



COLLEGE *of*
CHARLESTON

Systems Engineering: Design and Development

ENGR 387



Agenda

- **Definition of Model-Based Systems Engineering (MBSE)**
- **What is a Systems Model**
- **Purpose for Modeling a System**
- **Contracting Document-Based SE with MBSE**
- **MBSE Benefits**

This section is based primarily on Chapter 2 of A Practical Guide to SysML and Chapter 1 Lenny Delligatti SysML DISTILLED, A Brief Guide to THE Systems Modeling Language

Definition of Model-Based Systems Engineering (MBSE)

- MBSE Definition:
 - "Model-Based Systems Engineering (MBSE) is the formalized application of modeling to support system requirements, design, analysis, verification, and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases."*
- The intent of MBSE is to facilitate traditional SE activities, resulting in enhanced:
 - Communications
 - Specification and design precision
 - System design integration
 - Re-use of system artifacts
- Output of MBSE is a system model (<https://youtu.be/douEMf6LKA8>)

*International Council on Systems Engineering (INCOSE), *Systems Engineering Vision 2020*, Version 2.03, TP-2004-004-02, September 2007

What is a System Model

- A System model can be descriptive or analytic
 - Clarify and describe through *Descriptive* Models (e.g., System, SW, HW architecture, CAD)
 - Quantify and analyze through *Analytical* Models (e.g., simulation, engineering analysis)
- A descriptive model includes information on:
 - System specification
 - Design
 - Analysis
 - Verification
- Consists of elements that represent:
 - Requirements
 - Design elements
 - Test Cases
 - Design Rationale
 - Interrelationships (between the above)

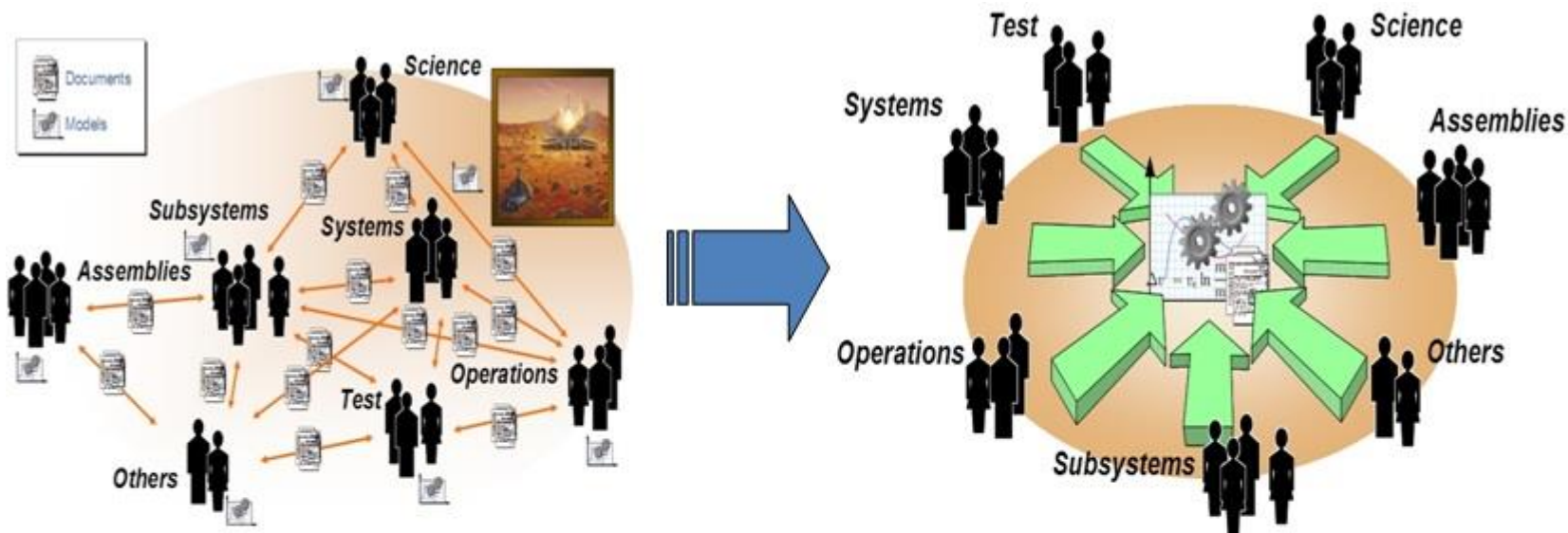
What is a System Model (cont)

- Primary use is to design a system that satisfies system requirements and allocates requirements to the system's components
- Used to enhance communication between system designer and developer

Purpose of Modeling a System

- Characterize an existing system
- Specify and design a new or modified system
 - Represent a system concept
 - Specify and validate system requirements
 - Synthesize system designs
 - Specify component requirements
 - Maintain requirements traceability
- Evaluate the system
 - Conduct system design trade-offs
 - Analyze system performance requirements or other quality attributes
 - Verify that the system design satisfies the requirements
 - Assess the impact of requirements and design changes

Contrasting Document-Based SE with MBSE



Today: Standalone models related through documents

Future: Shared system model with multiple views, and connected to discipline models. Reusable, model based engineering with virtual product development and simulation capability

Contrasting Document-Based SE with MBSE (cont)

- Traditional Document-Based SE produces a variety of documents
 - Completeness, consistency, and relationships between requirements, design, engineering analysis, and test information are difficult to assess since this information is spread across several documents
 - Difficult to perform traceability
 - Difficult to assess change impacts
- MBSE produces a system model contained in a model repository
 - System model includes system specification, design, analysis, and verification information
 - The system model can provide a more complete, consistent, and traceable system design
 - Enhances the quality of traceability and change impact assessments

MBSE Benefits

- MBSE enhances the ability to capture, analyze, share, and manage the information associated with the complete specification of a product, resulting in the following benefits:
 - Improved communications among the development stakeholders (e.g. the customer, program management, systems engineers, hardware and software developers, testers, and specialty engineering disciplines).
 - Increased ability to manage system complexity by enabling a system model to be viewed from multiple perspectives, and to analyze the impact of changes.
 - Improved product quality by providing an unambiguous and precise model of the system that can be evaluated for consistency, correctness, and completeness.
 - Enhanced knowledge capture and reuse of the information by capturing information in more standardized ways and leveraging built-in abstraction mechanisms inherent in model-driven approaches. This in turn can result in reduced cycle time and lower maintenance costs to modify the design.
 - Improved ability to teach and learn systems engineering fundamentals by providing a clear and unambiguous representation of the concepts.

"INCOSE Vision 2020; Model-Based Systems Engineering (MBSE)"; Highlights from MBSE Workshop; July 7, 2006

Summary

- Systems Engineering is evolving from a mostly Document-Based Approach to an increasingly more Model-Based Approach, in line with other engineering disciplines (Hardware, Software, Electrical, etc.)
- Purposes for modeling systems include characterizing, specifying, designing, and evaluating systems in a standardized approach.
- A Model-Based Systems Engineering (MBSE) approach offers improved communications among stakeholders, multiple system perspectives, and clear and standardized systems concepts for improved training.

References

The Johns Hopkins University APL MBSE using OOSM MBSE Overview