Developing a Strategy and Roadmap for Advancing the State-of-the-Practice of MBSE within Your Organization

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Current State of the Practice of MBSE in Many Organizations

- Lack of formally recognized procedures for creating and validating models and simulations in an organization's standard or "institutional" processes

- Modeling is not an inherent and consistent part of the organization's project and/or product development culture

- Lack of consensus or standards of how to do it

- Tool interoperability leaves much to be desired

- Engagement of stakeholder and user community with the design process is not what it should be

How a MBSE Strategy and Roadmap Can Help

- MBSE is a paradigm shift from the long tradition of document-based (or document-driven) approaches to systems engineering

  . . . and, we all know, *paradigm shifts are hard ! !*

  ➡ Planning is vitally important

- A **strategy** (or **strategic plan**) sets long-term direction based on vision and/or mission, goals, and objectives

- A **roadmap** helps "guide the way" by showing how something is arranged or can be accomplished over time

- *Caveat:* Both need to be well crafted with full stakeholder buy-in and must be put into practice

What is a Strategic Plan?*

- A sound plan should:
  - Serve as a framework for decisions
  - Provide a basis for investments
  - Establish clear directions for the future
  - Assist benchmarking & performance monitoring
  - Stimulate change

- A strategic plan is not the same as an *implementation plan*
  - A strategic plan sets long-term direction based on vision and mission
  - An implementation plan is shorter term, tactical, focused, contains clear measurable actions

Source: Adapted from http://www.planware.org/strategy.htm

Durability of Strategic Plan

- Strategic plans should have a durability of 3-5 years
- Planning should focus on a time horizon of 10-15 years
    - Goals & Objectives
- Plan should be reassessed annually
    - Alignment with organization's charter and mission
    - Progress/Return on Investment
        - Infusion into projects/products
        - Enabling proposals and projects/products
        - Risk reduction
        - Cost reduction

Elements of a Strategic Plan

- Vision
  - What might be possible?
- Mission
  - What can be achieved?
- Strategic Goals
  - What major milestones do we want to achieve?
- Strategic Objectives
  - What are the measurable methods we will take to achieve our goals? By when?

- Assessment of Current Capabilities:
  - What are our strengths & weaknesses?
- Initiatives:
  - What areas must be improved to reach the objectives?
- Accomplishments:
  - What progress has been made?

Establish the Vision and Mission for Your Organization

- A *vision* conveys "What might be possible?"
- Example:
  - "To be the world's premier center for excellence and innovation in "X"

- A *mission* conveys "What can be achieved?"
- Example:
  - "To consistently deliver our products and services on time and on budget and with utmost customer satisfaction"

- It is also helpful to identify your organizational charter
  - A charter identifies the boundaries and the areas of responsibility for a specific organization (or organizational entity)

Establish Strategic Goals and Objectives (1/2)

- ***Strategic goals*** identify "What major milestones do we want to achieve?"
    - Goals are articulated as broad, long-term statements of intent that may or may not be achieved

- Example:
    - Goal #1: Goal statement . . .
    - Goal #2: **Adopt model-based systems engineering (MBSE) to address growing system complexity**
    - Goal#3: Goal statement . . .
    - *etc.* . . .

Establish Strategic Goals and Objectives (2/2)

- ***Strategic objectives*** identify "What are the *measurable* methods we will take to achieve our goals? By when?"
- Example (specific to MBSE goal):
  - Objective #1: Incorporate MBSE visual modeling language standards such as OMG SysML into 50% of our project/product design capture practice. 3QFY12
  - Objective #2: Infuse a tailored industry leading MBSE methodology into local systems engineering practices and procedures for two ground data systems program areas. 2QFY13
  - Objective #3: Work with subject matter experts of five specific engineering sub-domains to develop MBSE information models for those domains. 4QFY14
  - *etc. . . .*

Assess Current Capabilities

- ***Assessment of current capabilities*** identifies "What are our strengths and weaknesses?"
- Example Strengths:
  - We have a young and agile workforce
  - We have a strong mentoring program
  - We are committed to adopting to industry standards
- Example Weaknesses:
  - We have a culture that resists change
  - We have a weak and underfunded training program
  - We have a lack of adequate tools and infrastructure

Establish Strategic Initiatives or Focus Areas

- – *Initiatives* identify "What areas must be improved to reach the objectives?"
- Current capability assessment will yield areas of strength and weakness
  - Weak areas should be targeted for focused institutional investment
- Roadmapping [described later] will also identify areas of needed focused investment (e.g., education & training, processes/practices, outreach, tools & infrastructure)
- Experience suggests advancing the state-of-the-practice of MBSE requires significant capital investment
  - Target multiple funding sources (e.g., internal, external, R&D)

Accomplishments

- ***Accomplishments*** capture "What progress has been made?"
  - Typically not included in a Strategic Plan document but part of regular reporting structure and regular progress reports to sponsors

- Measure early and often to assess progress of key milestones/accomplishments that have been made along the way
  - Convey early wins to your stakeholders on a regular basis, particularly, stakeholders who hold the investment $'s
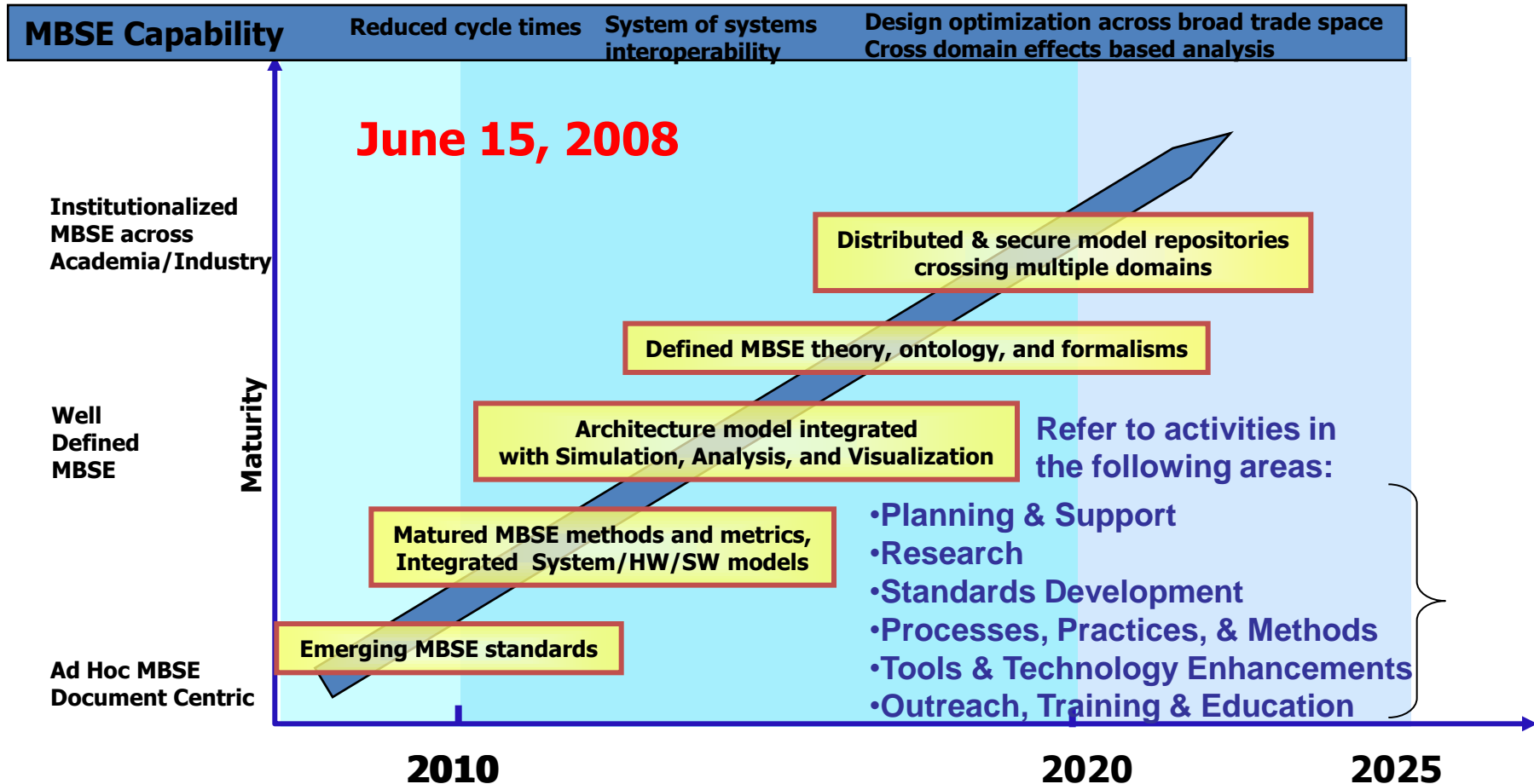 - Even a modest return on investment needs to be reported on at least an annual basis

Roadmapping
(The Business Case)

- A **roadmap** is any plan or guide to show how something is arrange or can be accomplished ("a way ahead")

- Strategically, a roadmap is a means to align strategy with the *people*, *processes*, and *technologies* need to execute the strategy

  – Provides shared transparency of vision and a means both to communicate long-term innovation and/or transformational goals

- With a roadmap, an innovation or transformation effort is more likely to achieve organization's strategic goals to drive top-line results

- Without a roadmap, an innovation or transformation effort may be wasted and results disappointing

Roadmap Organization and Structure

- A graphical depiction of a roadmap can be organized and structured in a variety of ways

- Example 1: Around increasing maturity levels vs. capability over time (INCOSE MBSE Roadmap)

- Example 2: In terms of roadmap *categories* and *elements* over time (Detailed example)

  – Organizational domains or categories are provided down the left of the map

  – Activities, deadlines, and dependencies as elements in the main part of the map

- In all cases, a multi-year timeline should be provided along the top or bottom of the map

Sample Roadmap
(INCOSE MBSE Initiative)

MBSE Capability	Reduced cycle times	System of systems interoperability	Design optimization across broad trade space Cross domain effects based analysis

June 15, 2008

Institutionalized MBSE across Academia/Industry

Distributed & secure model repositories crossing multiple domains

Defined MBSE theory, ontology, and formalisms

Well Defined MBSE

Architecture model integrated with Simulation, Analysis, and Visualization

Refer to activities in the following areas:

Matured MBSE methods and metrics, Integrated System/HW/SW models

- **Planning & Support**
- **Research**
- **Standards Development**
- **Processes, Practices, & Methods**
- **Tools & Technology Enhancements**
- **Outreach, Training & Education**

Emerging MBSE standards

Ad Hoc MBSE Document Centric

Maturity

2010   **2020**   **2025**

Category	FY07 Contact & Awareness	FY08 Understanding & Trial Use	FY09 Understanding & Trial Use	FY10 Adoption & Institutionalization	FY11 Internalization
Process, Practice, and Procedure Definition	Inventory candidate methdologies[a]	Select and tailor methodologies			
	Inventory current & emerging industry standards	Adopt industry standards (e.g., SysML/UML)			
	Inventory current & emerging data standards	Adopt data standards (e.g., XML, XSD)			
	Review local procedures	Incorporate one aspect of MBE into local procedures[a]	Incorporate several aspects of MBE into local procedures[a]	Local procedures modified to include MBE[a]	
	Perform an assessment of MBE on current development practices	Formalize impact analysis			
Strategic Model Development	Initiate information model (ontology) development	Partially complete project specific information model	Largely complete project specific information model	Complete project specific information model	Complete generalized information model template
	Monitor LS-IM&S activities[c]	Participate in LS-IM&S model development where appropriate			
	Participate on M&S standards Working Group	Notify staff and Chief Engineer upon release of final standard	Inventory opportunities to incorporate reqts specified in standard into process changes	Incorporate select reqts specified in standard into standard processes	
	Review institutional implications	Review institutional implications	Monitor impact to customer contract		

A More Detailed Roadmap (2/3)

Category	FY07 Contact & Awareness	FY08 Understanding & Trial Use	FY09 Understanding & Trial Use	FY10 Adoption & Institutionalization	FY11 Internalization
Strategic Model Development (cont'd)	M&S interim standards Review and update Model inventory	M&S *final* standards Define threads of usage Inventory standards for model interchange (e.g., XMI, AP233)	Demo model interchange standards	Adopt model interchange standards	
Architecture & Infrastructure Development	Survey and evaluate MBE tools under auspices of tool center service[d] Survey and evaluate tool frameworks for integration[d] (e.g., unified IDE)	Demo small set of candidate MBE tools using representative use cases (scenarios) Demo tool integration frameworks (e.g., plug-in frameworks - Eclipse)	Select and provision strategic MBE tools (use formal RFI/RFP process) Incorporate tools and/or plug-ins into tool integration framework Map tools and tool framework to updated processes		Tool center manage standard set of MBE tools with tool communities providing input on new tools
Tools & Technology Enhancements	Promote technology R&D proposals to further MBE Inventory MBE technology (internal and external) and estimate maturity of each	Establish Division technology priority in MBE[e]	Establish Division technology priority in MBE[e]	Interface with planning team for technology infusion for tailoring ideas[e]	

Category	FY07 Contact & Awareness	FY08 Understanding & Trial Use	FY09 Understanding & Trial Use	FY10 Adoption & Institutionalization	FY11 Internalization
Outreach & Education	Establish Multi-Division task force	Multi-Division task force annual reviews			
	Stakeholder briefings (e.g., "Briefings for Pete")	Stakeholder review progress			
		Purse strategic MBE candidates	Hire at least one candidate		
		Offer MBE expert seminar series			
	Establish candidate user and interest groups	Coordinate user and interest group periodic meetings			
	Roll out Concepts of MBE class through PD offered 2-4 times/yr	Initiate development of methodology curricula[a]	Offer methodology classes[a]	Expand and develop full MBE curricula	Offer full MBE curricula Lab-wide
Pilots & Infusion	Identify candidate mission/mission sets for implementation of MBE techniques				
	Partial application of MBE on pilot project	Partial application of MBE on real project (product line and/or	Complete application of MBE on pilot	Complete application of MBE on real project	Use of MBE on several real projects
	Identify candidate real project early adopters				All contractor efforts overseen using MBE
	Tailor technology strategies[e]	Identify candidate tech infusion opportunites	Infuse select	Infuse technologies into real project	

Notes:
[a]Applicable to MBSE, MBSwE, and MBSim
[b]MBE in this context translates to each of the four aspects of MBE listed above
[c]LS-IM&S = Large-Scale Integrated Modeling and Simulation
[d]Internally developed tools as well as open-source and off-the-shelf (OTS) tools
[e]Particularly for MBSwT

Detailed Roadmap Organized and Structured around OCM* Stages
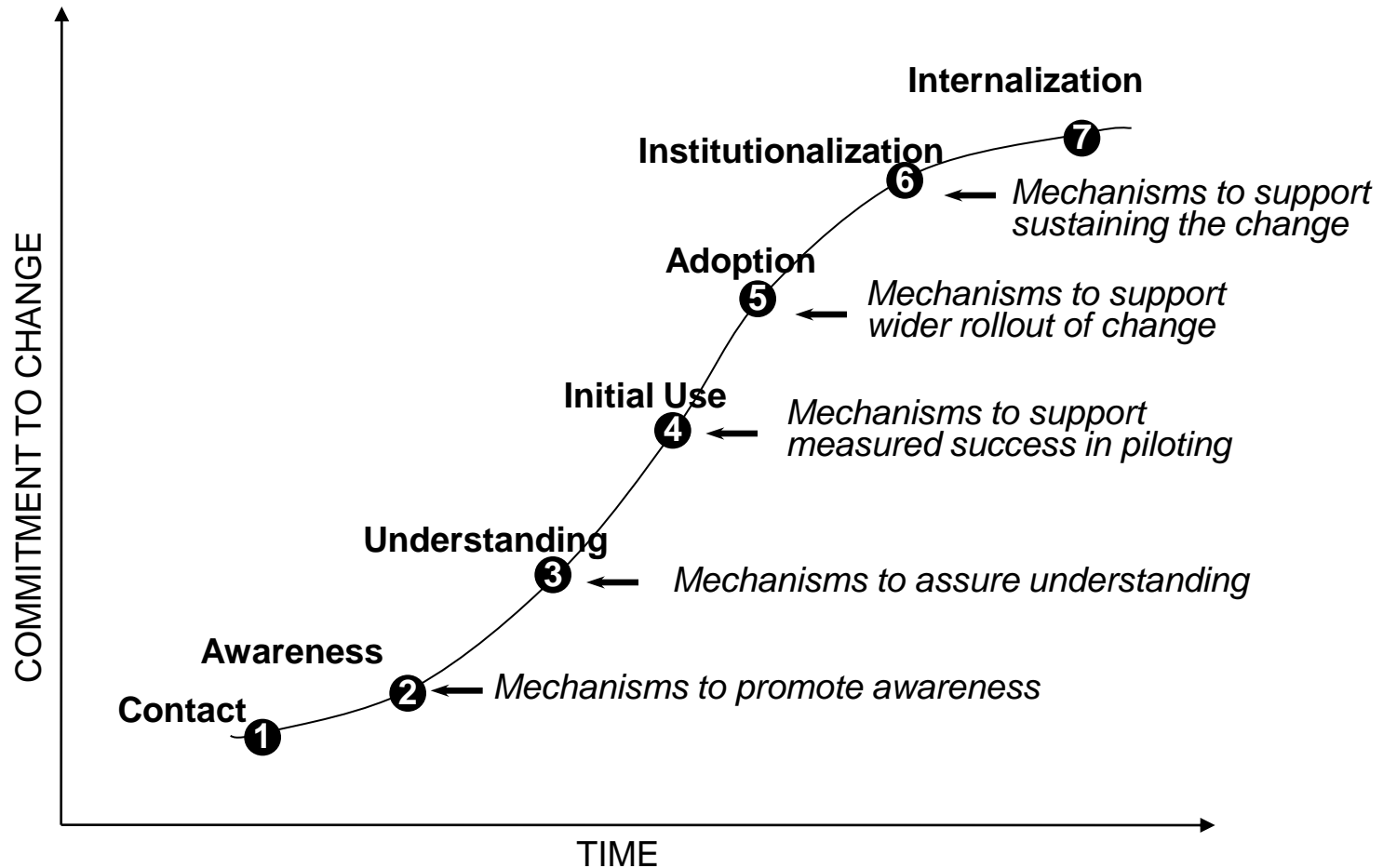
*Source: Adapted from *Out from Dependency: Thriving as an Insurgent in a Sometimes Hostile Environment*, SuZ Garcia and Chuck Myers, SEPG Conference, 2001.*

- Work on your ***implementation plans*** to articulate specific steps to help accomplish your MBSE goals and objectives
  - These are specific steps that address your identified areas of weakness and map to your roadmap elements and categories
  - Very likely to result in multiple implementation plans
- Implementation plans (also known as *transition plans* or *sequencing plans*) typically capture these questions:
  - Where are we?
  - Where are we trying to go?
  - What is it that we must avoid?
  - What is it that we should try to achieve?

- Sample outline:
  - Background
  - Objective
  - Success Criteria
  - Owner and Planning Team
  - Stakeholders/Affected Communities
  - Summary of Current Practices
  - Desired Practices
  - Approach for Converting from Current to Desired Practices
  - Applicable Processes, Rules, Regulation
  - Roll-Out Plan

- Sample outline (cont'd):
  - Dependencies
  - Milestones and Schedule
  - Recommendations for Future Work
  - Schedule for Follow-On Plan (if any)
  - Potential Sponsors

Summary

- Transitioning from the traditional document-based approach to systems engineering to a model-based approach remains difficult for most organizations
    - Represents a paradigm shift and paradigm shifts are hard!
    - Attempting to do so without a plan will only result in wasted efforts and disappointing results
- Recommendations:
    - Develop a *strategic plan* to set your long-term MBSE direction based on vision, mission, goals, and objectives
    - Develop a *roadmap* to provide "a way ahead"
    - Develop *implementation plans* to capture shorter term, tactical, and focused efforts that contains clear measurable actions
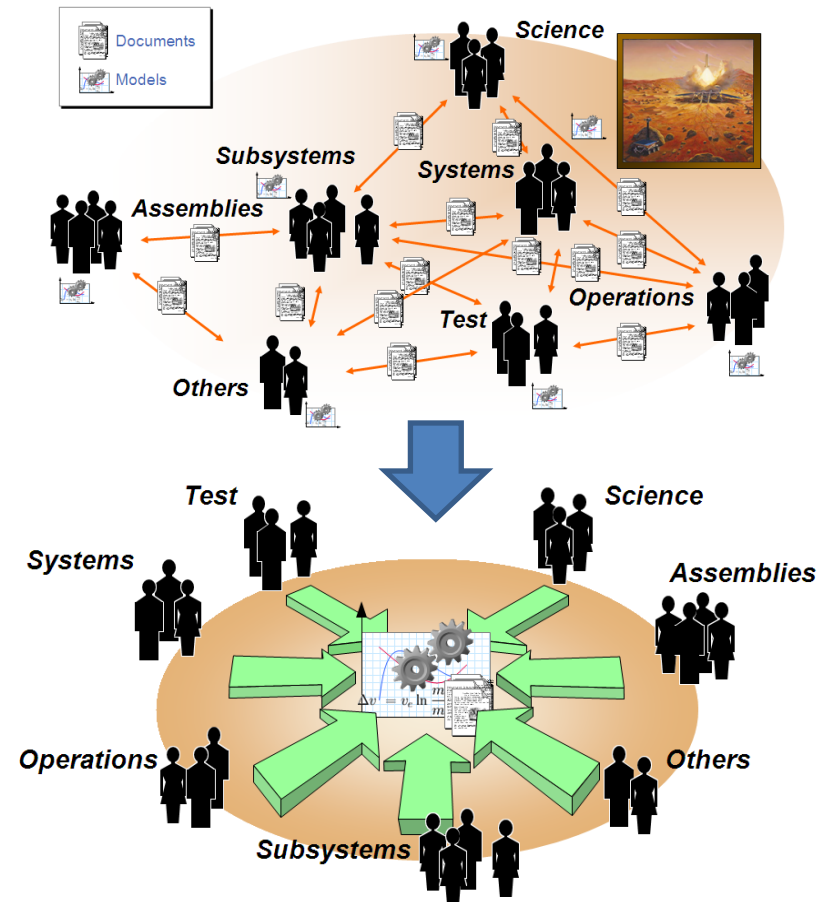
➡️ ***Execute your plans!***

Thank You!

Supplemental Charts
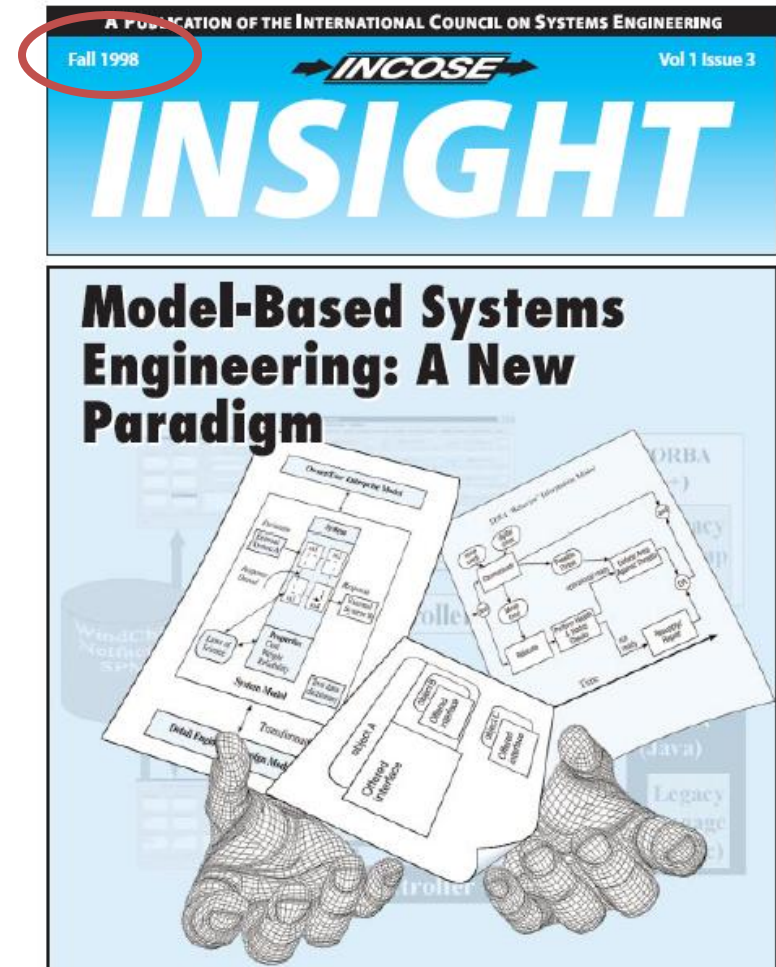
Dispel Common Myths about MBSE (1/3)

- **Myth:** MBSE is an enigma!

- **Fact:** MBSE is first and foremost a paradigm*
  - MBSE elevates models in the full lifecycle systems engineering process to a central governing and coordinating role in the specification, design, integration, validation, and operation of a system

*Paradigm: "A set of assumptions, concepts, values, and practices that constitutes a way of viewing reality for the community that shares them, especially in an intellectual discipline." (Source: New American Heritage Dictionary)

Dispel Common Myths about MBSE (2/3)

- **Myth:** MBSE is new

- **Fact:** MBSE has been around for a few decades
  - Early pioneering work by Jim Long and others goes back 30+ yrs
  - Mathematical foundation of MBSE published by A. Wayne Wymore in early 1990's
  - Published as a "new" paradigm by INCOSE in Fall 1998 INSIGHT issue

- **Myth:** MBSE means doing twice as much work as the old way of doing business

- **Fact:** MBSE supplements (and in many cases supplants) traditional systems engineering processes, procedures, and artifacts with their model-centric counterparts

New Approach

Model — Build representations of design components and interactions

Simulate — Execute coupled models and assess the results

Validate — Compare model against design & requirements

Refine — Adjust design or models as appropriate

Repeat

True concurrent engineering!