



2021
Annual **INCOSE**
international workshop
Virtual Event
January 29 - 31, 2021

The Imperative for Transformation

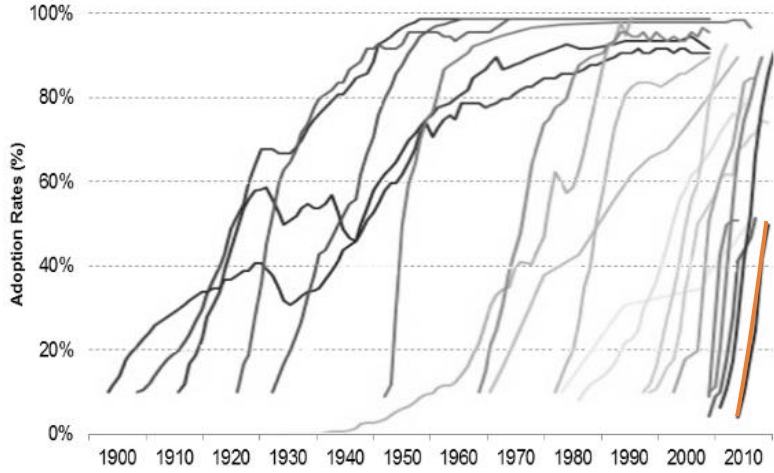
A Sense of Urgency

Troy Peterson
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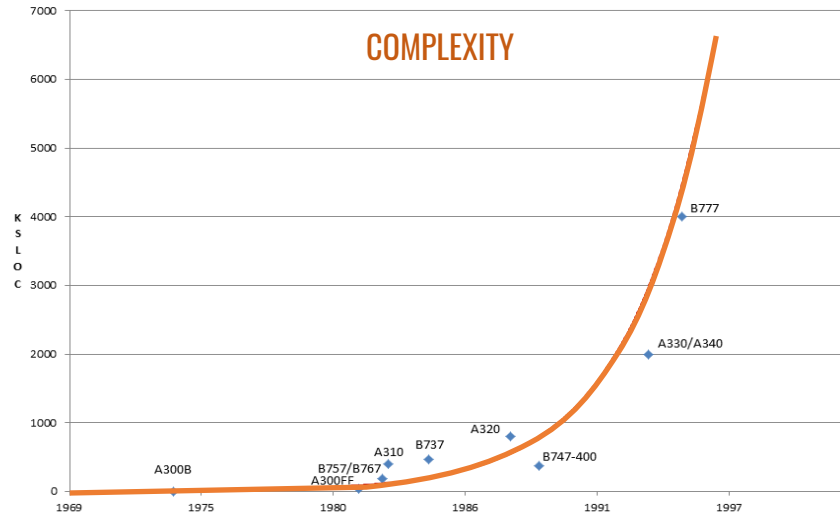
Contextual Challenges



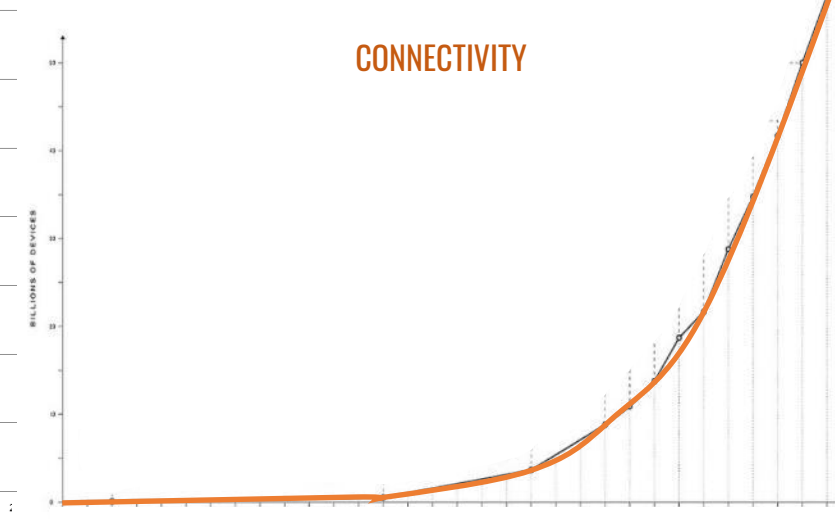
TECHNOLOGY PROLIFERATION



COMPLEXITY

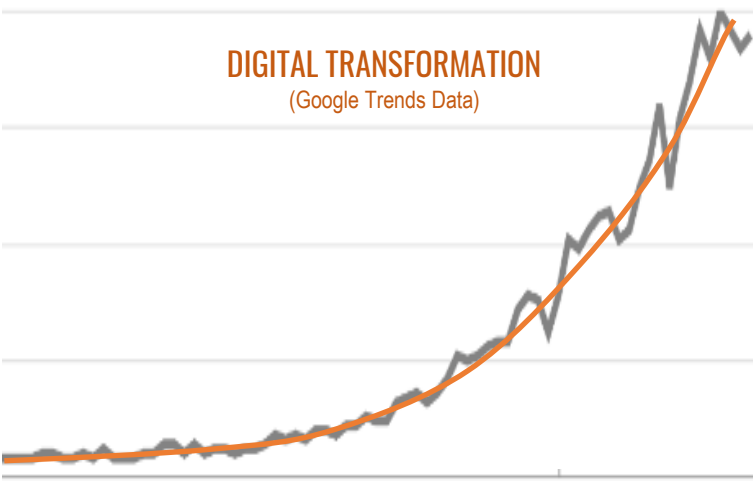


CONNECTIVITY

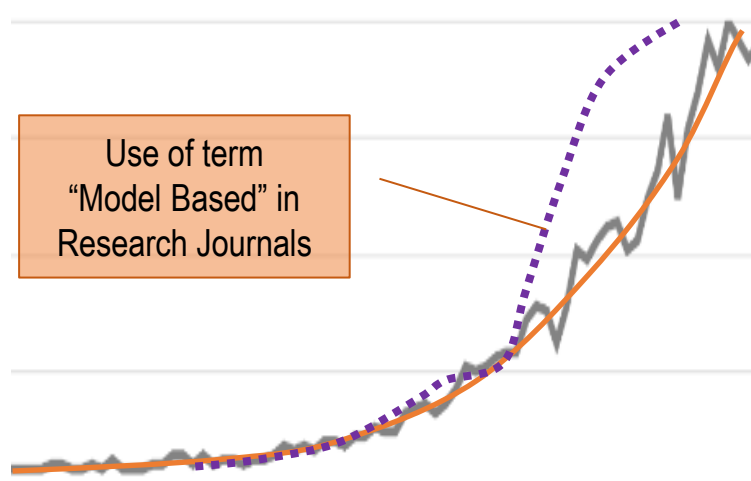


Solution Seeking

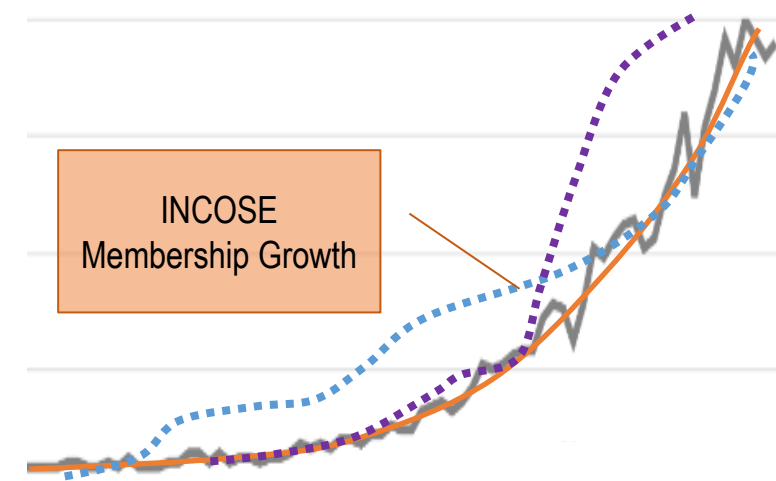
DIGITAL TRANSFORMATION (Google Trends Data)



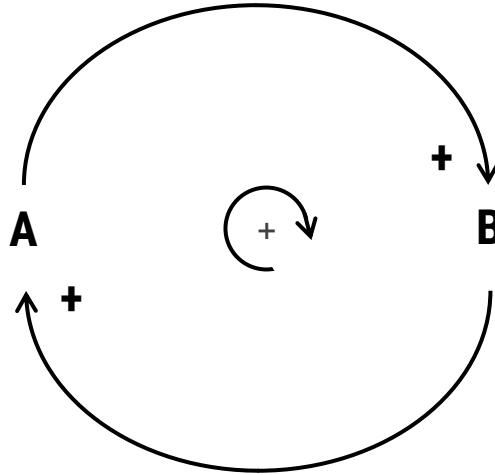
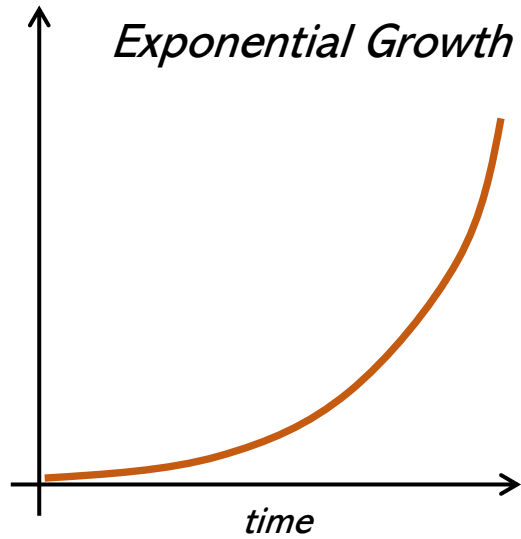
Use of term
"Model Based"
in
Research Journals



INCOSE
Membership Growth



Characterizing Exponential Growth



We routinely underestimate the power of exponential growth.

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

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





“When the rate of external change exceeds the rate of internal change, the end of your business is in sight.”

Jack Welch

Mega Trends Shaping Society and How and What we Innovate



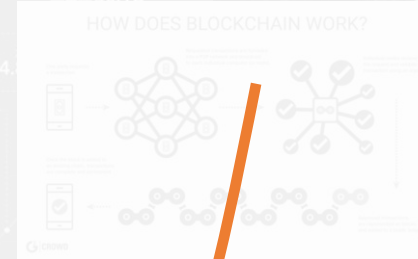
3D Printing



NEW FEEDBACK MECHANISMS

AGILE METHODS, APPLIED LEARNING, PATTERNS

Blockchain



ARTIFICIAL INTELLIGENCE & AUGMENTED INTELLIGENCE

Data Rich Environments

IoT / Hyper-Connectivity

Artificial Intelligence

ADVANCED MANUFACTURING & COMPRESSED DELIVERY TIMELINES

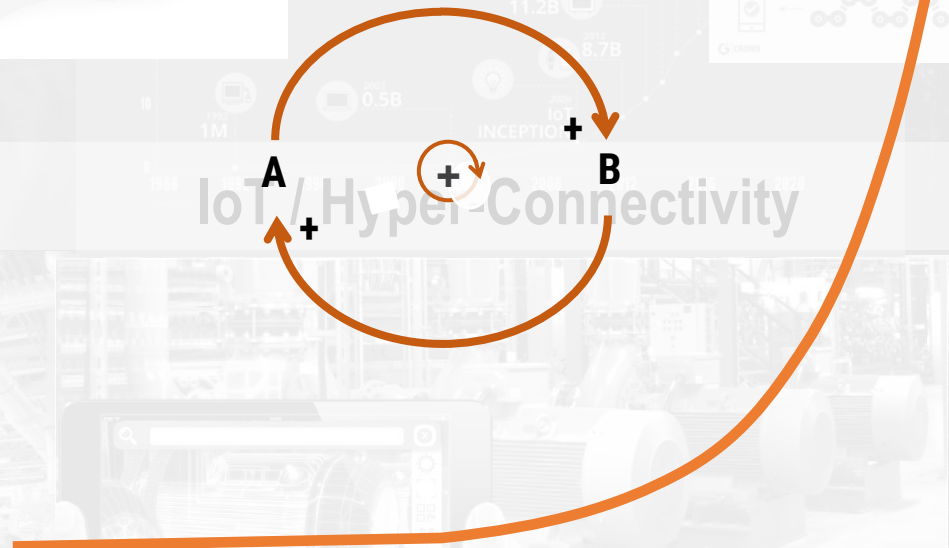
DIGITAL THREAD, DIGITAL TWIN, AUGMENTED REALITY, HPC

MODEL BASED METHODS

Industry 4.0

Digital Twin

High Performance Computing



Trends Toward MBSE/Digital Engineering: Professional Societies



DEPARTMENT OF DEFENSE
**DIGITAL
ENGINEERING
STRATEGY**
JUNE 2018

Office of the Deputy Assistant Secretary of Defense
for Systems Engineering
Washington, D.C.

Virtual Engineering Part of The Digital Revolution




FROM

Model-based systems engineering has grown in popularity as a way to deal with the limitations of document-based approaches, but is still in an early stage of maturity similar to the early days of CAD/CAE.

TO

Formal systems modeling is standard practice for specifying, analyzing, designing, and verifying systems, and is fully integrated with other engineering models. System models are adapted to the application domain, and include a broad spectrum of models for representing all aspects of systems. 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.

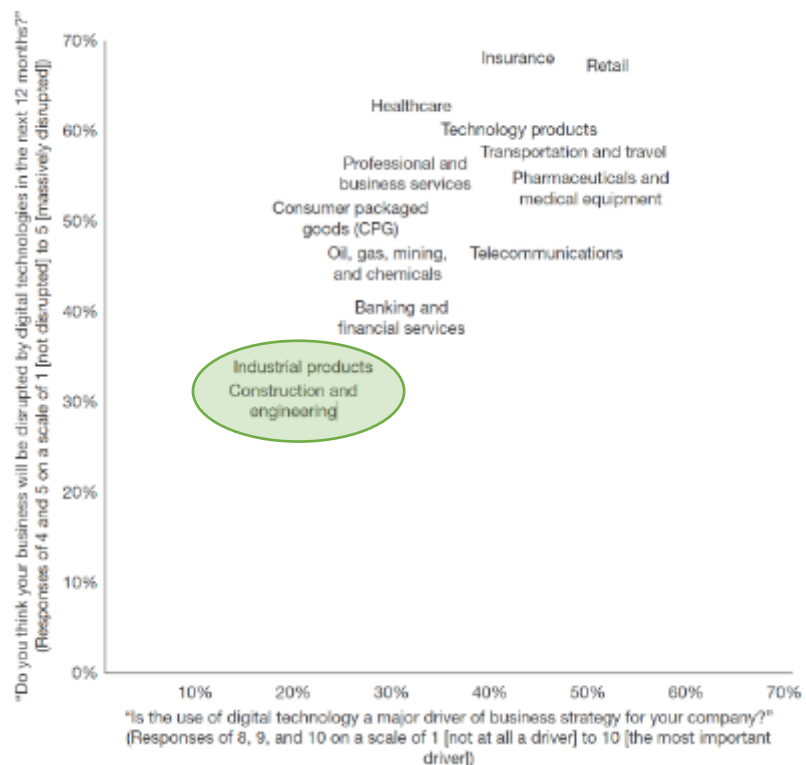


**A WORLD IN
MOTION***
Systems Engineering Vision • 2025

Digital Transformation Survey Data



Digital Technology Drives Strategy and Disrupts Your Business



FORRESTER

Schadler, Ted and Fenwick Nigel, The Digital Business Imperative, For eBusiness & Channel Strategy Professionals, Forrester, February 15, 2017

Digital Business Gains Executive Mindshare



How will your organizations investments in the following areas change in fiscal year 2017?

Gartner

Gartner INCOSE International Workshop MBSE Workshop Presentation, January 2018



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

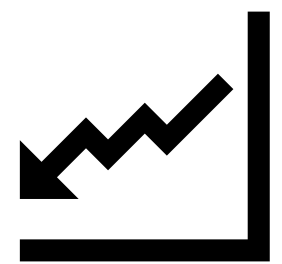
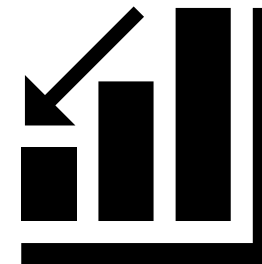


Why Transformations Fail



There are many reasons Transformation efforts fail.
enterpriseproject.com^{1,2}

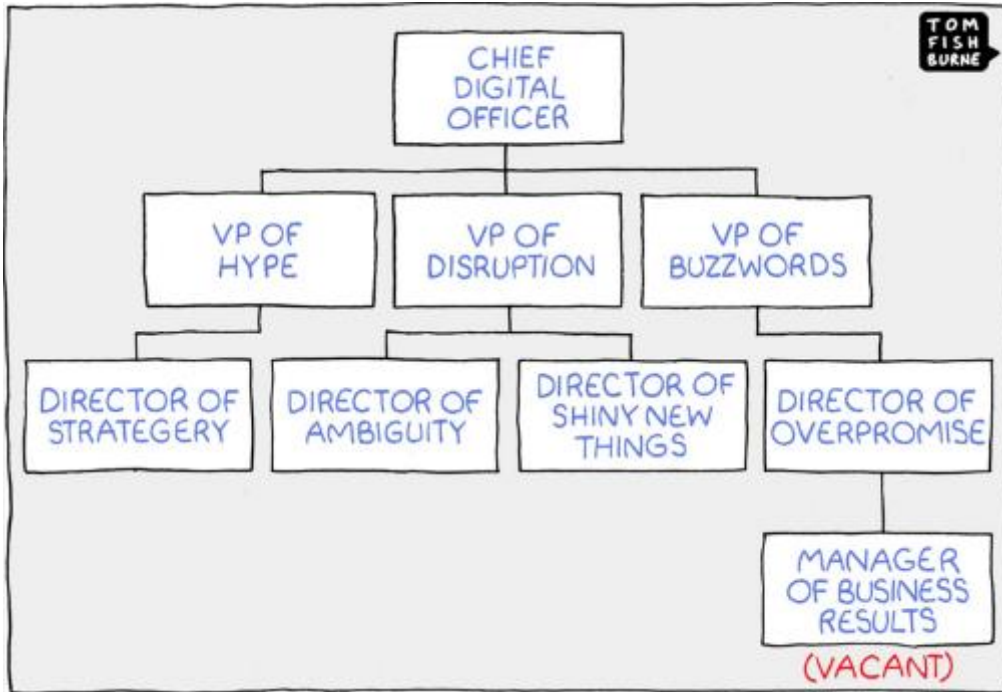
- ***Fatigue from continuous change*** is a top reason why more than 70 percent of digital transformations fail.
- According to the Evert Group, a whopping **73 percent of enterprises failed to provide any business value** whatsoever from their [digital transformation](#) efforts.
- Furthermore, **78 percent failed to meet their business objectives**. Put another way, only 22 percent achieved their desired business results.
- [Forrester surveyed](#) more than 1,500 business and technology decision-makers, and the results revealed **a troubling message of reluctance to change: 21 percent of survey respondents thought they were finished with their transformation**.



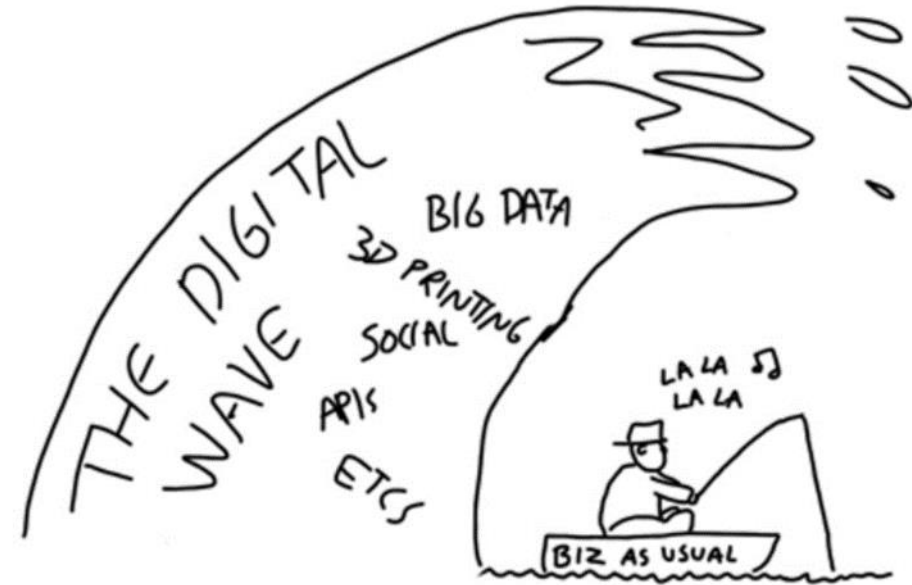
1. <https://enterpriseproject.com/article/2019/8/why-digital-transformations-fail-3-reasons#:~:text=Fatigue%20from%20continuous%20change%20is,percent%20of%20digital%20transformations%20fail.&text=While%20there%20are%20many%20causes,happens%20due%20to%20continuous%20change>.

2. <https://enterpriseproject.com/article/2020/8/digital-transformations-why-fail>

Imperative: Avoid Extreme States



Digitally Zealous

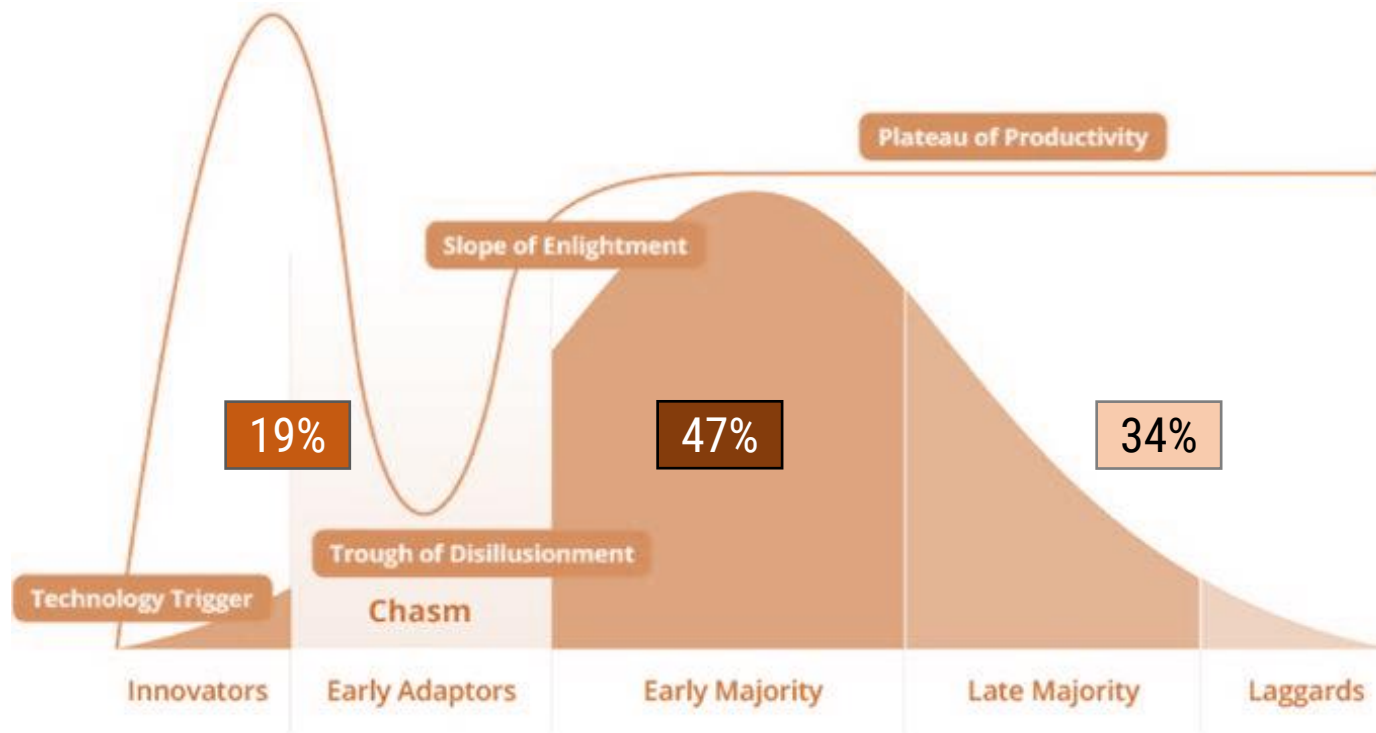
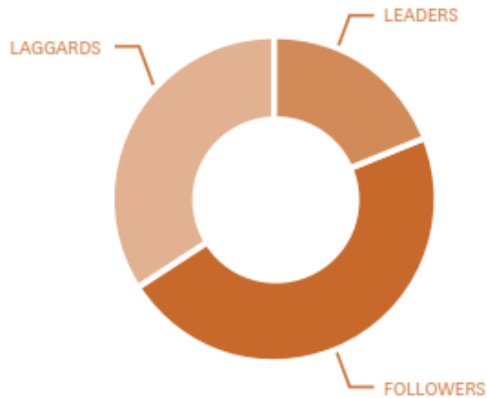


INSPIRED BY @DT AT #E20S

BY @VOINONEN

Digital Denial

Imperative: Avoid the Hype and Cross the Chasm



Rating of company's digital maturity in leadership and management⁵

More than 80% of respondents are either followers or laggards

Acceleration is very much about sharing, communicating and learning

Where would you plot your organization today?

1. Hype Cycle is a branded graphical presentation developed and used by IT research and advisory firm Gartner
2. Hype Cycle Graphic: https://en.wikipedia.org/wiki/Hype_cycle
3. Moore, Geoffrey A. "Crossing the Chasm - and Beyond" Strategic Management of Technology and Innovation Third Edition 1996
4. Hype Cycle, Chasm Combined Graphic: <http://www.datameer.com/blog/big-data-analytics-perspectives/big-data-crossing-the-chasm-in-2013.html>
5. Driving Digital Transformation: New Skills for Leaders, New Role for the CIO, Harvard Business Review

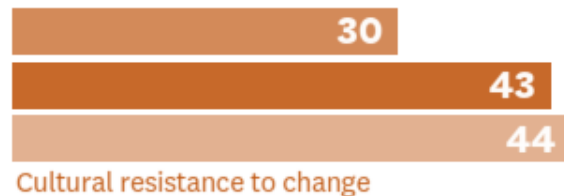
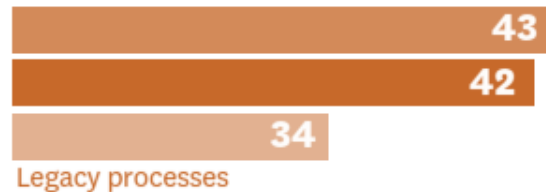
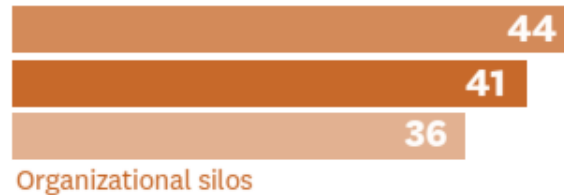
Imperative: Understand Barriers and Obtain Buy In¹



KEY BARRIERS TO DIGITAL BUSINESS DEVELOPMENT

Percentage who said, when it comes to digital business, these are the primary issues holding their organization back. [CHECK UP TO THREE]

● LEADERS ● FOLLOWERS ● LAGGARDS



Keys to Digital Transformation (HBR Report)

- Start from the **customers perspective**
- Digital leadership **starts at the top**
- **Engage in a discussion** of trends
- Think about **agile**
- Use examples to make it real
- Need a foundation of trust
- Use KPIs for sharing knowledge
- Break down walls wherever possible
- Need digital coaches or masters
- Create appropriate learning forums

1. Driving Digital Transformation: New Skills for Leaders, New Role for the CIO, Harvard Business Review

Imperative: Change Management and Integration



Integrate dimensions of change
Addresses dimensions in parallel
Concurrency and dimensional trades
Build grass-roots ownership
Obtain top leadership support

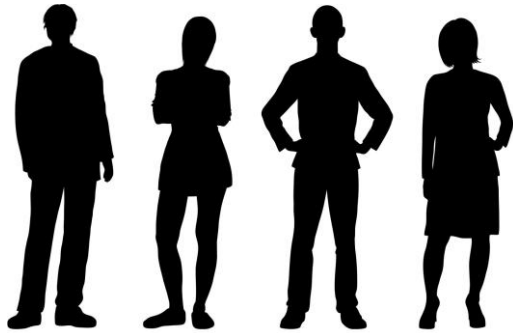
Consider:

$$ABP = CM(OE + PR + IT)$$

- ABP = Achieving Breakthrough Performance
- OE = Organizational Environment
- BPR = Business Process Reengineering
- IT = Information Technology
- CM = Change Management

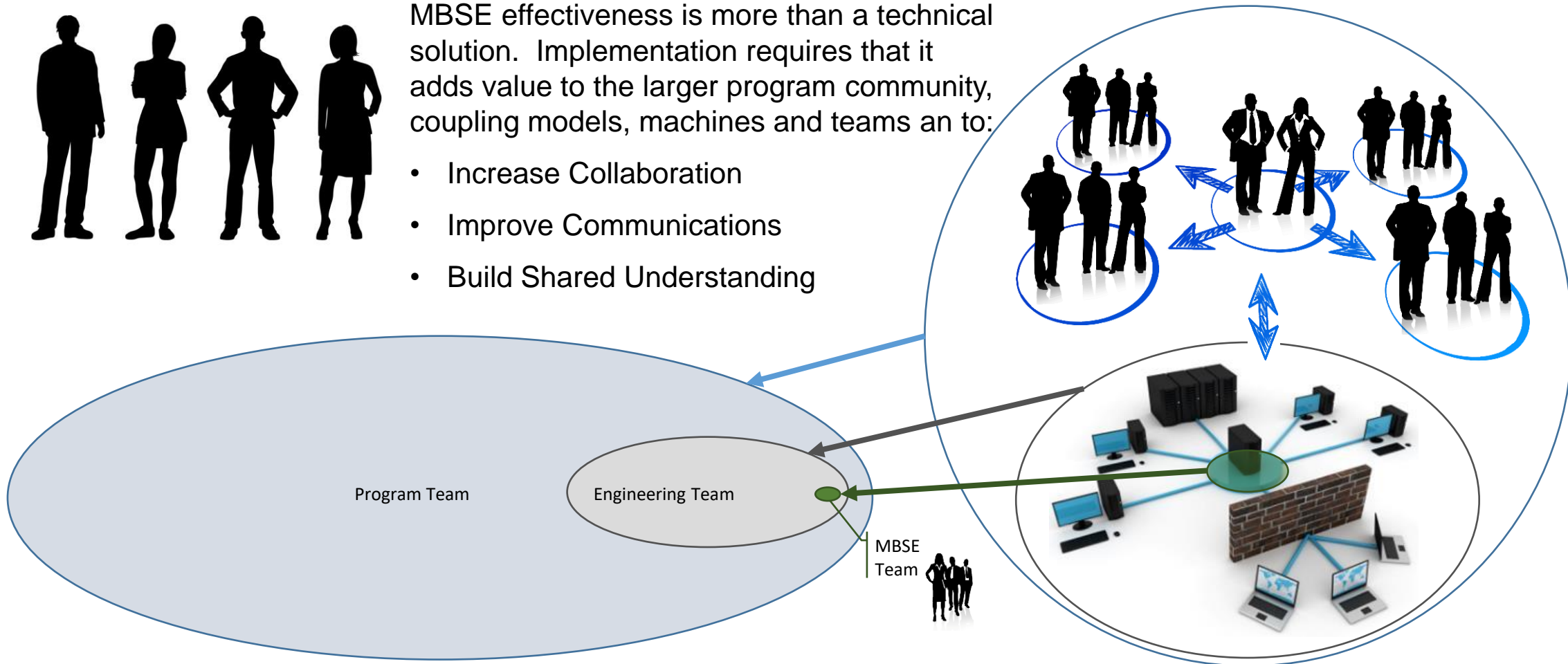
Transformation is
a people focused
endeavor.

Imperative: Add Value to the Larger Stakeholder Community

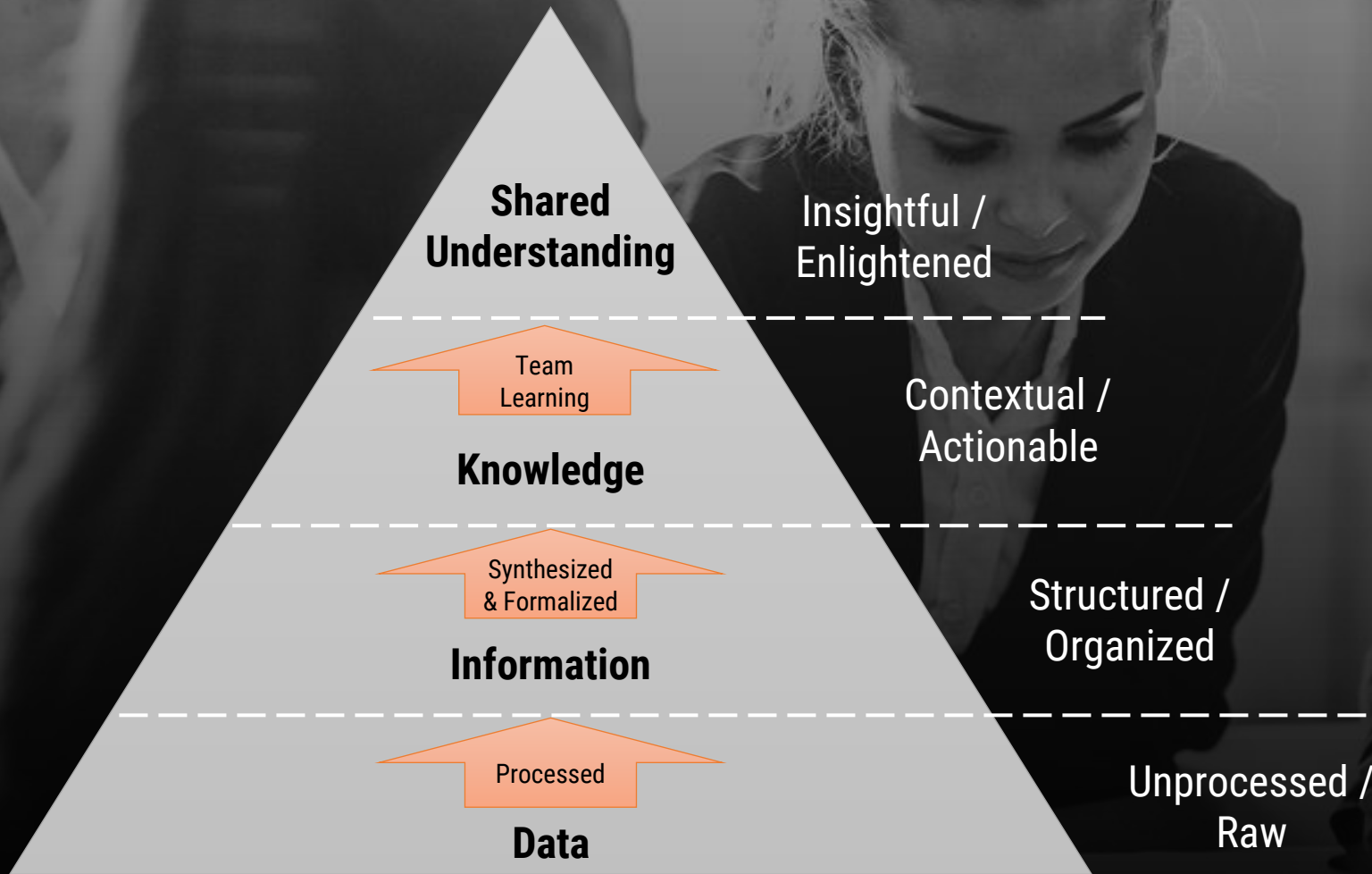


MBSE effectiveness is more than a technical solution. Implementation requires that it adds value to the larger program community, coupling models, machines and teams an to:

- Increase Collaboration
- Improve Communications
- Build Shared Understanding



Imperative: Build a Shared Understanding



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.

Imperative: Understand and Address Beliefs



WHAT ARE YOUR BELIEFS?

WHAT ARE OTHER'S BELIEFS?



Leadership

Experience

Collaboration

Funding

Organization

Culture

Language

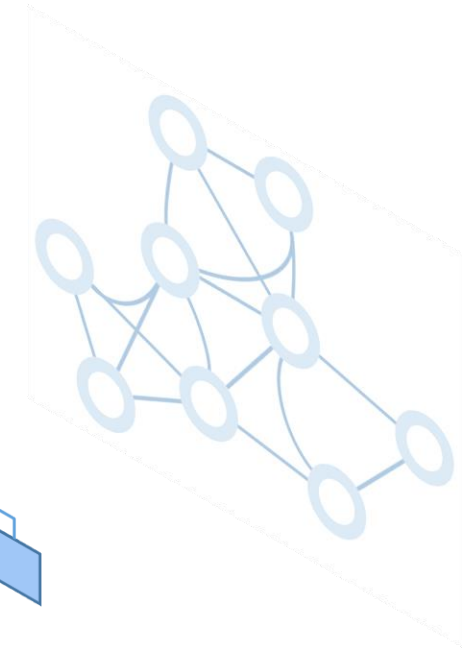
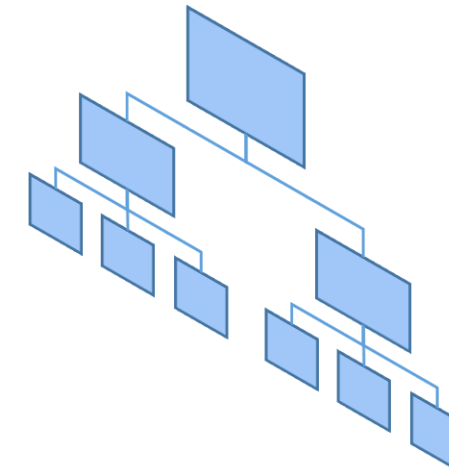
Systems Engineering is a Human Endeavor

Imperative: Create 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.

Imperative: Flip the Script



flip the script

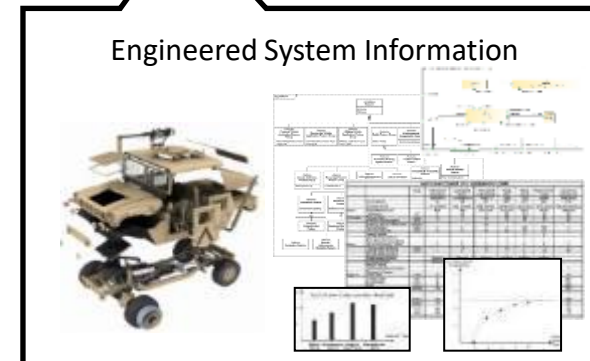
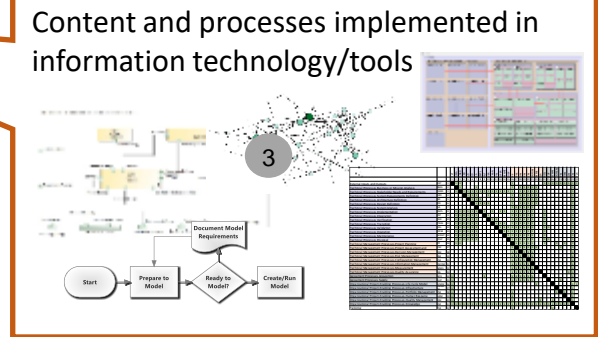
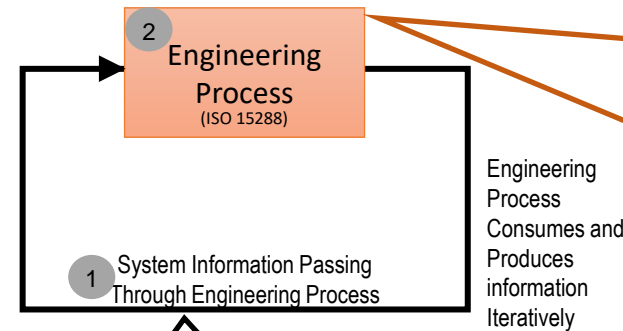
phrase of *script*

INFORMAL • NORTH AMERICAN

reverse the usual or existing positions in a situation; do something unexpected or revolutionary.
"Campbell **flips the script** on the old beauty-and-the-beast formula"

Definitions from Oxford Languages

- 1 Content**
Key system information that must be maintained consistently across information systems
- 2 Process**
Interrelated activities that direct what information goes where and when and to whom
- 3 Tooling & Automation**
Digital federation, integration, automation through the use of tooling, standards, common interfaces etc.



System Information
Target system model and concept, life cycle management models, architectures, agent models, CAD, Requirements, BOMs, etc.

Engineering Information
Designing and modeling the Systems Engineering Processes for digital system development and acquisition. Digital Thread is a configurable analytical framework within DE

Reference the INCOSE Patterns Working Group:
<http://www.omgwiki.org/MBSE/doku.php?id=mbse:pbse>

MBSE Evolution



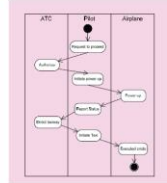
SE Practices for Describing Systems

Past / Now



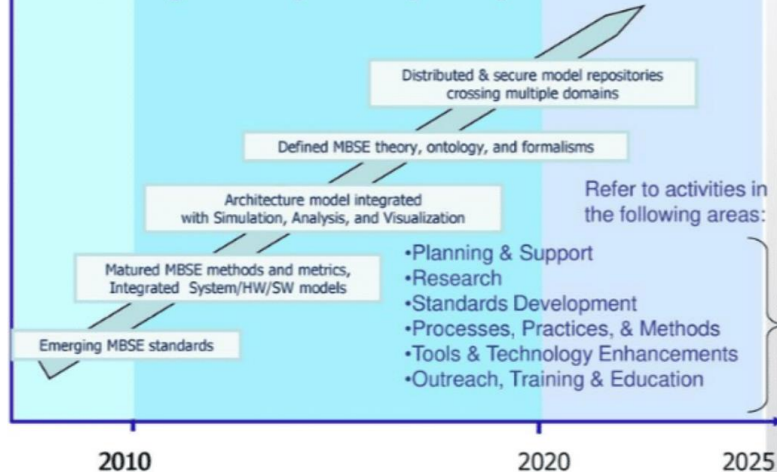
- ◆ Specifications
- ◆ Interface requirements
- ◆ System design
- ◆ Analysis & trade-off
- ◆ Test plans

Now / Future



- Moving from document-centric to model-centric (from PowerPoint/Excel/Word to SysML plus more)
- Analogy: Moving from physical drafting to 2D CAD to 3D feature-based CAD

Extending Maturity and Capability



A MODEL-BASED ENGINEERING (MBE) MANIFESTO

PURPOSE: *To motivate the transformation to Model-Based Engineering.*

Faced with increasing system complexity, interdependencies, breakdown of document-based methods, and other challenges, MBE provides the transformation in which **we value:**

- 1 Information over artifacts
- 2 Integration over independence
- 3 Expressiveness with rigor over flexibility
- 4 Model usage over model creation

We value the items on the right, but not at the sacrifice of the items on the left.

WITH THESE PRINCIPLES:

On behalf of stakeholders, MBE increases emphasis on **describing** the nature and content of the **information** produced and consumed, compared to the traditional emphasis on engineering process and procedure.

We recognize that—**independent** of specific information format, structure, language, syntax, the sequence or order of its production and consumption, and the domains and environments of our projects—the underlying nature (**semantics**) of the **essential** information we seek to discover and produce is **invariant** because of the very nature of engineering.

An essential and dynamically changing property of model information is its **credibility** to those people and processes which will **consume** that information. The critical nature of some **intended uses** of model information sets a higher bar on required investment in model **verification, validation** and **uncertainty quantification**.

Principles of **human-machine interaction** applied to the targeted stakeholders are vital to success. Application of advanced visualization methods **and augmented intelligence** capabilities can advance that success.

We seek an extended team across engineering disciplines with **common and integrated understanding** of the identity and nature of the model information as well as its content.

We seek effective **enterprise-wide reuse** of model-based information to more fully leverage past individual or local learning.

Systems engineering performed according to the above principles is required for the Engineering System itself, a complex and evolving system.

THE TEAM:

The team was assembled by invitation, intentionally drawing together different perspectives.

- Ed Carroll
Team lead-Sandia National Laboratories - Engineering Methods Research
- Nancy Hayden
SNL - Autonomous Systems/Engineering Policy
- Sharon Trauth
SNL-Systems Engineering/MBSE Practice
- Dana Grisham
SNL-Data Governance/Agile Methods

- Chris Schreiber
Lockheed Martin Space Systems-Systems Engineering Modernization

- Bill Schindel
ICTT Systems Sciences-Systems Sciences

- Frank Salvatore
Engility Corp-Systems Engineering/ Data Taxonomy

- Eliot Rich
Univ at Albany, SUNY-System Dynamics

Teleconference participation from:

- Steve Jenkins
JPL-Systems Semantics

- Anne O'Neil
Anne O'Neil Consultants-Organizational Transformation

Imperative: Engage with INCOSE



Unprecedented change and growing systems complexity is driving 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:

- Transformation Initiative
- MBSE Initiative / Incubator
- SysML v2
- Semantic Technologies for Systems Engineering
- MBSE Patterns Working Group (WG)
- Digital Engineering Information Exchange WG
- Augmented Intelligence for Systems Engineering Challenge Team (CT)
- Model Based X Ecosystem Challenge Team (CT)
- Model Based Enterprise Capabilities Matrix (CT)

Several other new working groups since this paper was published



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

Systems Engineering: Cracking the Code of Digital Transformation

Troy Peterson, tpeterson@systemxi.com
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ABSTRACT
While complex systems transform the landscape, the systems engineering discipline is also experiencing a transformation to a model-based discipline. In alignment with this, the International Council on systems engineering (INCOSE) is strategically accelerating this transformation by building a broad community that promotes and advances model-based methods to manage the high rate of change and complexity of systems today. This paper addresses contextual drivers for transformation, describes INCOSE activities aligned with accelerating the transformation, and makes the case that model-based systems engineering can help businesses crack the code of Digital Transformation as it pertains to innovation.

Key Words: Systems Engineering, Digital Transformation, Model-Based Systems Engineering (MBSE), Change

UNPRECEDENTED CHANGE

The world is changing all around us at an unprecedented rate and scale. This is affecting how we work, live, and think. From a systems engineering perspective, the rate and scale of change created a condition where the needs and expectations of stakeholders are continually in flux. This challenges traditional engineering methods which tend to be top-down, linear, and slow; lacking the agility necessary to adapt and keep pace today.

At the same time that systems are changing faster than before they are also exceedingly more interconnected. So, while we need to change and adapt faster, the changes we make can have extend an unintended propagation path of increasing risk. These risks range from loss of market share to safety-critical conditions potentially leading to loss of life. It's for this reason companies are diligently working to make both developed systems and the development process more agile, adaptable and robust to accommodate change and reduce risk.

There are limits however to how much developed systems can adapt to changing needs. When new needs, risks or opportunities are uncovered outside the working envelope of the system of interest engineering teams, need to rapidly develop and

deploy engineered solutions. Agility and resilience are measured not only by the system's ability to endure and adapt in context but also the ability of the engineering enterprise, and all of its life cycle management activities, to rapidly respond with verified and validated solutions (Dove 2013).

Over 50 years ago Christopher Alexander in his book *Notes on the Synthesis of Form* (Alexander 1964) stated that "...more and more design problems are reaching insoluble levels of complexity" and that they are changing "faster than before." He further noted that "Trial-and-error design is an admirable method. But, it is just real-world trial and error which we are trying to replace by a symbolic method (models). Because trial and error is too expensive and too slow." These statements are more applicable today than they were 50 years ago, and they will be even more applicable 50 years from now.

DIGITAL TRANSFORMATION

The situation outlined above has created a state of natural tension, the extent of which is related to a business's ability, or inability, to confidently meet needs in this new context. As a result, companies are seeking solutions to rapidly develop and match engineering capability and responsiveness to the rate of change. Many are

seeking to digitally transform business as a means to address the gap. An article in the *Harvard Business Review* on "The Digital Transformation of Business" (HBR 2015) noted that "companies that both identify which core business capabilities they need to differentiate and make a commitment to transform these core business capabilities with the right digital technology will greatly outperform competitors who don't." Furthermore, The World Economic Forum in its publication subtitled *Innovating in the Digital Economy* (Ballar, Dutta 2016) noted that "...the minds of business executives around the world are increasingly focused on innovation."

What core business capability could be more important to digitally transform than the innovation process itself? Systems engineering, and more specifically, model-based systems engineering (MBSE), is the core business capability to digitally transform for advantage. Just as the Rosetta Stone helped scholars crack the code of hieroglyphics, model-based systems engineering can help businesses crack the code of digital transformation. Multidisciplinary in nature, systems engineering spans over traditional boundaries providing an integrative view of the essential concepts required to innovate. Fundamentally, this includes parameterized models of stakeholder value, systems

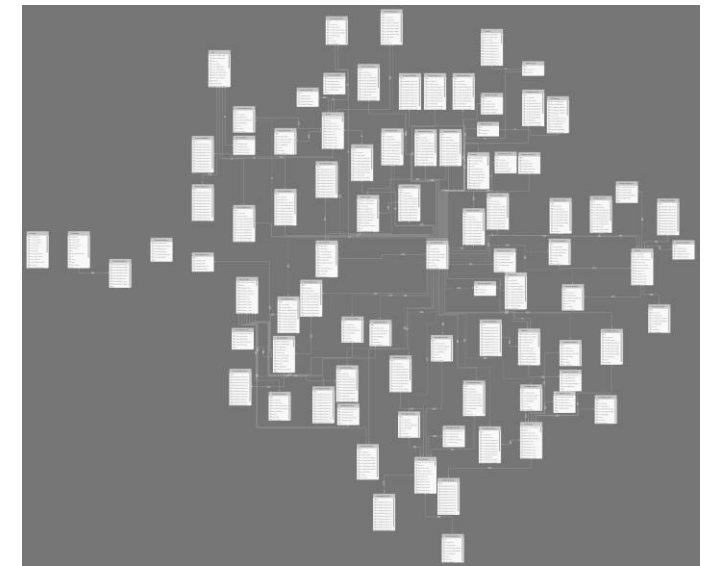
SPECIAL FEATURE
MAY 2019
VOLUME 22 / ISSUE 1

Transformation will occur with or without us



What if:

- Our focus was on data and how it drives decisions
- Our connectors to other disciplines information sets were readily available
- We had a large community of developers working to incorporate AI, ML, NLP
- Our tools easily mapped information across disciplines and even domains
- Our visualizations were understood by the broad stakeholder community
- Our visualizations were dynamic coving top to bottom - abstract to the detail



Get Data

Search

Online Services

- Planview Enterprise One - PRM (Beta)
- QuickBooks Online (Beta)
- Smartsheet
- SparkPost (Beta)
- SweetIQ (Beta)
- Planview Enterprise One - CTM (Beta)
- Twilio (Beta)
- Zendesk (Beta)
- Asana (Beta)
- Dynamics 365 Customer Insights (Beta)
- Emigo Data Source
- Entersoft Business Suite (Beta)
- FactSet Analytics
- Palantir Foundry
- Industrial App Store
- Intune Data Warehouse (Beta)

Manage relationships

Active	From: Table (Column)	To: Table (Column)
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<input checked="" type="checkbox"/>	Bill_Account_Based_Expense_Line (Id)	Bill (Id)
<input checked="" type="checkbox"/>	Bill_Account_Based_Expense_Line (Line_Index)	JournalEntry_Description_Line (Line_Index)
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<input checked="" type="checkbox"/>	Bill_TxnTaxDetail_TaxLine (Id)	Bill (Id)
<input checked="" type="checkbox"/>	BillPayment_Line (Id)	Bill_Payment (Id)
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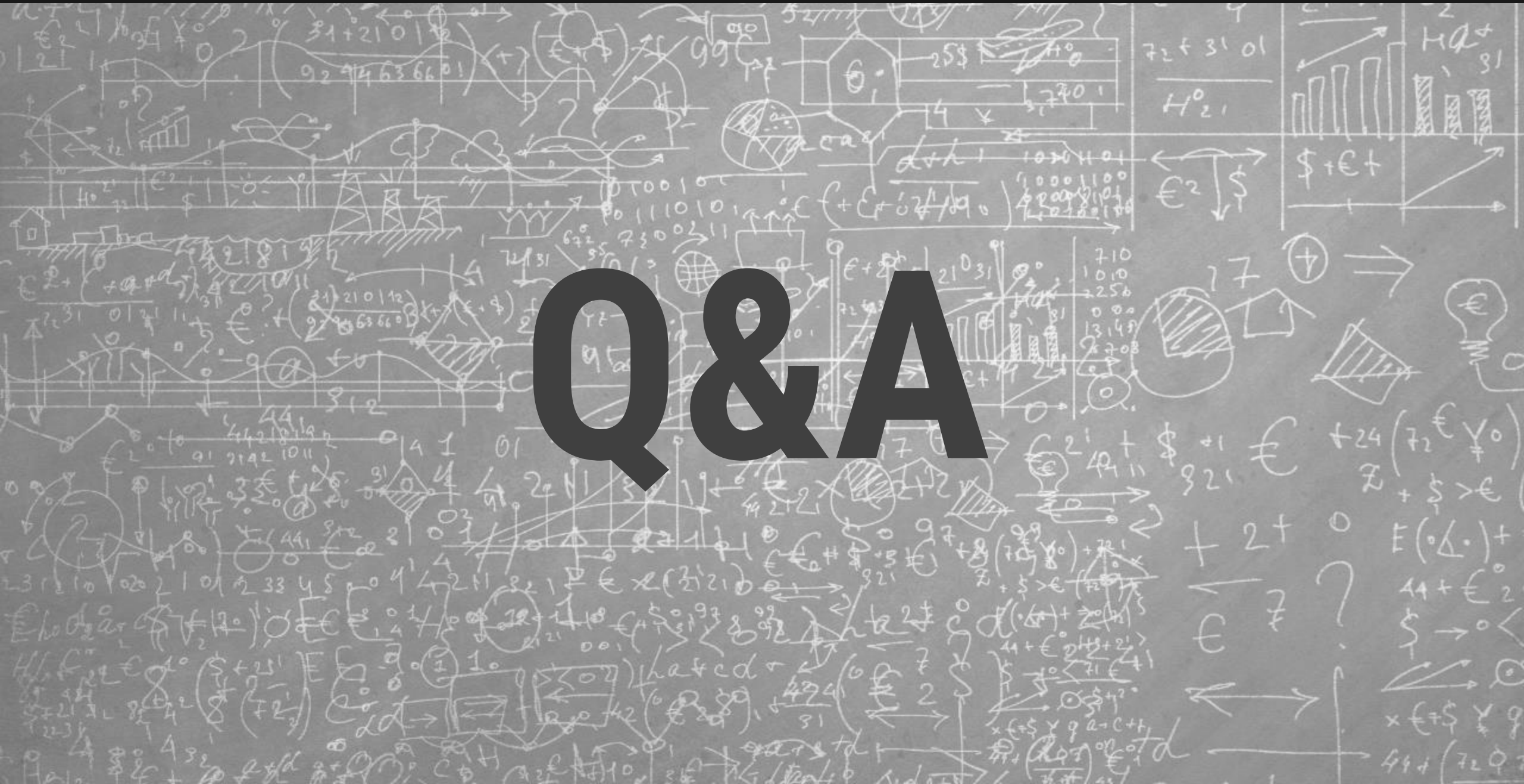
New... Autodetect... Edit... Delete





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

Q & A



About the Speaker



Troy Peterson

Vice President

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313.806.3929

Troy Peterson, SSI Vice President, and INCOSE Transformation lead is a recognized leader in developing model based solutions to speed innovation and solve complex systems challenges. He has led the delivery of numerous complex systems and methodologies while at SSI, Booz Allen and Ford Motor Company. His experience spans academic, non-profit, commercial and government environments across all lifecycle phases. Troy received a BS in Mechanical Engineering from Michigan State University, an MS in Technology Management from Rensselaer Polytechnic Institute and an advanced graduate certificate in Systems Design and Management from Massachusetts Institute of Technology. He also holds INCOSE CSEP, PMI PMP, and ASQ Six Sigma Black Belt Certifications.

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