National Defense Industrial Association
Systems Engineering Division
Modeling and Simulation Committee

Model Based Engineering Subcommittee
Overview

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Grow engineering capabilities to address emerging challenges (con't)

Identify opportunities to leverage Model-based engineering practices to improve systems engineering productivity and completeness

- Do existing policies, guidance and contracting mechanisms hinder model-based collaboration?

Reinvigorate exploration and exploitation of Modeling and Simulation Systems Engineering enablers to assess and mitigate acquisition program risks

- Modeling & Simulation Committee to lead the initial investigation
- Coordinate work schedule with new Committee chair

Model-Based Engineering Subcommittee Volunteers to Date

- Jeff Bergenthal (LM; subcommittee lead)
- Eileen Bjorkman (SAF/XCD; former AMSWG chair)
- Jim Coolahan (JHU/APL; SISO)
- Bill Espinosa (USN)
- Sandy Friedenthal (LM; INCOSE MBSE chair)
- Tony Pandiscio (Raytheon)
- Lou Pape (Boeing)
- Greg Pollari (Rockwell Collins; AVSI SAVI)
- Hans Polzer (LM; NCOIC)
- Jennifer Rainey (JHU/APL)
- Mark Rupersburg (GDLS)
- Frank Salvatore (HPTI)
- Don Schneider (Foxhole Technology)
- Dennis Shea (CNA)
- Roddey Smith (NGC)
- Charlie Stirk (CostVision; PDES, Inc.)
- Steve Swenson (Aegis Technologies)
- Bill Tucker (Boeing)
- Mike Truelove (SAIC)

Model-Based Engineering Subcommittee Charter

- Assess and promote Model Based Engineering (MBE) practices in support of the DOD capability acquisition life cycle*
  - Define Model Based Engineering (MBE)
  - Define how MBE is related to M&S
  - Identify the potential benefits of MBE
  - Identify the potential limitations of MBE
  - Identify how MBE practices can be used in capability acquisition with a primary focus on Systems Engineering
  - Identify MBE approaches to assess and mitigate risks throughout the capability acquisition life cycle
  - Identify the issues and challenges with using MBE practices across the capability acquisition life cycle
  - Identify where/how existing policy, guidance and contracting mechanisms support/hinder Model Based collaboration across program/capability boundaries
  - Provide recommendations:
    - For changes in policy, guidance, and contracting mechanisms that could further support Model Based collaboration
    - For near-term opportunities to leverage MBE in capability acquisition
    - For areas of MBE research & development that may have high potential pay-off

* - Acquisition Life Cycle: All phases of the capabilities life cycle including research, development, Test & Evaluation, production, deployment, operations and support, as well as evolution of deployed systems in response to changes in their environment over time.

Proposed Final Report Outline

- Upfront material – 6 slides
  - Cover slide
  - Report outline
  - Subcommittee members
  - Charter
  - Definitions
  - DOD Acquisition Initiatives
- Potential MBE benefits, costs, risks – 5 slides
  - High-level potential MBE benefits
    - Include pointers to any quantification of the benefits, analysis, etc. (should this be a separate slide?)
  - Where/how the potential benefits can be achieved across the acquisition life-cycle
  - Use of MBE for risk assessment and mitigation
  - Potential costs & risks
- Reference implementation (framework) – 3-4 slides
  - As is state
  - Gaps, issues, challenges
  - Objective MBE Framework ("to be" state)
- Policy, guidance and contracting mechanism impediments and issues – 1 slide
- Recommendations – 6 slides
  - Policy, guidance and contracting mechanisms
  - Roadmap for near, mid-term opportunities and longer term R&D
  - Some details on the near-term opportunities to leverage MBE
  - Some details on the mid-term
  - Some details on the recommended areas for MBE R&D
  - Workforce recommendations
- Summary – 1 slide

MBE Definition

- Model-based engineering (MBE): An approach to engineering that uses models as an integral part of the technical baseline that includes the requirements, analysis, design, implementation, and verification of a capability, system, and/or product throughout the acquisition life cycle.
- Model: A physical, mathematical, or otherwise logical representation of a system, entity, phenomenon, or process. (DoD 5000.59 -M 1998)
- Preferred MBE Practices:
  - Models are scoped to purpose/objectives
  - Models are appropriate to the context (e.g. application domain, life cycle phase)
  - The models represent the technical baseline that is delivered to customers, suppliers, and partners
  - Models are integrated or interoperable across domains and across the lifecycle
  - Core to MBE is the integration of descriptive/design models with the computational models.

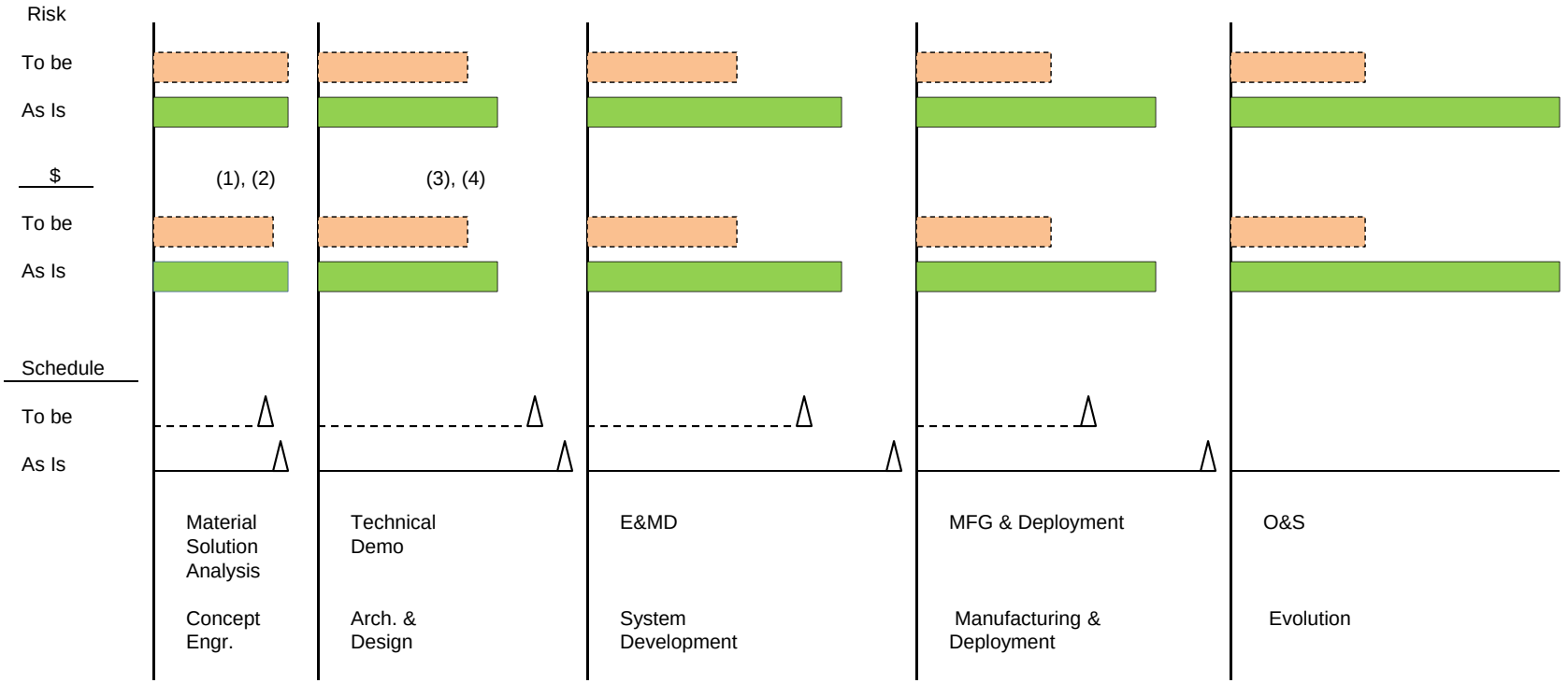
Characteristics of Models Used In MBE

- Models applicable to a wide range of domains (systems, software, electrical, mechanical, human behavioral, logistics, manufacturing, business, socio-economic, regulatory)
- Computer-interpretable computational model
  - Time varying (e.g. performance simulations, structural dynamic analysis)
  - Static (e.g. reliability prediction model)
  - Deterministic or stochastic (e.g. Monte Carlo)
  - May interact with hardware, software, human, and physical environment
  - Includes input/output data sets
- Human-interpretable descriptive models (e.g., architecture/design such as UML, SysML, UPDM, IDEF, electrical schematic, 3D CAD geometry, DODAF 2.0)
  - Symbolic representation with defined syntax and semantics
  - Repository based (i.e., the model is stored in structured computer format)
- Supporting metadata about the models including assumptions, versions, etc.

Note: MBE can also include the use of physical models (e.g. scale models for wind tunnels or wave tanks), but this is not the central focus.

References (1) XYZ Report
(2) ABC Interview
(3) _____
(4) _____

MBE Report
7-22-10



As-Is

SE	• _____	• _____	• _____
SW	• _____	• _____	• _____
HW	• _____		
Test	• _____		
Ilities	• _____		
Mfg	• _____		

To Be

SE	• _____	• _____	• _____
SW	• _____	• _____	• _____
HW	• _____		
Test	• _____		
Ilities	• _____		
Mfg	• _____		

Elements of MBE "To-Be" State

- Model-centric approach to engineering
  - Models are an integral part of the technical baseline
  - Descriptive models are single source of ground truth for analysis models
- Full life cycle application
  - Requirements → early validation → virtual integration → build/support
- Depth and breadth
  - From SoS (System of Systems) down to component
  - Interoperable across domains
  - Supply chain integration/exchange: customers, suppliers, partners
- Implementation
  - Supports metadata (model assumptions, versions, properties, etc.)
  - Distributed model bus/repository with secure, reliable data exchange
  - Strong mathematically-based semantics
  - Integrated model management (configuration, synchronization)
  - Publish and subscribe registry

Architecture & Design Phase

- As Is: Top-down requirements allocation; some use of models for requirements allocation and system trades; very stove-piped – little ability to have models work across domains; little ability to visualize the requirements and architecture
- End Goal (to be): Model(s) of the system at sufficient level of detail for PDR that are carried forward into EMD
- Benefits:
  - Higher quality requirements (less ambiguous)
  - Higher confidence that design will provide capabilities
    - Less uncertainty associated with internal components
    - Earlier validation with the customer / user
  - Better understanding of system behavior and complexity
  - Earlier HSI verification and validation, including assembly, manufacturing, and maintenance
  - Better, more rapid assessment of proposed changes

Development Phase

- As Is: use a lot of models in many stove-pipes – not interoperable, nor built with other domains in mind; not synchronized with design; lack of traceability; lack of data integration and synchronization; hidden and conflicting assumptions
- End Goal (to be): integrated architecture-centric, cross domain models and data
- Benefits:
  - Concurrent design
  - Faster and more effective transition to manufacturing and sustainment
    - Co-design → manufacturing, systems, etc. (IC products)
  - Reduced integration & test time
  - Fewer defects and less rework
    - Necessary rework can be accomplished more efficiently
  - Improved impact analysis (time and effectiveness of the solution)

This Afternoon's Breakout

- Depiction of the "To Be" Framework

- MBE Process
  - Within each phase
  - Across phases
  - Concurrent engineering