Naval Postgraduate School
Systems Engineering Department
Monterey, CA

Defining a Model-Based Systems Engineering Approach for Technical Reviews

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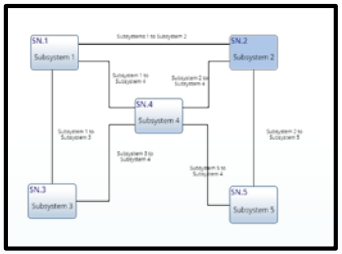
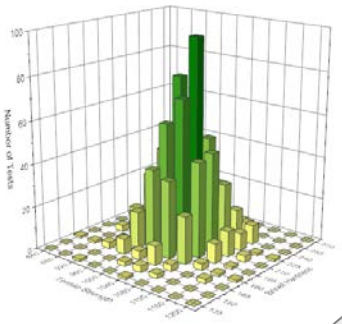
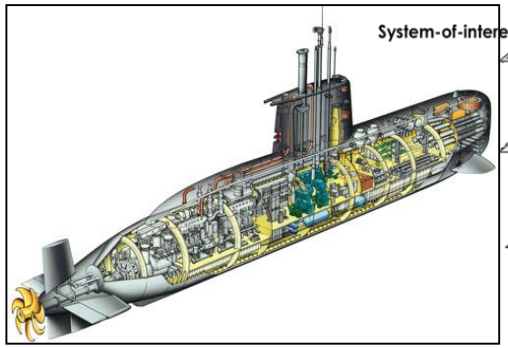
Background

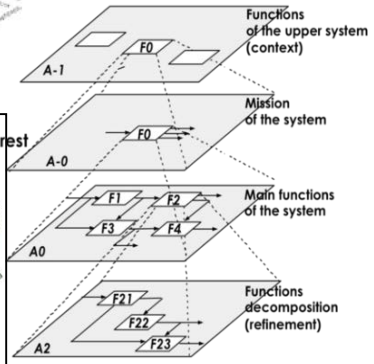
Traditional Systems Engineering Technical Reviews



Model-Based Systems Engineering Technical Reviews







Model-Based Systems Engineering was envisioned to transform systems engineering from a document-based to model-based discipline.

Digital Engineering*

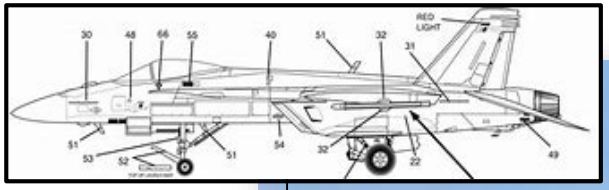
DoD defines digital engineering* as an integrated digital approach that uses authoritative sources of system data and models as a continuum across disciplines that support lifecycle activities from concept through disposal.

* The terms “Model-Based Systems Engineering (MBSE)” and “Digital Engineering” are considered synonymous for this presentation. MBSE is technically defined in the corresponding paper.

- **Goal 1:** Formalize the Development, Integration, and Use of Models to Inform Enterprise and Program Decision Making
  - 1.1 Formalize the planning for models to support engineering activities and decision making across the lifecycle.
  - 1.2 Formally develop, integrate, and curate models.
  - 1.3 Use models to support engineering activities and decision making across the lifecycle.

Source: DoD Digital Engineering Strategy (2018)

Dimensions of a System



Systems Perspective

Program Management Perspective

Work Breakdown Structure

Cost Breakdown Structure

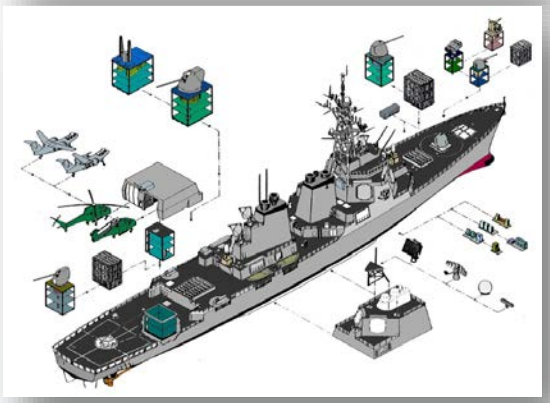
Operational Perspective

Concept of Operations

MBSE requires an increased emphasis on the model, specifically the objects and relationships it contains, rather than the “artifact” to encourage better model development, usage, and decision-making.

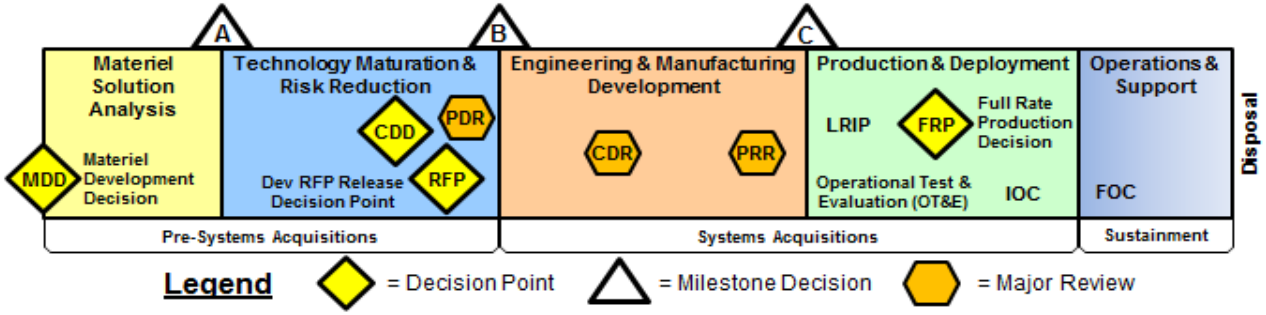
MBSE Approach

- A MBSE approach focuses on data at the entity level.
- Each entity has defined relationships, allowing it to represent the structural complexities within the system.
- Each entity has one or more corresponding visual representations that allow for comprehension and decision-making.
- The relationships between the principal entities define structure, address complexity, and ensure system traceability across the model.



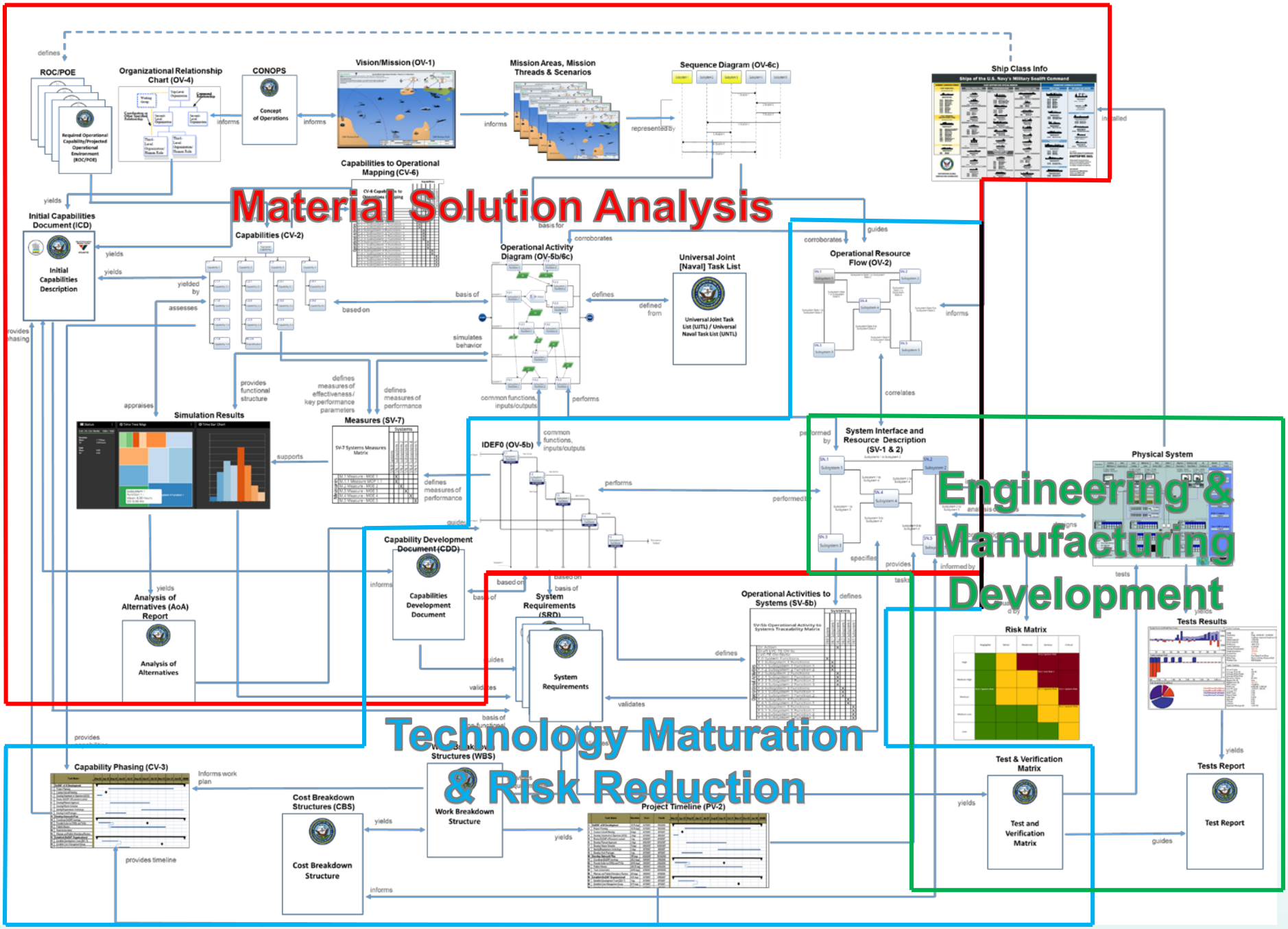
Systems consists of “building blocks” and the relationships between them that form a complete and functional entity.

Modeling with the System Acquisition Lifecycle

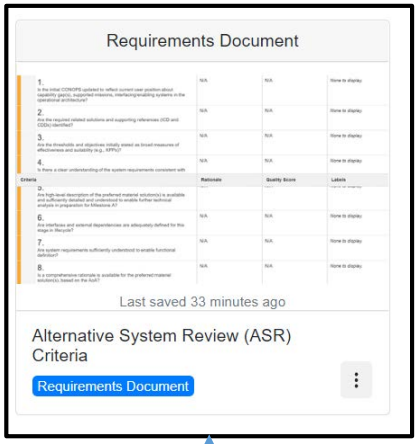


- The System Acquisition Lifecycle Model identifies five primary phases which take the system from concept develop and material solution analysis through operations and support.
  - The first three phases (prior to Milestone C) are where the most significant engineering occurs.
  - Each phase contains one or more technical reviews.
- MBSE focuses on model development of the "virtual system" throughout the lifecycle, and away from artifacts produced exclusively for technical reviews.

Use models to support engineering activities and decision making across the lifecycle. - *DoD Digital Engineering Strategy, Goal 1.3*

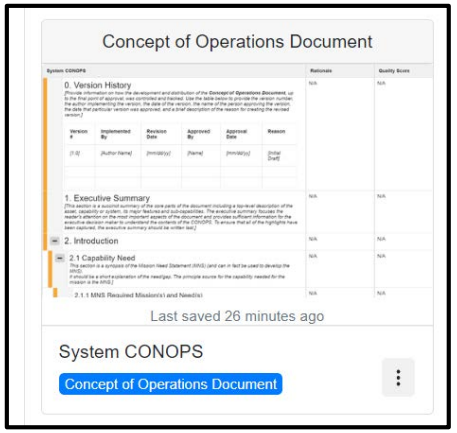

Material Solution Analysis
Engineering & Manufacturing Development
Technology Maturation & Risk Reduction
ROC/POE
Organizational Relationship Chart (OV-4)
CONOPS
Concept of Operations
Vision/Mission (OV-1)
Mission Areas, Mission Threads & Scenarios
Sequence Diagram (OV-6c)
Ship Class Info
Capabilities to Operational Mapping (CV-6)
Initial Capabilities Document (ICD)
Initial Capabilities Description
Capabilities (CV-2)
Operational Activity Diagram (OV-5b/6c)
Universal Joint [Naval] Task List
Universal Joint Task List (UJTL) / Universal Naval Task List (UNTL)
Operational Resource Flow (OV-2)
Simulation Results
Measures (SV-7)
IDEF0 (OV-5b)
System Interface and Resource Description (SV-1 & 2)
Physical System
Capability Development Document (CDD)
Capabilities Development Document
Analysis of Alternatives (AoA) Report
Analysis of Alternatives
System Requirements (SRD)
System Requirements
Operational Activities to Systems (SV-5b)
Risk Matrix
Tests Results
Capability Phasing (CV-3)
Work Breakdown Structures (WBS)
Work Breakdown Structure
Cost Breakdown Structures (CBS)
Cost Breakdown Structure
Project Timeline (PV-2)
Test & Verification Matrix
Test and Verification Matrix
Tests Report
Test Report

Documents



Technical Review Criteria

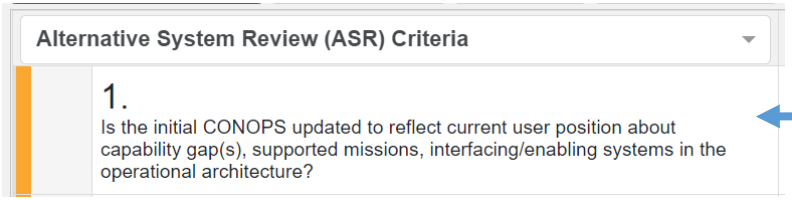
CONOPS

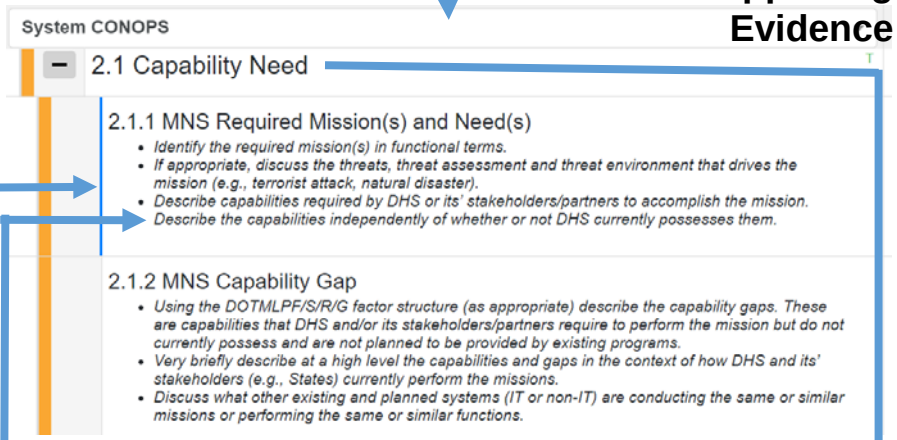


Specific Criteria

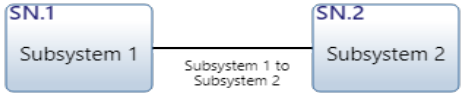
Statements

Relevant Supporting Evidence

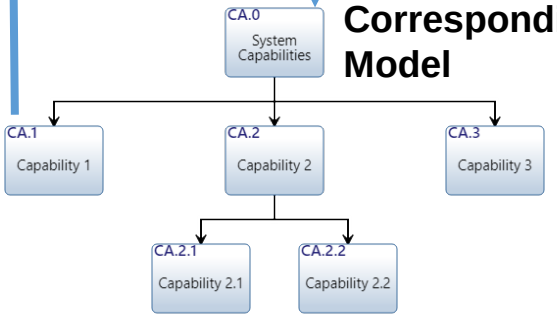




Systems



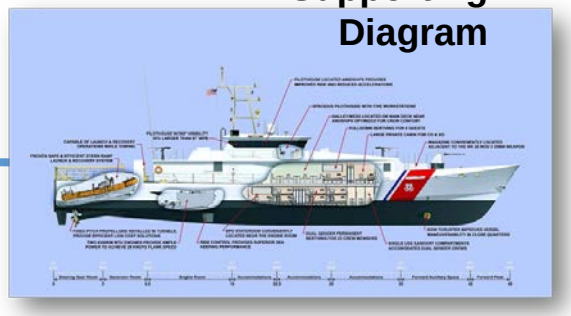
Capabilities



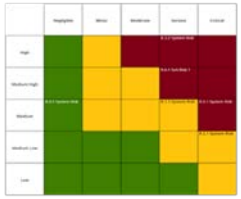
Corresponding Model

Artifact

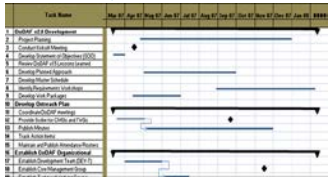
Supporting Diagram



Risks



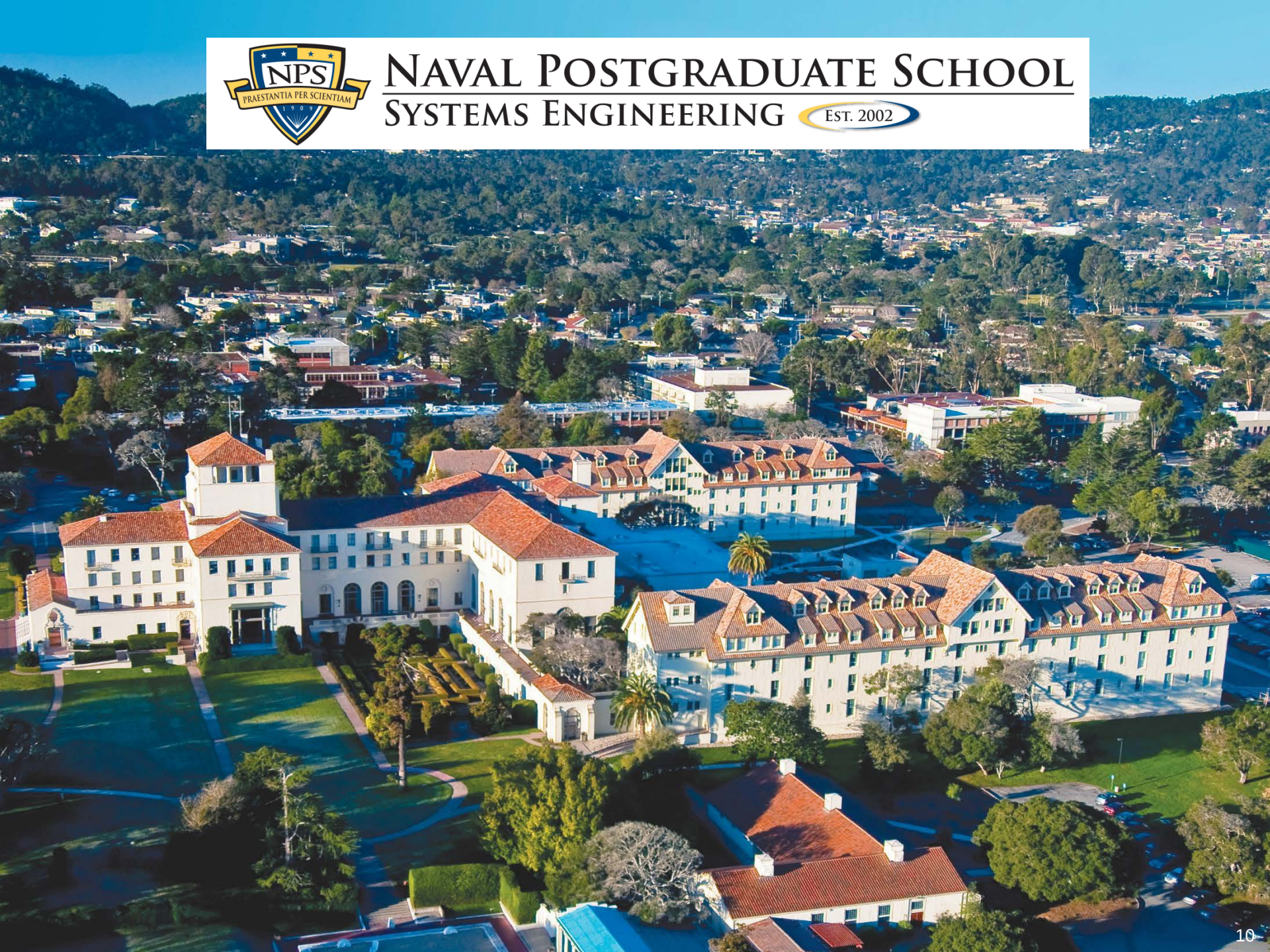
Schedule



Getting Off the Stage Thoughts…

- Formalized planning for modeling and decision-making across the lifecycle must include a new approach to technical reviews.
- Next Steps:
  - Revise technical review entrance criteria to capitalize on the new MBSE approach.
  - Perform a “generic” review to highlight the changes in information available.
- There is a strong need to ensure that decision-makers understand the different model types and what information can be gleaned from them.

MBSE requires a mindset change, a change in systems engineering processes, and a change in expectations of the artifacts required during the systems engineering process.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