Systems Engineering Transformation:
Accelerating transformation to a model-based discipline

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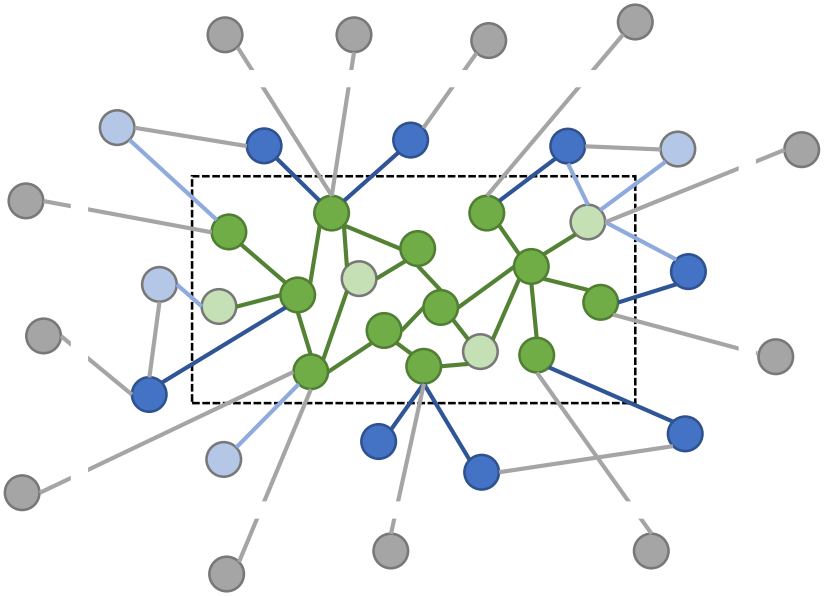
The Pervasive Systems Phenomenon



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

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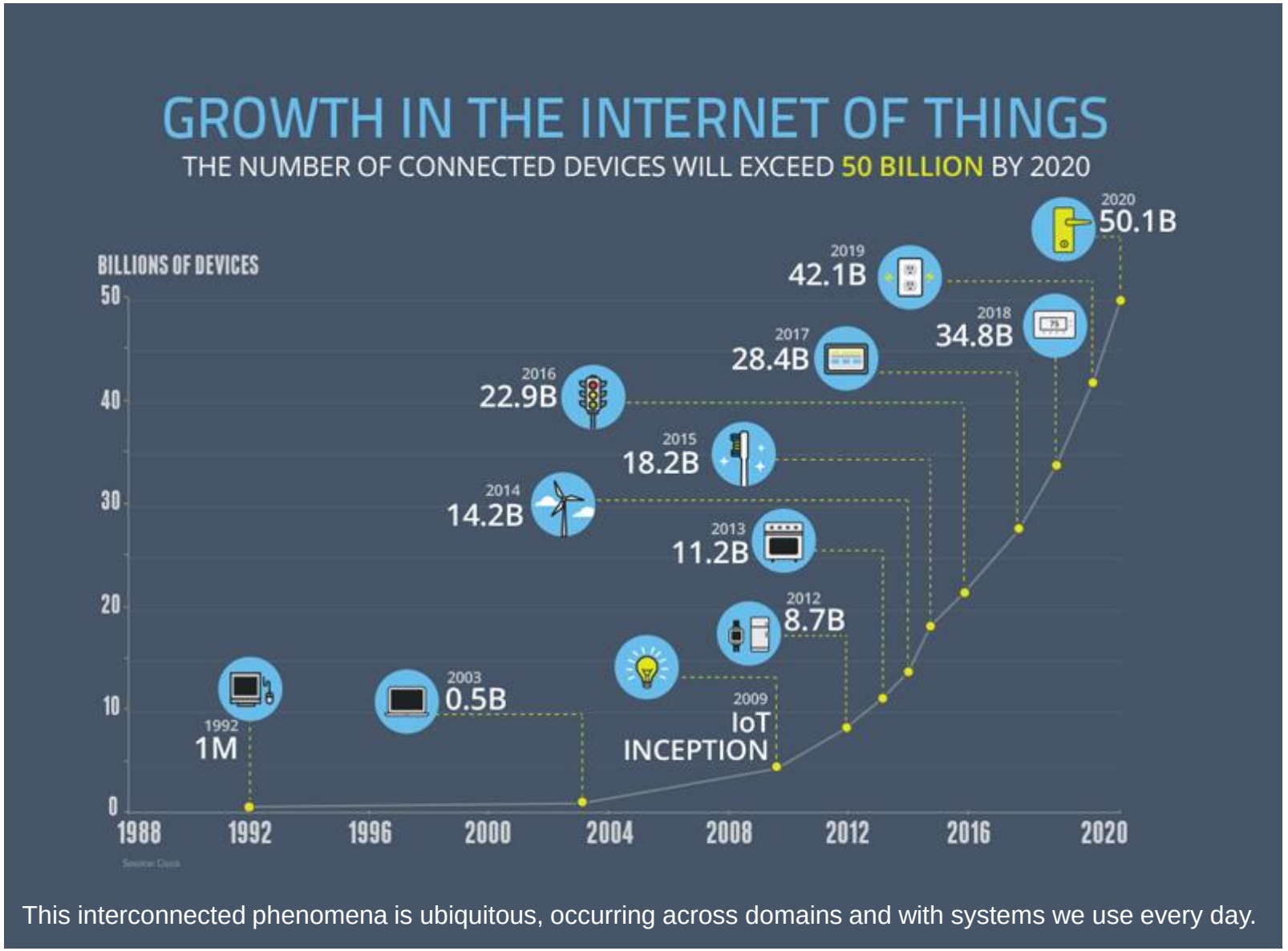
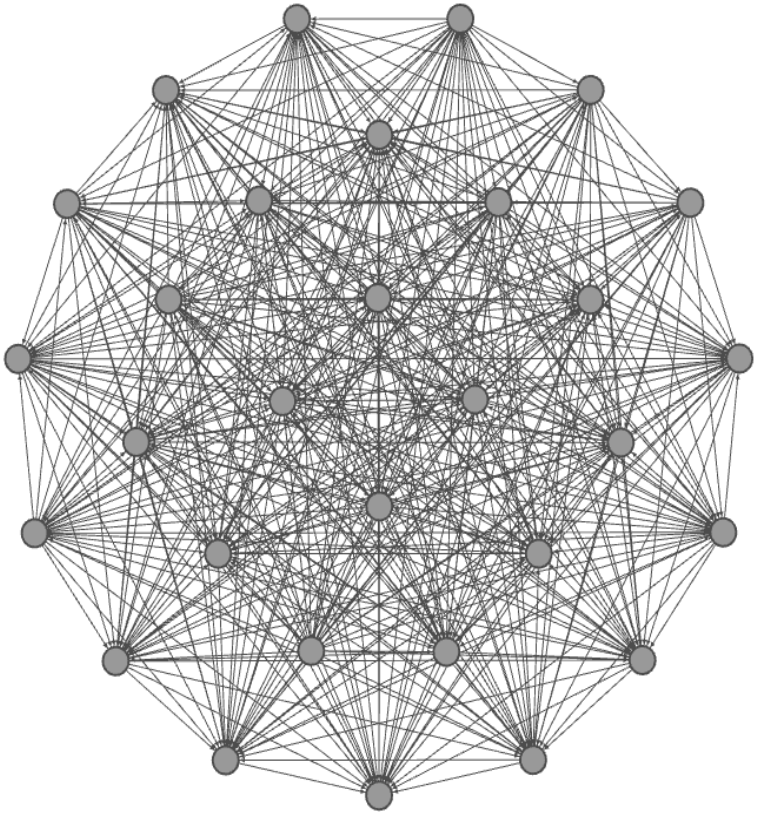
Internet of Things



This interconnected phenomena is ubiquitous, occurring across domains and with systems we use every day.

Why Transformation



Nodes = 30, potential links = 435, unique configurations = 2^{435}

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

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The Context – Is this all new?

"Today more and more design problems are reaching insoluble levels of complexity."

"At the same time that problems increase in quantity, complexity and difficulty, they also change faster than before."

"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. Because trial and error is too expensive and too slow."

Christopher Alexander,
Notes on the Synthesis of Form[1],

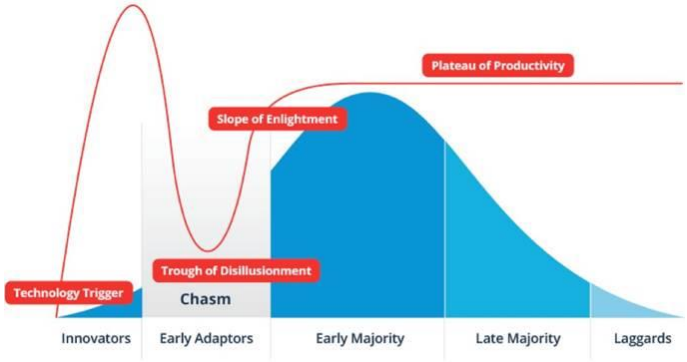
1. Christopher Alexander, "Notes on the Synthesis of Form" Harvard University Press, Cambridge Massachusetts, 1964

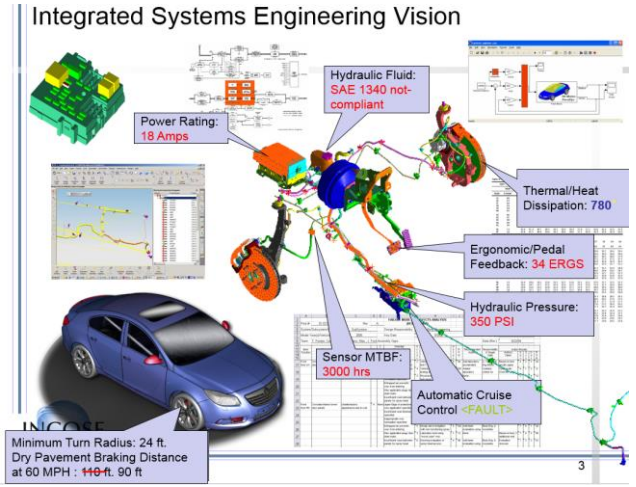
SE Transformation Overview

Objective:

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

- Accelerates:
  - Understand the hype cycle[1] and bridge the chasm[2]…
  - Empower others to enlighten and influence adoption
- Transformation:
  - A marked change, as in appearance or character, usually for the better[3]. e.g. documents to models
  - Lead and support the community in crossing the chasm
- Model Based Discipline
  - System models of all types
  - Modeler Collaboration and Model Integration





1. Hype Cycle is a branded graphical presentation developed and used by IT research and advisory firm Gartner
2. Moore, Geoffrey A. "Crossing the Chasm – and Beyond" Strategic Management of Technology and Innovation Third Edition 1996
3. Excerpted from The American Heritage Dictionary of the English Language, Third Edition 1996 by Houghton Mifflin Company
4. Friedenthal, Sandy and Sampson, Mark - MBSE Initiative Overview - http://www.omgwiki.org/MBSE/doku.php

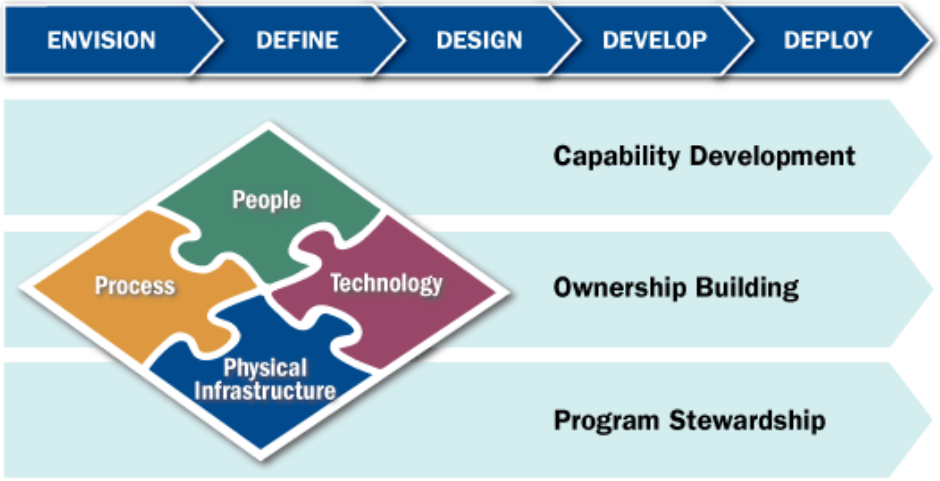
Model Based Discipline: The Next Evolutionary Step

- Model Based Discipline
  - Models are not new to us
  - Transformation is not a wholesale change
  - Model based is the next evolutionary step
  - In some ways we're going "back to the future"

- Understand the Current State
  - Take inventory of current state of transition and progress toward becoming a model based discipline

- Envision and define the future state of SE:
  - Vision 2025,what are the business objectives, associated metrics, stakeholders, technology and transition needs, typical what if questions, priorities etc.
- Leverage Transformation and Change Management methods and frameworks

Transformation: Change Management and Leadership



Transformation Life Cycle™ (TLC): Booz Allen Hamilton

Consider key dimensions of change

- People, Process, Technology, and Physical Infrastructure
  - Integrate dimensions of change
  - Addresses dimensions in parallel
  - Leverage concurrency to encourage cross dimension trades
  - Build ownership at the grass-root level

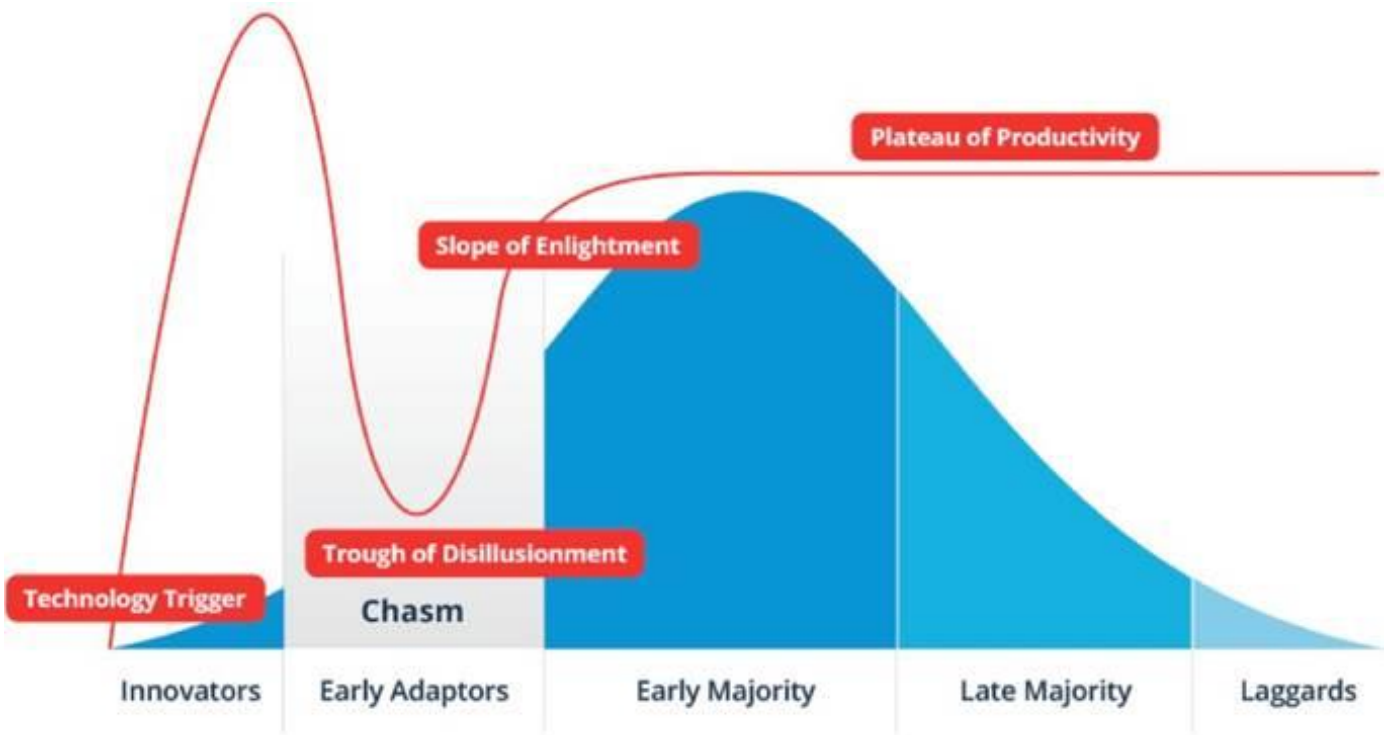
Consider:

ABP = CM(OE + BPR + 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.

Accelerates: Hype Cycle and Chasm

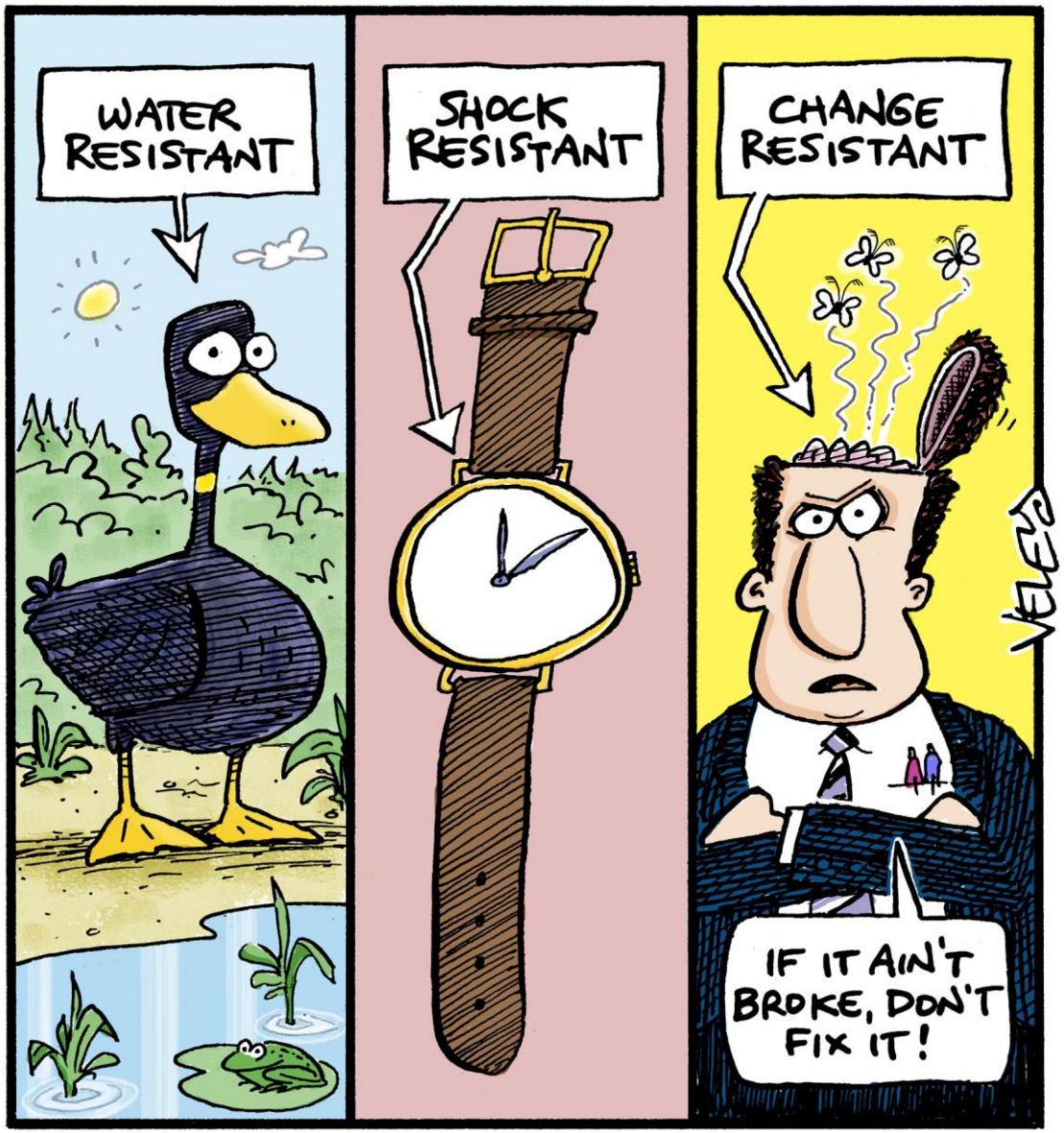


Acceleration is very much about sharing, communicating and learning

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 Combind Graphic: http://www.datameer.com/blog/big-data-analytics-perspectives/big-data-crossing-the-chasm-in-2013.html

Change Management



https://redapplemom.files.wordpress.com/2011/06/change-cartoon1.jpg

Change Encouragement

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

Kurt Lewin

The best way to mange change is to create it.

Peter Drucker

MBSE Future in Vision 2025

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.

Transformation to a Model-Based Discipline

Objective: 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
- Align with SE Vision 2025 (see page 38-39)

SWOT Analysis – Early Draft

Strengths (current)	Weaknesses (current)
- Strong interest in current MBSE initiative. Momentum created - SysML Standard and Development - High attendance at IW workshop - Part of Vision 2025	- Perception that SysML ≡ MBSE - Not fully integrated or accepted - Limited spread to other WG activities - Limited set of examples available - Ad hoc application - Building the theoretical foundation
Opportunities (future)	**Threats (future)**
- Mainstream Systems Engineering as a Model Based Discipline - Connect to other MBE disciplines and take lead in integration - Application across domains e.g. BIM - Improve the overall business case for systems engineering	- Stove piping of MBSE - Miss the larger community – stuck in the chasm / trough - Other modelling communities pick up the lead for MBSE - MBSE viewed as applicable only to large projects

Team

Assistant Director for Transforming SE to a Model Based Discipline

- Troy Peterson

Core team of experts supporting the effort – Meet one or two times a month…

- Jeff Bergenthal
- Sandy Friedenthal
- Joachim Fuchs
- John Gill
- Mark Sampson
- Bill Schindel

Adding stakeholder representatives to obtain diverse perspectives

- INCOSE CAB, IOB, Working Groups etc.
- Strong connection to the INCOSE MBSE Initiative
- Representatives from targeted MBE applications (NAFEMS, BIM, ….)
- Domain representatives

Please let me know if you are interested

Products & Interactions

- Strategy and Plan for Transformation
  - Vision, mission, goals, objectives, tasks and associated metrics
- Transformation Business Case / ROI Briefing
  - Collection of works to help make the case for transformation
  - Compelling Storylines and Case Studies
  - SE Transformation Principles (heuristics, lessons learned, best practices)
- Strategic Collaboration and Communication
  - Who all should INCOSE collaboration from a Transformation perspective
  - How do we better reach and communicate with stakeholders
- Invigorate and Integrate Working Groups
  - Help with modeling foundations – Ontology, Model Types/Taxonomy
  - Bring together our collective strength

What do we consider a successful outcome

What Success looks like at IW 2016 and/or IS 2016

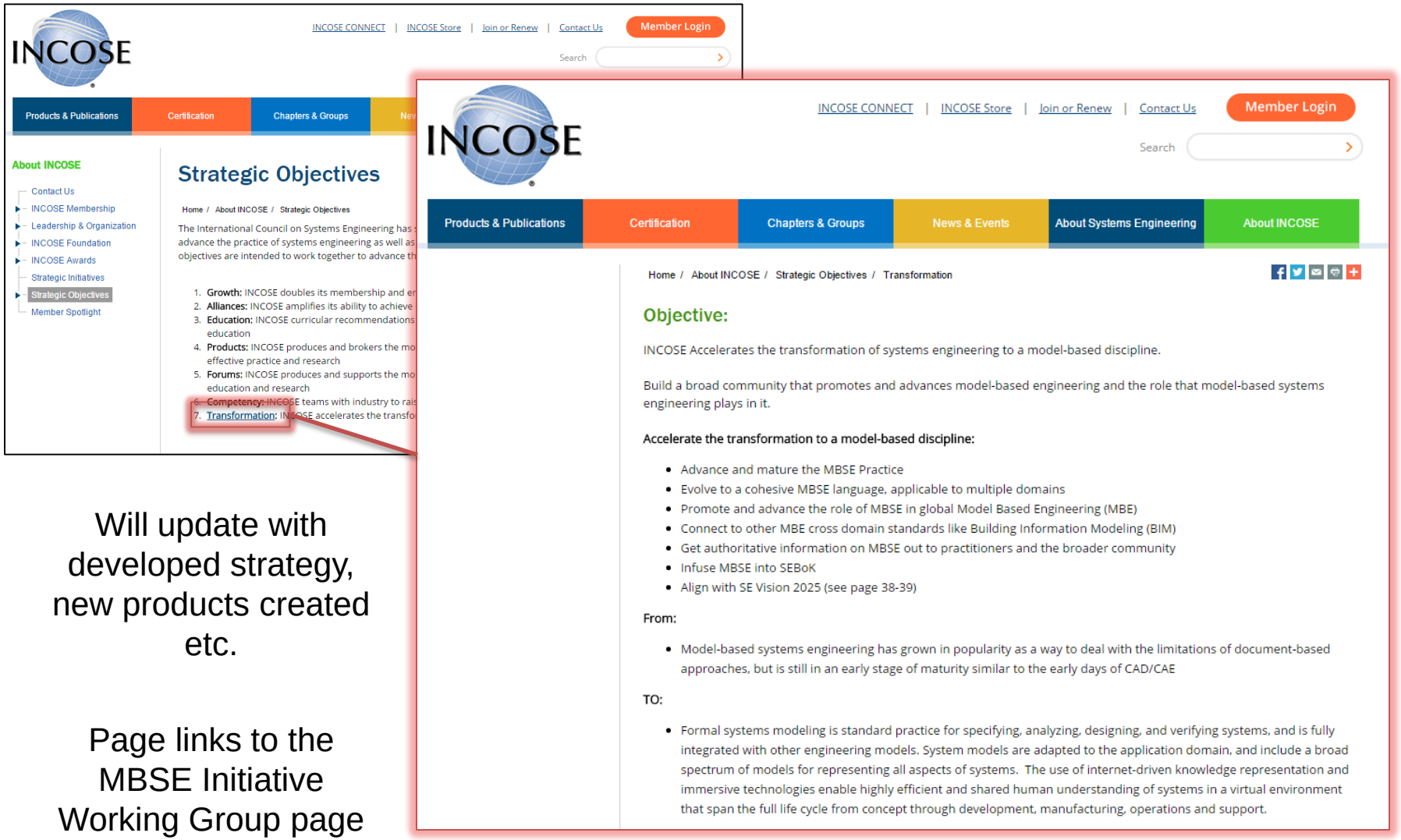
- New AD for transformation selected
- Strategy defined for implementing the Transformation
- First steps taken to mainstream MBSE
  - Partial MBSE workshop @ IW + MBSE topics addressed during (WG) meetings
  - Explicit have MBSE activities displayed during ongoing WG activities
- Work on explicit connecting products between MBSE and NAFEMS as well as the Building Information Modeling

What Success looks like at the end of 2019 (5 years)

- Decision makers ask for models rather than documents
- MBSE is not a separate track at IS and IW but integrated in all WG activities
- Systems Engineering is a Model Based discipline, explicitly connected to X# of MBE applications

I think we can do more!

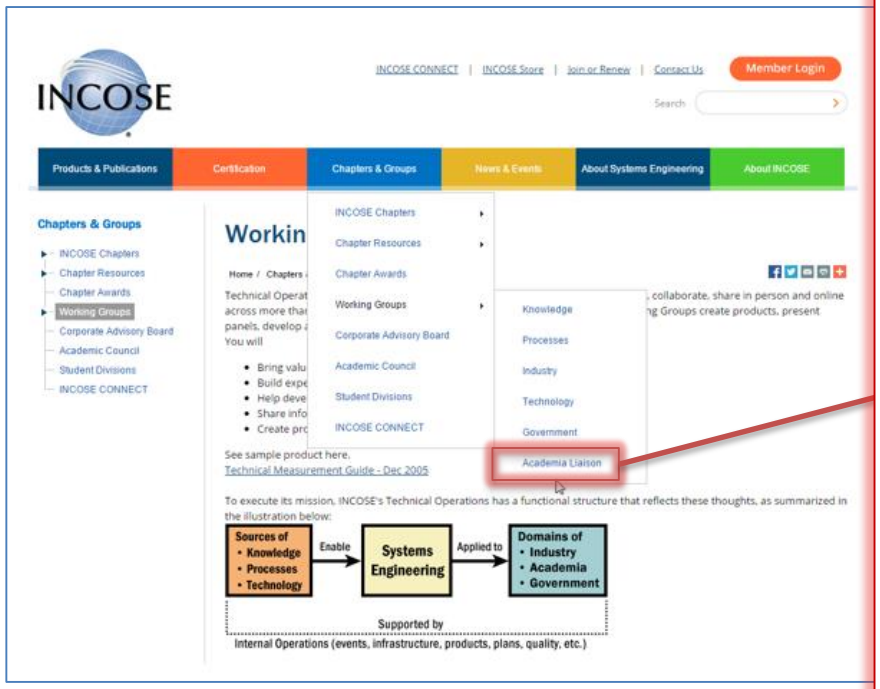
Accomplishments: Transformation Page



Will update with developed strategy, new products created etc.

Page links to the MBSE Initiative Working Group page

Accomplishments: MBSE Initiative Page



Links take users to INCOSE / OMG MBSE Initiative Wiki. Page also points to the SE Transformation INCOSE page as well.

Model Based Systems Engineering (MBSE) Initiative

Home / Chapters & Groups / Working Groups / MBSE Initiative

MBSE Initiative - Sandy Friedenthal and Mark Sampson

Link to SE Transformation site

Click Link to view project site

Challenge Teams

FILE	DESCRIPTION	DATE	WEBBITE
Modeling and Simulation Interoperability	Russell Peak	01 Jul, 2015	Link
Space Systems Modeling	Louise Anderson	01 Jul, 2015	Link
Telescope Modeling	Robert Karban	01 Jul, 2015	Link
Biomedical Device Modeling	Ajay Thukral	01 Jul, 2015	Link
GEOSS Modeling	Lawrence McGovern	01 Jul, 2015	Link
Patterns	Bill Schindel	01 Jul, 2015	Link

Activity Teams

FILE	DESCRIPTION	DATE	WEBBITE
MBSE Usability	Bjorn Cole	01 Jul, 2015	Link
Methodology and Metrics	John Watson	01 Jul, 2015	Link
Model Management	Amit Fisher	01 Jul, 2015	Link
Modeling Standards	Roger Burkhart	01 Jul, 2015	Link
Ontology	Henson Graves	01 Jul, 2015	Link
System of Systems/Enterprise Modeling	Ron Williamson/Matthew Hause	01 Jul, 2015	Link
Model Based Test	Frank Alvidrez	01 Jul, 2015	Link

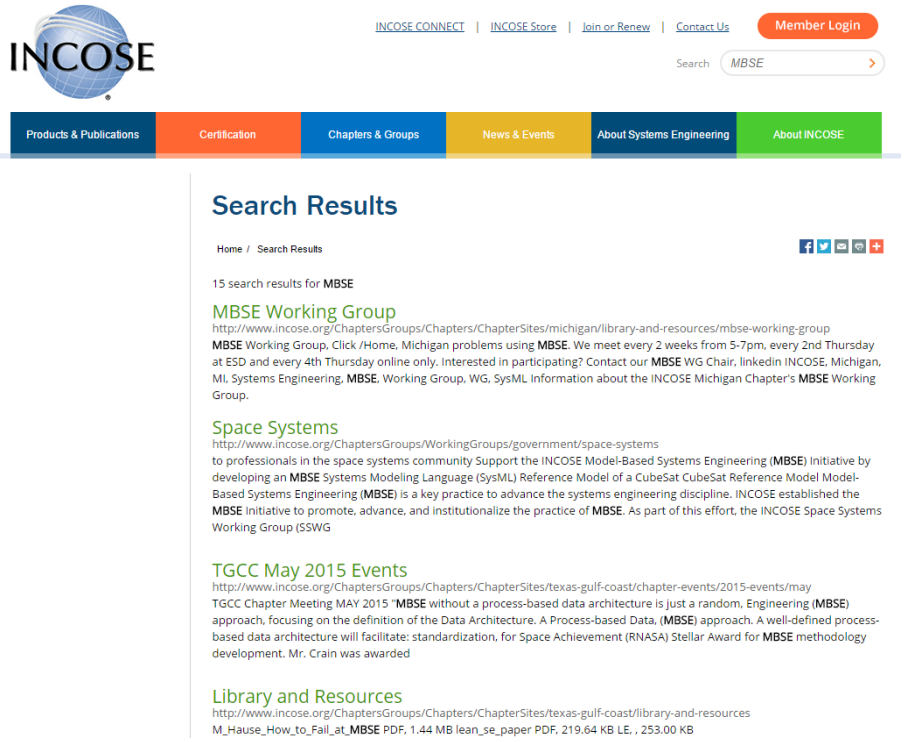
Affiliated INCOSE Groups

FILE	DATE	WEBBITE
Tool Integration and Interoperability	01 Jul, 2015	Link
Tools Database	01 Jul, 2015	Link
NAFEMS-INCOSE Systems Modeling & Simulation Working Group (SMSWG)	01 Jul, 2015	Link
Association Francaise d'Ingeierie Systeme	01 Jul, 2015	Link
MBSE SIG of INCOSE The Netherlands Chapter	01 Jul, 2015	Link
UK Chapter MBSE Wiki	01 Jul, 2015	Link
Tool Vendor Collaboration with MBSE Teams	01 Jul, 2015	Link

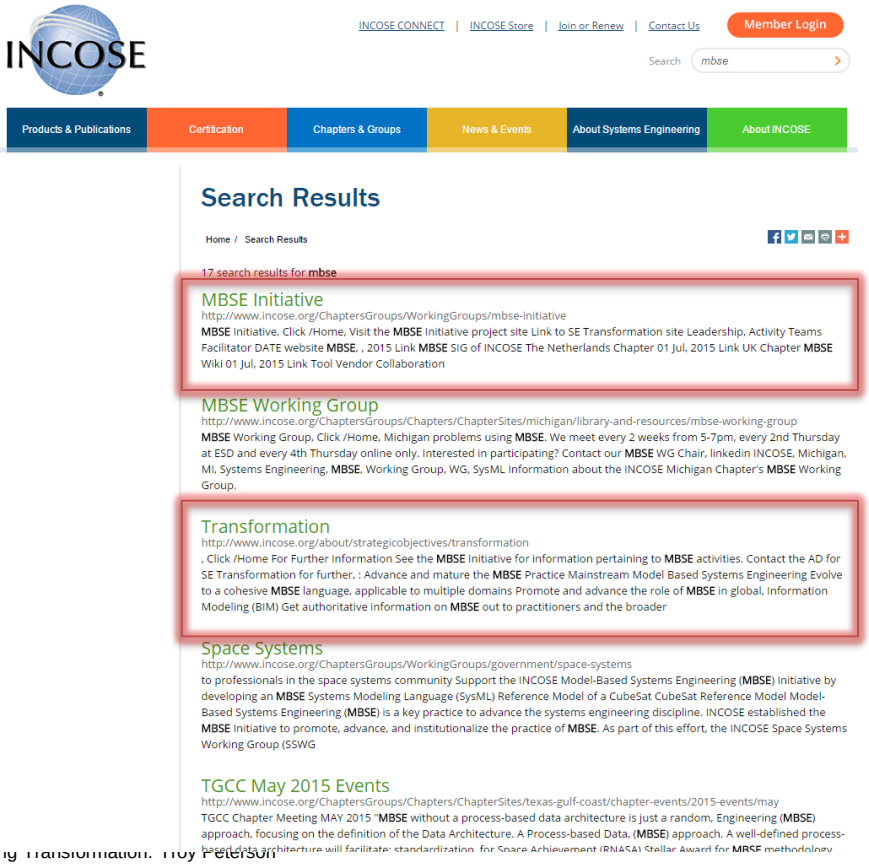
Accomplishments: MBSE Search Results

- Search of MBSE on the INCOSE site…

BEFORE



AFTER



Accomplishments: Stakeholders & Voice

Understanding our Stakeholders

- Who are they, internal and external
- Many enablers and roadblocks discussed and captured

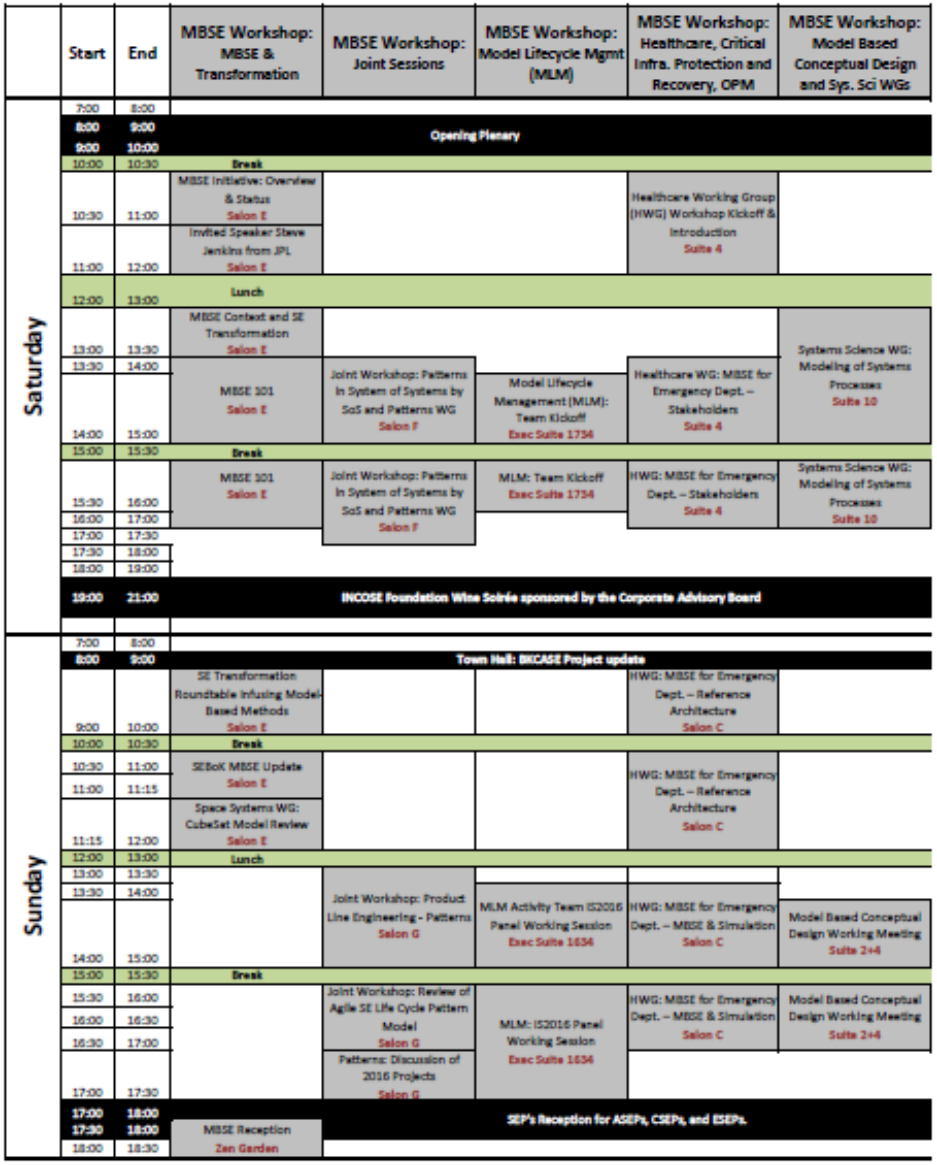
2015 IS CAB Breakout Sessions Topics:

- Process/Method
- Value / ROI
- Documents to Models

2016 IW: Infusing MBSE Panel and MBSE 101

- Funding MBSE
- Interchange formats
- Intellectual property issues
- Human interaction with models across the lifecycle

MBSE Workshop Agenda & Logistics



	Start	End	MBSE Workshop: MBSE & Transformation	MBSE Workshop: Joint Sessions	MBSE Workshop: Model Lifecycle Mgmt (MLM)	MBSE Workshop: Healthcare, Critical Infra. Protection and Recovery, OPM	MBSE Workshop: Model Based Conceptual Design and Sys. Sci WGs
Saturday	7:00	8:00					
	8:00	9:00	Opening Plenary				
	9:00	10:00					
	10:00	10:30	Break				
	10:30	11:00	MBSE Initiative: Overview & Status Salon E			Healthcare Working Group (HWG) Workshop Kickoff & Introduction Suite 4	
	11:00	12:00	Invited Speaker Steve Jenkins from JPL Salon E				
	12:00	13:00	Lunch				
	13:00	13:30	MBSE Context and SE Transformation Salon E				Systems Science WG: Modeling of Systems Processes Suite 10
	13:30	14:00		Joint Workshop: Patterns in System of Systems by SoS and Patterns WG Salon F	Model Lifecycle Management (MLM): Team Kickoff Exec Suite 1734	Healthcare WG: MBSE for Emergency Dept. – Stakeholders Suite 4	
	14:00	15:00	MBSE 101 Salon E				
	15:00	15:30	Break				
	15:30	16:00	MBSE 101 Salon E	Joint Workshop: Patterns in System of Systems by SoS and Patterns WG Salon F	MLM: Team Kickoff Exec Suite 1734	HWG: MBSE for Emergency Dept. – Stakeholders Suite 4	Systems Science WG: Modeling of Systems Processes Suite 10
	16:00	17:00					
	17:00	17:30					
	17:30	18:00					
	18:00	19:00					
	19:00	21:00	INCOSE Foundation Wine Soirée sponsored by the Corporate Advisory Board				
Sunday	7:00	8:00					
	8:00	9:00	Town Hall: BKCASE Project update				
	9:00	10:00	SE Transformation Roundtable Infusing Model-Based Methods Salon E			HWG: MBSE for Emergency Dept. – Reference Architecture Salon C	
	10:00	10:30	Break				
	10:30	11:00	SEBoK MBSE Update Salon E			HWG: MBSE for Emergency Dept. – Reference Architecture Salon C	
	11:00	11:15					
	11:15	12:00	Space Systems WG: CubeSat Model Review Salon E				
	12:00	13:00	Lunch				
	13:00	13:30					
	13:30	14:00		Joint Workshop: Product Line Engineering - Patterns Salon G	MLM Activity Team IS2016 Panel Working Session Exec Suite 1634	HWG: MBSE for Emergency Dept. – MBSE & Simulation Salon C	Model Based Conceptual Design Working Meeting Suite 2+4
	14:00	15:00					
	15:00	15:30	Break				
	15:30	16:00		Joint Workshop: Review of Agile SE Life Cycle Pattern Model Salon G	MLM: IS2016 Panel Working Session Exec Suite 1634	HWG: MBSE for Emergency Dept. – MBSE & Simulation Salon C	Model Based Conceptual Design Working Meeting Suite 2+4
	16:00	16:30					
	16:30	17:00					
	17:00	17:30		Patterns: Discussion of 2016 Projects Salon G			
	17:00	18:00		SEP's Reception for ASEPs, CSEPs, and ISEPs.			
	17:30	18:00					
	18:00	18:30	MBSE Reception Zen Garden				

- Competency/Professional Development
- Others TBD

	Start	End	MBSE Workshop: MBSE & Transformation	MBSE Workshop: Joint Sessions	MBSE Workshop: Model Lifecycle Mgmt (MLM)	MBSE Workshop: Healthcare, Critical Infra. Protection and Recovery, OPM	MBSE Workshop: Model Based Conceptual Design and Sys. Sci WGs
Monday	7:00	8:00					
	8:00	9:00	Town Hall: INCOSE 5-year Objectives: Transformation and Impactful products				
	9:00	9:15					
	9:15	9:30	Model-based System Management in the Autonomy Era Exec Suite 1619	Joint NAFEMS-INCOSE Systems Modeling & Simulation WG Salon C			
	9:30	10:00					
	10:00	10:30	Break				
	10:30	11:00	SE Transformation Working Session (Closed) Exec Suite 1619	Joint NAFEMS-INCOSE Systems Modeling & Simulation WG Salon C	MLM Activity Team To-Be ConOps Working Session Salon G		
	11:00	12:00					
	12:00	13:00	Lunch				
	13:00	13:30			MLM Activity Team To-Be ConOps Working Session Salon G		Systems Science WG: Is This System Still Fit For Purpose Suite 10
	13:30	14:00					Systems Science WG: Systems Thinking/Modeling for Conceptual Design Suite 10
	14:00	15:00					
	15:00	15:30	Break				
	15:30	16:00			MLM Session Cont. Salon G	Critical Infra. Protection & Recovery WG: Value of MBSE to Critical Infrastructure Protection & Recovery Salon F	Architecture WG: Architecture Framework Development/Updates Suite 4
	16:00	16:30					
	16:30	17:30					Architecture WG: Architecture and Human Factors Suite 4
Tuesday	7:00	8:00					
	8:00	9:00					
	9:00	10:00				Object-Process Methodology: Automation systems and Integration, ISO/PAS 19450:2015(en) Suite 2	Systems Science WG: Warfield's Science of Generic Design and Structural Modeling Suite 10
	10:00	10:30	Break				
	10:30	11:00	SE Transformation Working Session (Closed) Suite 2		MLM Activity Team To-Be ConOps Working Session Exec Suite 1734		Warfield's Science of Generic Design and Structural Modeling Cont. Suite 10
	11:00	11:30					
	11:30	12:00					
	12:00	13:00	Lunch				
	13:00	14:00	MBSE Initiative Outbriefs Salon E		Model Lifecycle Management Activity Team IS2016 Paper and Planning Session Exec Suite 1734		
	14:00	14:30					
	14:30	15:00	Break				
	15:00	16:00	Closing Plenary				
	16:00	18:30	Closing Reception and Working Group Bazaar / Market Place				

Model Based Related Content at the 2016 IW

Metrics on the new MBSE Workshop format

- 30+ model based related sessions in MBSE Workshop
- 4 joint sessions (Patterns, SoS, PLE, Agile and NAFEMS)
- Almost half the present WGs have model content (15/34)
- Half of those with model content are new to the workshop
- Receive an additional 8 commitments for next year

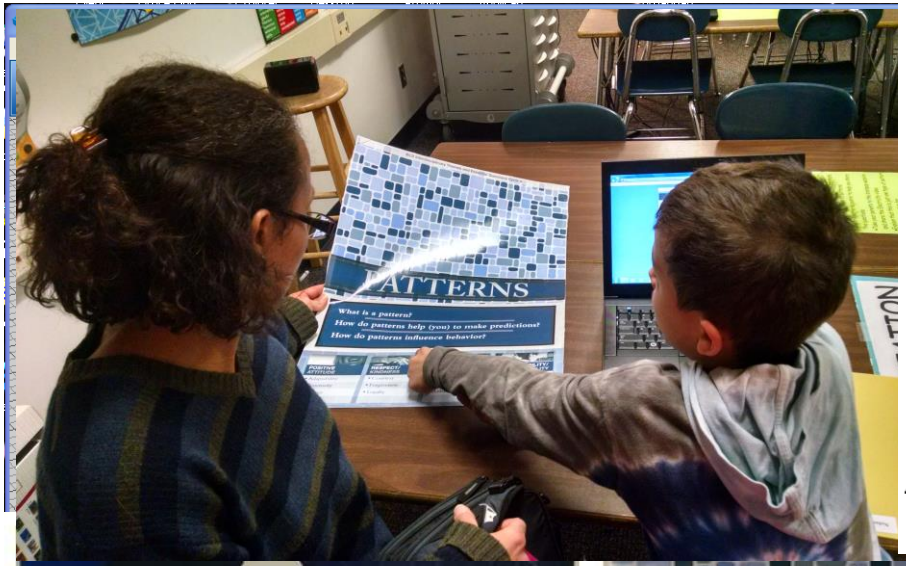
Models reflecting reality…

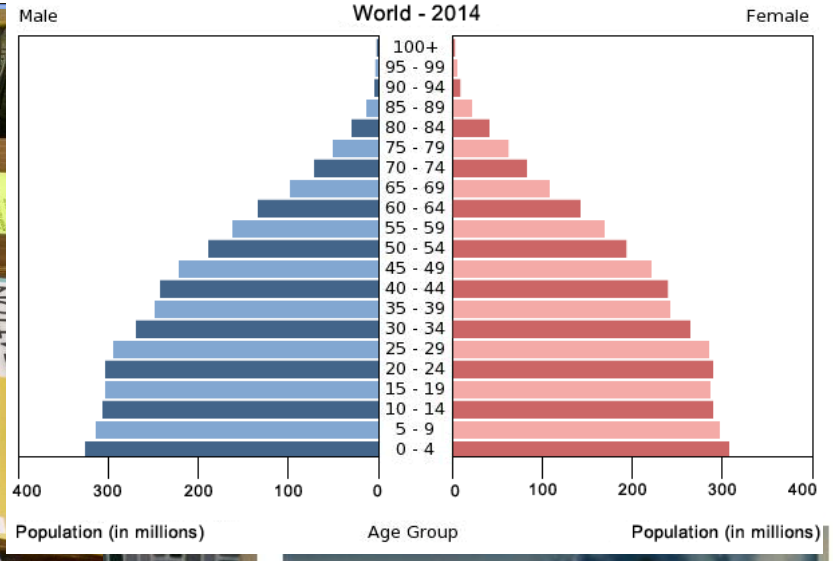
MOTORSPORT: Nissan picks 'gamers' for Le Mans

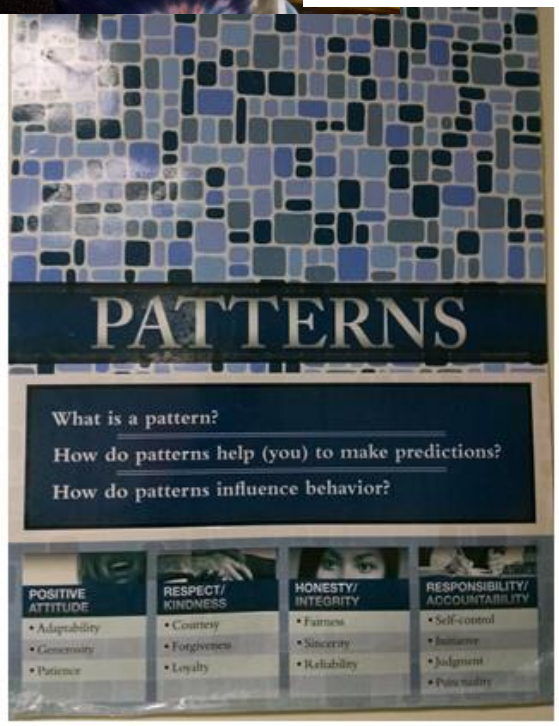
February 13, 2015

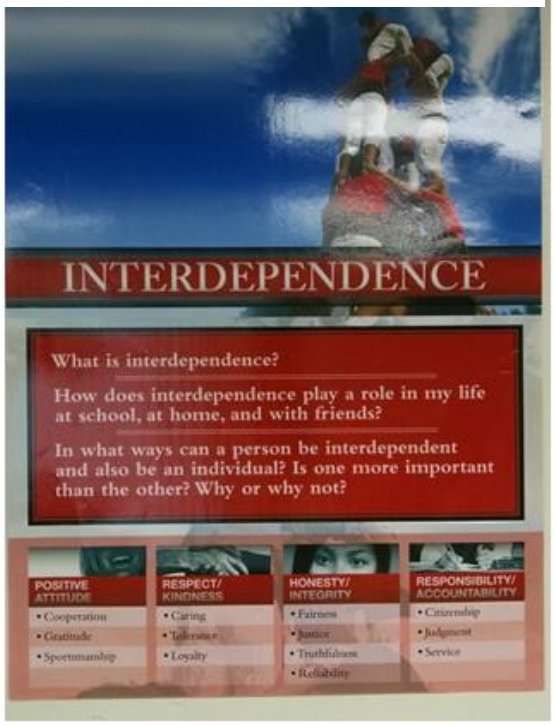
story | *photos*

MBSE - 2007 to present…





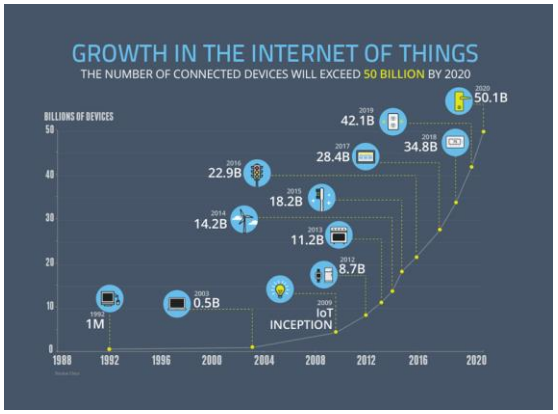




Motivation for Transformation

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

Jack Welch



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

W. Edwards Deming