Representing Systems with Models

Lead Author: *Sanford Friedenthal,* ***Contributing Authors:*** *Dov Dori, Yaniv Mordecai*

A model is a simplified representation of a system at some particular point in time or space intended to promote understanding of the real system. As an abstraction of a system, it offers insight about one or more of the system's aspects, such as its function, structure, properties, performance, behavior, or cost.

Contents

Overview

The modeling of systems as holistic, value-providing entities has been gaining recognition as a central process of systems engineering. The use of modeling and simulation during the early stages of the system design of complex systems and architectures can:

- document system functions and requirements,
- assess the mission performance,

- estimate costs,
- evaluate tradeoffs, and
- provide insights to improve performance, reduce risk, and manage costs.

Modeling and analysis can complement testing and evaluations which occur later in the life cycle. In some systems, modeling and simulation may be the only way to fully evaluate performance (e.g., ballistic missile defense) or to evaluate system performance in severe scenarios (e.g., response to weapons of mass destruction attacks on the homeland). Furthermore, advanced simulations, e.g. flight simulators, and command and control center simulations, can be a cost-effective technique for personnel training in accompaniment with operational system training (INCOSE 2012).

Modeling serves to make concepts concrete and formal, enhance quality, productivity, documentation, and innovation, as well as to reduce the cost and risk of systems development.

Modeling occurs at many levels: component, subsystem, system, and systems-of-systems; and throughout the life cycle of a system. Different types of models may be needed to represent systems in support of the analysis, specification, design, and verification of systems. This knowledge area provides an overview of models used to represent different aspects of systems.

Modeling is a common practice that is shared by most engineering disciplines, including:

- electrical engineering, which uses electrical circuit design models
- mechanical engineering, which uses three-dimensional computer-aided design models
- software engineering, which uses software design and architecture models.

Each of these disciplines has its own language with its syntax and semantics, serving as a means of communication among professionals in that discipline. Analytic models are used to support power, thermal, structural, and embedded real-time analysis.

Modeling Standards play an important role in defining system modeling concepts that can be represented for a particular domain of interest and enable the integration of different types of models across domains of interest.

Topics

Each part of the Guide to the Systems Engineering Body of Knowledge (SEBoK) is divided into knowledge areas (KAs), which are groupings of information with a related theme. The KAs, in turn, are divided into topics. This KA contains the following topics:

- What is a Model?
- Why Model?
- Types of Models
- System Modeling Concepts
- Integrating Supporting Aspects into System Models
- Modeling Standards

References

Works Cited

INCOSE. 2012. *Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities*, version 3.2.2. San Diego, CA, USA: International Council on Systems Engineering (INCOSE), INCOSE-TP-2003-002-03.2.2.

Primary References

Dori, D. 2002. *Object-Process Methodology – A Holistic Systems Paradigm*. Berlin, Germany: Springer Verlag.

Estefan, J. 2008. *A Survey of Model-Based Systems Engineering (MBSE) Methodologies*, rev, B. Seattle, WA, USA: International Council on Systems Engineering. INCOSE-TD-2007-003-02. Available at: http://www.omgsysml.org/MBSE_Methodology_Survey_RevB.pdf. Accessed April 13, 2015.

Friedenthal, S., A. Moore, R. Steiner, and M. Kaufman. 2012. *A Practical Guide to SysML: The Systems Modeling Language,* 2nd Edition. Needham, MA, USA: OMG Press.

Guizzardi, G. 2007. "On ontology, ontologies, conceptualizations, modeling languages, and (meta)models," *Proceedings of the Databases and Information Systems IV Conference,* Amsterdam, Netherlands. Available at: ACM http://portal.acm.org/citation.cfm?id=1565425. Accessed

December 4 2014.

INCOSE. 2007. *Systems Engineering Vision 2020*. Seattle, WA, USA: International Council on Systems Engineering. September 2007. INCOSE-TP-2004-004-02.

Wymore, A.W. 1993. *Model-Based Systems Engineering*. Boca Raton, FL, USA: CRC Press, Inc.

Additional References

Holt, J. and S. Perry. 2008. *SysML for Systems Engineering*. Stevenage, UK: Institution of Engineering and Technology. Available at: Ebrary http://site.ebrary.com/id/10263845. Accessed December 4 2014.

Grobshtein, Y. and D. Dori. 2011. "Generating SysML views from an OPM model: Design and evaluation," *Systems Engineering,* vol. 14, no. 3, Sept.

West, P., J. Kobza, and S. Goerger. 2011. "Chapter 4, systems modeling and analysis," in Parnell, G.S., P.J. Driscoll, and D.L Henderson Eds., *Decision Making for Systems Engineering and Management*, 2nd ed. Wiley Series in Systems Engineering. Hoboken, NJ, USA: Wiley & Sons Inc.

< Previous Article | Parent Article | Next Article >
SEBoK v. 2.6, released 20 May 2022
