



2017

annual **INCOSE**
international workshop

Los Angeles, CA, USA

January 28 - 31, 2017

Transformation of Systems Engineering into a Model Based Discipline

MBSE Wiki and INCOSE Website



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MBSE Workshop and Related Meetings at INCOSE IW 2017 (Jan. 28 - 31)

Driven by the INCOSE Board's strategic objective to become a 'model-based discipline,' the Systems Engineering Transformation effort and Model Based Systems Engineering (MBSE) Initiative continue to expand upon the highly successful MBSE Workshop, now to the International Workshop (IW) 2016, MBSE will be at the IW. In alignment with the INCOSE's Systems Engineering focus on current practices, advancements and collaborative

This page provides an overview of the MBSE-related information. Each group is encouraged to maintain a meeting page application, or INCOSE website. Presentations and other these pages.

MBSE Workshop Objectives

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

- Advance and mature the MBSE Practice
- Mainstream Model Based Systems Engineering
- Promote and advance the role of MBSE in global Model Based Engineering (MBE)
- Get authoritative information on MBSE out to practitioners
- Infuse model based methods throughout INCOSE
- Engage stakeholders to assess the current state of MBE
- Determine needs and value of model based methods
- Advance stakeholder community and advance model based engineering

IW 2017 MBSE Schedule

The following PDF file contains the [IW 2017 MBSE Workshop Schedule](#).

This agenda includes the main MBSE workshop schedule linked from the tables below as they become available.

MBSE Workshop Schedule

All MBSE Workshop sessions are being held in Salon E, with the exception of the MBSE reception on Sunday, which will be held in the Zen Garden.

Links to presentations will be added to the agenda items below as they become available.

Saturday, January 28, 2017

Time	Agenda Item/Presentation Link	Presenter
10:30-11:00	MBSE Initiative	Mark Sampson (Siemens)
11:00-12:00	Robust Design and Process Effectiveness through Model-Based Methods	Casey Medina & Kristina Fuerst (Terumo Medical)
13:00-13:30	Systems Engineering Transformation Strategic Objective	Troy Peterson (SSI)
13:30-14:15	Invited Speaker: Digital Engineering	Kristen Baldwin (U.S. DoD DASD(SE))
14:15-15:00	Model-Centric Decision Making	Donna Rhodes (MIT)
15:30-16:15	How is Model-based Systems Engineering Justified?	Ed Carol (Sandia National Labs)
16:15-17:00	Future Directions for SysML v2	Sandy Friedenthal
17:00-17:45	MBSE & SysML Education	Russell Peak (Georgia Tech)
17:45-18:00	MBSE Workshop Wrap-up & Look ahead	Mark Sampson (Siemens) & Troy Peterson (SSI)

Other groups with MBSE-related topics on Sunday (see group section below for details)

Time(s)	Group
13:00-17:45	Tool Integration and Model Lifecycle Management Working Group

Sunday, January 29, 2017

Time	Agenda Item/Presentation Link	Presenter
9:00-9:30	MBSE Initiative & SE Transformation	Mark Sampson (Siemens) & Troy Peterson (SSI)
9:30-10:00	Closing the Design Cycle Loop with Executable Requirements and OSLC	B. Sherman (Procter & Gamble) & H. Tummescheit (Modelon) & J. Llorens (The Reuse Co.)
10:30-11:00	JPL Model-Based Systems Engineering Case Study	Chris Delp (NASA JPL)
11:00-11:30	NASA Model-Based Systems Engineering Pathfinder 2016 Summary and Path Forward	K. Weiland & J. Holladay (NASA)
11:30-12:00	ESA Euclid - Case Study	Jose Lorenzo (European Space Agency)
13:00-13:30	Systems Engineering at Ford Motor Company Case Study	Christopher Davey (Ford Motor Company)
13:30-14:00	Model-Based Engineering at Raytheon Case Study	Stephanie Chiesi (Raytheon)
14:00-14:30	MBSE Ecosystem Overview	Lonnie VanZandt (Sodius)

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SE Transformation

Objective:

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

Build a broad community that promotes and advances model-based engineering and the role that model-based systems engineering plays in it.

Accelerate the transformation to a model-based discipline:

- Advance and mature the MBSE Practice
- Mainstream Model Based Systems Engineering
- Evolve to a cohesive MBSE language, applicable to multiple domains
- Promote and advance the role of MBSE in global Model Based Engineering (MBE)
- Connect to other MBE cross domain standards like Building Information Modeling (BIM)
- Get authoritative information on MBSE out to practitioners and the broader community
- Infuse MBSE into SEBOK
- Align with SE Vision 2025 (see page 38-39)

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.

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

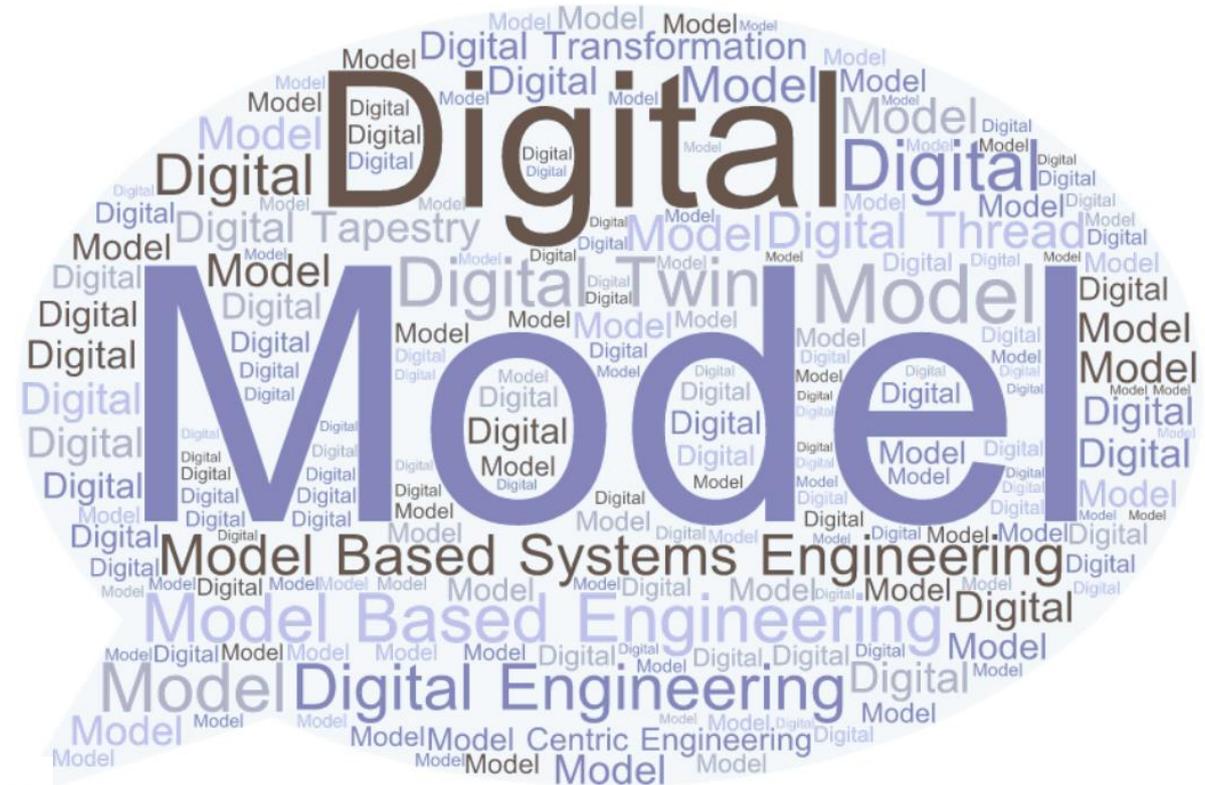
<http://www.incose.org/about/strategicobjectives/transformation>

Our Hope for the MBSE Workshop





- What do we mean by:
 - Model Based Systems Engineering
 - Model Based Engineering
 - Model Based Development
 - Model Based Design
 - Model Centric Engineering
 - Model Based Methods
 - Digital Engineering
 - Digital Design
 - Digital Thread
 - Digital Twin
 - Digital Tapestry





High Priority Products to be Worked

1. Definitions and Terms
2. Digital Artifacts
3. MBSE Primer
4. Value Briefing / Case Studies / ROI

Other Products to be Worked

1. Detailed assessment / roadmap, maturity model
2. Viewpoints/Products for specific stakeholders for products (stakeholders, Acquisition/Contracts)
3. Training plan / Resources / Education
4. Model Libraries

Products Worked

1. Stakeholder List
2. Strategy & Action Plan
3. Assessment Roadmap
4. Enablers & Roadblocks

MBSE Propeller Hat Award



MBSE Propeller Hat Award

One of the INCOSE Curmudgeons (Noun: bad-tempered, surly person) criticized the MBSE Initiative as a “bunch of propeller hats in the basement”. He was challenging us to bring MBSE exercised by a few modeling nerds out of the basement to make it widely available and commonly practiced by all systems engineers (and for that matter by all engineers). This award is a recognition to those individuals or working groups who have done the most in bringing “MBSE out of the basement” through:

- Democratization of modeling
- Simplifying complex problems through models
- Educating upcoming generations of engineers on MBSE
- Automating complex systems engineering practices
- Advancing the practice of systems modeling



JPL for Open MBEE and
MBSE Workshop Contributions



Bill Schindel for Patterns
Collaborations and
Transformation Contributions



Artificial Intelligence Model Based Change
Cyber Security Systems Engineering Innovation
Transformation
Data Science Digital Cloud Analytics
Internet of Things Design Thinking
Industry 4.0



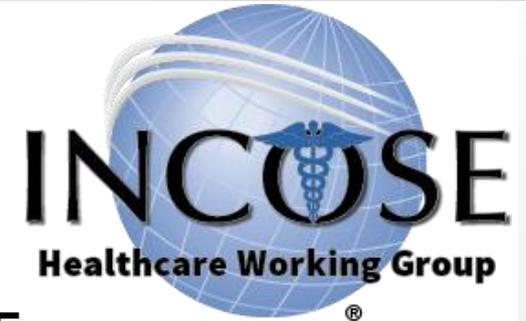
MBSE Initiative as an MBSE Incubator

- Digital Artifacts:
 - Identifying and characterizing MBSE digital artifacts
- Manufacturing Modeling & Industry 4.0
 - Connecting models across the lifecycle – Manufacturing, SC, Logistics
- V&V of models (Potential Collaboration ASME, INCOSE, NAFEMS)
 - *Human – machine interactions solving complex problems (match play)*





- **SE Transformation Working Session**
- **Healthcare Working Group**
- **SysML v2 Working Group Meeting**
- **Tool Integration and Model Lifecycle Management Working Group**
- **Decision Analysis Working Group /DoD Digital Engineering**
- **M&S Interoperability Challenge Team - MBX Ecosystems Workshop**
- **NAFEMS-INCOSE Systems M&S Working Group**
- **Patterns Working Group**
- **Assessment Instrument**



Biomedical-Healthcare MBSE Challenge Team Technical Track

Sunday, January 29, 2017 – Morning Session

SE/MBSE Methods for Medical Device Compliance and Compliance Review

Sunday, January 29, 2017 – Afternoon Session

SE/MBSE Methods to Capture the Clinical Environment for Device Developers

Bob Malins

Co-Lead, Healthcare Working Group

rjmalins@eaglesummittech.com



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Problem Statements for Challenge Team 2016 Efforts

- **Question 1:**

- Can SE methods and MBSE techniques help device developers achieve safe and effective devices and facilitate (including speed up) the regulatory review and approval process?
 - Focus on applicable standards
 - Focus on FDA review process and issues therein
 - Outcomes – Sunday morning session

- **Question 2:**

- Can SE methods and MBSE techniques capture critical characteristics of the clinical environment in a form device developers can use as part of developing safe and effective devices?
 - Focus on how clinicians use devices
 - Focus on process, interfaces, usability, interoperability
 - Outcomes – Sunday afternoon session

SCOPE: Infusion pump devices and technology

Outbrief from IW2017

- **MBSE for medical device compliance, regulatory submission, safety analyses**
 - MBSE tools offer a significant capability for performing the work needed to address FDA concerns
 - The model will not likely ever be part of the submission
 - But the model can be a critical tool for driving the design, organizing the evidence, packaging the submission
 - Tool vendors are providing new, highly relevant capabilities
 - Standards tracking and reporting
 - FMEA, FTA, and other hazard and safety analysis
 - Relevant libraries of standards and regulatory requirements would be very useful
- **MBSE for capturing the critical characteristics of the clinical environment**
 - Device developer perspective ...
 - The critical elements of the clinical environment driving usability can be captured
 - Much of the usability analysis requirement can be performed in the tool
 - Clinician and hospital director perspective ...
 - Still very unclear where MBSE can contribute
 - Approaches such as Lean, Value-Stream mapping, clinical simulation offer immediate tangible benefits
 - While the MBSE model faces significant challenges communicating to clinicians
 - But there could be utility for large-scale projects (e.g., information architecture, clinician friendly EMR, etc.)

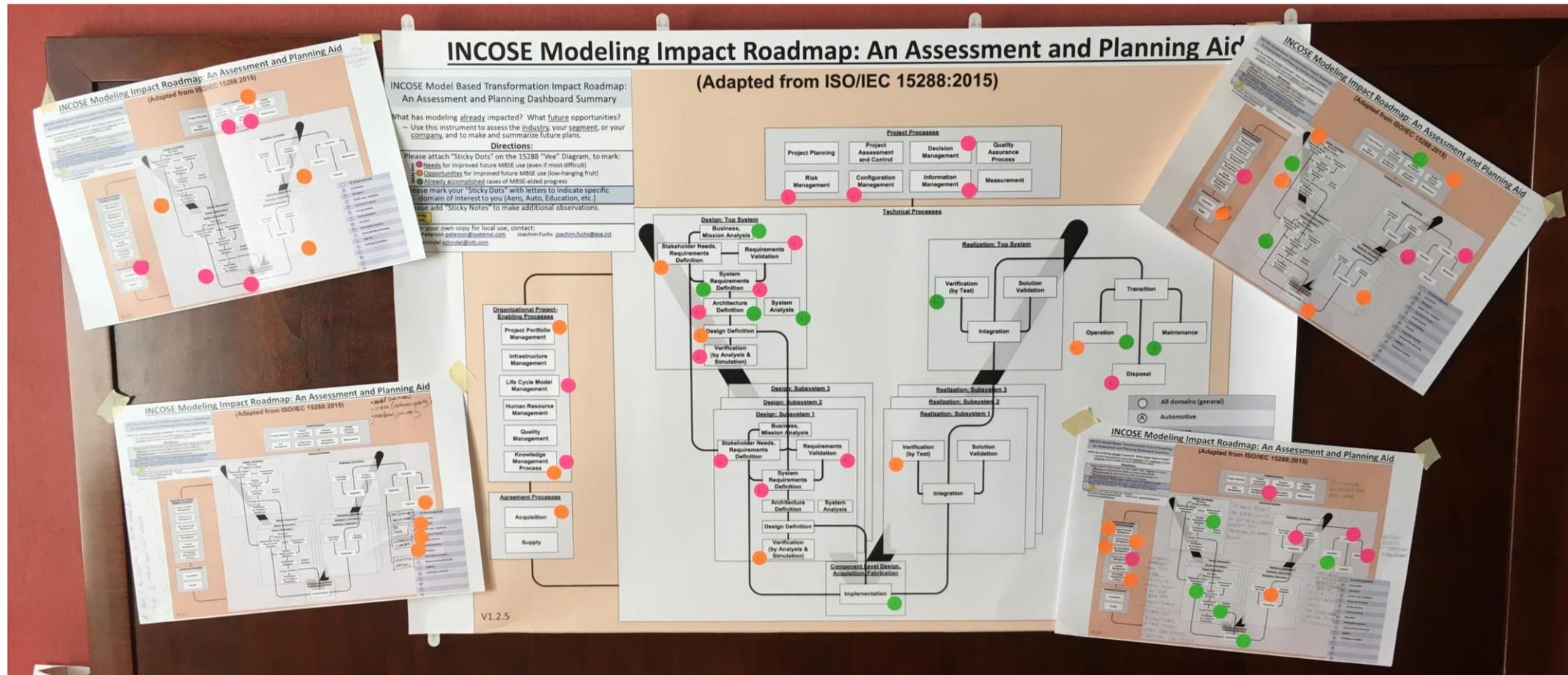


CAB Breakout: Assessment / Roadmap Instrument: A simple instrument

- Intentionally very simple:
 - Focused “one level down” from the intention to apply model-based methods to SE.
 - Level of detail = the individual ISO 15288 life cycle processes.
- Intended to address these important questions:
 - What are you trying to improve? (Which 15288 processes?)
 - Where are the biggest potential gains? The easiest potential gains?
 - What is already improved?
- But not:
 - How will your goals be accomplished?
 - What are the details of your plan?
 - Not a CMMI



Breakout session





Main takeaways

- Good instrument to start the discussion and highlight areas
- Very big differences between organisations / sectors
 - Avoid accumulation without this parameter
- Need for further improvement
 - Two functions: Assessment (status quo) and future (gap analysis)
 - Representation very design centric
 - Some aspects difficult to "locate", e.g.
 - Links between boxes (at model level)
 - Contract relations (only acquisition...?)
- Potential feedback also on process standard, if driven by model-based



Open Mic

What can we do better?

What are your needs?

What did you like?



Questions



Objective: *INCOSE accelerates the transformation of systems engineering to a model-based discipline*

- Advance and mature the MBSE Practice (MA3)
- Mainstream Model Based Systems Engineering (MA3)
- Evolve to a cohesive MBSE language, applicable to multiple domains (MA3:O1)
- Promote and advance the role of MBSE in global Model Based Engineering (MBE) (MA2:O1)
- Connect to other MBE cross domain standards like Building Information Modeling (BIM) (MA1:O3)
- Get authoritative information on MBSE out to practitioners and the broader community (O3)
- Infuse MBSE into SEBoK (MA1:O1)
- Align with SE Vision 2025 (see page 38-39) (All)





SE Transformation Products: Stakeholders

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	

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.

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 Detail

- Objectives have MOEs
- Objectives have traceable Activities / Task level actions to accomplish objective
- Baseline Assessment of current state will need to be completed.
- Objective 4: Assessment & Roadmap will enable baseline assessment by ISO 15288 process areas

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
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Objective 4 Assessment & Roadmap	Assess INCOSE's efforts (WG, Objectives, Initiatives etc.) for inclusion of MBSE across the Systems Modeling 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.
Objective Measures of Effectiveness (MOEs)	<p>O1: % of INCOSE products including model based content</p> <p>O1: # of sections in existing products with model based content weighted by significance (L, M, H); Marking these assessments into the SE Transformation Roadmap (by ISO 15288 process area).</p> <p>O1: Inclusion of Model Based content into certification (SEP would signify an understanding of MBSE)</p> <p>O2: # of domains represented within MBSE Workshop</p> <p>O2: Stakeholders breadth in INCOSE and activities</p> <p>O2: % WG/Activity teams including model based content</p> <p>O2: % of model based content in IW and IS</p> <p>O2: # of WG's that are including model-based content weighted by the impact on the practice (L, M, H); Marking these assessments into the SE Transformation Roadmap (by ISO 15288 process area).;</p> <p>O2: # of models included in products, or used to describe products (SEBoK for example)</p> <p>O3: # of joint products with model based content</p> <p>O3: #of MOU's which help infuse model based content</p> <p>O4: # of gaps identified</p> <p>O4: % of content missing MBSE</p> <p>O4: Progress in inclusion of model based methods on the Assessment & Roadmap for INCOSE</p>	<p>O1: Is MBSE and MBE defined across modeling community</p> <p>O2: % and quantity of stakeholder types across domains engaged</p> <p>O2: Use Xfrmation A-R to characterize current state and obtain E&O</p> <p>O3: # of stakeholders,</p> <p>O3: # of domains represented,</p> <p>O3: Stakeholder Representative meeting attendance</p> <p>O3: Stakeholder feedback on A-R progress in organizations</p> <p>O4: Pilot completed and feedback positive, neutral or negative</p>	<p>O1 & O3: Trend % of SE publications with model based content - note by domain</p> <p>O1: Use Xfrmation A-R to assess ease of model based activities (creation, communication, level of automation et al.)</p> <p>O2: # of non-SE stakeholders in stakeholder representative list engaged</p> <p>O2: Targeted questionnaire toward non SE stakeholders on perception of value of model based methods</p> <p>O2: Increased hits on MBSE content on INCOSE website, ...measures global buzz...</p> <p>O2: Trend % of SE Academic programs include model based methods</p>
Imperatives / Actions / Activities	<p>O1: Engage product providing groups for assessments noted in O1 MOEs</p> <p>O4: Internal application of MBSE Assessment & Roadmap</p>	<p>O1: Leverage relationship and efforts with NAFEMS for model definitions and model taxonomy</p> <p>O2: Create stakeholder model in a modeling tool</p> <p>O2: Run A-R pilot and aggregate results; refine A-R from Pilot, Run A-R across Stakeholder community (CAB, Stakeholder Reps etc.), Aggregate results and publish</p> <p>O4: Pilot Assessment & Roadmap to obtain initial Feedback</p> <p>O4: Expand A&R activity to CAB & Stakeholder Reps.</p> <p>Provide change agents success stories/ value of MBSE implem. from across domains</p>	<p>(standards, ontology, visualization, methods etc.).</p>

Refining MOEs

Mapping and building out tasks level with POCs and Funding



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.

