2022 Annual INCOSE international workshop

HYBRID EVENT

Torrance, CA, USA

Jan 29 - Feb 1, 2022

INCOSE IW: MBSE Workshop

Transformation

www.incose.org/IW2022

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SSI Vice President

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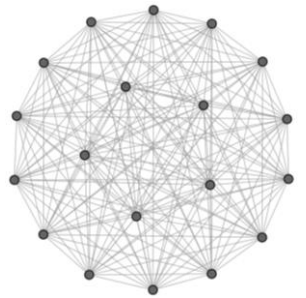


Nodes = 19, potential links = 171, unique configurations = 2^{171}

Number of known atoms in the universe ~ 2^{158} and 2^{246}

System Elements & Interactions

External Elements & Interactions

Increased Density of System Elements & Interactions

Increased Density of System External Elements & Interactions

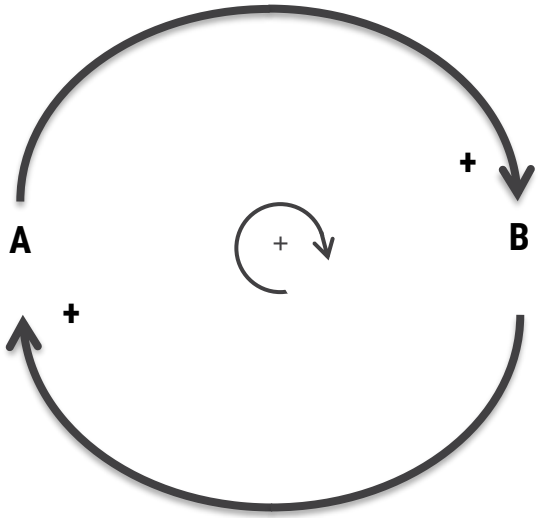
Increased Interactions Between External Elements

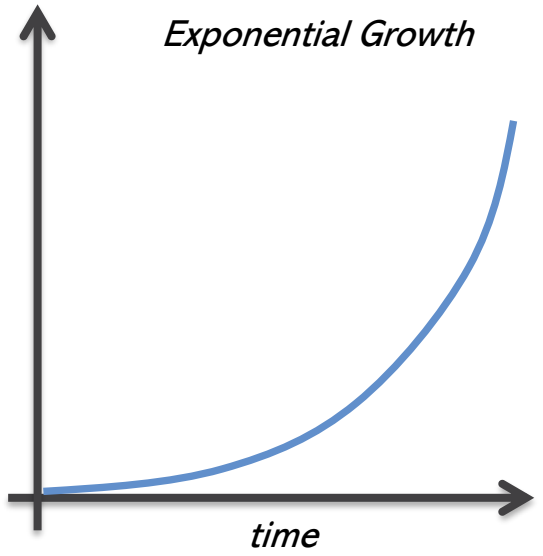
Expanding System Domain Boundary Increasing Interactions

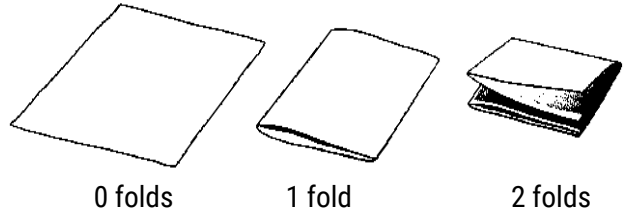
P-51 Mustang	Delta	F-35 Lightning
First Flown: October 26, 1940	**+60 years**	First Flown: October 2000
Retired from Service in US: 1978 (38 years)	**2x**	Projected Retirement: 2070 (70 years)
Maximum take off weight: 12,000 lbs	**6x**	Maximum take off weight: 70,000 lbs
Maximum speed: 440 mph	**3x**	Maximum speed: 1,200 mph
Lines of Code: 0	**8Mx**	Lines of Code: 8,000,000
1940 Cost: $50,000.00 (CV ~$1M each)	**2000x**	Cost: $100M
Contract to Prototype: 102 days	**48x**	Contract to Prototype: 4929 days

Traditional development methods do not adequately address the complexity of systems today

The explosive growth of cyber-physical systems has rapidly and dramatically increased complexity all around us. Seamlessly intertwining computational algorithms and physical components, these systems have significantly increased the demands on engineering rigor to ensure safety, quality, security, sustainability, adaptability, and more, all while delivering products more rapidly.





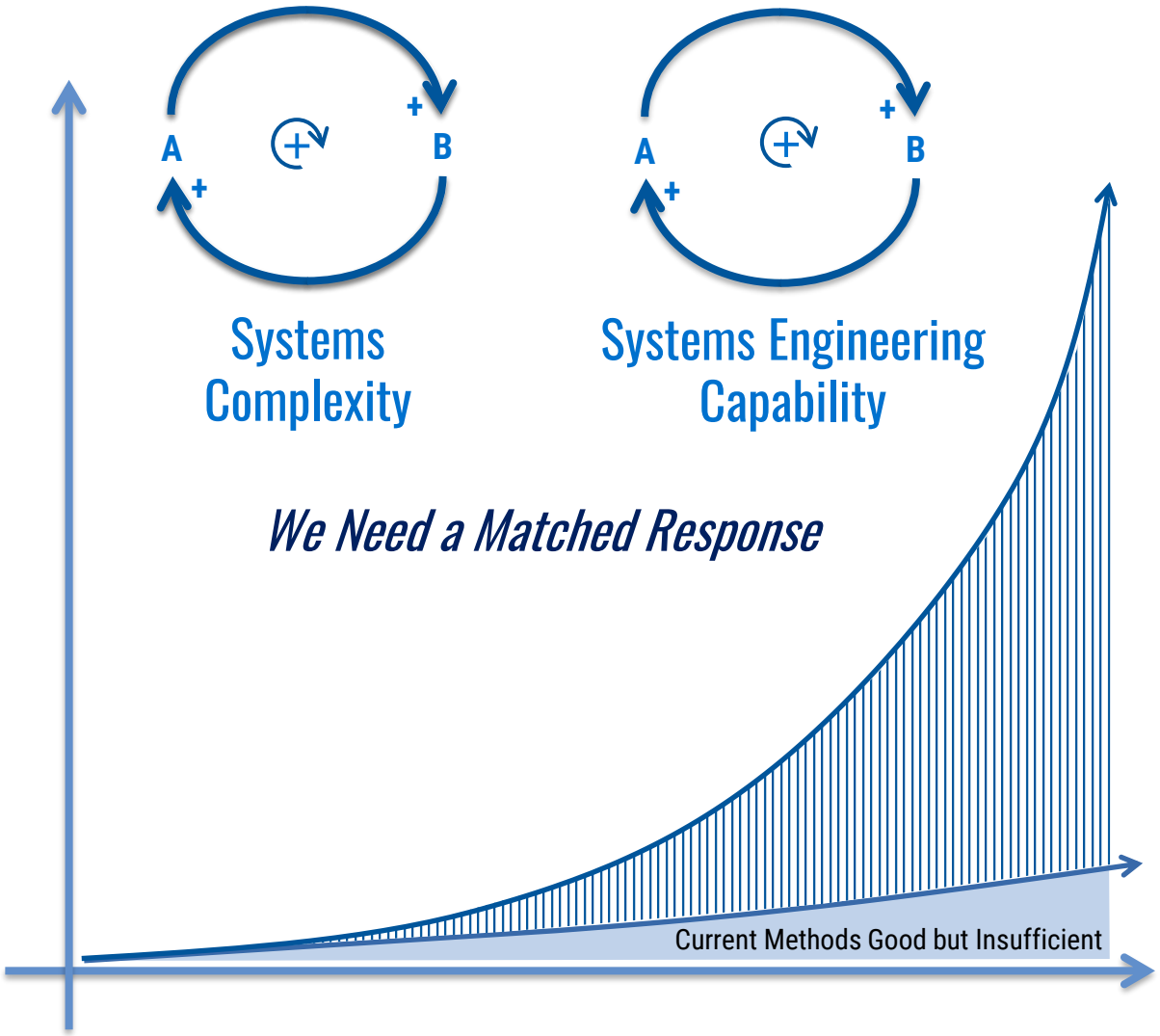


We routinely underestimate the power of exponential growth.

What is the thickness of a piece of paper after folding it 42 times? What about 100 times?

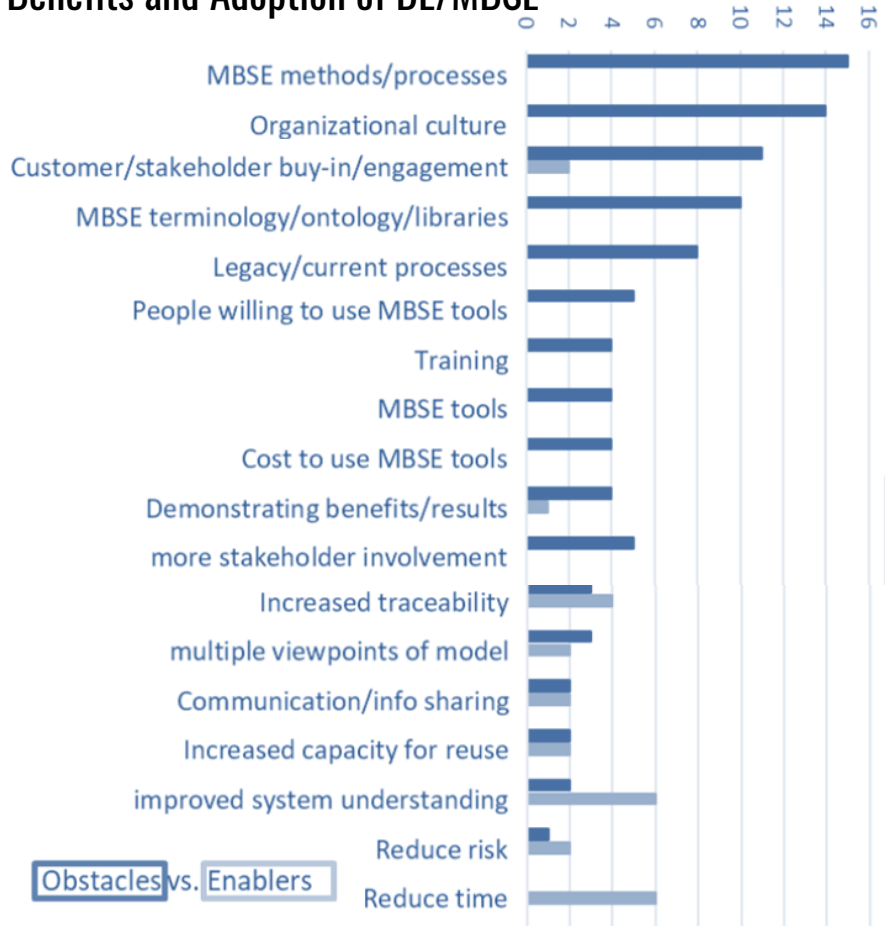
Connected Devices | Electronics/ Sensors Usage | SLOC
Technology Adoption | Automation | Autonomy

42x = 440,000 km thick
100x = 850T * distance to our sun



INCOSE NDIA SYSTEMS ENGINEERING RESEARCH CENTER

Benefits and Adoption of DE/MBSE

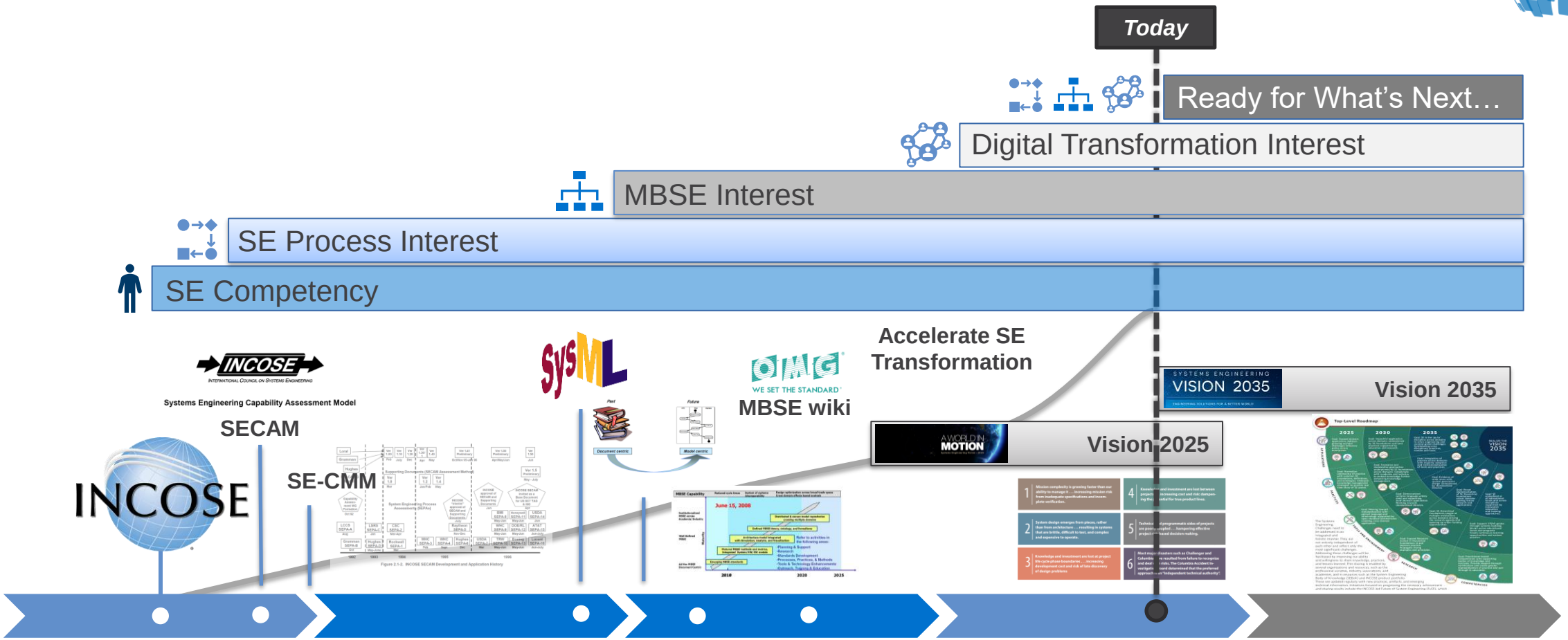


Gartner

Observation from 2020 Gartner Study

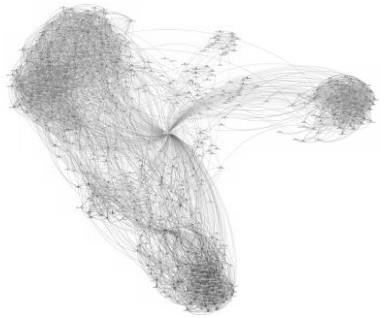
From Gartner's perspective, "the transformation journey is ***taking large enterprises especially at least twice as long and costing twice as much as they originally anticipated***." In large part this is due to cultural readiness

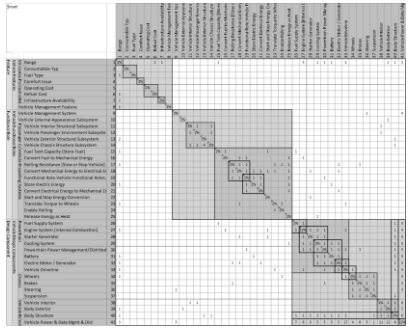
Gartner 2020, The IT Roadmap for Digital Business Transformation


Today
Ready for What's Next…
Digital Transformation Interest
MBSE Interest
SE Process Interest
SE Competency
Accelerate SE Transformation
INCOSE
Systems Engineering Capability Assessment Model
SECAM
SE-CMM
SysML
OMG
WE SET THE STANDARD
MBSE wiki
A WORLD IN MOTION
Vision 2025
SYSTEMS ENGINEERING VISION 2035
Vision 2035
1990
2000
2010
2020
2030

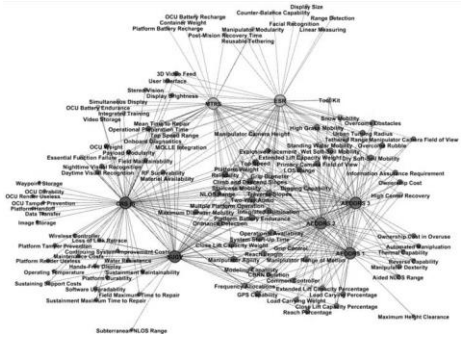
Sociotechnical Alignment

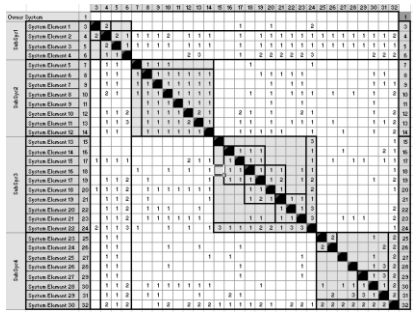
Organizational Architectures



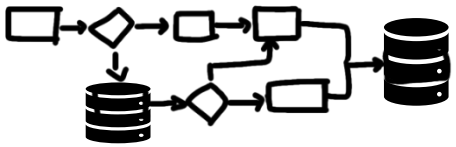


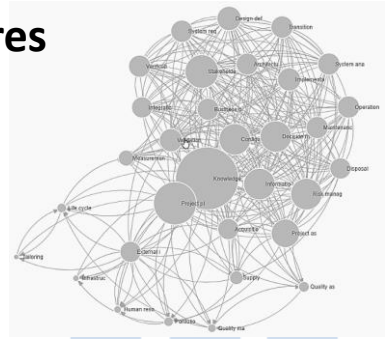
Target System Architectures

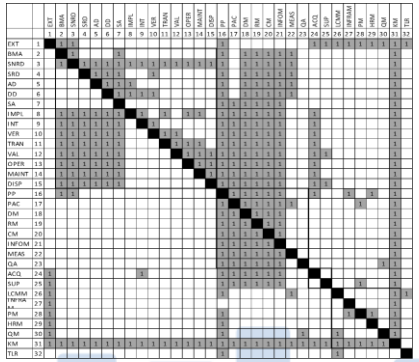


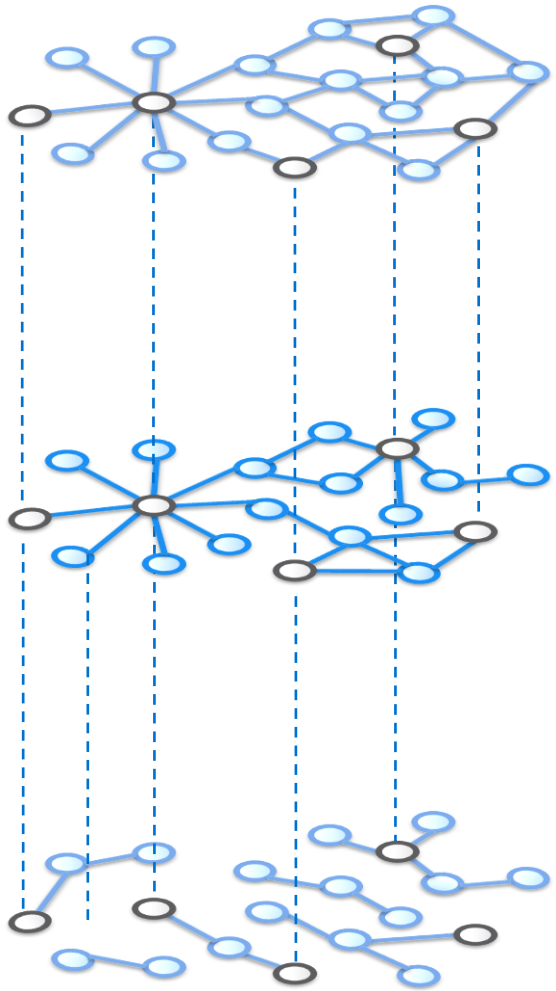


Development/Process Architectures

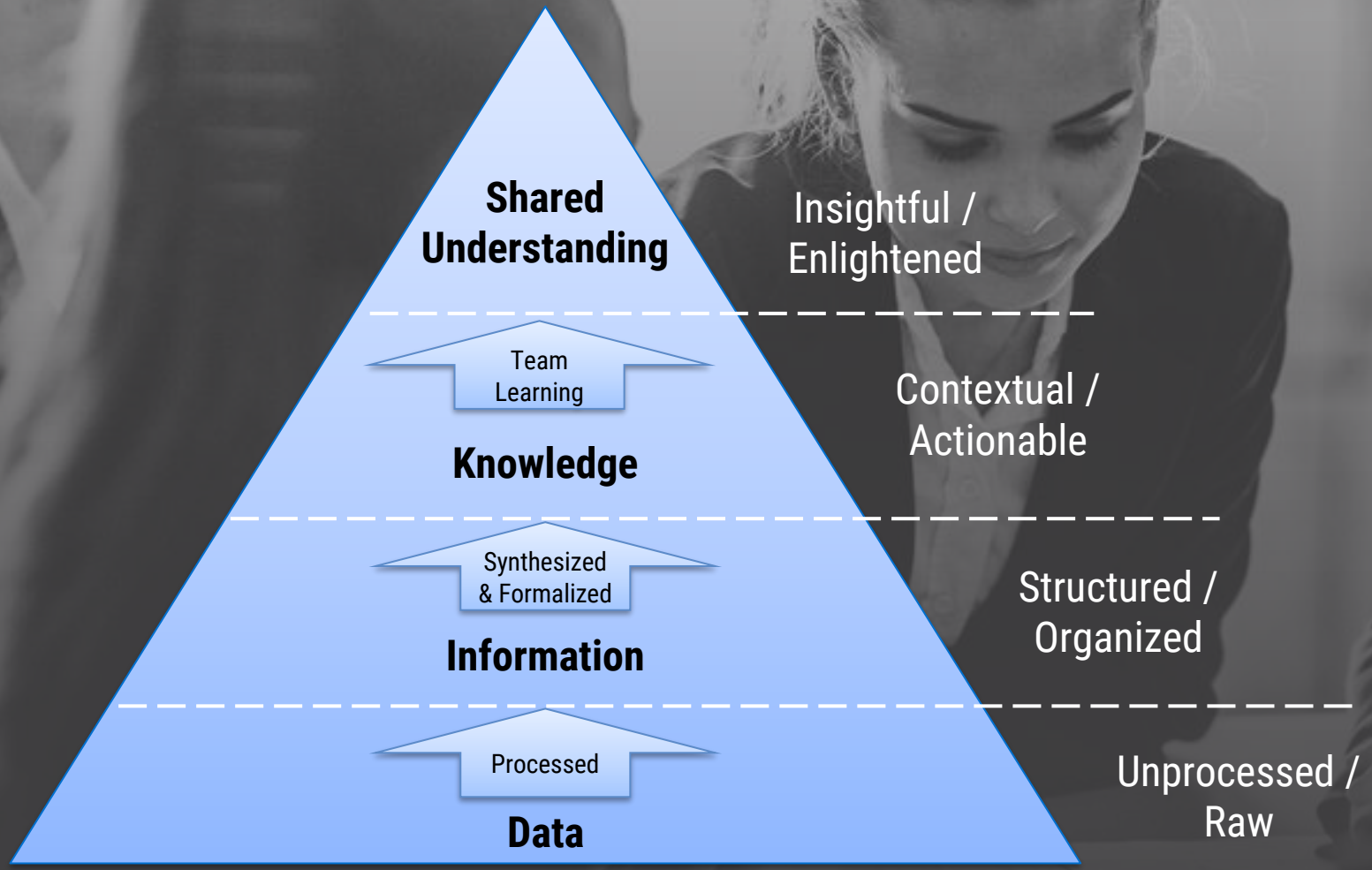








Build a Shared Understanding

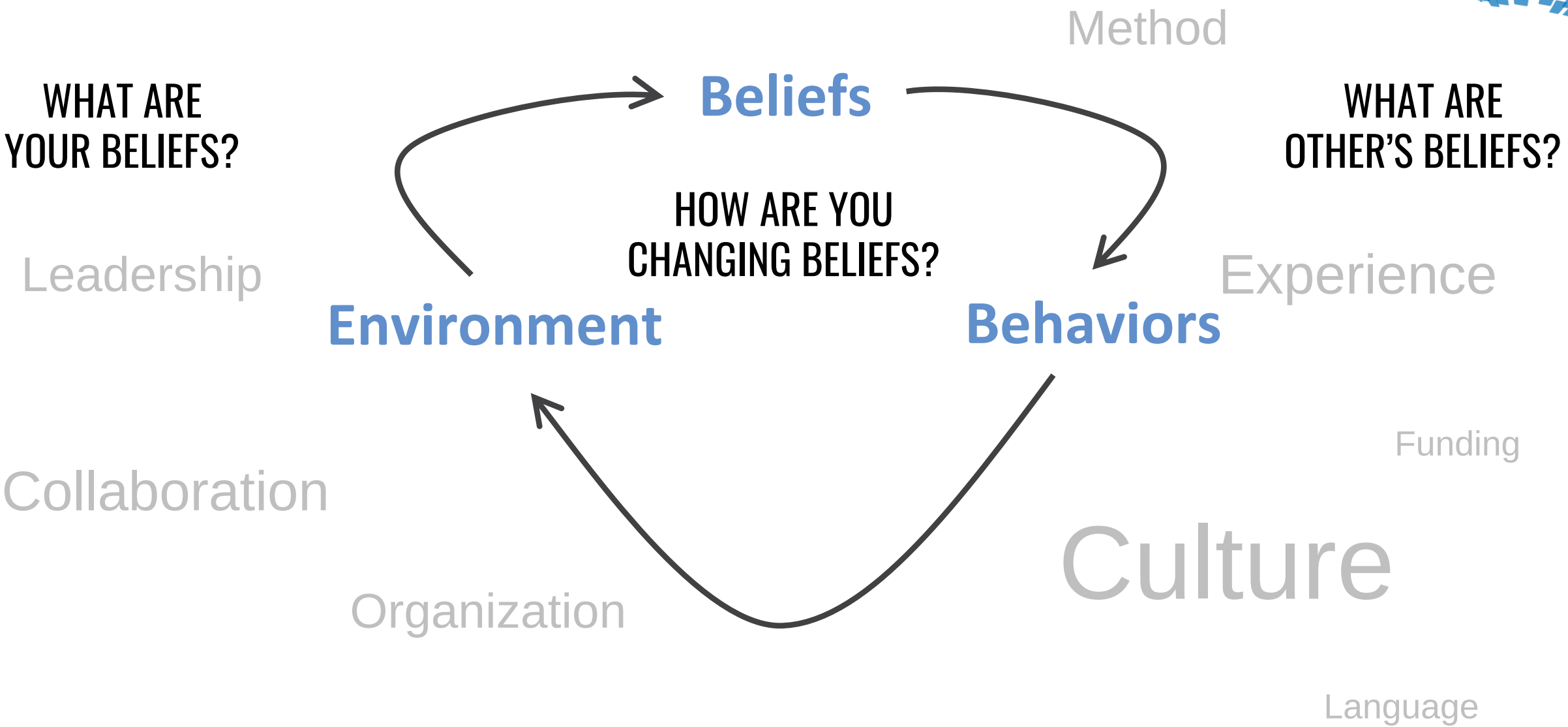


Vision25 Systems Engineering
INCOSE
A WORLD IN MOTION
Systems Engineering Vision • 2025

From: …Limitations of document-based approaches, but is still in an early stage of maturity similar to the early days of CAD/CAE.

To:…The use of internet-driven knowledge representation and immersive technologies enable highly efficient and **shared human understanding** of systems in a virtual environment that span the full life cycle from concept through development, manufacturing, operations, and support.

Lead Organizational Change



Systems Engineering is a Human Endeavor

Aid the Larger Stakeholder Community

MBSE effectiveness is more than a technical solution. Implementation requires that it adds value to the larger program community, coupling models, machines and teams and to:

- Increase Collaboration
- Improve Communications
- Build Shared Understanding

Imperative: Flip the Script

1 Content

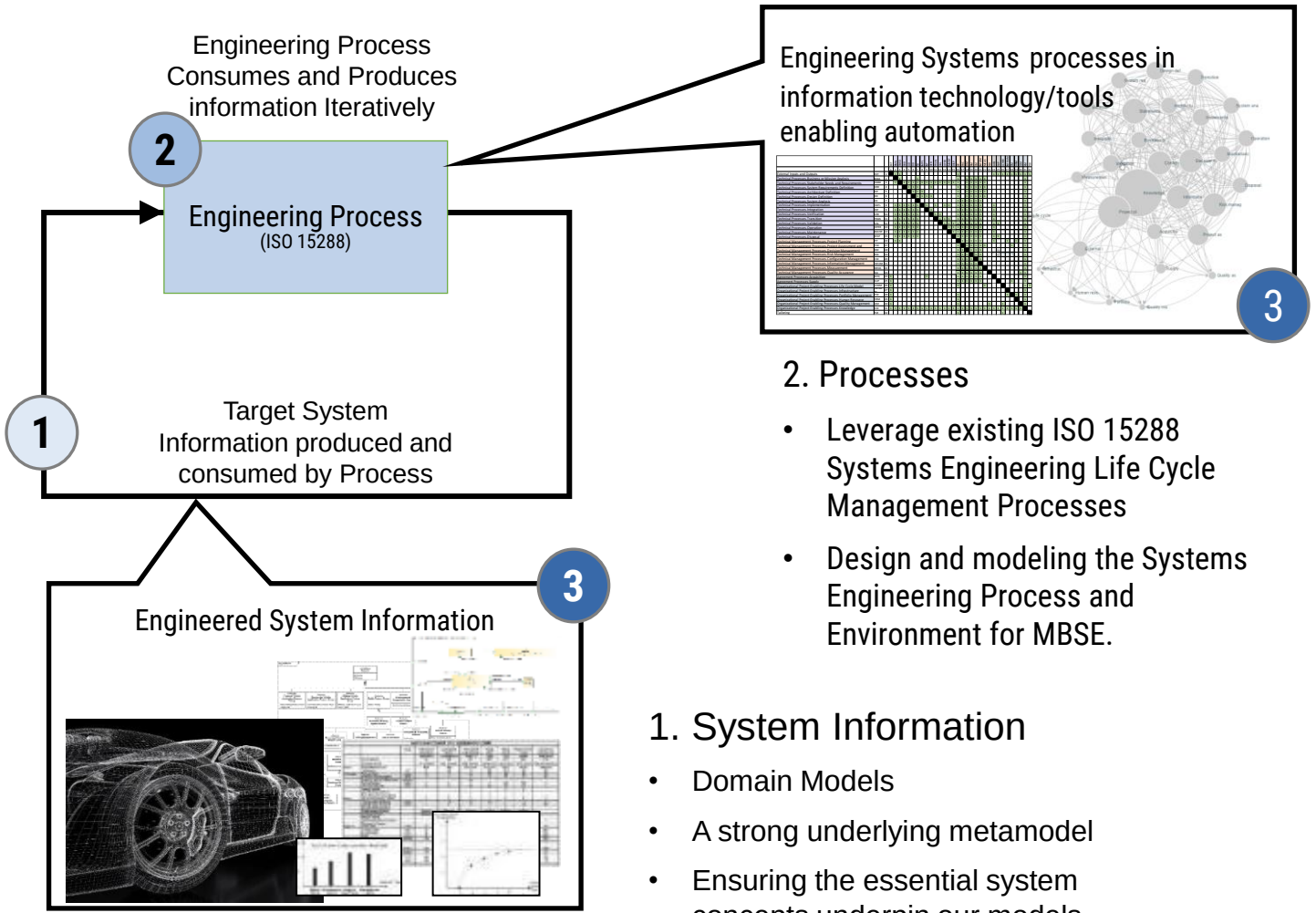
Key system information that must be produced, consumed and maintained consistently across the life cycle

2 Process

Interrelated activities that direct what information goes where, when and to whom

3 Automation

Digital federation, integration, automation through the use of tooling, standards, common interfaces etc.



http://www.omgwiki.org/MBSE/doku.php?id=mbse:pbse

2. Processes

- Leverage existing ISO 15288 Systems Engineering Life Cycle Management Processes
- Design and modeling the Systems Engineering Process and Environment for MBSE.

1. System Information

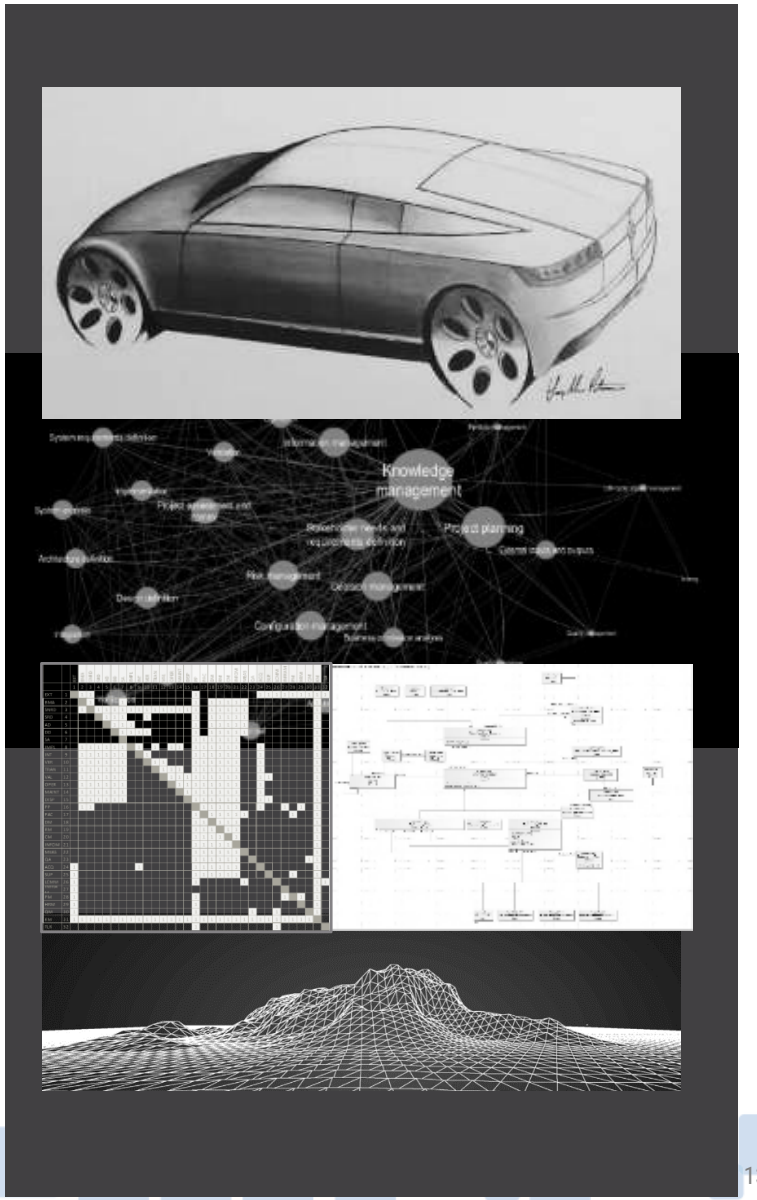
- Domain Models
- A strong underlying metamodel
- Ensuring the essential system concepts underpin our models
- Science, Engineering, Math…

Remember: Automating junk, makes more junk automatically

Imperative: Use Multiple Models

Evidence shows that people who think with models consistently outperform those who don't. And, moreover people who think with lots of models outperform people who use only one.

Scott E. Page "Model Thinking" Course Description



Models are powerful; they help us understand the world, they provide a path forward for our ideas, and they invoke action.

Imperative: Don’t dig a hole, know where you want to go

“Would you tell me, please,” Alice asks the cat, “which way I ought to go from here?”

“Well”, responds the Cheshire Cat, “That depends a good deal on where you want to get to.”

“Oh, I don’t much care where –“ says Alice.

The Cheshire Cat responds ”If you don’t care where you are going, then it really doesn’t matter which way you go.”

Have a Goal
Know where you want to go…

The model is not the end game
Improved outcomes are…

Poor SE dooms MBSE
MBSE multiplies good SE

Lesson: Don’t be Alice & Remember: Automating junk makes more junk automatically!

Imperative: Employ Augmented Intelligence (AuI)

- Reinforce knowledge in formal models and pattern based methods with AuI
- Maximize Human + Machine Collaboration
- Allocate work based on strengths
- The Human + Machine combined “team” is more effective than either is in isolation.

Remember: AuI = Human + AI
AuI > Human
AuI > AI

Kasparov’s Law

weak human + machine + better process
beats
strong human + machine + inferior process.

Leverage INCOSE Resource and Activities

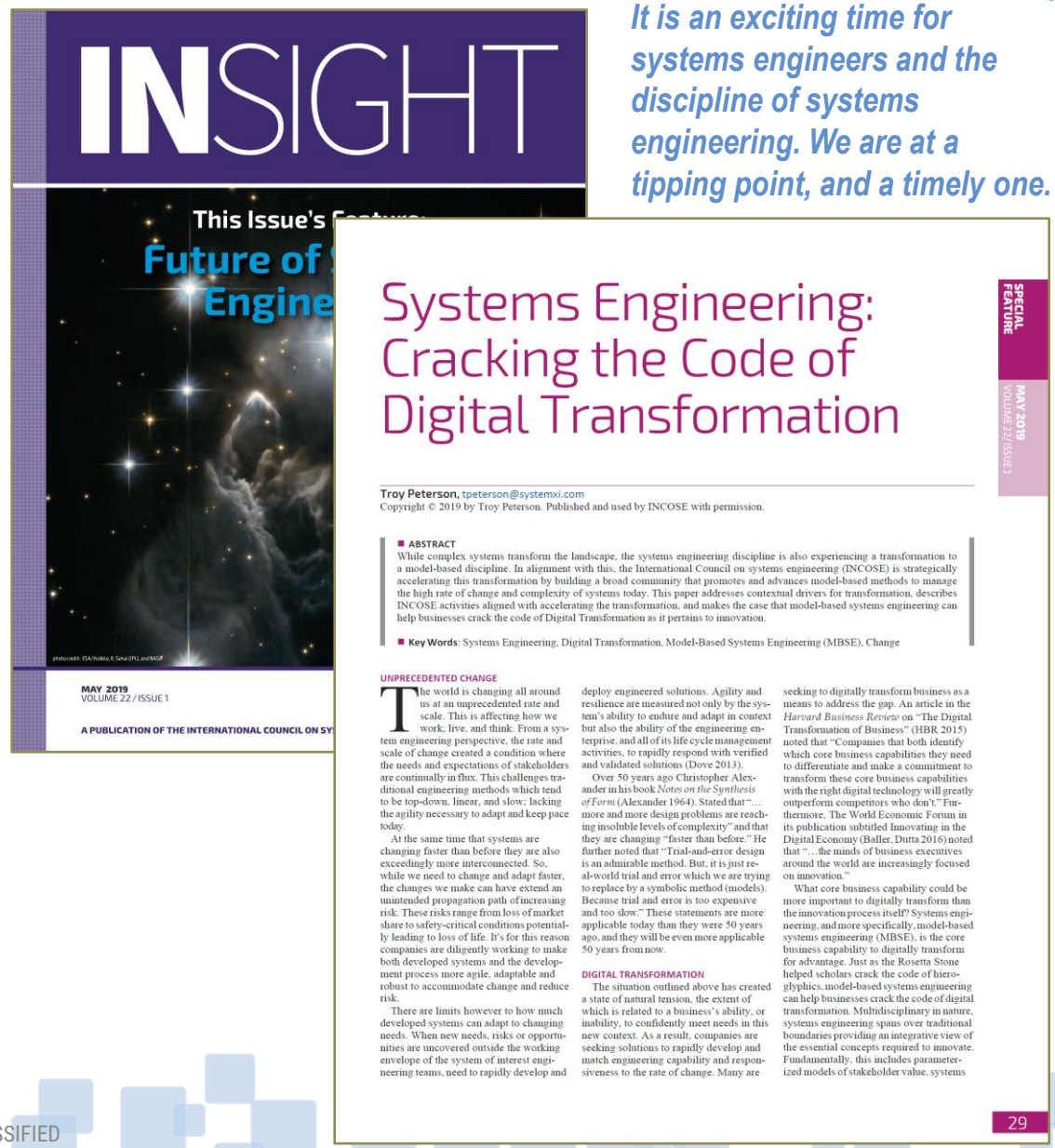
Unprecedented change and growing systems complexity is diving the need for digital transformation and most notably in how we innovate or perform systems engineering.

INCOSE is leading many activities to help accelerate the necessary transformation, some of these include:

- FuSE
- Many impactful Working Group and related products
- INCOSE Collaborations and products ex. SysML v2
- MBSE Initiative/Incubator - Transformation

What's Next:

- Vision 2035
- Strengthen and apply SE Foundations
- Systems Engineer the Engineering System
- Augmented Systems Engineering
- Exponential Improvements in Systems Engineering

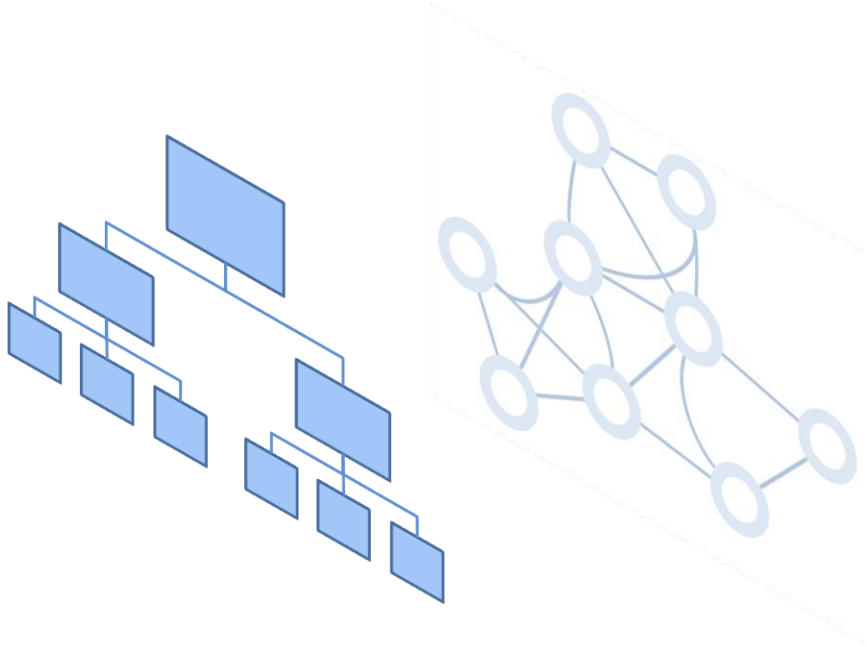


It is an exciting time for systems engineers and the discipline of systems engineering. We are at a tipping point, and a timely one.

Creating a Sense of Urgency

Leading Change: John P. Kotter
Eight-Step Process for undertaking major change.

1. ***Creating a Sense of Urgency***
2. Building a Guiding Coalition
3. Developing a Strategic Vision and Initiatives
4. Expanding the Network of Change Agents
5. Empowering Broad-Based Action
6. Generating Short-Term Wins
7. Consolidating Gains and Producing More Change
8. Instituting Change in the Culture



Accelerate: John P. Kotter
Kotter's new book *Accelerate* refines principals and adds the concept of a "dual operating system".

- One operating system is characterized by management, hierarchy and driven toward efficiency
- The other is characterized by leadership, networks, strategic acceleration and driven to innovate.
- Operating systems align nicely with the System of Innovation framework used in INCOSE's Agile and Patterns Working Groups where we see the distinct roles of executing and managing systems development and managing knowledge and what is learned in execution.

Drive Change

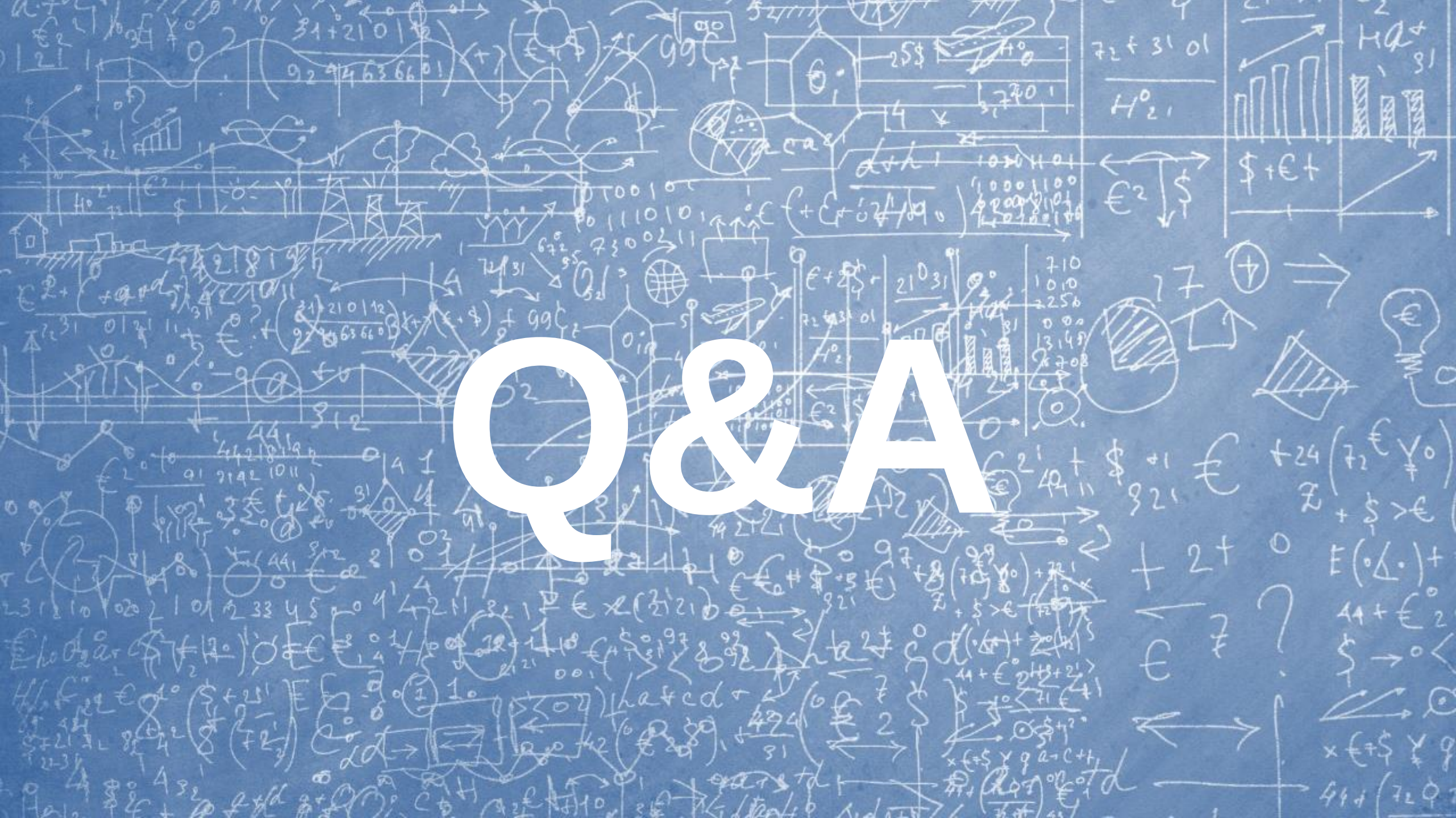
If you want to truly understand something – try to change it.

Kurt Lewin

The best way to manage change is to create it.

Peter Drucker

- It’s a paradigm shift
- The previous state is unrecognizable
- It doesn’t happen overnight, it takes time, and effort


Q&A

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