

Appendix D: Model-Based Systems Engineering (MBSE)

Introduction

For more than forty years, the practice of systems engineering followed a linear path: requirements are documented first, followed by analysis, and then conceptual design, a process repeated through the development life cycle. However, regardless of the engineering process employed—waterfall, incremental, iterative, spiral, and even sprint-based — the lack of integration from one phase to another in the cycle results in longer delivery times and increases costs to correct errors introduced at transition points.

Model-Based Systems Engineering (MBSE)¹⁾ is an initiative in the systems engineering community that uses model-based descriptions and transformations so that work occurs concurrently. Requirements collection, analysis, and specifications are performed at the same time as conceptual design. MBSE is practiced across many industries around the globe. For example, it was used to develop the world's largest telescopes, propulsion engines for fighter jets, and autonomous driving cars.

Value Proposition

MBSE is often contrasted with a more traditional document-based approach to systems engineering where system information is spread across many document-based artifacts (hand-written text documents, spreadsheets, and drawings). MBSE brings information together into a cohesive integrated model of the system that:

- *Enhances precision, consistency, and traceability;*
- *Includes behavioral analysis, system architecture, requirement traceability, performance analysis, simulation, test, etc.;*
- *Formalizes the practice of systems development through the use of models;*
- *Integrates information across discipline-specific engineering tools, including hardware and software design, analysis, simulation, and test; and*
- *Facilitates shared understanding of the system among the development team resulting in: a) quality/productivity improvements and lower risk; b) rigor and precision; c) ongoing communications among development team and customer; and d) management of complexity.*

¹⁾

“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.” INCOSE SE Vision 2020 (INCOSE-TP-2004-004-02), Sept 2007 MBSE

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