Career Advice for Early Career Systems Engineers
INCOSE Enchantment Chapter Panel

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Future Perceptions: MBSE Adoption

- Question: In your years of experience, do you see any necessary changes to the status quo of system engineering processes?

- *Yes, in the Life Cycle Management areas of Operations, Maintenance and Disposal. New projects and programs are exciting and get funding. There is far less attention for existing or aging systems that account for two-thirds of the total system cost. My experience indicates most programs have sustainment issues. SE processes need to change by looking at sustainment opportunities for legacy systems as part of modeling new systems.*

- *MBSE can help SEs prioritize end of life and end of service hardware & software license renewals to include traceability of configuration items to requirements for tech refresh.*

- Do you think there are certain procedures or guidelines that due to the advancement in technology, communication, and the way daily activities are performed are now obsolete or in need of a refreshment?

- *Yes, with the increasing migration to MBSE, we need to get away from artifacts feeding the model and instead use the model to generate those artifacts. The MBSE file becomes the contract deliverable.*

Systems Engineering

- Systems Engineering (SE) is a, profession, perspective, process, & discipline

- SE is a **profession** that concentrates on the design and application of the whole (system) as distinct from the parts.

- SE is a **perspective** that involves looking at a problem in its entirety (holistic life cycle view).

- SE is a **process** that decomposes a system to subsystems, and then integrates it all back into the larger whole.

- Systems engineering is the **discipline** that makes success possible using tools, techniques, methods, knowledge, standards, principles, and concepts (including models).

Models

"**All models are wrong...**"

Models can never represent exact real behavior.

Mental Models
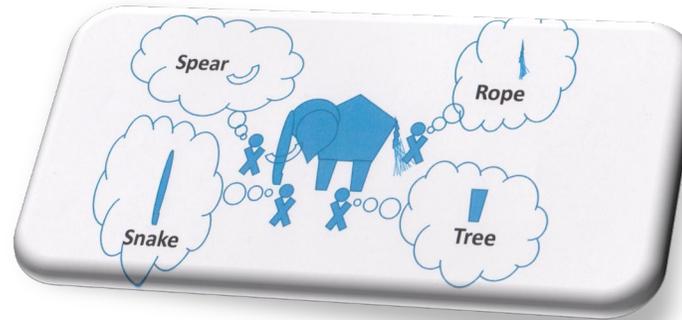
Everyone has a model in their head that may be partially right (tale of blind men and elephant).

Models are visual representations of concepts

- Improves explanations
- Promotes discussions
- Organizes data
- Conveys information
- Reduces inconsistencies

Transport System
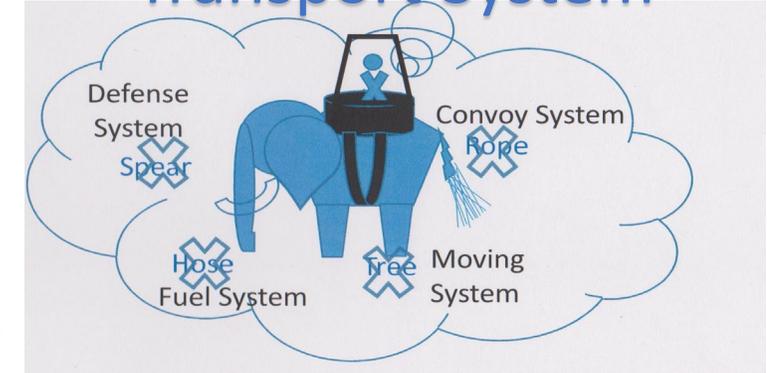
"All models are wrong, but some are useful." ~ George E. P. Box

Model Based Systems Engineering (MBSE)

- MBSE does NOT replace Systems Engineers but MBSE is still systems engineering.

- It has been a slow process but DoD is adopting MBSE. It takes time to implement MBSE as many engineers and project managers are unfamiliar with formal modeling to support the System Life Cycle (SLC).

- Adoption of MBSE means changing to reviewing artifacts online with a model to support requirements, analysis, design, verification & validation, and signing off material via electronic signatures

- MBSE users will need education, training, and practical hands-on experience.

- Systems Engineers with MBSE experience are likely to be increasingly more marketable than those without.

https://www.incosewiki.info/Model_Based_Systems_Engineering/index.php?title=MBSE_Adoption_Guide_-_v0.5

Past MBSE Perceptions

- In your 15 years, how have you seen the adoption of MBSE across the different industries?

- *In my **20+** years as a DoD Navy contractor, the adoption of MBSE went from being almost non-existent to being contractual with close government-industry coordination. Contractors already using modeling tools were quicker to adopt MBSE. A major obstacle was trained personnel.*

- *The Navy stood up a program office specifically for MBSE implementation, providing a road-map, training, licenses, user groups, support personnel and on going brown bag support. Even with the directives and support, it took three years for the last program I was on to fully adopt MBSE. Advocating took a year! The second year was a series of lessons learned. The third year added non-systems engineers and stakeholders.*

- *Today, I am working to implement Digital Engineering & MBSE on my current program with Space Systems Command.*

- *Note: Of interest is that the MBSE Initiative was kicked off at the INCOSE International Workshop (IW) in 2007 in Albuquerque, NM. INCOSE Surveys were conducted in 2009, 2012, 2014, 2018, and 2019 to better understand the adoption trends of model-based systems engineering.*

Future MBSE Perceptions

- Which industries who have not adopted the practice would benefit the most?

- *Across all domains, emerging technologies would benefit from the application of MBSE: Aerospace, automotive, critical infrastructure, defense, healthcare, infrastructure, oil & gas, power & energy, social systems, space systems, telecommunication, and transportation.*

- *The banking industry may benefit the most. They have modeling teams (software) and systems engineering teams but SEs are not using MBSE.*

DoDAF and MBSE

- MBSE appears to be the approach DOD projects are embracing but many engineers and project managers are unfamiliar with formal modelling to support the System Life Cycle (SLC) and consequently take SYSML training. They learn about structure, behavior, and requirement diagrams but when they see DODAF models in a Preliminary Design Review they are left disappointed with their training. What kind of training do you recommend for software developers, engineering SMEs, and managers that are adopting MBSE to support the SLC?

- *Department of Defense Architecture Framework (DoDAF) Version 2.02 is a SE Model used to present various viewpoints.*

- *DODAF models are options included in MBSE tools like CAMEO for blending SYSML diagrams with DoDAF views.*

- *Those who have the SYSML training need to be agents of the change they want to see. They become advocates for MBSE but implementing it means having them sitting with an experienced modeler to support the SLC.*

- *For those adopting MBSE, they need experiential training – being used*

https://dodcio.defense.gov/library/dod-architecture-framework/

DoDAF Viewpoint Groups:

All Viewpoint (AV)
Capability Viewpoint (CV)
Data and Information Viewpoint (DIV)
Operational Viewpoint (OV)
Project Viewpoint (PV)
Services Viewpoint (SvcV)
Standard Viewpoint (StdV)
Systems Viewpoint (SV)

DOORS and MBSE

- Programs that maintain their system requirements in DOORS are questioning the need for DOORS when requirements can be modelled in Cameo. What trends are you seeing in industry regarding tools for requirements management? Does it make sense to keep requirements in DOORS when those same requirements must be represented in an MBSE model for traceability between requirements, architecture, and design?

- *Industry trends regarding tools for requirements management are varied. Many programs using MBSE are not getting rid of DOORs. Some of the MBSE tools, like CAMEO provide plugins for special features. CAMEO has the DataHub plugin to synchronize requirements between DOORS and the MBSE model. For programs that can not afford both, the model offers better traceability between requirements, architecture, and design.*

- *Training of software developers, engineering SMEs, and managers will help advance MBSE. As they learn about structure, behavior, and requirement diagrams, they will become more comfortable using the model during Design Reviews as the authoritative source. Orientation training and a week long bootcamp will benefit programs wanting to incorporate MBSE.*

The Future Systems Engineer

- The engineer needs broader Systems knowledge, skills, and abilities to operate as a systems engineer and transform needs to solutions.

- SEs are responsible for concept, architecture, and design. They analyze and manage complexity and risk. They decide whether the deployed system actually works as intended.

- More recently, emerging technologies such as artificial intelligence, machine learning, deep learning, mechatronics, cyberphysical systems, cybersecurity, Internet of Things (IoT), additive manufacturing, digital thread, Factory 4.0, etc. are challenging approaches to SE. All of these challenges, and the SE responses to them, make it even more important that SE continues its transition to a model-based discipline. *

*https://www.sebokwiki.org/wiki/INCOSE_Systems_Engineering_Handbook

Links

- https://www.dau.edu/
- https://dodcio.defense.gov/library/dod-architecture-framework/
- https://www.incose.org/
- https://www.sebokwiki.org/wiki/INCOSE_Systems_Engineering_Handbook
- https://www.incosewiki.info/Model_Based_Systems_Engineering/index.php?title=MBSE_Adoption_Guide_-_v0.5
- www.dau.edu/library/defense-atl/DATLFiles/Sept-Oct_2019/Moschler.pdf
- https://news.mit.edu/2018/mit-online-course-model-based-design-transforming-us-dod-navair-acquisitions-0806
- https://www.nationaldefensemagazine.org/articles/2021/8/25/space-systems-command-to-embrace-digital-engineering
- https://www.sebokwiki.org/wiki/Model-Based_Systems_Engineering_Adoption_Trends_2009-2018