The Essential Discipline for Digital Transformation

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2019 INCOSE IW

January 27, 2018

INCOSE Overview

16000 MEMBERS

70 CHAPTERS

35 COUNTRIES

100 CORPORATE ADVISORY BOARD MEMBERS

VISION:

- A better world through a systems approach.

MISSION

- To address complex societal and technical challenges by enabling, promoting, and advancing Systems Engineering and systems approaches.

INCOSE Strategic Objective (1/7):

- Accelerate the transformation of systems engineering to a model-based discipline.

INCOSE Collaborations:

- INCOSE has several collaboration agreements with other institutions such as ISO, OMG, ASME, MORS, NAFEMS, PMI, ISSS, ISFR, IIE, and others

Accelerating Innovation Effectiveness:

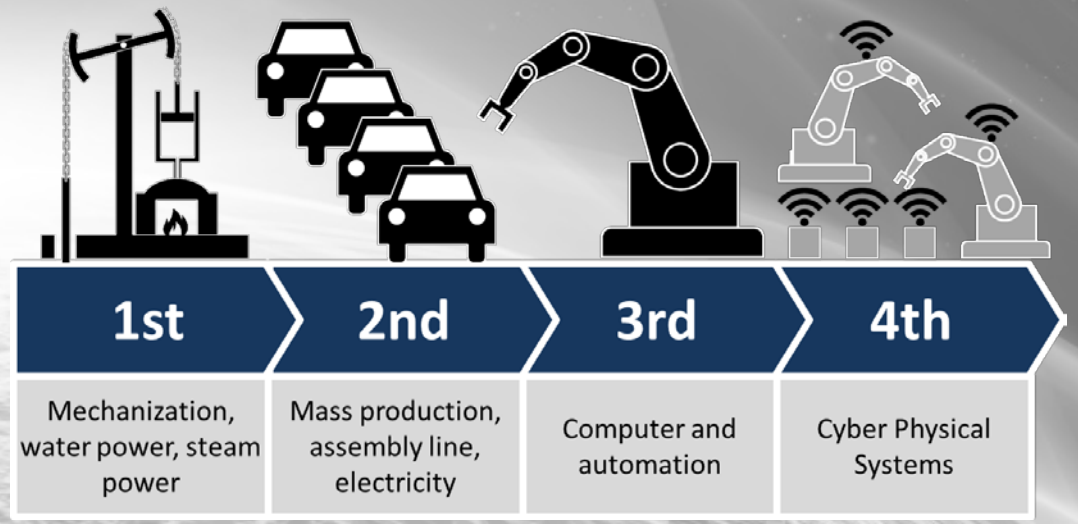
Model-Facilitated Collaboration by Regulators, Technical Societies, Customers, and Suppliers

Digital Transformation & the Forth Industrial Revolution

“The world is entering the Fourth Industrial Revolution. Processing and storage capacities are rising exponentially, and knowledge is becoming accessible to more people than ever before in human history. The future holds an even higher potential for human development as the full effects of new technologies such as the Internet of Things, artificial intelligence, 3-D Printing, energy storage, and quantum computing unfold.”

The Global Information Technology Report
Innovating in the Digital Economy
World Economic Forum

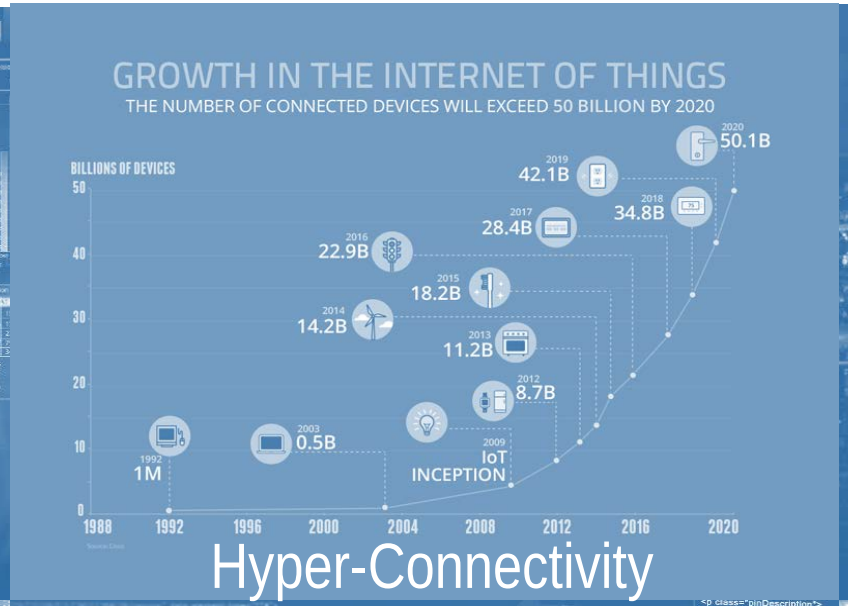
WORLD ECONOMIC FORUM
COMMITTED TO IMPROVING THE STATE OF THE WORLD



What is the role of Systems Engineering in the next Industrial Revolution

How Well Have We Taken Advantage of the Latest Technologies and Trends?

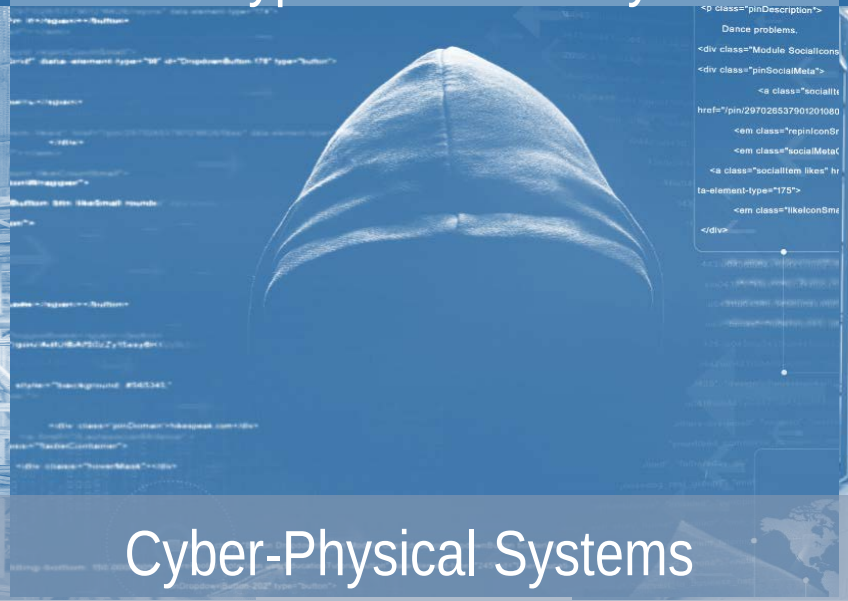
Data Rich Environments



Hyper-Connectivity

Artificial Intelligence

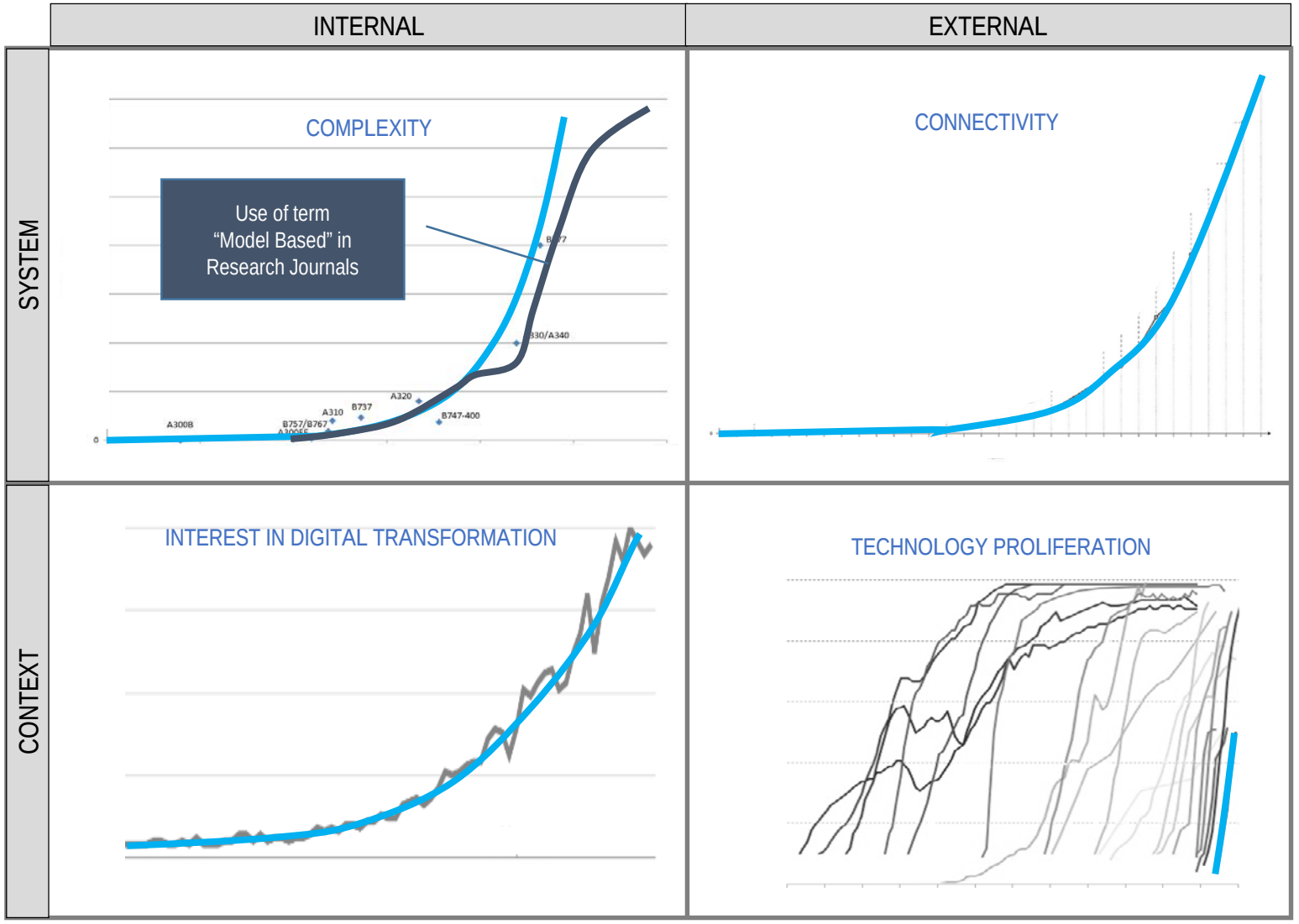
Industry 4.0



Cyber-Physical Systems

High Performance Computing

How should we address rapid rates of change?



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

Jack Welch

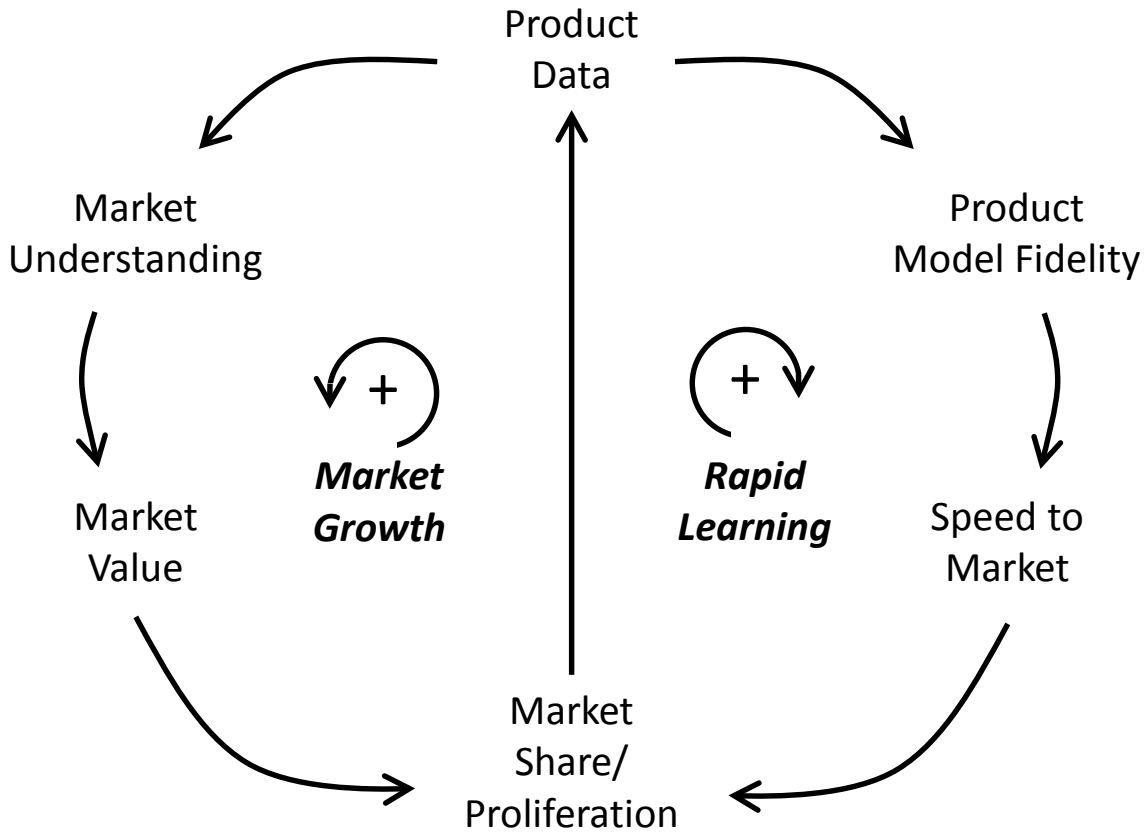
What's Required to Better Integrate Technology and More Swiftly Adapt?

THE WALL STREET JOURNAL

Models Will Run the World

By Steven A. Cohen and Matthew W. Granade – August 19, 2018

- If software ate the world, models will run it.
- There is no shortage of hype about artificial intelligence and big data, but models are the source of the real power behind these tools.
- Their products get better, allowing them to collect more data, which allows them to build better models, making their products better, and onward.
- The software revolution has transformed business. What's next? Processes that constantly improve themselves without need of human intervention.



Future of Systems Engineering

INCOSE FuSE
Future of Systems Engineering

Purpose: Evolve the practice, instruction and perception of systems engineering to:

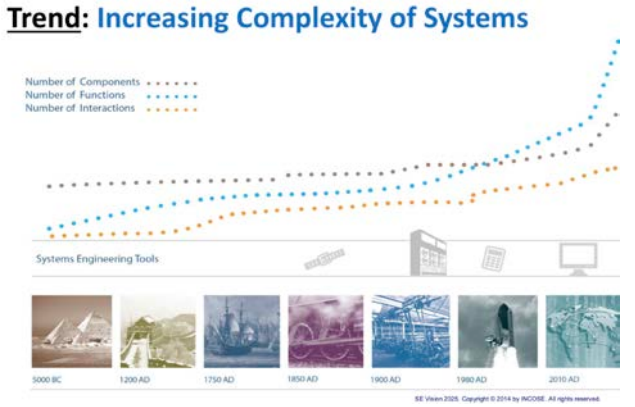
- Position systems engineering to leverage new technologies in collaboration with allied fields
- Enhance the systems engineer's ability to solve the emerging challenges
- Promote SE as essential for achieving success and delivering value

Goal: Create a road map that drives the evolution of systems engineering to:

- be increasingly *adaptable, evolvable and fit for purpose*
- account for human abilities, needs as an integral system element and their interactions with a system
- be more responsive in resolving increasingly challenging societal needs
- realize and enhance Systems Engineering Vision 2025 and other visionary inputs

Scope: Identify the needs, priorities and means for transforming systems engineering including:

- underlying foundations, systems theory and principles
- people, methods, tools, processes, education and training
- the future social and ethical duties, contributions, and responsibilities of future systems engineers



A Systems Community Initiative

Transforming Systems Engineering

Systems engineering will lead the effort to **drive out unnecessary complexity** through well-founded architecting and deeper system understanding

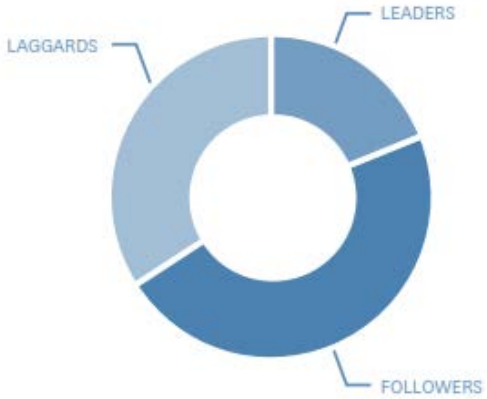
A **virtual engineering environment** will incorporate modeling, simulation, and visualization to support all aspects of systems engineering by enabling improved prediction and analysis of complex emergent behaviors.

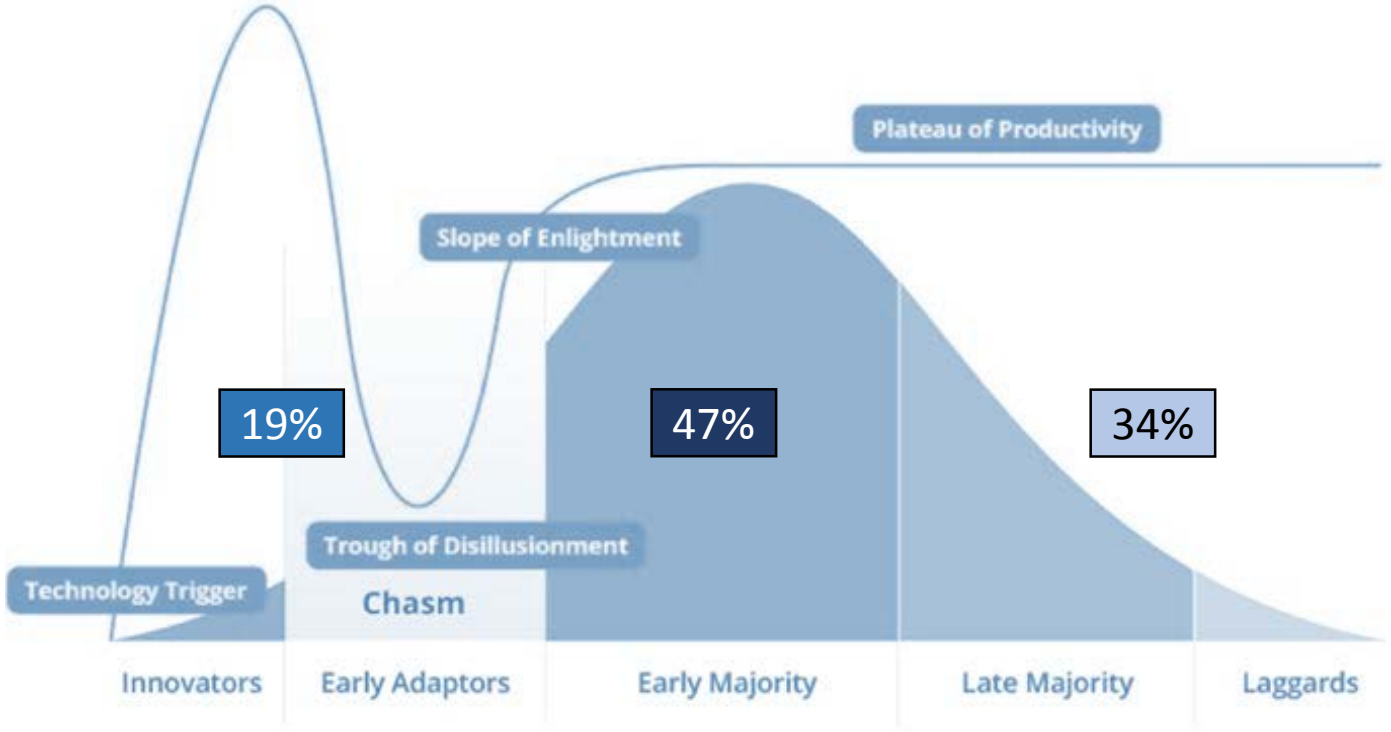
Composable design methods in a virtual environment **support rapid, agile and evolvable designs of families of products**. By combining formal models from a library of component, reference architecture, and other context models, different system alternatives can be quickly compared and probabilistically evaluated.

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.

Accelerating: Technology Adoption – Hype and Chasm





Rating of company's digital maturity in leadership and management[5]

More than 80% of respondents are either followers or laggards

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

Transformation: Change Management and Leadership

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 very much a people focused endeavor.

Transformation: INCOSE CAB MBSE Top Enablers, Needs and Obstacles

Documents to Models

Enablers
- Translate models into decision maker language
- Ability to analyze quickly, proper level of fidelity
- Change management best practices

Needs
- Models need to answer stakeholder questions
- Connect modeling to programmatic success
- Demonstration how modeling speeds innovation

Obstacles
- Why change, what is the ROI
- Inability to know if model used is reliable; VVUQ
- Up front costs in resources, time to learn etc.

Process / Methods

Enablers
- Clearly demonstrate the value of system model(s)
- Models uncover errors in existing artifacts
- Aid an early adopter with a pain point

Needs
- Systems engineering and domain ontologies
- Common MBSE methods and practices
- Better ability to review model quality/accuracy

Obstacles
- Contracting and policy
- Use of requirements documents versus models
- Benefits are not obvious but they should be

Model Based ROI

Enablers
- Seeing through the “Mystique” of MBSE
- Framework to view ROI by process area
- Capitalizing models as intellectual property

Needs
- Baseline to compare MBSE application Viewpoint of ROI from multiple stakeholders
- Covering all of ISO 15288 process areas

Obstacles
- Weak Systems Eng. foundation for MBSE
- Lack of understanding; one size does not fit all
- Expressing “Soft” versus “Hard” ROI for MBSE

Shifting our focus to System Information

1 Content

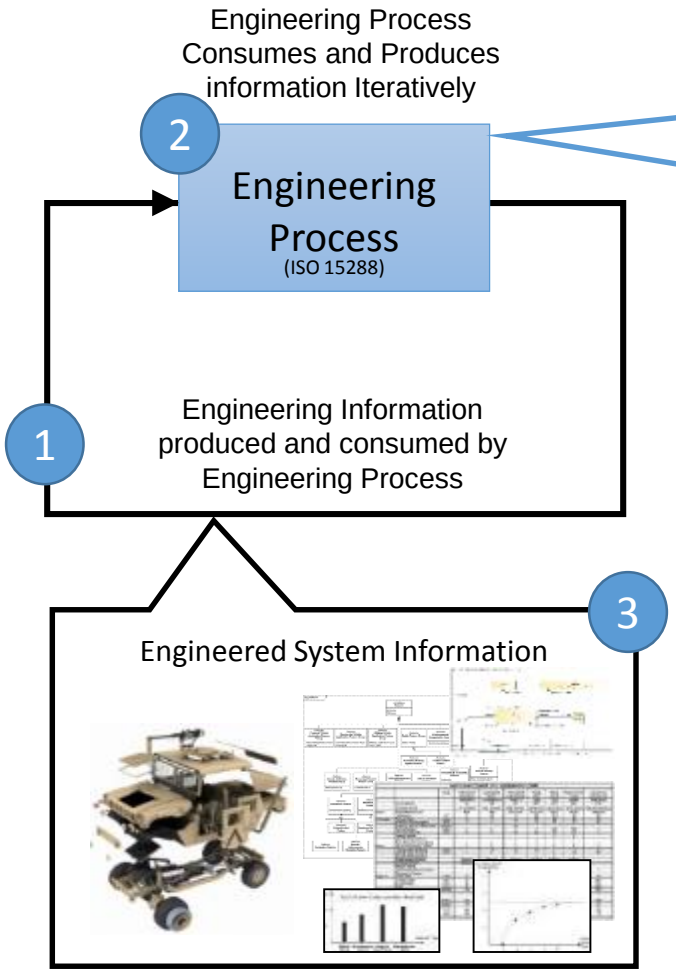
Key system information that must be produced, consumed and maintained consistently across the life cycle

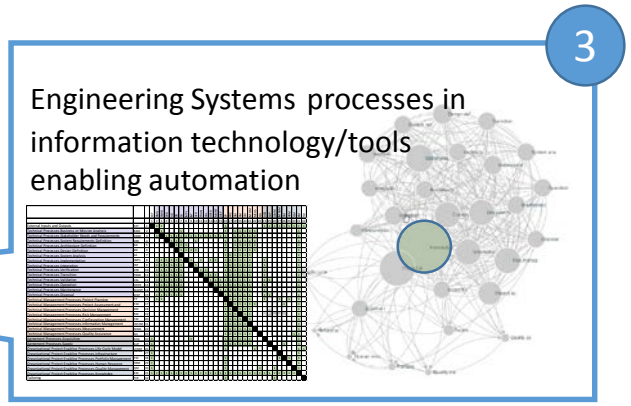
2 Process

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.





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

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

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

Remember: Automating junk, makes more junk automatically

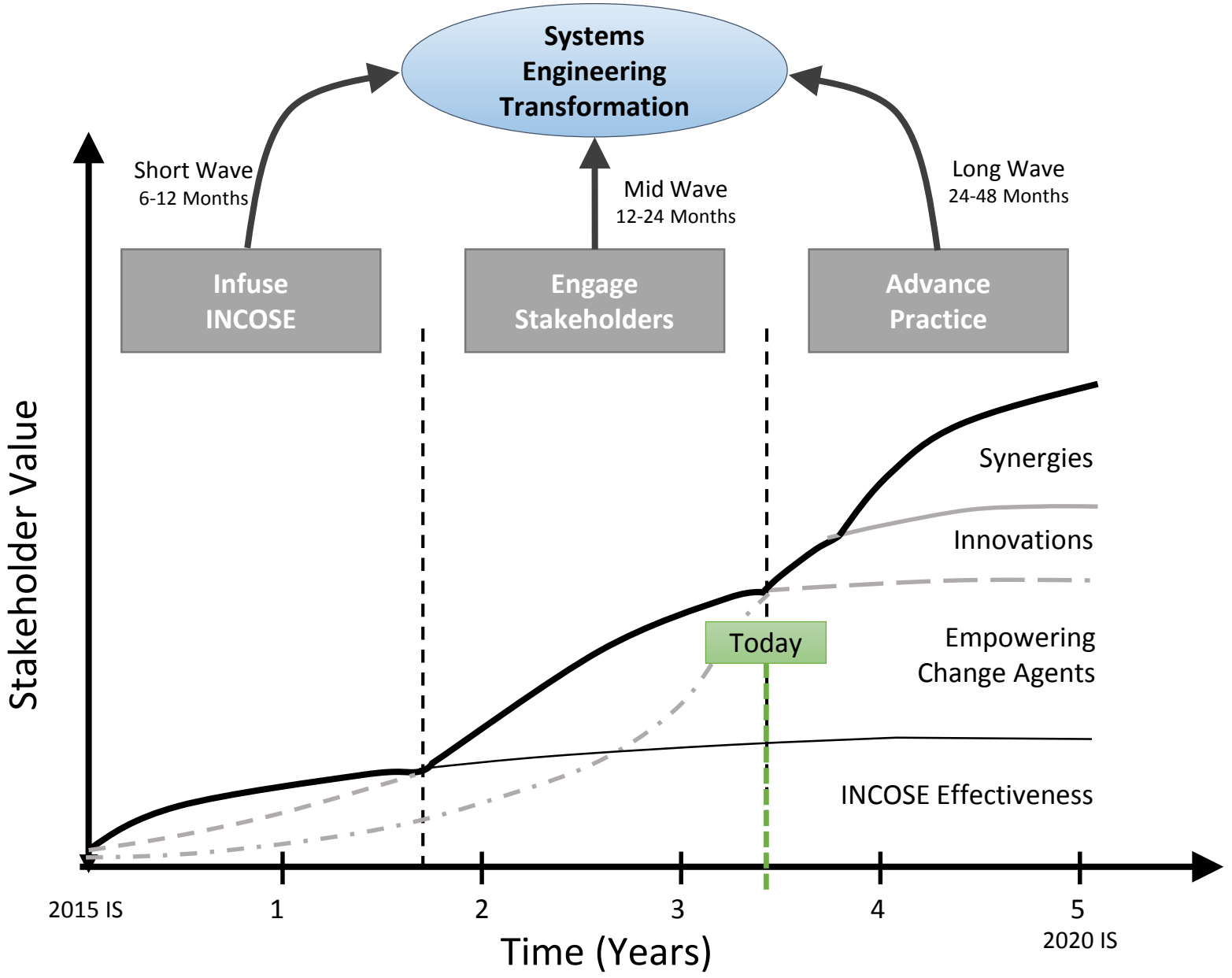
Transformation Strategy Overview

- Vision
- Mission
- Mission Areas
- Goals
- Objectives

Vision	**Systems Engineering is acknowledged as a model based discipline**		
Mission	**INCOSE accelerates the transformation of systems engineering to a model-based discipline**		
Mission Area #	**1**	**2**	**3**
Mission Area	**Infuse INCOSE**	**Engage Stakeholders**	**Advance Practice**
Mission Area	**What can INCOSE Do?**	**What is practiced and needed?**	**What is possible?**
Goals	Infuse model based methods throughout INCOSE products, activities and WGs	Engage stakeholders to assess the current state of practice, determine needs and values of model based methods	Advance stakeholder community model based application and advance model based methods.
Objective 1 Foundations	Inclusion of model based content in INCOSE existing/new products (Vision, Handbook, SEBoK, Certification, Competency Model, etc.)	Define scope of model based systems engineering with MBE practice and broader modeling needs	Advance foundational art and science of modeling from and best practices across academia, industry/gov. and non profit.
Objective 2 Expand Reach	Expand reach within INCOSE of MBSE Workshop; highlight and infuse tech ops activities with more model based content (products, WGs etc.)	Identify, categorize and engage stakeholders and characterize their current practices, enablers and obstacles	Increase awareness of and about stakeholders outside SE discipline of what is possible with model based methods across domains and disciplines (tech/mgmt)
Objective 3 Collaborate	Outreach: Leverage MOUs to infuse model based content into PMI, INFORMS, NAFEMS, BIM, ASME and others, sponsoring PhD Students, standardization bodies, ABET	Build a community of Stakeholder Representatives to infuse model based advances into organizations practicing systems engineering.	Initiate, identify and integrate research to advance systems engineering as a model based discipline
Objective 4 Assessment/ Roadmap	Assess INCOSE's efforts (WG, Objectives, Initiatives etc.) for inclusion of model based methods across the Systems Modeling Assessment/Roadmap	Engage stakeholder community with Systems Modeling Assessment/ Roadmap to better understand the state of the practice of MBSE. Push and pull content from stakeholders (change agents and the "to be convinced")	Provide baseline assessment framework, Systems Modeling Roadmap, to create a concrete measure of current state of the art of what's possible/what's the potential.

Strategy Notional Timeline

- Mission Areas
- Internal Short Wave
- External Mid Wave
- Advancing Long Wave
- Waves Run Concurrently
- Activities build on each other
- Important to fully engage stakeholder this next year. Pilot Assessment & Roadmap this CY and kick-off more broadly at 2017 IW.



Transformation Developments and Outcomes

Outcomes Achieved

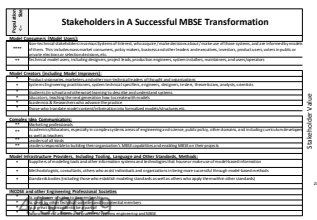
- Supported incubation of >7 Challenge Teams/WGs
- Provided >35 INCOSE Transformation briefings
- INCOSE IS and IW MBSE Lightening Rounds
- Model Wrapper / Features Packaging Framework
- Model Based Assessment Roadmap
- Model Based Stakeholder List
- Model Based Enablers & Roadblocks
- INCOSE Transformation Webinar
- Strategy & Action Plan
- Transformation website created
- Many Transformation Briefings

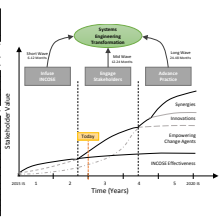
New/Related Developments

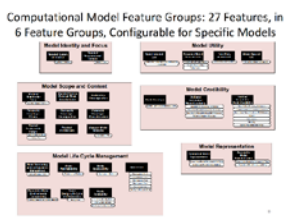
- Challenge Teams as Innovation Incubators
- Collaborative V&V of models with ASME
- Expanding and Developing new MOUs
- Supporting OCM effort within INCOSE
- MBSE FAQs Development
- Model Based Exemplars
- INCOSE MBSE Primer
- Model Based Value Briefing
- Supporting ST4SE: Semantic Technologies
- INCOSE Assessment Roadmap completion

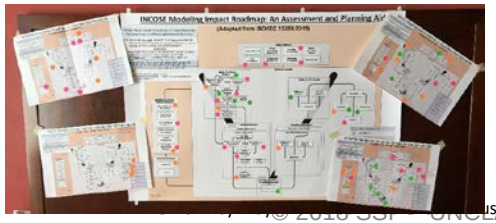
Next Steps

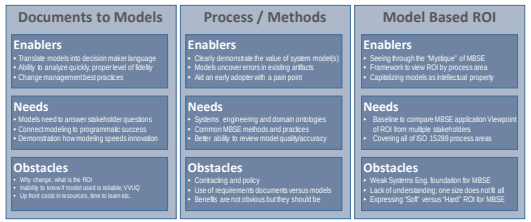
- Kickstart and Support Transformative INCOSE Activities
- Infuse Change Management principles across INCOSE
- Collaborate with FUSE, Vision etc.
- Establish a Sector Ambassador program to extend reach
- Improve communications (INSIGHT Transformation Corner Update webpage on incose.org)
- Update and refine metrics on Strategy
- Continue Working Standards review for changes related to model based

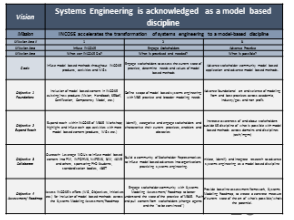












Transformation Stakeholders

The purpose of the Vision 2025 is to *inspire and guide* the direction of systems engineering across diverse stakeholder communities, which include:

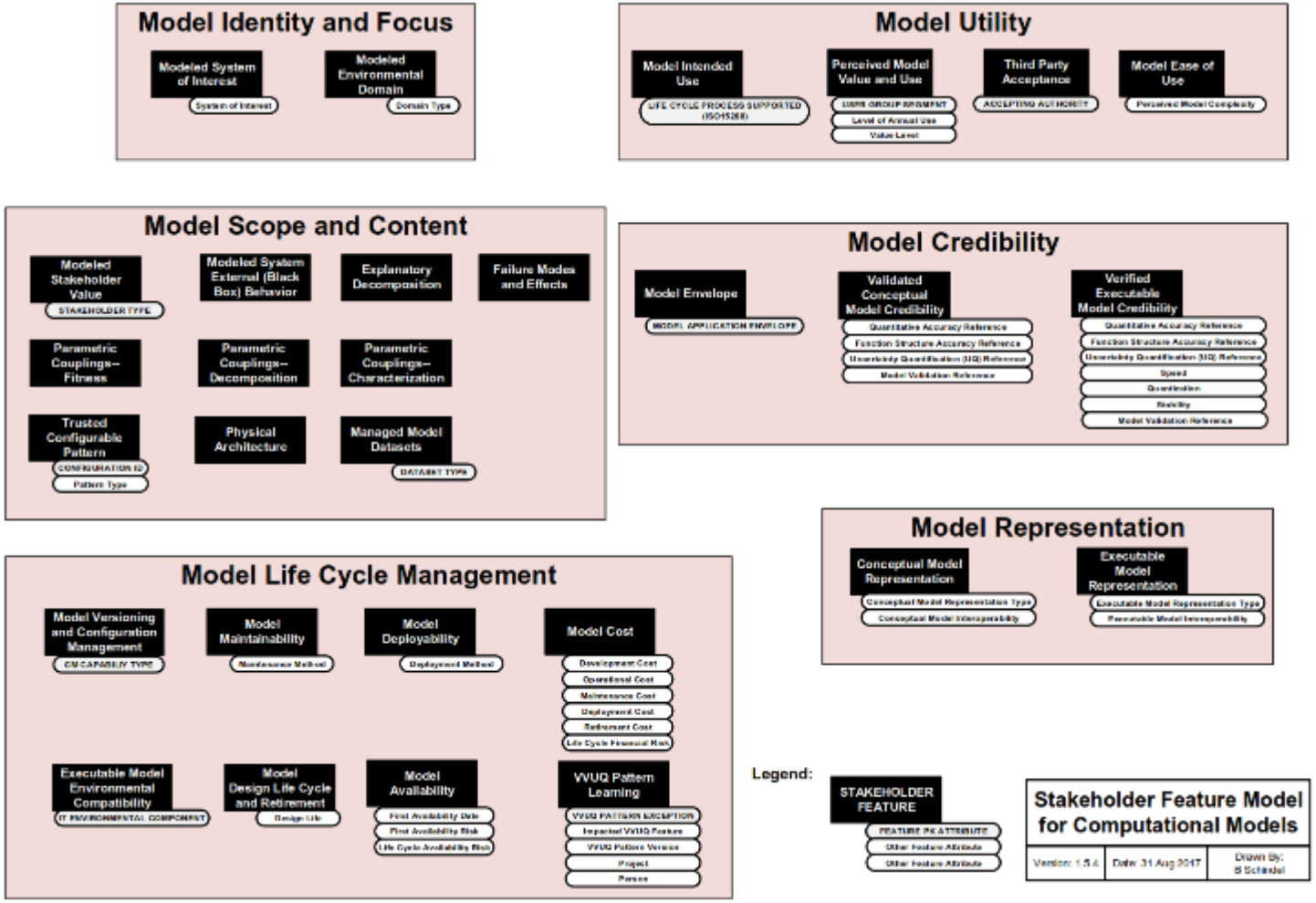
- **Engineering Executives**
- **Policy Makers**
- **Academics & Researchers**
- **Practitioners**
- **Tool Vendors**

This vision will continue to evolve based on stakeholder inputs and on-going collaborations with professional societies.

Population Size <--	Stakeholders in A Successful MBSE Transformation
Model Consumers (Model Users):	
****	Non-technical stakeholders in various Systems of Interest, who acquire / make decisions about / make use of those systems, and are informed by models of them. This includes mass market consumers, policy makers, business and other leaders and executives, investors, product users, voters in public or private elections or selection decisions, etc.
**	Technical model users, including designers, project leads, production engineers, system installers, maintainers, and users/operators
Model Creators (including Model Improvers):	
*	Product visionaries, marketers, and other non-technical leaders of thought and organizations
*	Systems Engineering practitioners, system technical specifiers, engineers, designers, testers, theoreticians, analysts, scientists
*	Students (in school and otherwise) learning to describe and understand systems
*	Educators, teaching the next generation how to create with models
*	Academics & Researchers who advance the practice
*	Those who translate model content/information into formalized models/structures etc.
Complex Idea Communicators:	
**	Marketing professionals
**	Academics/Educators, especially in complex systems areas of engineering and science, public policy, other domains, and including curriculum developers as well as teachers
**	Leaders of all kinds
**	Leaders responsible to building their organization's MBSE capabilities and enabling MBSE on their projects
Model Infrastructure Providers, Including Tooling, Language and Other Standards, Methods:	
*	Suppliers of modeling tools and other information systems and technologies that house or make use of model-based information
*	Methodologists, consultants, others who assist individuals and organizations in being more successful through model-based methods
*	Standards bodies (including those who establish modeling standards as well as others who apply them within other standards)
INCOSE and other Engineering Professional Societies	
*	As a deliverer of value to its membership
*	As seen by other technical societies and by potential members
*	As a great organization to be a part of
*	As promoter of advance and practice of systems engineering and MBSE

INCOSE/ASME Model Stakeholder Features Pattern

- Being created in the INCOSE supported ASME VV50 standards committee project, also in use in the INCOSE Transformation effort.
- Metadata in the form of a model itself, describing “what is in the model” – like a barcode which describes a product.
- 29 Model Features, spread across 6 feature groups



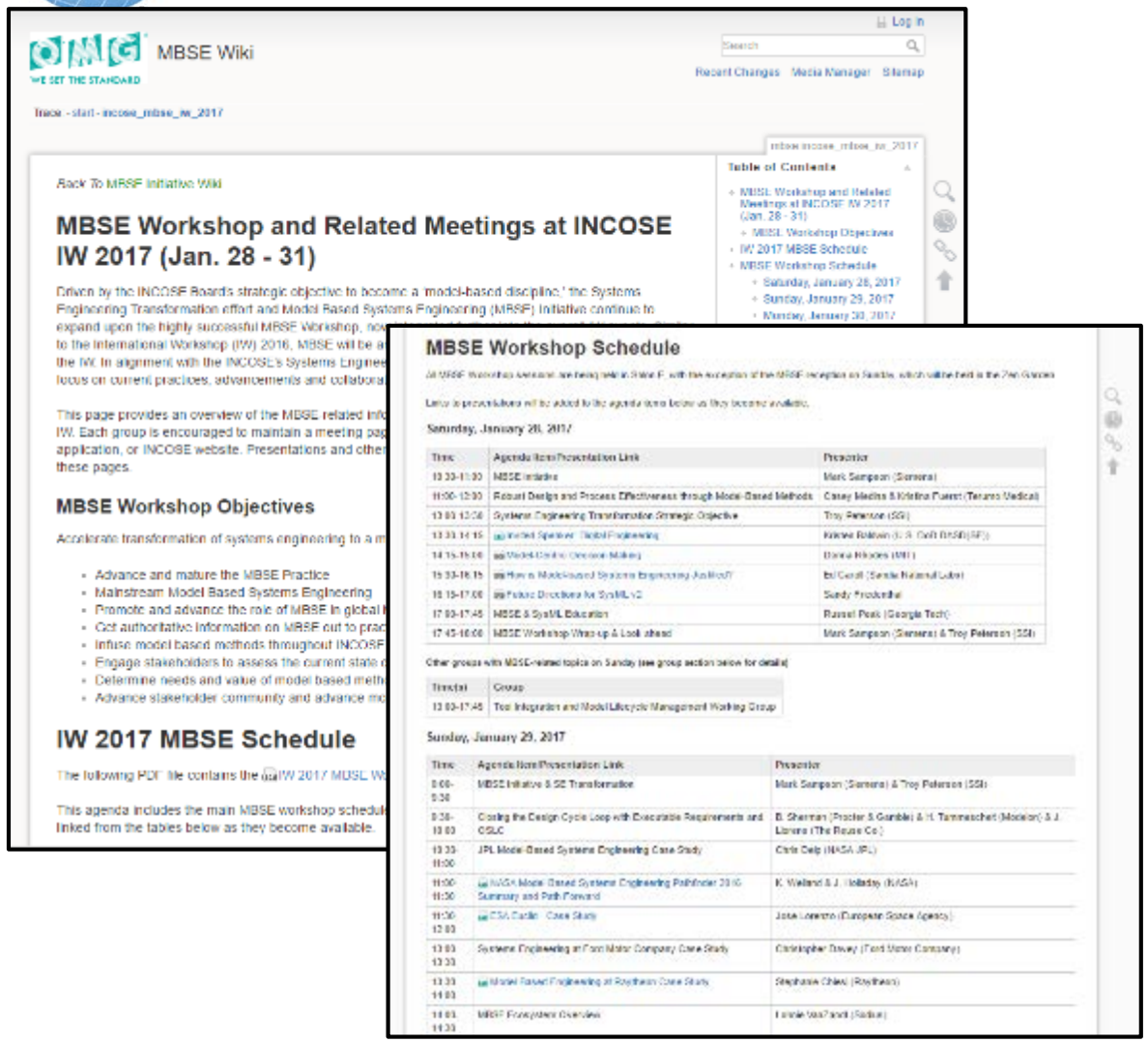
MBSE Initiative as an Incubator and Transformation Agent

- Digital Artifacts Challenge Team -> Digital Engineering Information Exchange WG:
  - Identifying and characterizing MBSE digital artifacts across the lifecycle
- Augmented Intelligence in Systems Challenge Team
  - How can machine learning and AI aid systems engineering in the innovation process
- Model-Based Enterprise Capabilities Matrix
  - Effort directed to help organizations improve their model-based enterprise capabilities
- Production and Distribution Systems Challenge Team
  - Connecting models across the lifecycle – Industry 4.0, Supply Chain, Logistics
- V&V of models (Potential Collaboration ASME, INCOSE, NAFEMS)
  - Verification and Validation of Models – tied to ASME VV50 standards project

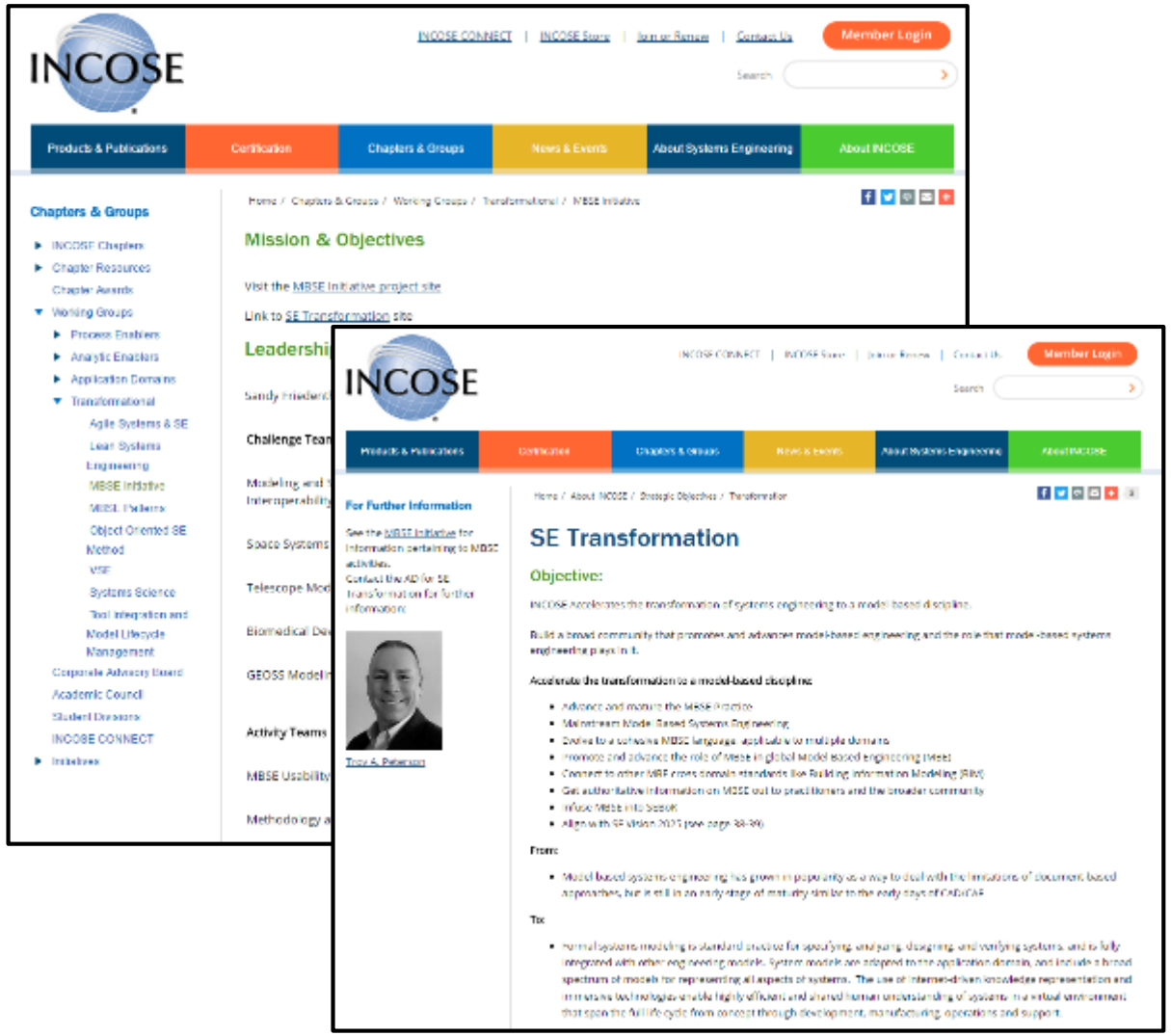
Generic life cycle (ISO/IEC/IEEE 15288:2015)

Concept stage	Development stage	Production stage	Utilization stage	Retirement stage
			Support stage	

MBSE Wiki and Website



http://www.omgwiki.org/MBSE/doku.php?id=mbse:incose_mbse_iw_2017



http://www.incose.org/about/strategicobjectives/transformation

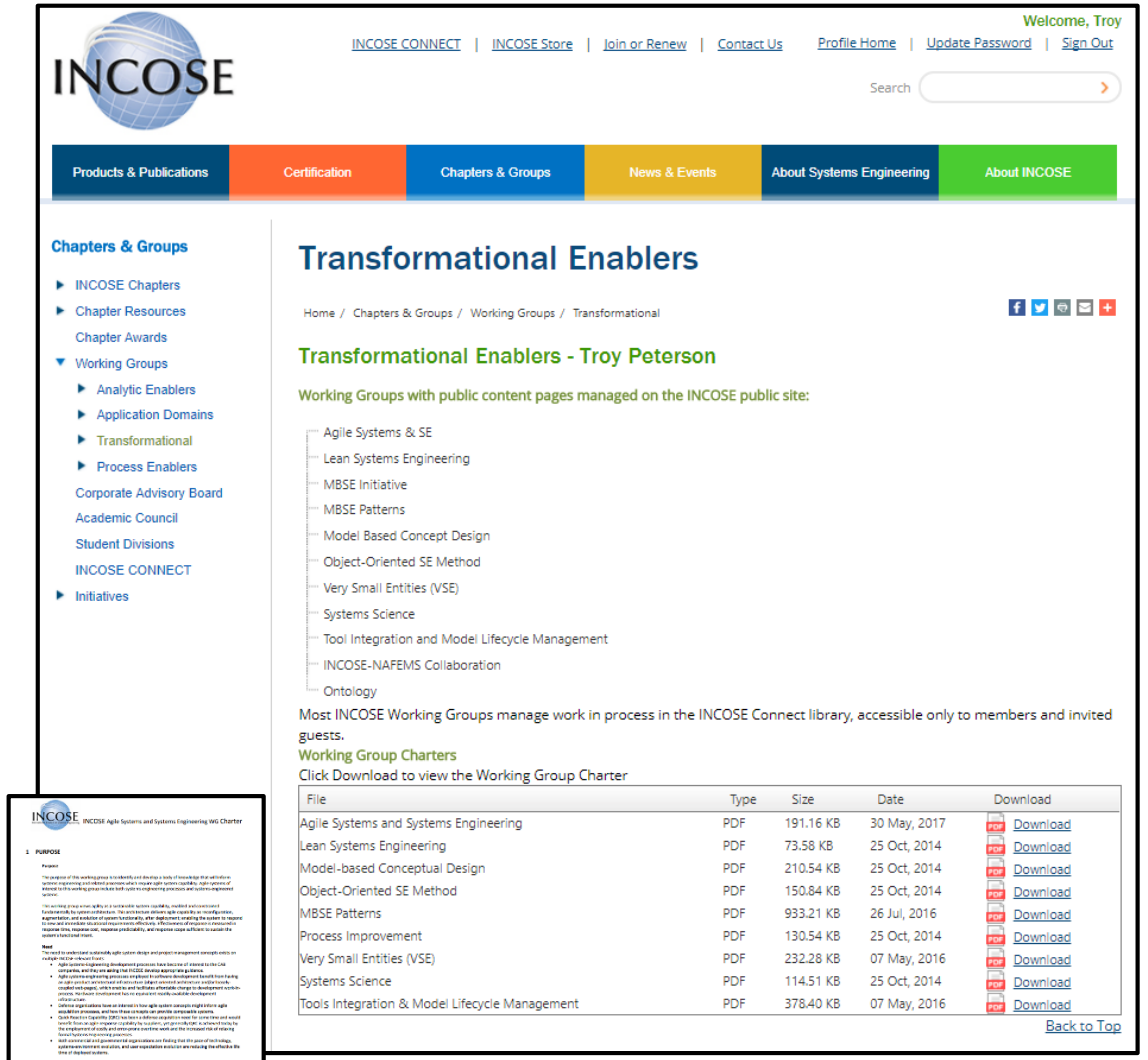
Other Working Groups

Transformational Working Groups (WG)

- Agile Systems and Systems Engineering
- Lean Systems Engineering
- Model Based Systems Engineering Initiative
- Model-based Conceptual Design
- Object-Oriented SE Method
- MBSE Patterns
- Very Small Entities (VSE)
- Systems Science
- Tools Integration & Model Lifecycle Management
- INCOSE-NAFEMS Collaboration
- Ontology

Visit site for WG charters and to learn more

http://www.incose.org/ChaptersGroups/WorkingGroups/transformational



Assertion

Systems Engineering
is the essential discipline for Digital Transformation

Transformation, Change and Trust – Speed Depends on Relationships

Leading Change: John P. Kotter

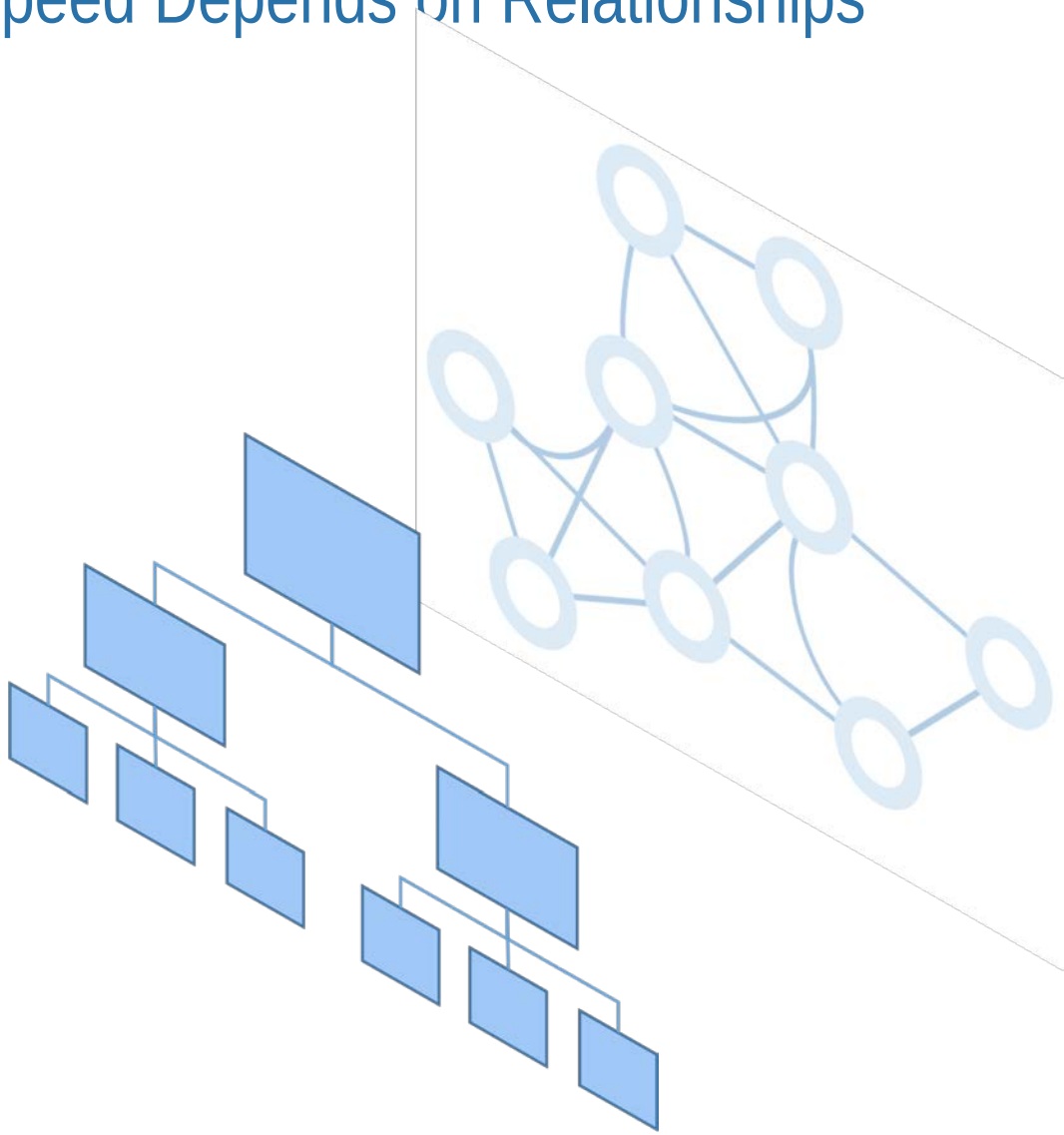
Eight-Step Process for undertaking major change.

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, relationships, strategic acceleration and driven to innovate.



“It is not necessary to change. Survival is not mandatory.”

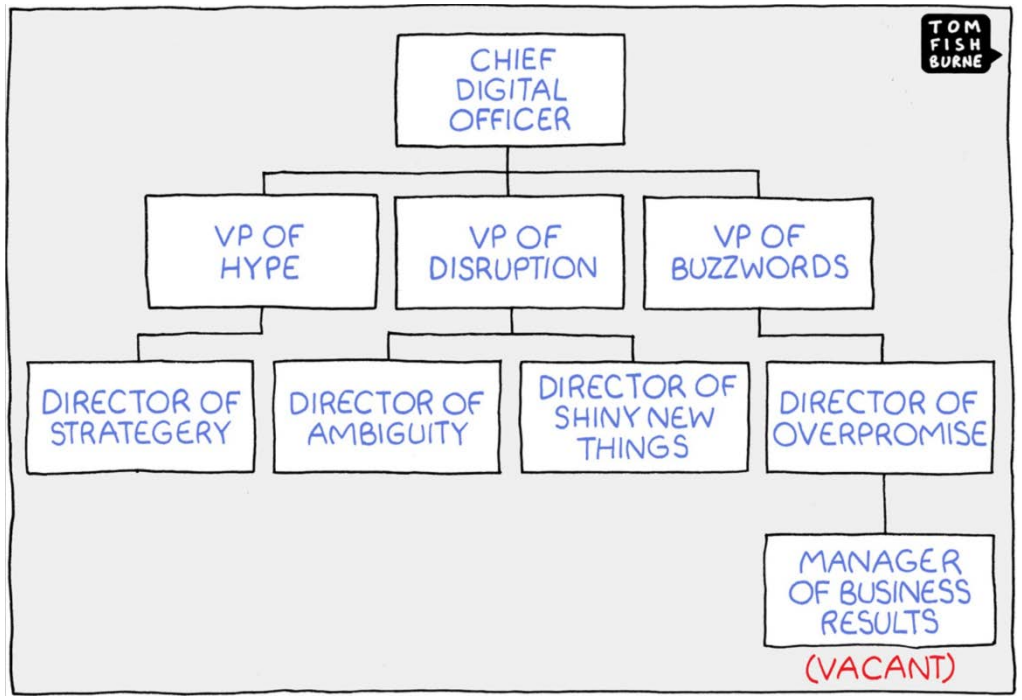
W. Edwards Deming

INCOSE’s Transformation Strategic Objective:
https://www.incose.org/about-incose/transformation

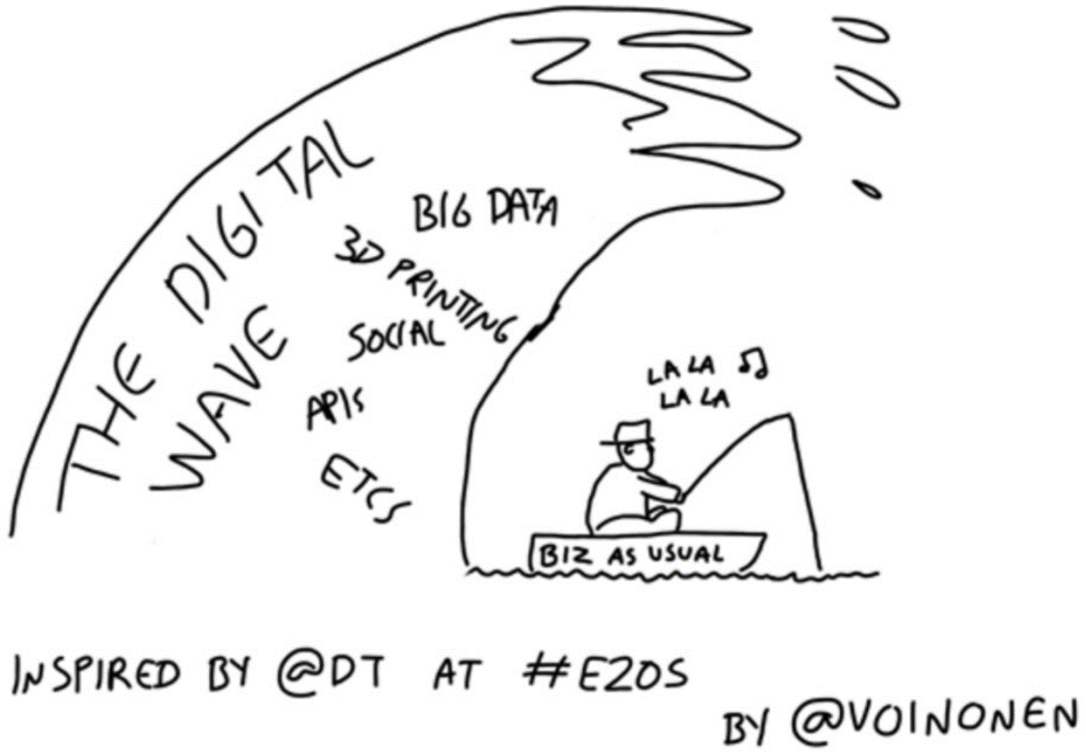
Engage as a Transformation Stakeholder Representative, visit:
https://www.incose.org/about-incose/transformation

INCOSE Q&A

Digital States



Digitally Zealous



Digital Denial

Troy Peterson

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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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