

Model-Based Systems Engineering (MBSE) in Government: Leveraging the 'M' for DoD Acquisition

Philomena Zimmerman Deputy Director, Modeling, Simulation, and Analysis ODASD, Systems Engineering

> 2014 INCOSE MBSE Workshop January 25, 2014

INCOSE IW - MBSE 1/26/2014 | Page 1



DASD, Systems Engineering





Providing technical support and systems engineering leadership and oversight to USD(AT&L) in support of planned and ongoing acquisition programs

INCOSE IW - MBSE 1/26/2014 | Page 2



Systems Engineering Opportunity The Builder is Always Defined by the Tools



"I believe we are on the threshold of seeing ... integrated design tool suites for complex electromechanical systems. I believe we will begin to see <u>simulation become a more integrated part of</u> <u>the design process rather than something that is</u> <u>engaged separately</u>. I believe we will see the ability to affordably explore much more complex design spaces, with the opportunity to better understand how the implication of design changes downstream ripples back across an entire product design."

Remarks at 23rd Annual INCOSE International Symposium, June 25, 2013, Philadelphia, PA

Model-based systems engineering plays a key role in making this vision possible



Mr. Stephen P. Welby DASD, Systems Engineering





INCOSE IW - MBSE 1/26/2014 | Page 4





<u>ISSUE</u>: Current DoD acquisition activities do not develop, or maintain a single, integrated authority/artifact (aka system model) for a subset of program <u>technical</u> data. Further, relevant data between acquisition activities is not adequately shared.

<u>VISION</u>: Use of a single model (aka system model) as an evolving, cohesive representation and unifying <u>technical</u> instantiation of the program under conceptualization, development, manufacture, and/or support:

- will increase efficiency of DoD system acquisition lifecycle activities, and
- increase confidence in decisions made regarding an acquisition program when the single (system) model (data) for that program is used.

<u>METHOD</u>: A system model will be instantiated by using artifacts and processes which already exist, or are already required by DoD acquisition policies, guidance, and best practices.

<u>OUTCOME</u>: The system model will be used by anyone performing activities related to the program as it evolves across the acquisition lifecycle, including but not limited to defining requirements, trading design aspects, designing, engineering, cost budgeting, staffing, manufacturing, fielding, training, sustaining, and disposing. The resultant system model will integrate program <u>technical</u> data into a complete description of the system.

INCOSE IW - MBSE 1/26/2014 | Page 5



MS&A Fundamentals



MDA USA USAF_USMC

DEPARTMENT OF DEFENSE ACQUISITION MODELING AND SIMULATION WORKING GROUP

Systems Engineering Modeling, Simulation, and Analysis Fundamentals

- The responsibility for planning and coordinating program modeling and simulation efforts belongs to the Program Manager and may be delegated to the Program Systems Engineer and other program staff as appropriate.
- Modeling and simulation efforts are included in the systems engineering effort as part of program/project risk management and cost and schedule planning. Modeling and simulation efforts include identifying metrics that relate the use of modeling and simulation to cost savings and risk reduction.
- Systems engineers use models to define, understand, communicate, assess, interpret, and accept the project scope; to produce technical documentation and other artifacts; and to maintain "ground truth" about the system(s).
- Programs should identify and maintain a system model, representing all necessary viewpoints on the design and capturing all relevant system interactions.
 - Unless impractical, the program should develop the system model using standard model representations, methods, and underlying data structures.
 - b. The system model is a product of both system and design engineering efforts. The program should construct the model by integrating data consumed and produced by the modeling and simulation activities across and related to the program. The program should confirm the model baseline at appropriate technical milestones.
 - c. The program should construct depictions of system concepts developed in support of technical reviews using the system model as source data.
 - d. The system model should include, but should not be limited to, parametric descriptions, definitions of behaviors, internal and external interfaces, cost inputs, and traces from operational capabilities to requirements and design constructs.
 - e. The system model should be a part of, and should evolve with, the program development baseline. The system model should be integrated throughout the program life cycle and across domains within a program's various phases.
 - f. The system model can provide source data for the program to use to construct instantiated models to support system trades; optimizations; design evaluations; system, subsystem, component, and subcomponent integration; cost estimations; etc.
 - g. The program should update the system model throughout the program life cycle. Capturing these updates in the system model will provide continuity among the program modeling and simulation users and activities. During the development and construction of models and simulations, the program should ensure the models will be applicable to other program areas such as training and testing.
- The development of models, construction of simulations, and use of these assets to perform program definition and development activities (to include pre-MDD, and pre-milestone A) requires collaboration among all project stakeholders.
- 6. Proper use of modeling and simulation throughout the acquisition life cycle is critical for program success. The program should provide sufficient training to support the appropriate use of modeling and simulation. The program should identify metrics and track the metrics to support the linkage between the training and increased support to the program.
- Modeling and simulation provides critical capabilities to effectively deal with issues including but not limited to interoperability, joint operations, and systems of systems across the entire acquisition life cycle.
- Models employed in acquisition activities should be credible, and the program should use the models while acknowledging a level of risk appropriate to the application (see DoD Instruction 5000.61, DoD Modeling and Simulation (M&S) Verification, Validation, and Accreditation (VV&A)).

Version 2.25, April 2013. For Additional Information: http://www.acq.osd.mil/se/initiatives/init_ms.html Distribution Statement A: Approved for public release.

http://www.acq.osd.mil/se/docs/SE-MSA-Fundamentals.pdf

Purpose: One page that conveys a high-level, concise, and comprehensive set of truths for Mod/Sim <u>usage</u> in Systems Engineering support to acquisition

• Key Areas Emphasized:

- Program Systems Engineer is responsible for Mod/Sim planning and coordination
- Mod/Sim is included in key schedule and programmatic plans
- <u>SE uses models to define,</u> <u>understand, and communicate</u> <u>technical artifacts</u>
- <u>Models are continually updated</u> <u>throughout program life-cycle</u>
- Project success is dependent on appropriate Mod/Sim training of team

INCOSE IW - MBSE 1/26/2014 | Page 6



Defense Acquisition Guidebook (DAG) Ch 4 – System Engineering



- Section 4.1 Introduction
- Section 4.2 Systems Engineering Activities in the Life Cycle
- Section 4.3 Systems Engineering Processes provides a description of each process and contains the design considerations including specialty engineering.
 - 4.3.19 Tools, Techniques, and Lessons Learned SE tools and techniques support the Program Manager and Systems Engineer in performing and managing the SE activities and processes to improve productivity and system cost, schedule, capabilities, and adaptability. The program should begin applying SE tools and techniques during the early stages of program definition to improve efficiency and traceability and to provide a technical framework for managing the weapon system development.
 - 4.3.19.1 Modeling and Simulation Models and simulations are SE tools used by multiple functional area disciplines during all life-cycle phases.
 Modeling is essential to aid in understanding complex systems and system interdependencies, and to communicate among team members and stakeholders. Simulation provides a means to explore concepts, system characteristics, and alternatives; open up the trade space; facilitate informed decisions and assess overall system performance.



DAG Ch 4: Various Applications of Modeling and Simulation





INCOSE IW - MBSE 1/26/2014 | Page 8



DAG Ch 4: Technical Data Management Process



INCOSE IW - MBSE 1/26/2014 | Page 9



Interim DoDI 5000.02, Operation of the Defense Acquisition System



Enclosure 3: Systems Engineering

 Section 9. MODELING AND SIMULATION: The Program Manager will integrate modeling and simulation activities into program planning and engineering efforts. These activities will support consistent analyses and decisions throughout the program's life cycle. Models, data, and artifacts will be integrated, managed, and controlled to ensure that the products maintain consistency with the system and external program dependencies, provide a comprehensive view of the program, and increase efficiency and confidence throughout the program's life cycle.



Challenges with Achieving the Endstate?



- Identify stakeholders the social system
 - Identifies who, and what is important; and how to communicate effectively

Communication Channels

- Socialize
 - Capitalize on opportunity basis with Services, Agencies, Industry groups, etc.
- Educate
 - Remember modeling and simulating are tools within SE toolkit so make the modeling and simulating education/training part of SE education/training
- Find the example activities
 - Engineered Resilient Systems
 - Service/Agency successes in Programs of Record, and support activities
- Policy and Guidance







Philomena "Phil" Zimmerman Deputy Director Modeling, Simulation and Analysis Systems Analysis Directorate Office of the Deputy Assistant Secretary of Defense for Systems Engineering (ODASD(SE)/SA)

philomena.m.zimmerman.civ@mail.mil 571-372-6695

INCOSE IW - MBSE 1/26/2014 | Page 12



DAG 4.3.19.1 Modeling and Simulation



- Models and simulations should be:
 - Developed and matured through the life of the program
 - Properly managed and controlled as part of the program's technical baseline
 - Developed and documented, to include metadata (see Modeling and Simulation Community of Interest Discovery Metadata Specification (MSC-DMS)) and open systems standards, to maximize opportunity for reuse and repurposing (both within the program and in support of other acquisition efforts)
 - Included as part of the technical data package to be transitioned into the next phase of the life cycle or into other efforts



Some Uses of the System Model





DAG Ch 4: Benefits of Using Modeling and Simulation throughout the Acquisition Life Cycle

INCOSE IW - MBSE 1/26/2014 | Page 14



System Model Supports All Dimensions of System Acquisition

(from Dr. P. Montgomery, NPS)



INCOSE IW - MBSE 1/26/2014 | Page 15





- Interim Department of Defense Instruction (DoDI) 5000.02, "Operation of the Defense Acquisition System," November 25, 2013 http://www.dtic.mil/whs/directives/corres/pdf/500002_interim.pdf
- Defense Acquisition Guidebook (DAG) Chapter 4 Systems Engineering https://acc.dau.mil/dag4
- Department of Defense Acquisition Modeling and Simulation Working Group, "Systems Engineering Modeling, Simulation and Analysis Fundamentals," July 2013 http://www.acq.osd.mil/se/docs/SE-MSA-Fundamentals.pdf