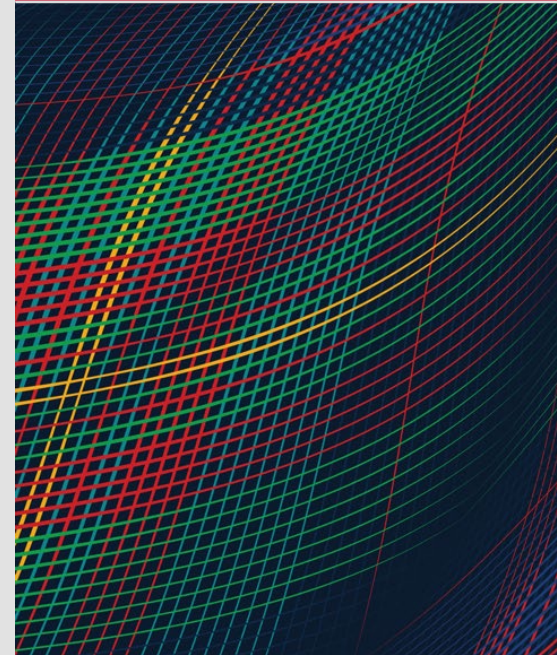


MBSynergy: A Scenario-Based Approach for Improving MBSE

MARCH 2025

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DM25-0384

BLUF: “Of Models and Men” – Digital Engineering through

Digital Engineering is reshaping both engineering practice and organizations

OUSD(R&E) Digital Engineering Strategy (2018) established a vision,

DoD 5000.97 is a mandate for deploying Digital Engineering and MBSE

Claim: MBSE deployment is both (a) an organizational change and (b) a technological adoption problem. Both problems should be addressed.

This Talk: SEI MBSynergy project, improving MBSE deployment

Organization transformation and culture change, inherited from Agile

Capturing, communicating, and optimizing model lifecycle using UAF

How: scenario-based approach for describing MBSE processes

DoD Digital Engineering: Of Models and Men

OUSD(R&E) Digital Engineering Strategy:

Five overarching objectives

1. Formalize the development, integration, and use of models to inform enterprise and program decision making.
2. Provide an enduring, authoritative source of truth.
3. Incorporate technological innovation to improve the engineering practice
4. Establish a supporting infrastructure and environments to perform activities, collaborate, and communicate across stakeholders.
5. Transform the culture and workforce to adopt and support Digital Engineering across the lifecycle.

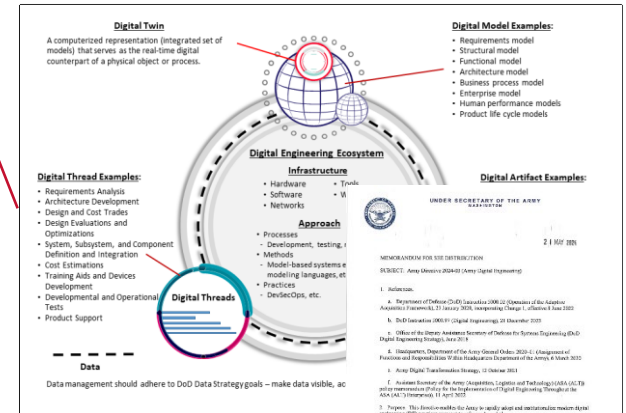


DoD Digital Engineering: Of Models and Men

OUSD(R&E) Digital Engineering Strategy:

Five overarching objectives *being covered by DoD 5000.97 implementations*

1. Formalize the development, integration, and use of models to inform enterprise and program decision making.
2. Provide an enduring, authoritative source of truth.
3. Incorporate technological innovation to improve the engineering practice
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5. Transform the culture and workforce to adopt and support Digital Engineering across the lifecycle.



DoD 5000.97 +
branch declinations

DoD Digital Engineering: Of Models and Men

OUSD(R&E) Digital Engineering Strategy:

Five overarching objectives **This talk is about 1. and 5**

1. Formalize the development, integration, and use of models to inform enterprise and program decision making.

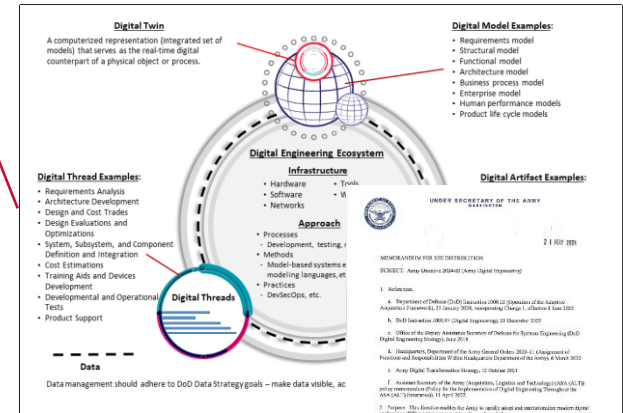
2. Provide an enduring, authoritative source of truth.

3. Incorporate technological innovation to improve the engineering practice.

4. Establish a supporting infrastructure and environments to perform activities, collaborate, and communicate across stakeholders.

5. Transform the culture and workforce to adopt and support Digital Engineering across the lifecycle.

5000.97 provides technological foundations for 2 to 4

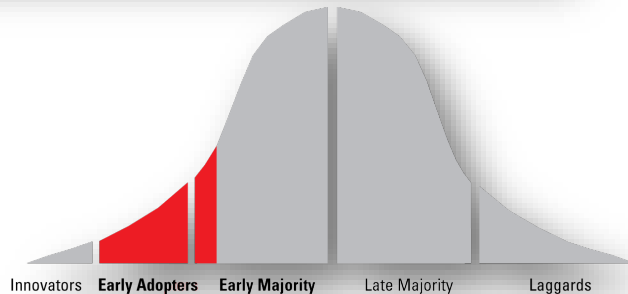
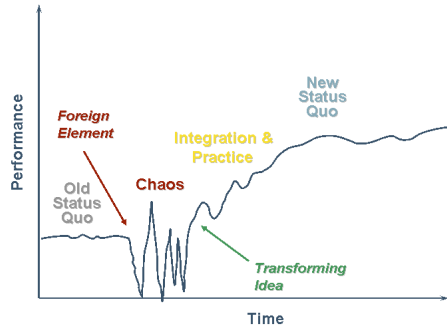


DoD 5000.97 +
branch declarations

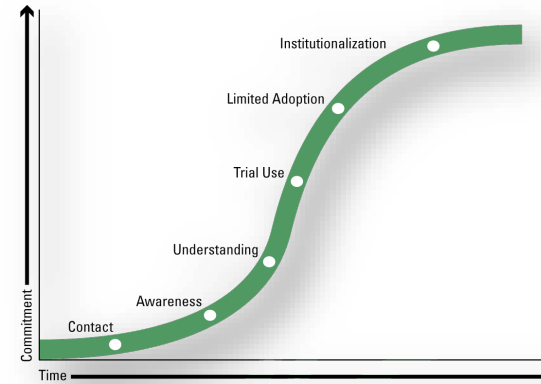
Goal #5: Transforming the culture and workforce to adopt and support Digital Engineering across the lifecycle

Adoption Tools and Methods

Understand the Change Cycle and Your Adoption Population

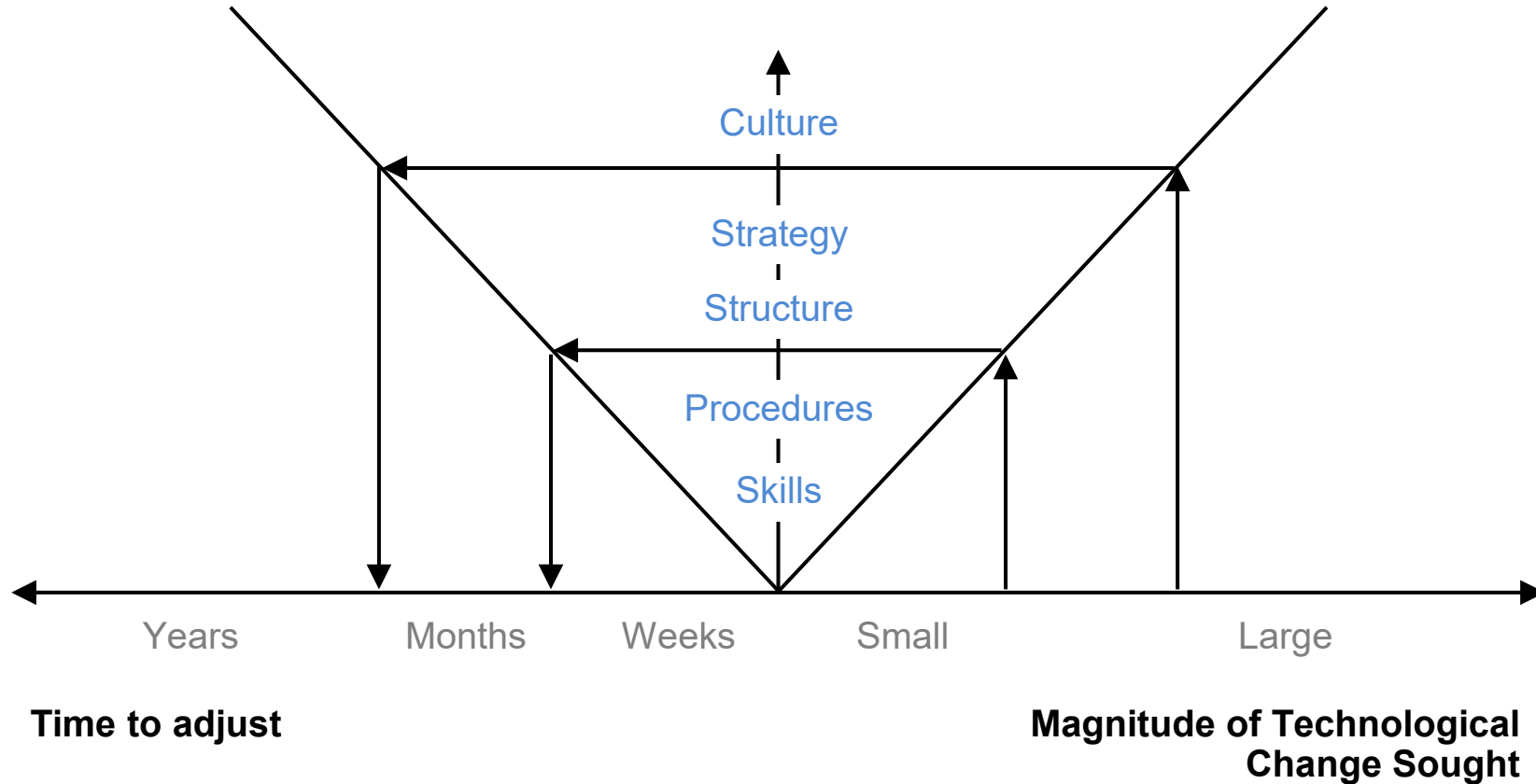


Prepare for Both Communication and Implementation Support Mechanisms that are Needed

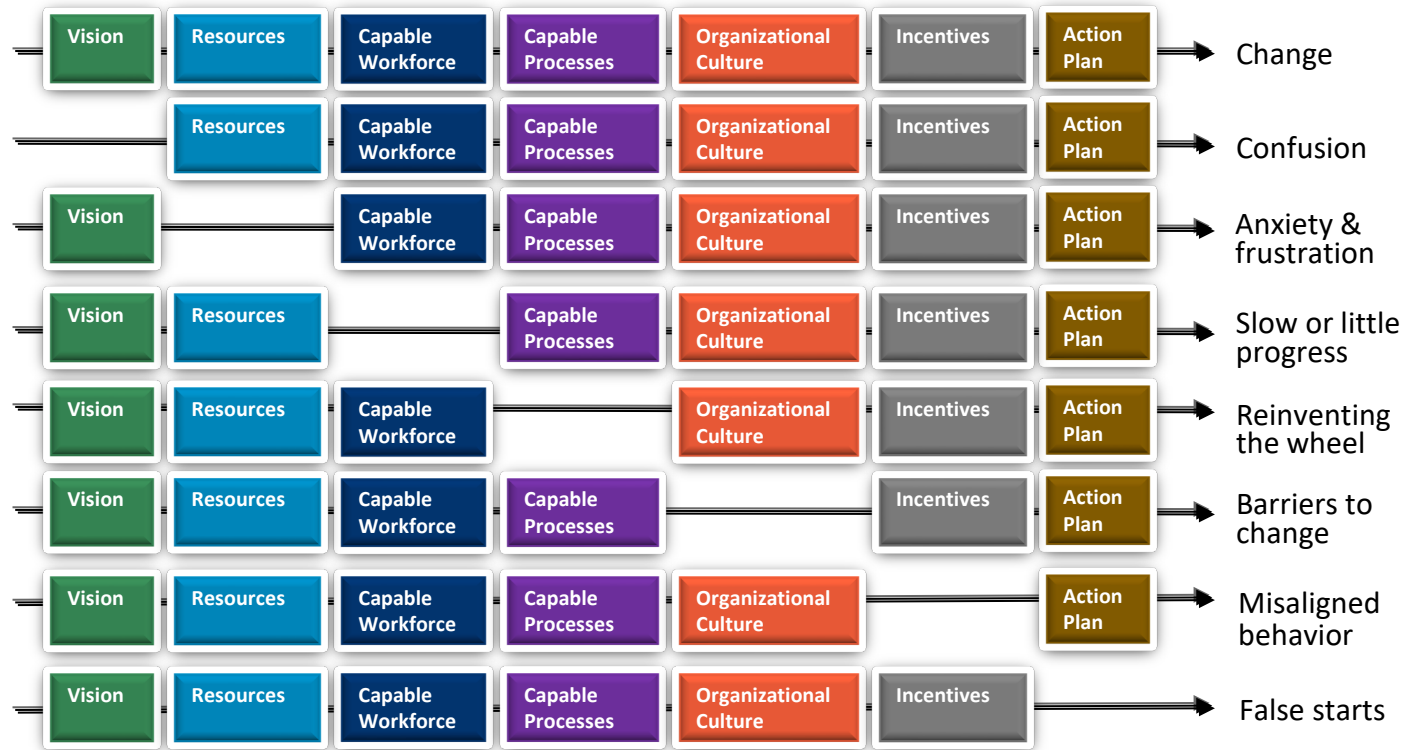


*Adapted from Daryl R. Conner and Robert W. Patterson,
"Building Commitment to Organizational Change,"
Training and Development Journal (April 1983): 18-30.

Scope of Change and Level of Learning Required



Leadership, Vision, and Goals in Organizational Improvement



Adapted by Buttles (2010) from: Delorise Ambrose, 1987

Goal #1: Formalize the development, integration, and use of models to inform enterprise and program decision making

The processes, tool, training, and policies quadrille

Several discussions around training, tools, policies with DoD stakeholders

Expressed needs for training, tools, and policies modifications ..

But, these topics are interdependent:

Training prepares personnel for a role in an organization

Tools support multiple roles, easing communication for improved efficiency

Role in a process contributes to an organization mission, through processes

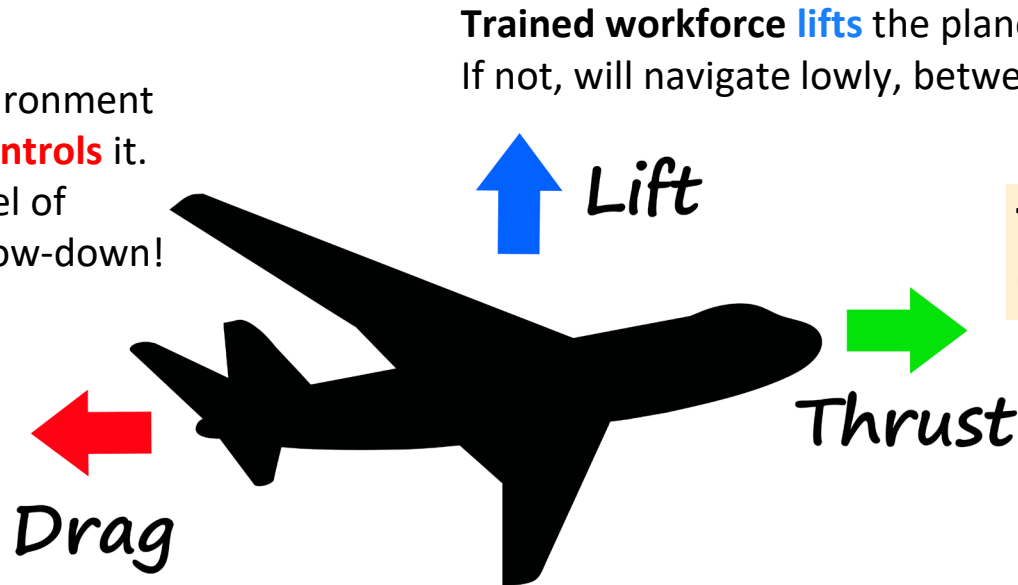
Policies codify the above: interactions between roles, roles/skills, etc.

SEI claim: processes/tool/training are intertwined issues by construction

Within an organization, each personnel executes its role^[1] using their acquired skills^[2] and applying selected tools^[3], in accordance with rules, regulations, and a project governance^[4]

Training, tooling, policies, and MBSE process .. or if MBSE was an aircraft

Digital Engineering environment
drags the system and **controls** it.
It exercises the right level of
actuation. Not a plain slow-down!



Trained workforce **lifts** the plane
If not, will navigate lowly, between cliffs

Thrust should be defined **first**
Other elements **co-optimized**

MBSE process increase
organization **thrust**, enabling
lift and drag

Policies acts like **gravity**: allow the plane
to reach its destination and land /
avoid going outside of the atmosphere.

Changes in Policies acts like **rough air**:
turbulences that disturb a trajectory and
could jeopardize the journey.

From document-based MBSE processes to MBSE as process models

[What is the issue?] deploying MBSE within an organization, is a challenge

MBSE to address engineering complexity and scale through abstraction, automation

Paradox: MBSE processes described using documents, training material => slow down, miscommunication

[Why this issue?] Root cause: Model-Based Systems Engineering is a complex system

MBSE is not “just” a tool, that you “just” train for. It is deeply rooted in an organization’s missions, functions

MBSE should be adopted by and adapted to an organization, not forced into it

[How to solve it?] SEI MBSynergy research: **model the model lifecycle**

How models are built, highlight their relations, data exchange, and quality attributes

Who builds the models: stakeholders, skills, tools

When/why the models is used: for engineering, review, T&E, ...

[When/Where/Who?] Through a workshop format, stakeholders capture a MBSE process

As a UAF model or document (!) to ease communication and ensure ..

alignment with Enterprise Architecture to consistency and correctness

Back to the fundamental question: why models?

A scenario starts with a specific business goal set by an organization

Examples of high-level scenarios

“Program has a legacy system and a model of the system. The MBSE model is used by to obtain information in a timely manner without assistance by engineers or developers.”

“Program has a legacy Cyber-Physical System (CPS). The system currently supports communication with remote stations. A need arises for secure communication with a collection of teamed mobile assets.”

“Program has a legacy system. A need arises for new capabilities that can be satisfied with a known component that is available from an established vendor. The vendor can provide some performance attributes and has modeled the component structure, behavior, and interfaces. Can we employ a model-based virtual integration of the components?”

SEI is looking for scenarios that are relevant for your organization

Scenarios to create thrust

Patterns to express MBSE Process

A scenario is an input/output process: “within an environment, stakeholders with specific skills achieve a business goal when a stimulus (trigger) is met, producing a response and generating outputs from inputs with measured quality attributes.”

Scenarios definition requires a consensus, built through workshops, involving

Modeling experts, project representatives across multiple functions (eng., testing, ...)

Example: *“PM desires a model-based representation of the architecture of a system to perform trade-off analysis (e.g. performance vs. cost).”*

Ingredient of a good scenario : Clarity (!)

Goals: what do you want to achieve? How do you measure it?

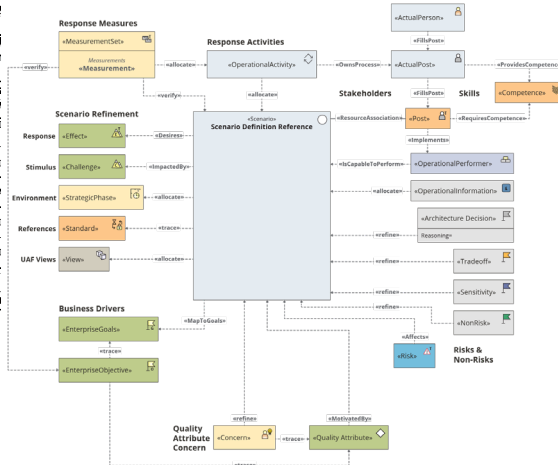
Roles: their required skills, their contribution to project success

Interfaces: how do stakeholder communicate? How are models interconnected?

Dual representation of Scenarios

A scenario is an input/output process: “within an environment, stakeholders with specific skills achieve a business goal when a stimulus (trigger) is met, producing a response and generating outputs from inputs with measured quality attributes.”

Scenario Definitions		
SEI Term	UAF Element	Definition
Scenario	Operational Activity	An activity is an action performed in conducting the business of an enterprise. It does not describe hardware/software system functions.
Stakeholders	Operational Performer(s)	Operational Taxonomy [Scenario Definition Reference]
Business Goal(s)	Capability(s)	The ability to act under conditions through a set of
Quality Attribute	Measurement Set	A collection of measures representing some measure
Environment	Condition(s)	Defines the local conditions for an Operational Activity
Stimulus	Pre-condition	An optional set of conditions that must be met before the scenario can be executed
Stimulus Input	Operation Exchange Item	A list of Operational Activities that trigger the scenario
Response	Operational Activity Action	A call of an Operational Activity that is the result of the scenario
Response Output	Operation Exchange Item	A list of Operational Activities that are the result of the scenario
Response Result	Post condition	An optional set of conditions that must be met after the scenario is executed
Skills	Competence	A specific set of skills that are required for the scenario
References	Documentation	Reference documents that describe the scenario

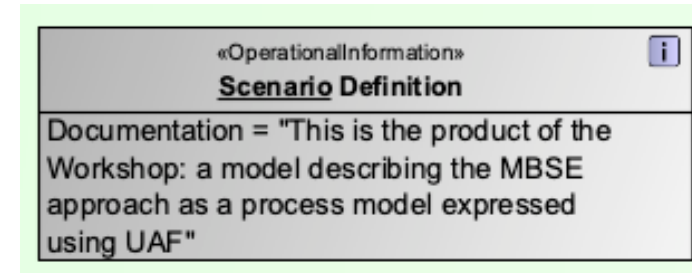
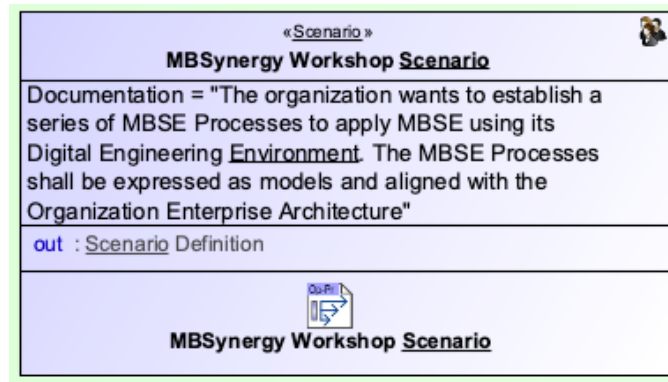


Dual definition:

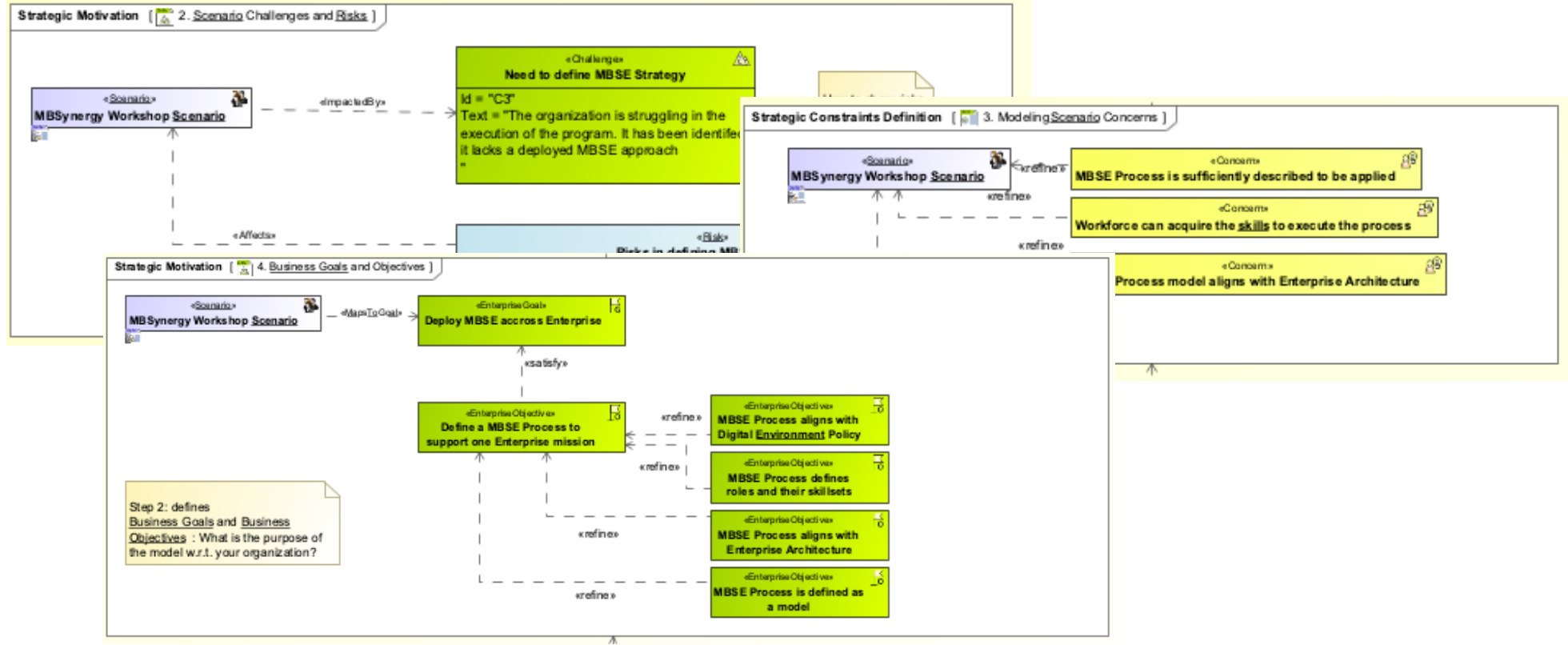
1. plain text for early discussion, exchange, and communication;
2. UAF 1.2 for rigor (taxonomy), review, evaluation: correctness of "interfaces"; goals, skills, quality assessment connected to Enterprise Architecture, ...

Equivalent definition, different benefits

Phase 1: define the overarching goal you want to achieve and the product of the activity

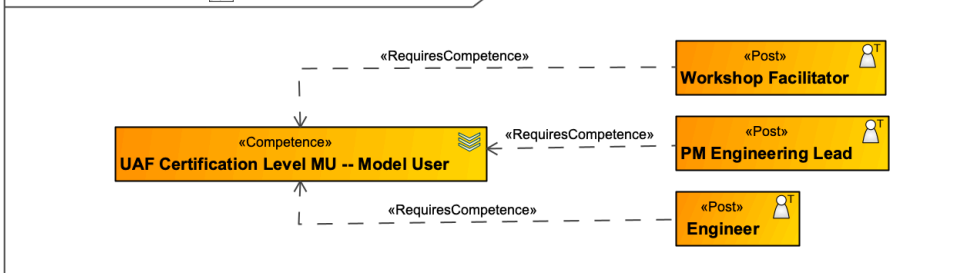


Phase 2: elicit the scenario needs, risks, concerns for modeling, and goals and objectives for the organization

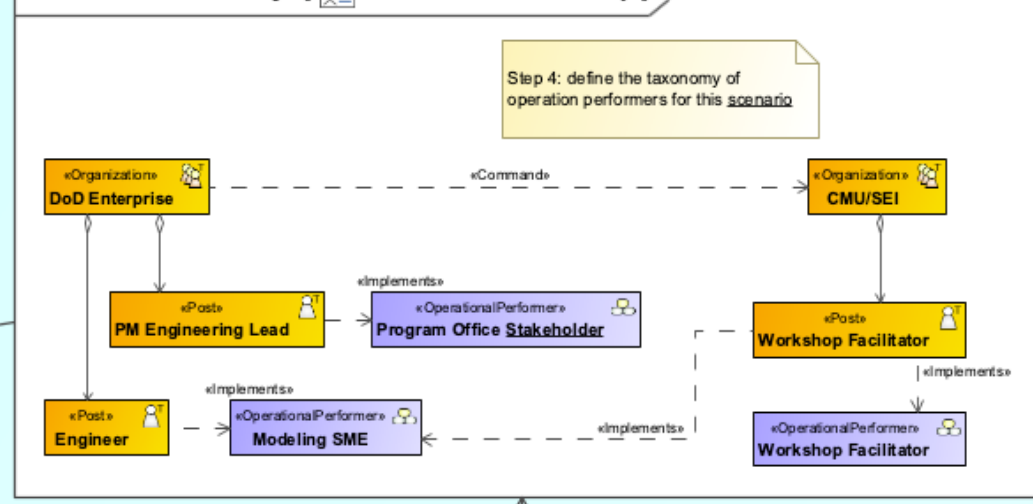


Phase 3: define the scenario as a collection of operations coordinated and executed by personnel.

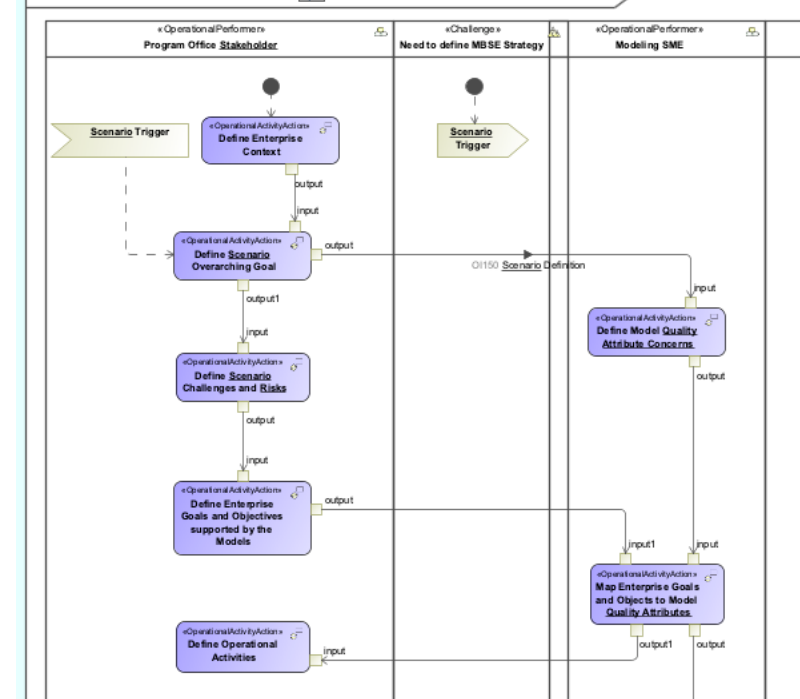
Personnel Taxonomy [1. Posts and Skills Taxonomy]



Personnel Taxonomy [8. Personnel Taxonomy]



Operational Process Flow [MBSynergy Workshop Scenario]



Library of scenarios, combination of scenarios

NPS Acquisition Research Symposium'25

Need for library of scenarios, to address

Decomposition – Systems Engineering

Composition – Systems of Systems

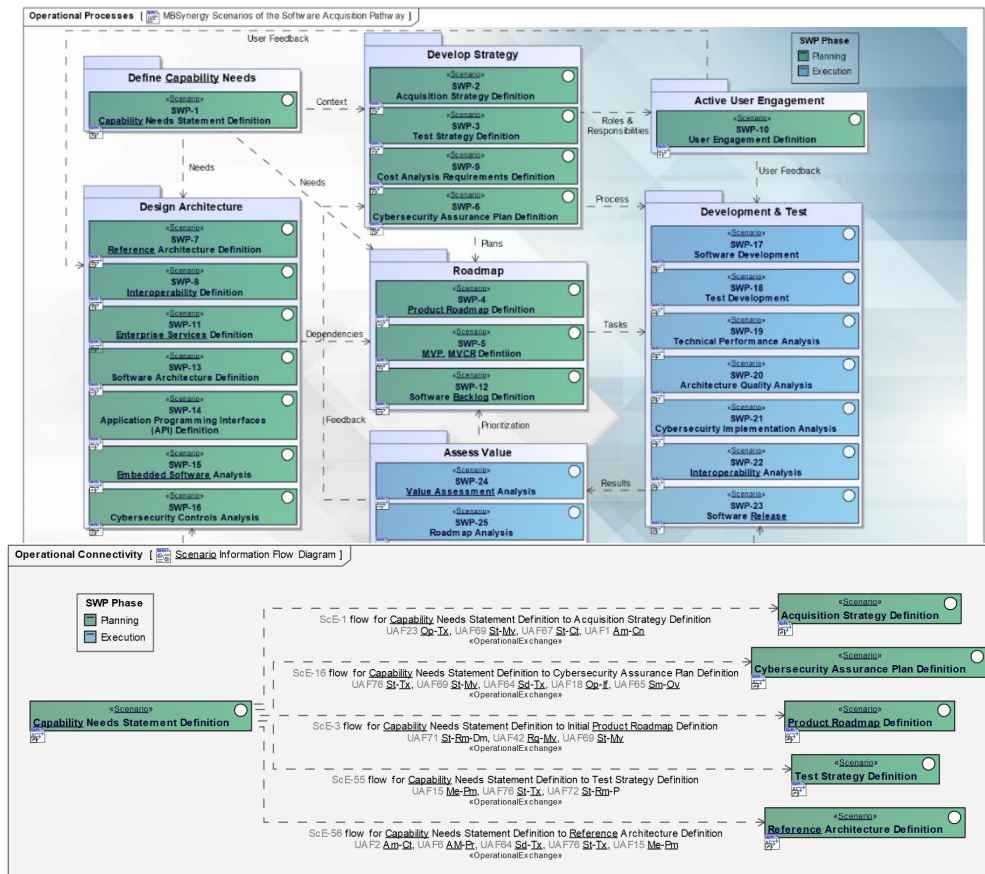
Use case: Software Acquisition Pathway

25 scenarios for Embedded Systems

Interdependent: data exchange, sequencing

Complex to deploy, yet now a mandate

Solution: SwP scenarios as reference architecture then per-project specialization



Way forward – how to create scenarios?

Scenarios are a tool to create, define, optimize, and execute MBSE processes

- UAF profile to structure scenario

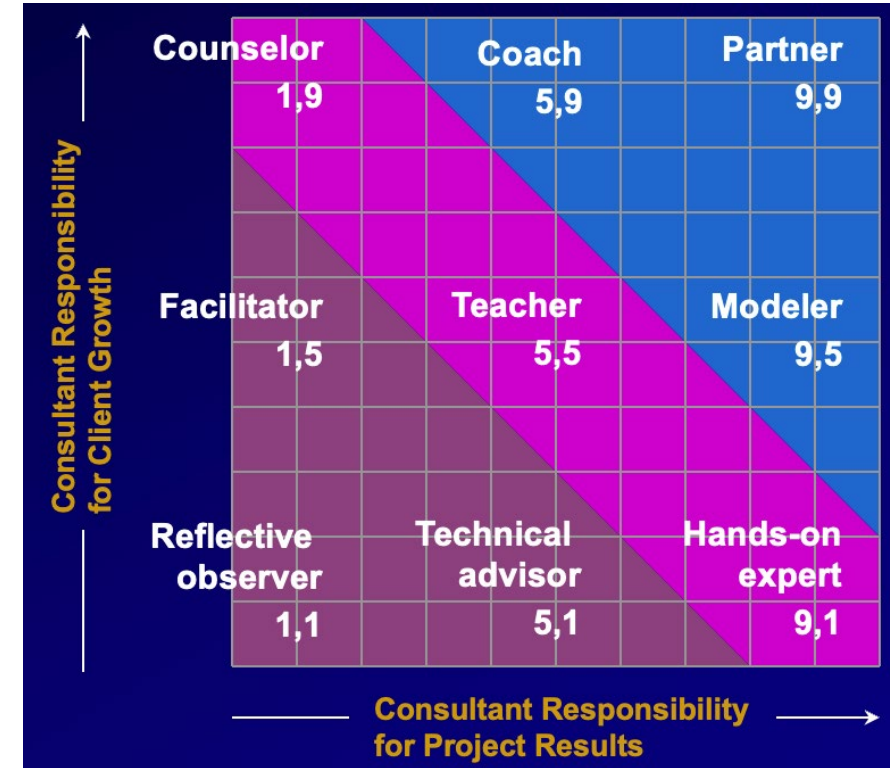
- Connected to EA: skills, roles, tools

SEI is defining a workshop format to help organizations eliciting scenarios, involving

- Organizations' stakeholders and

- Technical Advisor/Reflective Observer to guide

Impact: organizations fine tune their MBSE approach, from well-established practice, to meet their goals



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