Model-Based Enterprise Capabilities Matrix
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INCOSE
International Council on Systems Engineering

Model-Based Enterprise Capability Matrix
Challenge Team Effort

- Co-Leads:
  - *Joe Hale, NASA/MSFC, joe.hale@nasa.gov*
  - *Al Hoheb, The Aerospace Corporation/SED, albert.c.hoheb@aero.org*
- Challenge team:
  - *Federation of those willing to assist in the development and deployment of the products; now 75 and growing*
- Products:
  - *The Technical Project Plan (TPP)*
  - *The Matrix document purpose is to provide a reference for enterprise and program/project organizations to assess their current and desired implementation of modeling*
  - *The Users Guide is a role-based guide for how to use the matrix for developing a strategic vision, roadmap, apply a yardstick, and perform tactical planning*
  - *http://wiki.omg.org/MBSE/ references provide an on-line overview of the products and the Challenge team efforts*
  - *INCOSE Connect – download area*

Model-Based Enterprise Capabilities Matrix 1.7

Snip of page matrix (page 1 of 3), blue show changes from previous version

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INCOSE Model-Based Enterprise Capabilities Matrix (1.7)

Model-Based Capability /Stage	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Commentary
Workforce/Culture						
MBSE Approach/Objectives	Awareness that MBSE may be used and may be beneficial	Sub-Discipline Tool use (e.g., CRADLE, DOORS)	Full System Models. Modeling results used to inform systems engineers in system analysis, design, and integration.	Full System Models; Model views translated into more traditional views for use and understanding by organization. Modeling results support decision making.	Full System Models; Organization familiar and competent in using modeling views for key system decisions	MBSE Approach/Objectives are well defined and broadly communicated to, and understood by, Engineering, Program/Projects, CIO, S&MA, etc.
Model-Based Tool Use	Not using enterprise and system level modeling tools, not covering the system life cycle	Limited use of enterprise and system level modeling tools, not covering the system life cycle	Use of specific enterprise and systems model(s) within System Engineering organizations.	Use of specific enterprise and systems model(s) within Systems Engineering organizations - understanding how external systems engineering models relate.	Use of specific enterprise and sytsems model(s) within Systems Engineering organizations across an enterprise.	Expecting different tools to be used intra/inter-Center, between government and contractor, and across contractors
SE-driven Model Building	Models are not developed for the system or enterprise engineering processes	Models are developed for parts of the system engineering or enterprise engineering processes	Full System/Enterprise Models are developed	Multiple System Models are integrated for the enterprise	Multiple enterprise models are interfaced within or across mission areas	Model structure/architecture driven by SE objectives/analyses/uses and evidentiary artifacts
Lifecycle Coverage	No models or models only address specific problems within a life cycle phase	Models cover only Single life cycle Phases	Models cover Multi-Phases; Limited Reviews	Multi-Contiguous Phases	End-to-End, Top-to-Bottom	Across all Phases and down to lowest decomposition
Institutional Adoption (e.g., agency, service, center)	Some parts of the institution have adopted (e.g., new programs/inititative, pilot programs, and business case driven)	Adoption by institution Enterprise or Systems Engineering Organizations.	Common implementation basis across institution.	Consistent institutional approach across organizations with variations as appropriate for specific needs.	Policy and practice driven across the institution.	Tools, training, and IT infrastructure provided/maintained by Institutional resources
Organizational Adoption (e.g., enterprise, program, project)	have adopted (e.g., new programs/inititative, pilot programs, and business case driven)	Adoption by organization Enterprise or Systems Engineering Organizations.	Common implementation basis across organization.	Consistent organization approach across programs/projects with variations as appropriate for specific needs.	Policy and practice driven across the organization.	Discussion about whether this is at institutional level or at lower level
Modeling roles and responsibilities	Modeling roles and responsibilities are not identified	Modeling roles and responsibilities are identified	Modeling roles and responsibilties are characterized by model-based Knowledge, Skills, and Abilities (KSAs)	Modeling roles are provided the permissions necessary to perform their responsibilities	People who need to be active are identified and involved. Sufficient staffing and staffing plan ensures all roles are fulfilled.	Roles and responsibilities may include such modeling roles as: enterprise manager, program/project manager, SE, IT, Modeler, policy maker, contracting, model curator, model manager, model data manager, ASOT configuration manager or others.
Modeling Development Skills	Model-based Knowledge, Skills, and Abilities (KSAs) are defined and unknown. None, or ad-hoc for all staff	Model-based Knowledge, Skills, and Abilities (KSAs) are defined for modelers. Modeling of components of the Enterprise or System.	Model-based Knowledge, Skills, and Abilities (KSAs) are defined for roles involved with modeling; Enterprise Architect, SE, PM, IT, modelers, etc... Novice Modelers on full Enterprise or System -subsystem models.	Abilities (KSAs) are defined for roles involved with enterprise management. Expert model development lead with experience practicing modeling on at least 1 project that successfully completed at least 3 major technical reviews that used models in support of the review.	Expert model development lead that sets modeling standards and evaluates the model product quality of other modelers	More than just modeling tool expertise. This includes expertise in model structure/architecture that supports all subsequent uses
Modeling Use skills	None, or ad-hoc for all staff	Can generate tool standard digital artifacts as needed to evaluate the Enterprise or System.	Can generate tool custom digital artifacts as needed to evaluate the Enterprise or System.	Can generate custom digital artifacts across tools, models, and data sets to evaluate the Enterprise or System.	Can contribute to defining the enterprise, system, and other data needed by the complete team to perform analysis for IPTs, reviews, audits, and other technical and programmatic decisions.	This covers a role that all government team members must have to conduct model based acquisition
Modeling-related Training/KSA development	No training or development activities	Tool familiarity training completed. Initial experience to perform their modeler or user roles.	Modeling or model users experience on specific tools with respect to their role as a user or modeler	Demonstrating role capabilities using the models, coaching and instructing others	Provide leadership in proposing, designing, and delivering training that is appropriate for the modeling and user roles	Multilevel training series, including "hands-on" real world(-like) execution. Paul Walter to help flesh this section out
Common Language	System terminology defined for the project or program.	Common Glossary/Data Dictionary	Top Tier Ontology is defined for the enterprise.	Discipline Ontologies	Common, tiered taxonomies/ontologies is defined and consistent with accept community standards.	A hierarchy of taxonomies and ontologies: Generic Upper Level with subordinate domain/discipline Lower Levels. Was Data Structures row, moved up from Tools & IT Infrastructure
SE Processes/Methodology						
SE Agreement Process	Modeling is not incorporated as part of the agreement processes.	Given a clear business case, modeling is applied in an ad hoc manner across projects or programs	Given a clear business case, modeling is applied manner across projects or programs	Consistent model business case descriptions are being practiced across an enterprise	Consistent model business case driven planning guidance is in place and is being practiced across an enterprise	This is a rollup of 6.1.1 and 6.1.2. Matrix Users may want to replace this line item with the set of processes that are most important to their application. The stage descriptions may be the same for each process or tailored.
SE Organizational Project- Enabling Processes	Modeling is not incorporated as part of the Organizational Project Enabling processes.	Given a clear business case, modeling is applied in an ad hoc manner across projects or programs	Given a clear business case, modeling is applied manner across projects or programs	Consistent model business case descriptions are being practiced across an enterprise	Consistent model business case driven planning guidance is in place and is being practiced across an enterprise	This is a rollup of 6.2.1 to 6.1.6. Matrix Users may want to replace this line item with the set of processes that are most important to their application. The stage descriptions may be the same for each process or tailored.
SE Technical Management Processes	Modeling is not incorporated as part of the Technical Management processes.	Modeling is part of the processes to improve quality and models contribute to the authoritative source of truth	Modeling is the basis for the processes. Digital artifacts are used to make SE Technical Management decisions.	Modeling is the basis for the processes and is used to optimize results across the project or program.	Modeling is the basis for the processes and is used to optimize results across the enterprise.	This is a rollup of 6.3.1 to 6.3.8. Matrix Users may want to replace this line item with the set of processes that are most important to their application. The stage descriptions may be the same for each process or tailored.
SE Technical Processes	Modeling is not incorporated as part of the Technical processes.	Modeling is part of the processes to improve quality and models contribute to the authoritative source of truth	Modeling is the basis for the processes with digital threads covering some of the processes. Digital artifacts are used to make SE decisions.	Modeling is the basis for the processes with digital threads covering all selected processes. Digital artifacts and digital twins are used to make SE decisions.	Modeling is the basis for the processes with digital threads covering all processes Digital artifacts and digital twins are used to make SE decisions.	This is a rollup of 6.4.1 and 6.4.14. Matrix Users may want to replace this line item with the set of processes that are most important to their application. The stage descriptions may be the same for each process or tailored.
Program/Project Processes/Methodology						

Fully populated matrix – ready for pilot use!

User Guide Outline

- Overview
- Developmental History (abbreviated)
- Matrix Structure
- User Roles and Examples of Relevant Attribute Scope & Domains
- Matrix Uses:
  - *Strategic Vision*
  - *Roadmap*
  - *Yardstick*
  - *Tactical Planning*
  - *Source Selection*
- Tailoring
  - *Use language that is important to the organization*
    - E.g., NASA uses "project," DoD uses "Program"
  - *Identification of individual SE processes to be addressed that are critical to success*
    - E.g. CM/DM
  - *Addition/deletion of rows to focus on organization perspective*
- Glossary (TBS): http://www.omgwiki.org/MBSE/doku.php?id=mbse:deix

See separate User's Guide document for contents

Document Pedigree and Plan

✓Nov 2016 Aerospace MBSE Community Roadmap
✓Oct 2017 NASA MFSC MBSE Maturity Matrix
✓Nov 2017 OSD Digital Engineering Working Group – presentation and co-lead kickoff
✓Jan 2018 INCOSE IW Breakout **Workshop** – presentation and workshop; – 2 half day session with over 50 participants, resulted in draft INCOSE matrix version 1.0
✓Mar 2018 INCOSE Challenge Team Inputs -- comments
✓May 2018 Aerospace System Engineering Forum -- presentation and **workshop**; draft INCOSE matrix version 1.1
✓May 2018 USAF DE Working Group presentation – presentation, draft version 1.2
✓June 2018 INCOSE Challenge Team Inputs -- draft version 1.3 in, draft users guide
✓July 2018 INCOSE IS **workshop** -- draft version 1.3 in, draft users guide
✓Aug 2018 version 1.4, wiki site initially populated
✓Sept 2018 1.5, updated users guide
✓Oct 2018 OSD Cross-check against the OSD DE Strategy – all strategy elements covered
✓Oct 2018 NDIA SE Conference **workshop –** first fully populated matrix
✓Nov 2018 Presentation to MIT/LL
✓Dec 2018 INCOSE Challenge Team Inputs – matrix ver1.6a, TPP2.1 (signed), UG=>4
• Jan 2019 INCOSE IW Outbrief and Breakout **workshop** – matrix ver1.7
• Feb 2019 Aerospace System Engineering Forum **workshop**
• TBD Draft INCOSE document approval submittal
• TBD document draft use and available to members on INCOSE Connect

The products have come a long way in a short time – one calendar year!
Would like to engage IEEE and AIAA as well

Product Status

- Model-Based Enterprise Capabilities Matrix (MBECM) INCOSE Challenge Team Technical Project Plan (TPP) version 2.1
  - *Approved*
- Model-Based Enterprise Capabilities Matrix (MBECM) version 1.7
  - *Fully populated matrix with all original inputs scrubbed to be more readable and specific*
  - *Close to the version to be brought to the Jan. 2019 INCOSE IW and workshop*
- User's Guide version 4
  - *PPTX charts instead of a Word doc*
  - *Additional concepts: e.g., Application to Source Selection, Qualifying Bidders*
    - Sample reports
  - *Glossary of terms TBS: http://www.omgwiki.org/MBSE/doku.php?id=mbse:deix*
- http://wiki.omg.org/MBSE/ updated
  - *references provide an on-line overview of the products and the Challenge team efforts*
- INCOSE Connect - not started

Elements of the Matrix Technical Project Plan

Model-Based Enterprise Capabilities Matrix
Problem statement and Opportunities

- Problem Statement:
  - *Organizations are implementing system engineering with increasing model based capabilities and would benefit from a reference matrix to assess their current state and plan their desired state. The Model-Based Enterprise Capabilities Matrix (MBECM) provides the reference for these types of assessments.*

- Opportunities:
  - *The Model-Based Enterprise Capabilities Matrix (MBECM) and associated User's Guide are based on original works from NASA/MSFC and The Aerospace Corporation with INCOSE providing the collaboration opportunity.*
  - *The opportunity to link and cross-check the work against <u>systems engineering</u> and <u>enterprise architecture</u> work as well as the US DoD Office of the Secretary of Defense (OSD) related to digital engineering and their published <u>Digital Engineering</u> (DE) Strategy enabled the products to be used at the enterprise, systems, program and project levels as well as address key roles in acquisition and development. Mapping the matrix capabilities to the <u>ISO/IEC/IEEE 15288:2015</u> - Systems and software engineering standards as well as the DE Strategy has ensured proper coupling of capabilities to both processes and desired results.*
  - *In addition, the co-leads have used the opportunity to leverage NASA and Aerospace reports to define the matrix stage and cell information for the capabilities.*

Model-Based Enterprise Capabilities Matrix
Vision and Expected Outcomes

- INCOSE's Vision 2025 document, identifies "Virtual Engineering Part of The Digital Revolution" and "Integrating Model-based Approaches" as key concepts transforming systems engineering to the desired future state.
  - *This INCOSE vision can be furthered by the Matrix and User's guide.*

- The Matrix and User's Guide identify a comprehensive set of model-based capabilities, that were credibly sourced, and can be used by organizations to plan the improvement of their model based enterprise capabilities.
  - *Users are encouraged to tailor the Matrix to their needs; adopting their organization language, promoting or collapsing rows based on their risks and needs, and applying it to their enterprise and programs/projects.*

- Model-Based Enterprise Capabilities Matrix (MBECM) is an excel-based spreadsheet composed of descriptive model-based capability rows and columns that define the capability stage.
  - *The cells in a capability row progress from a capability that has little or no model based elements to the highest stage with the greatest amount of model based capability for an enterprise.*

- The associated User's Guide describes how organizations may use the matrix
  - *An input for strategic and tactical planning, development roadmaps, enterprise/program/project assessment, source selection, or for specific roles such as the program/project manager, system engineering, Information System lead, or modeler to plan and build their capabilities.*

Model-Based Enterprise Capabilities Matrix
Stakeholders

- INCOSE Stakeholders such as the INCOSE SE Transformation group and the INCOSE MBSE Initiative. The co-leads and many of the contributors are from the U.S. space industry however the Challenge Team members cut across industries and countries. The eventual stakeholders will be INCOSE and those that use INCOSE products -- spanning industries and country affiliations.

- DoD, specifically OSD (DASD/SE) sponsored the 2018 IW breakout that led to the formation of the Challenge team and scoped the initial products. INCOSE Organization Stakeholders include the INCOSE AD Technical Information and the INCOSE Technical Director. The project leads then created a set of meeting and workshop opportunities to increase Challenge team membership, conducted Challenge Team meetings to continue to refine the scope and content of the products.

- There are high- levels of interest across OSD, DoD services, Service Centers, programs, and projects as well as across NASA Centers, JPL, the USAF, AF Space and Missiles System Center, and across industry.

- The Challenge team membership as of December 2018 was around 80.

You Can Help

- Provide comments to the Matrix/Users guide.
    - *General comments:*
        - What else would you need in order to bring this to your organization and use it?
        - How can we share information about Matrix/User's Guide application?
        - What parts of the Matrix are you uncomfortable with and what recommendations do you have?
        - What else would you like to be addressed in the User's Guide?
    - *Specific Comments:*
        - Select the matrix rows for the role you are most familiar with and provide enhanced specificity.
        - Provide research, papers, standards, that support the work or should be considered to make changes.
- Try out the Matrix and User's Guide by applying them and provide feedback.
- Participate in a workshop

Upcoming Workshop Opportunities

- 26-29 January 2019 INCOSE International Workshop
  - *Working session Monday 28 January, 1-3pm, Salon C*

- 12-14 February 2019 Aerospace, System Engineering Forum, "Leveraging MBSE Across the Enterprise"
  - *Open to U.S. Citizens*
  - *El Segundo, California*
  - *https://aerospace.org/events/systems-engineering-forum*
  - *Model-Based Enterprise Capabilities Matrix Workshop Tuesday 2/12, 1-5pm*

Model-Based Enterprise Capability Matrix

Monday 28 Jan. 2019 INCOSE Workshop Agenda, 1-3

10 minutes Welcome and self-Introductions, sign in sheet

10 minutes Provide an overview of the Matrix and it's Users Guide

1. *Reprise parts of plenary presentation*

60 minutes Working session

1. *Instructions for attendees*
2. *Split into groups by role; EA/PM, SE, IT, Modeler*
3. *Round 1: Validate the role-based MBE capabilities*
   - Does each set of role-based capabilities cover what is necessary?
   - Need to use other capabilities rows outside of the role? Which ones?
   - Recommended changes to rows/cells?
4. *Round 2: Create a sample report. What would it look like? Heat map, table, etc.?*
   - Get sample results, record observations and findings

20 minutes Outbrief key findings

10 minutes Recommended actions for co-leads and INCOSE

Validate the Matrix and User's Guide Concepts