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.
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