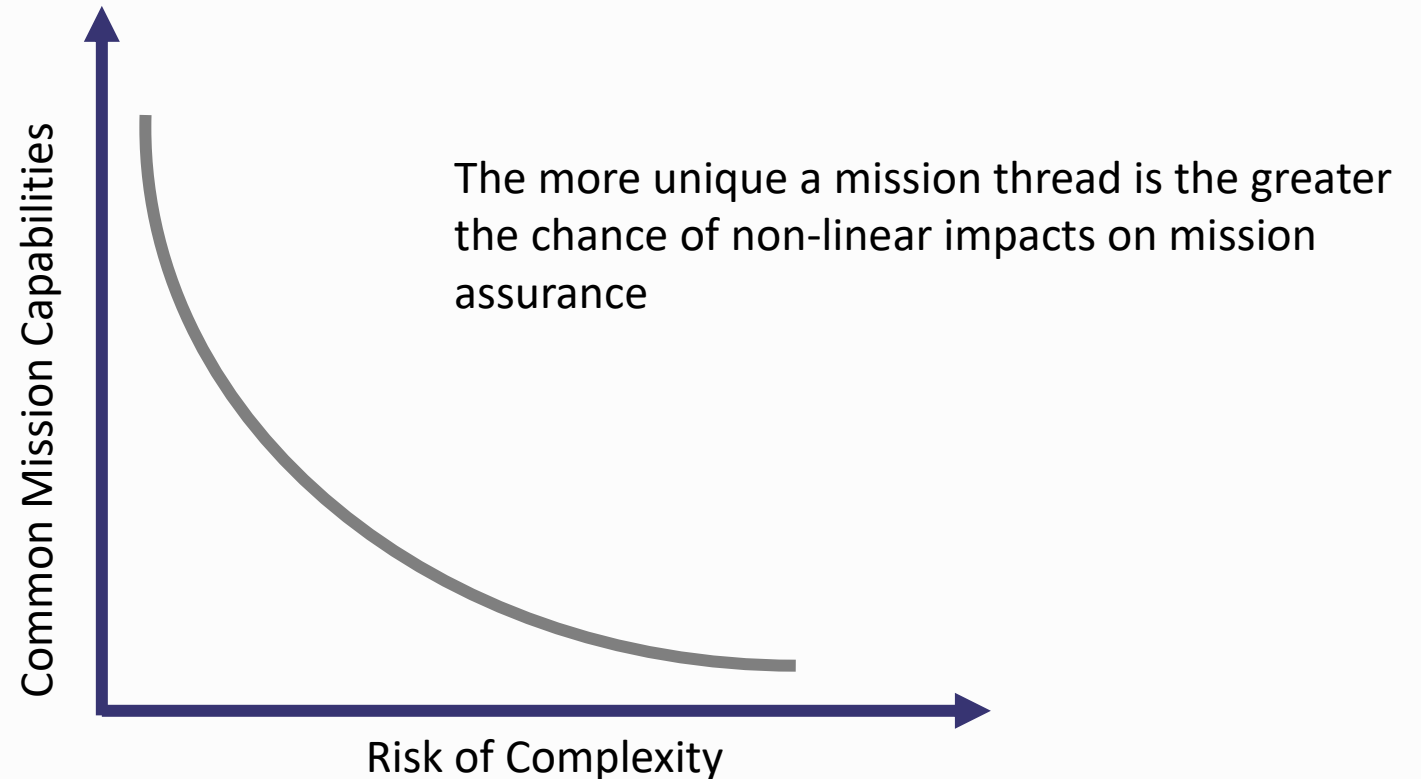
Trade studies between mission effectiveness and common capabilities

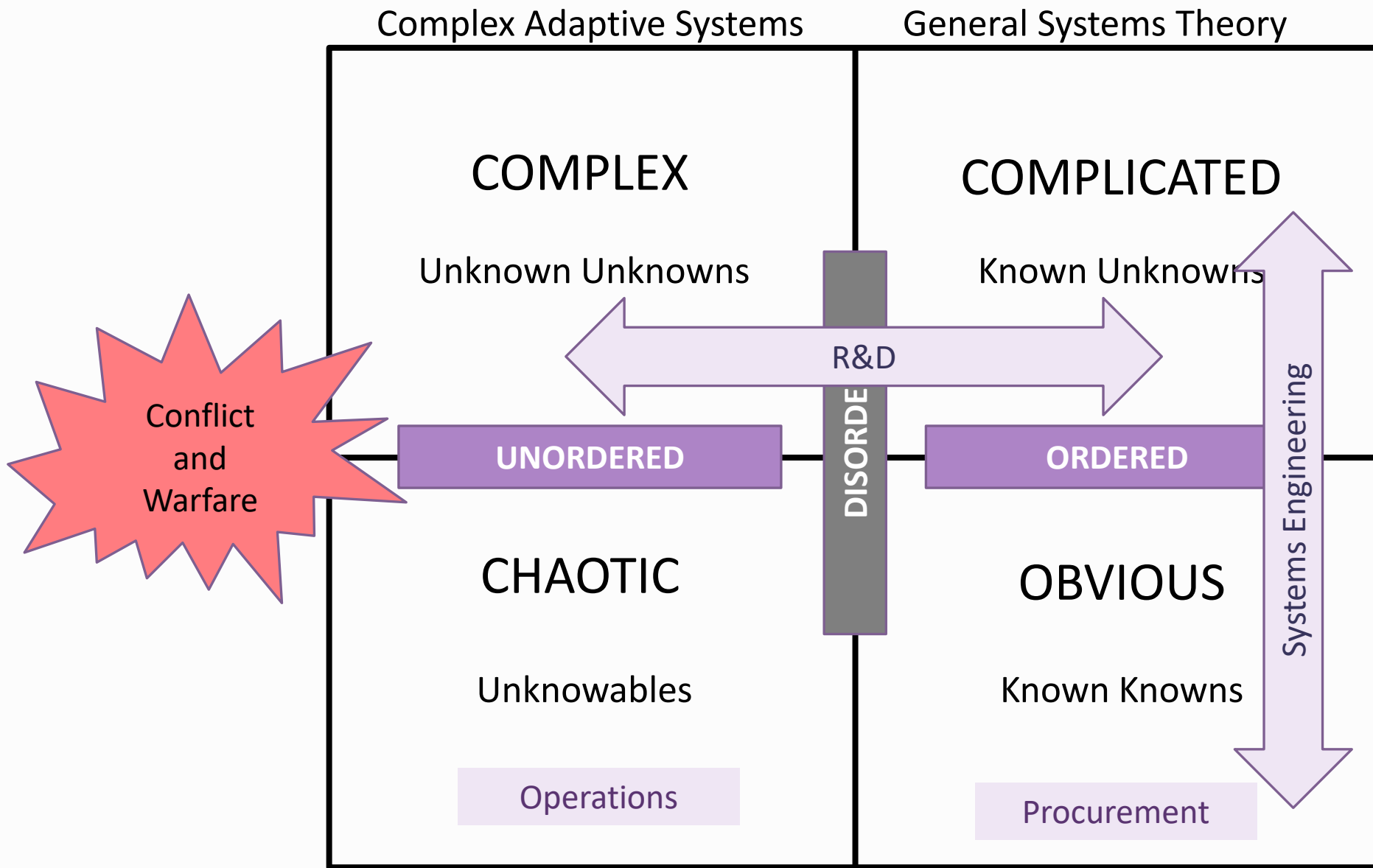
The Non-linearity Effect

For want of a nail the shoe was lost. For want of a shoe the horse was lost. For want of a horse the rider was lost. For want of a rider the battle was lost. For want of a battle the kingdom was lost.

- A Proverb

- Something minor has a disproportionate effect on outcomes
- Complexity increases the possibility of having non-linear interdependencies
- Standardization of capabilities across missions provides a measure of assurance





Kurtz and Snowden, IBM, 2003

What Do We Know?

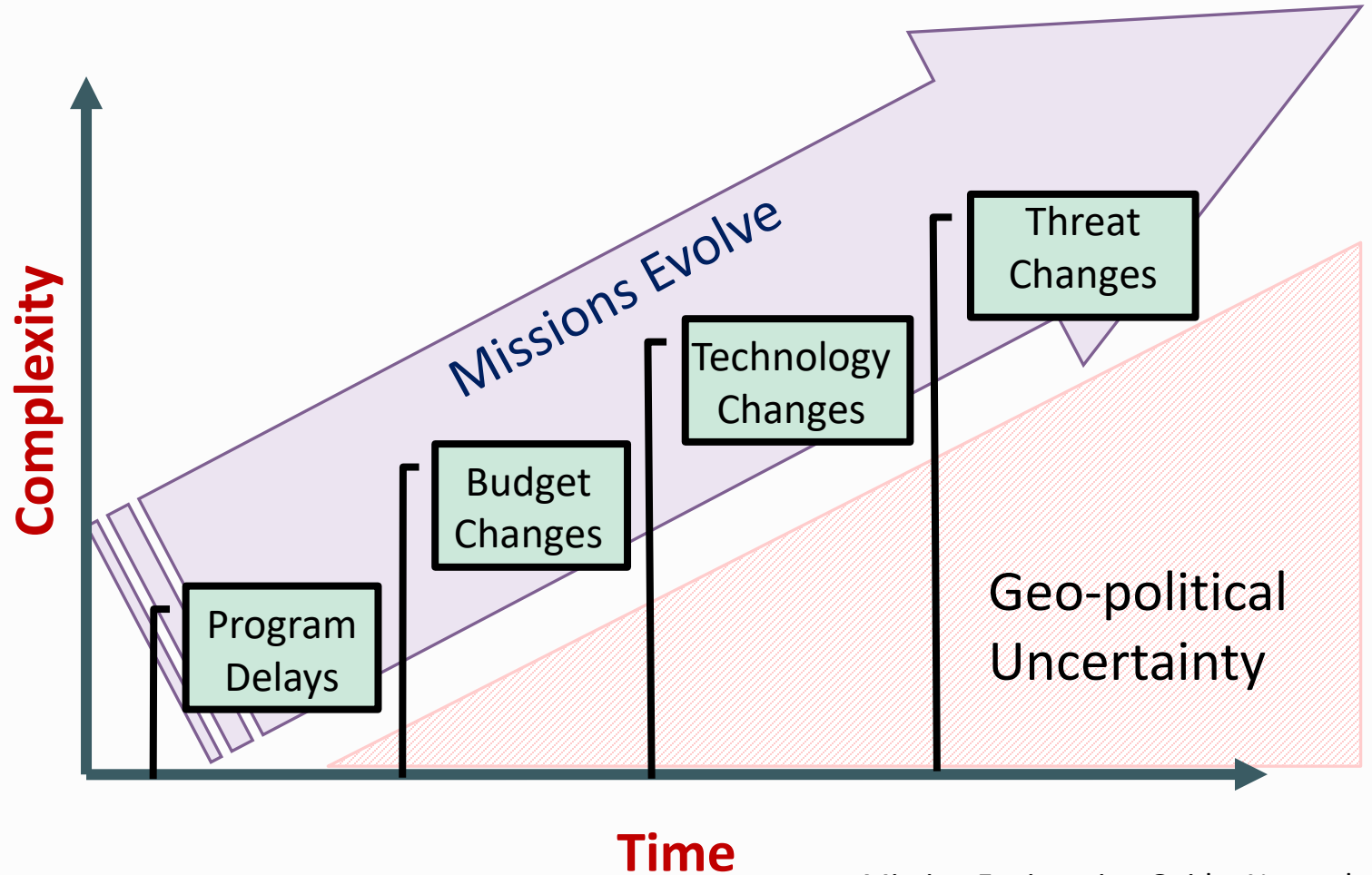
Change is constant and unpredictable

Systems must adapt

Real-world complexity always creeps in

Present imperative is to move faster, innovate quicker

Three Axes of Mission Engineering



Mission Engineering Guide, November 2020

How does ME Deal with Complexity?

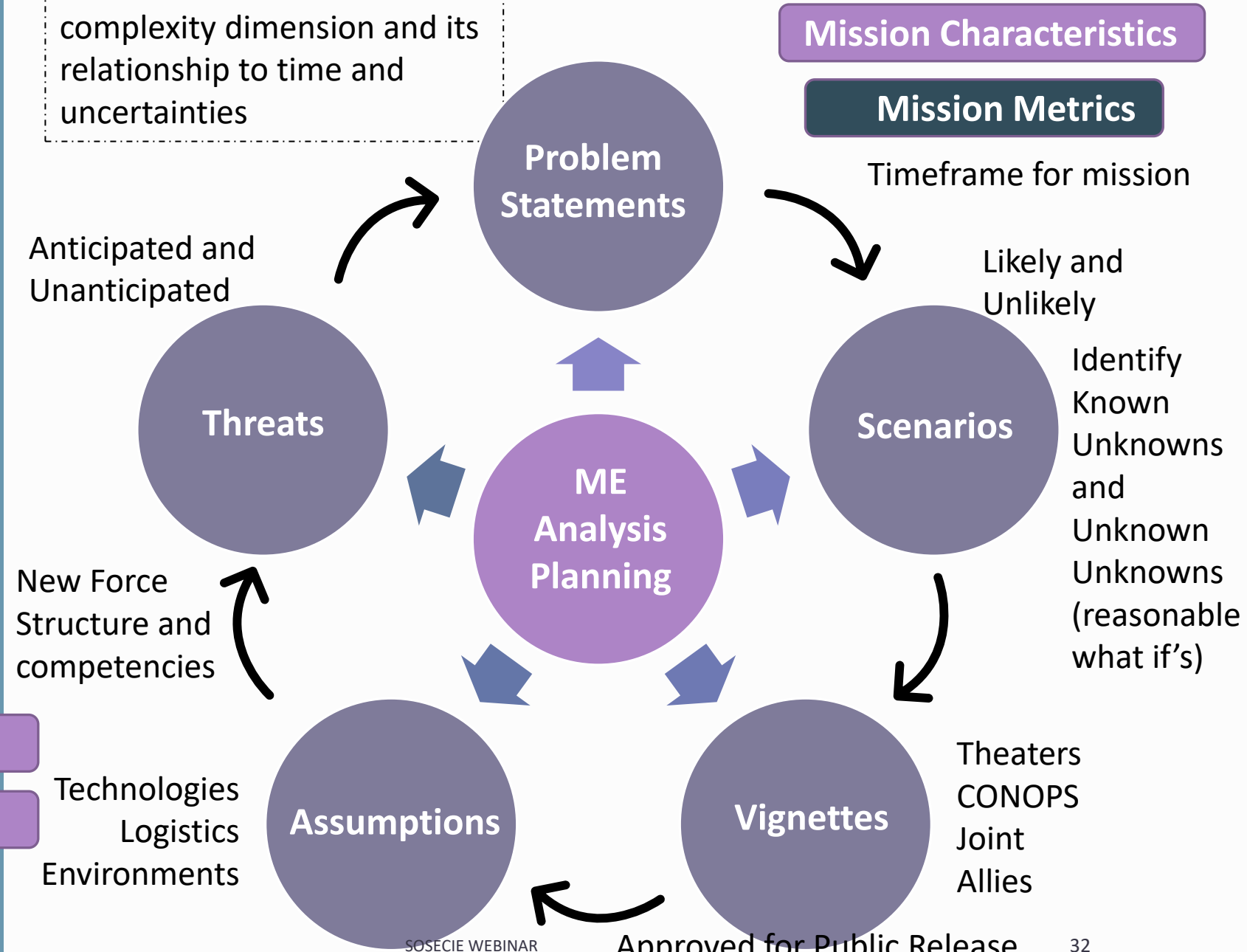
By addressing questions that impact mission architectures while planning the analysis

- What are we trying to do?
- Who should be doing it?
- What is the context?
- What is the timeframe?

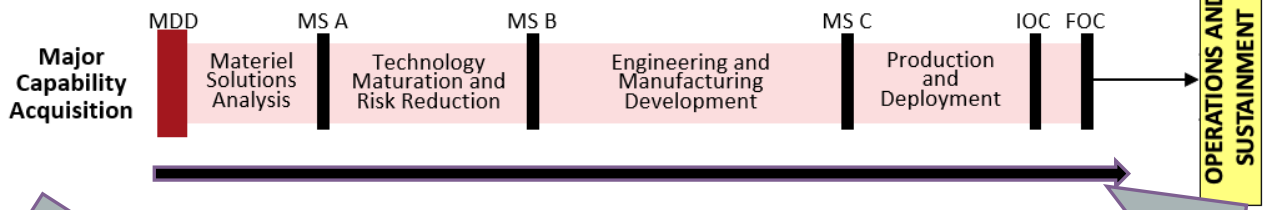
Relationships

Dependencies

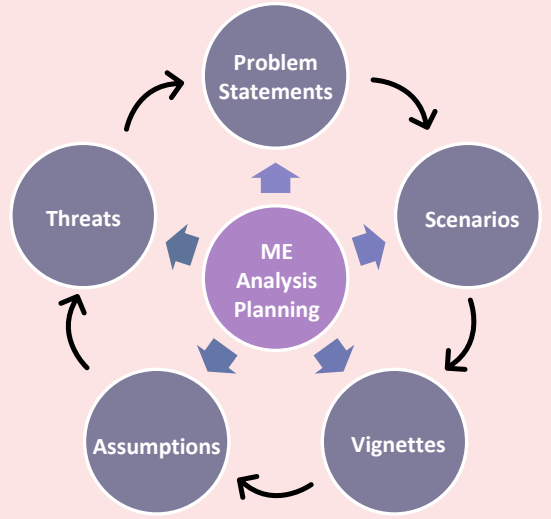
This is the time to look at the complexity dimension and its relationship to time and uncertainties



Adaptive Acquisition Framework

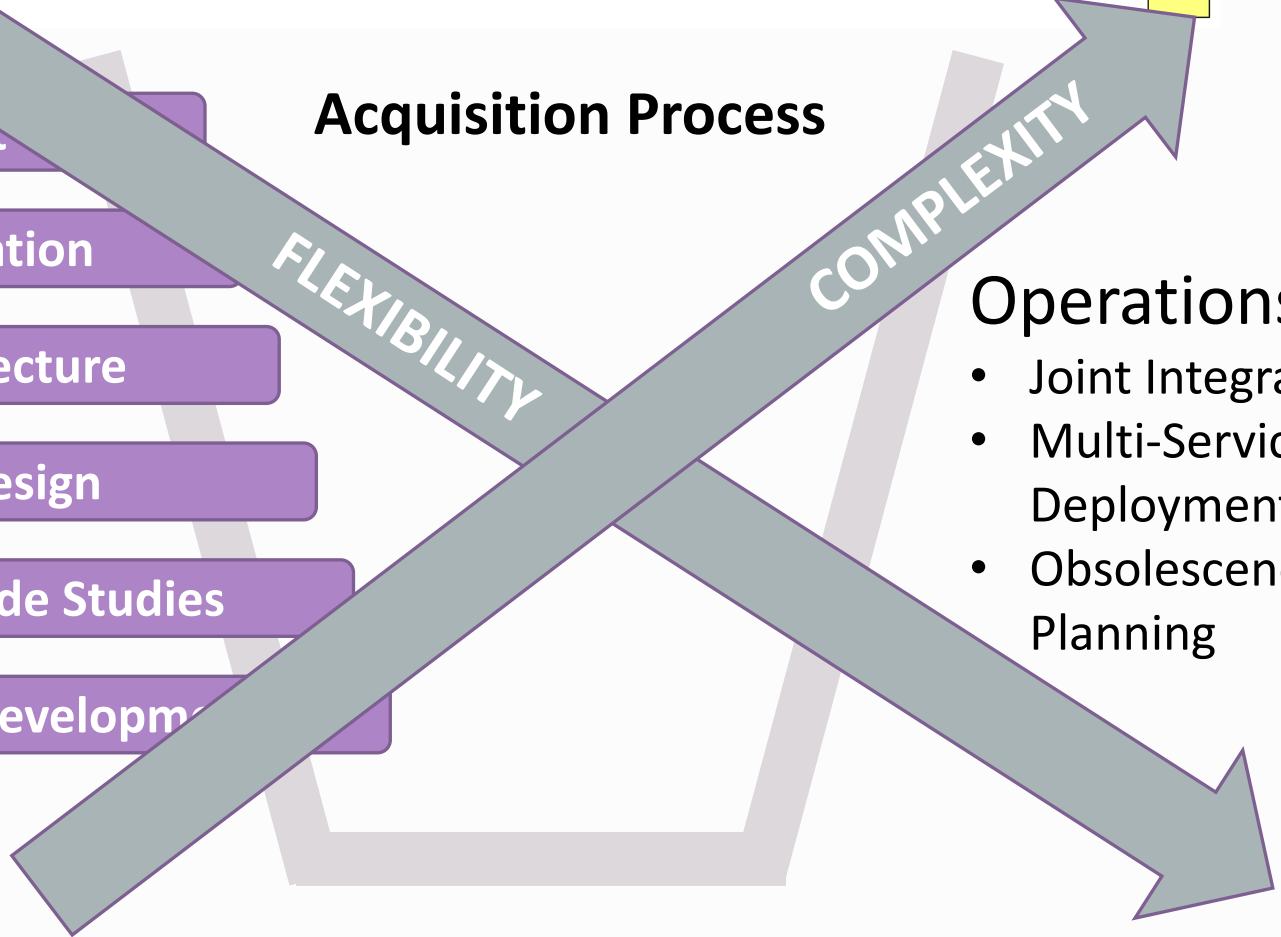
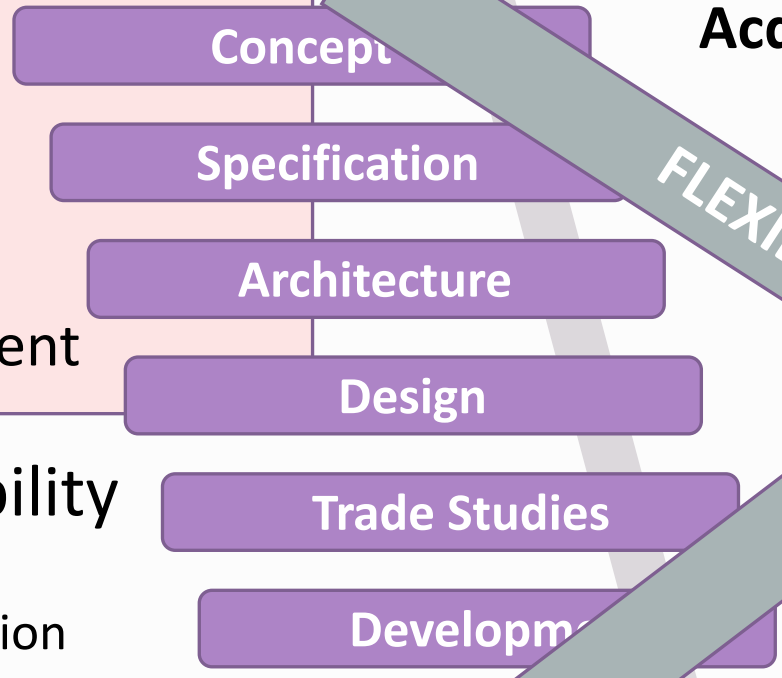


GMRA/GCRA



Mission Engineering
Capability Assessment

- Design for Flexibility**
- Digital Engineering
 - Modeling & Simulation
 - MOSA
 - SOS Interoperability



- Operations**
- Joint Integrated Ops
 - Multi-Service Force Deployment
 - Obsolescence Planning

Summary

- Mission Engineering addresses complexity
 - Problem Statements, Scenarios, Assumptions
- Systems Engineering Provides Flexibilities
 - Modeling and simulation
 - MOSA
 - SOS Interoperability
- Over time the ability to deal with complexity shifts from design to operations – plan on it!



Thank You

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