



2022
Annual **INCOSE**
international workshop
HYBRID EVENT
Torrance, CA, USA
Jan 29 - Feb 1, 2022

schindel@ictt.com

V1.2.2

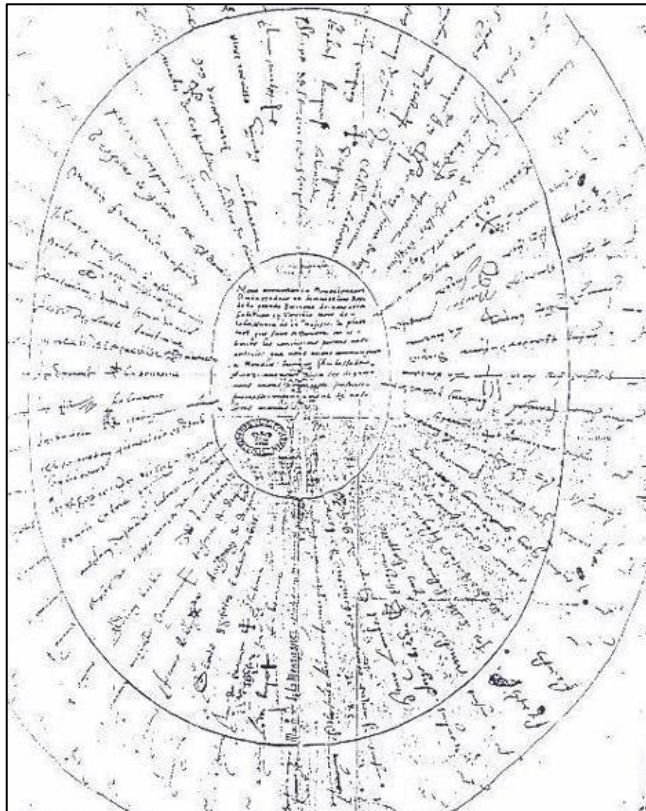
https://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:mbse_patterns_wg_participation_in_incose_iw2022

**Invitation to Patterns WG Meeting
at IW2022: Sunday, Jan 30,
1:00 – 3:00 Pacific Time, Salon B-C**

MBSE Patterns Working Group

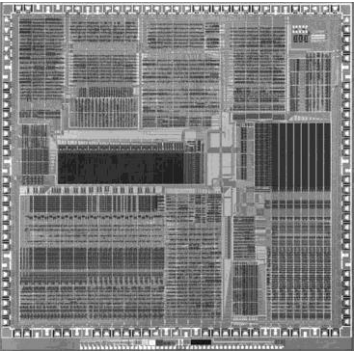
IW2022 MBSE Workshop, 30 Jan 2022:
Working Groups **'Round Robin'** Session

Round robin (n.): "petition or complaint signed in a circle to disguise the order in which names were affixed and prevent ringleaders from being identified," 1730, originally in reference to sailors and frequently identified as a nautical term. <https://www.etymonline.com/word/round%20robin>

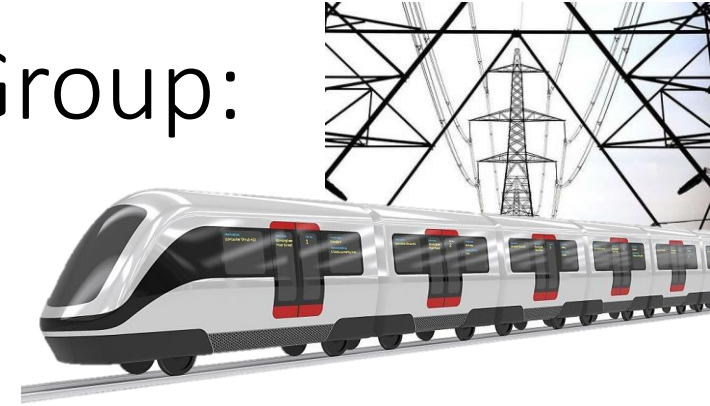


Jessé de Forest's Round Robin from 1621

[https://en.wikipedia.org/wiki/Round-robin_\(document\)](https://en.wikipedia.org/wiki/Round-robin_(document))

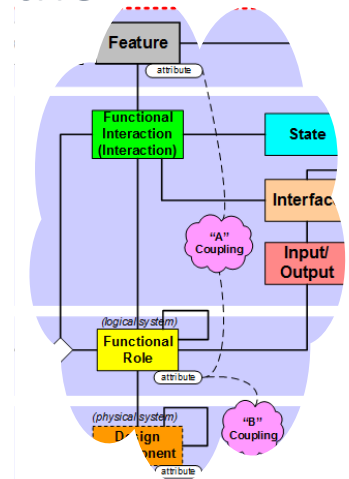


Focus of MBSE Patterns Working Group: S*Patterns



Configurable, re-usable system models:

1. Models containing a certain minimal set of elements are called S*Models (S* is short for “Systematica”)
2. Those underlying elements are called the S*Metamodel, which was inspired by the physical sciences
3. S*Models using those elements may be (have been) expressed in any modeling language (e.g., OMG SysML, or other languages)
4. S*Models can be (have been) created and managed in many different COTS modeling tools.
5. Re-usable, configurable S*Models are called S*Patterns
6. By “Pattern-Based Systems Engineering” (PBSE) we mean MBSE enhanced by these generalized assets
7. These are system-level patterns (models of whole managed platforms), not just smaller-scale component design patterns



Current working group projects, activities—status, Q&A

1. Interface Patterns Project
2. Semantic Technologies for Systems Engineering (ST4SE) Project (orig. suggested by S. Jenkins, H-P deKoning).
3. Adaptive Learning Ecosystem Pattern—the INCOSE ASELCM Reference Framework (orig. joint w/Agile SE WG).
4. Universal Model Metadata Wrapper: Model Characterization Pattern (MCP), w/ASME VV Stds Cmte & V4 Inst.
5. S*Pattern Configuration Wizard.
6. Minimal S*Models—A Primer (including S*Metamodel and its formal mappings to OMG SysML and tools)
7. S*Patterns Primer (second ed)
8. ASME Guideline for Managing Credibility of Models for Adv. Manufacturing, w/ASME VV50 Stds Working Grp.
9. AIAA Aerospace Digital Twins Case Studies Pub; Digital Twin Analysis and Planning Reference Pattern, w/AIAA.
10. AIAA Aerospace Digital Threads Position Pub; Digital Thread Analysis & Planning Reference Pattern, w/AIAA.
11. *Handbook of System Sciences*, for ISSS via Springer: Chapter: “Patterns in Science and Engineering”, w/ISSS.
12. *Handbook of Model-Based Systems Engineering*, Madni & Augustine, eds, Springer, Chapter: “MBSE Patterns”.
13. *INCOSE SE Handbook*, 5th Ed., for INCOSE, D. Walden et al, eds, material on S*Metamodel and ASELCM Pattern
14. *INCOSE Vision 2035*, SE Theoretical Foundations Project.
15. *INCOSE INSIGHT*, Dig. Engg. Issue, 2022, F. Salvatore, ed, Realizing the Promise of Digital Engineering: The Innovation Ecosystem Reference Pattern for Analysis, Planning, and Implementation.

Attachment



Brief descriptions of current and recent projects



Interface Pattern Project

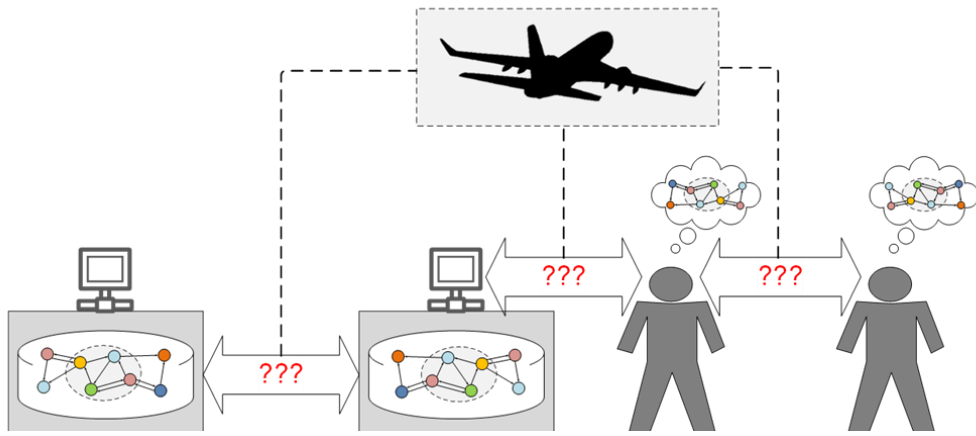
- Configurable patterns for Interfaces of all types
- Originally suggested by Frank Salvatore
- Initial work during 2017-2019
- Became part of ST4SE Project in 2020
- Additional progress on configurable Interface Pattern achieved in 2021 as part of semantic technologies exercise.



Semantic Technologies for Systems Engineering (ST4SE)

Suggested by S. Jenkins, H-P deKoning. TPP:

http://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:incose_patterns_wg_st4se_project_tpp_v2.0_signed.pdf



- This project combines demonstration of (1) [automated generation of consistent trustable models from trusted model-based patterns] with (2) [automated checking of human-generated models against trusted model-based patterns].
- Human beings may be the original interpreters of the meaning of models, but non-human semantic technologies have joined human interpreters of meaning.
- Information technologies that deal with model semantics (encoded meaning) include modeling languages, model authoring tools, simulation engines, web-based semantic data structures, and query and reasoning technologies.
- Semantic technologies strengthen impact of model-based semantics on engineering.
- Technical Product Plan: INCLOSE distribution of data structures, not just documents.
- Interested participants can be part of evaluating utility and new distribution paradigms.

Adaptive Learning Ecosystem Pattern—the Learning Ecosystem (ASELCM) Reference Framework

- Collaborating with INCOSE Agile SE WG, a reference pattern was contributed by Patterns WG during the two-year INCOSE study of agile SE practices of four major organizations during 2015-2017, leading to four published case studies. (Led by Rick Dove, Agile SE WG.)
- The original pattern (Agile SE Life Cycle Management (ASELCM) Operational Reference Pattern) was subsequently formalized by the Patterns WG as a configurable S*Pattern in SysML, for the planning, analysis, and management of advancement in learning ecosystems for projects, enterprises, and supply chains.
- The resulting multi-layer pattern focuses on leveraging Digital Engineering to advance performance through the paradigm of strengthened Consistency Management.
- Those interested in participating can be a part of extension and application of this pattern in case studies of their own projects, enterprises, or supply chains, plus related tooling.

26th annual INCOSE International Symposium
Edinburgh, UK
July 18 - 21, 2016

Introduction to the Agile Systems Engineering Life Cycle MBSE Pattern

3. System of Innovation (SOI)
Learning & Knowledge Manager for LC Managers of Target System
Life Cycle Manager of LC Managers
2. Target System (and Component) Life Cycle Domain System
Learning & Knowledge Manager for Target System
LC Manager of Target System
1. Target System
Target Environment

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http://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:is2016_intro_to_the_aselcm_pattern_v1.4.8.pdf

INCOSE Agile Systems Engineering Life Cycle Management (ASELCM) Pattern

Consistency Management as an Integrating Paradigm for Digital Life Cycle Management with Learning

Including Computational Model VVUQ and Applications for Semantic Technologies

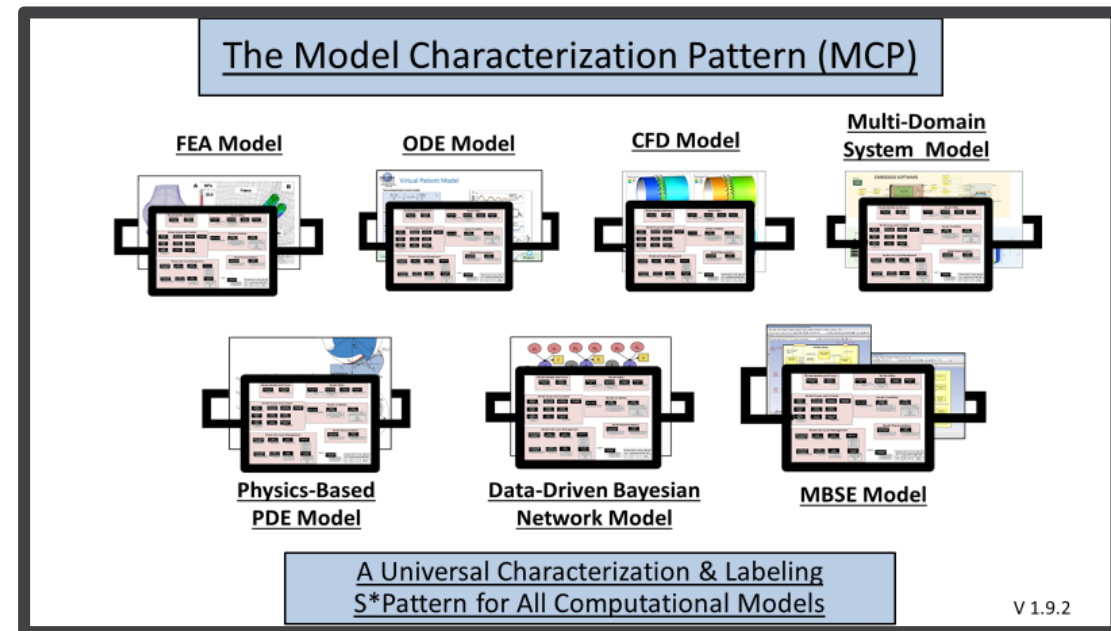
INCOSE/OMG MBSE Patterns Working Group
09.27.2020 V1.2.3

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http://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:aselcm_pattern_-_consistency_management_as_a_digital_life_cycle_management_paradigm_v1.2.2.pdf

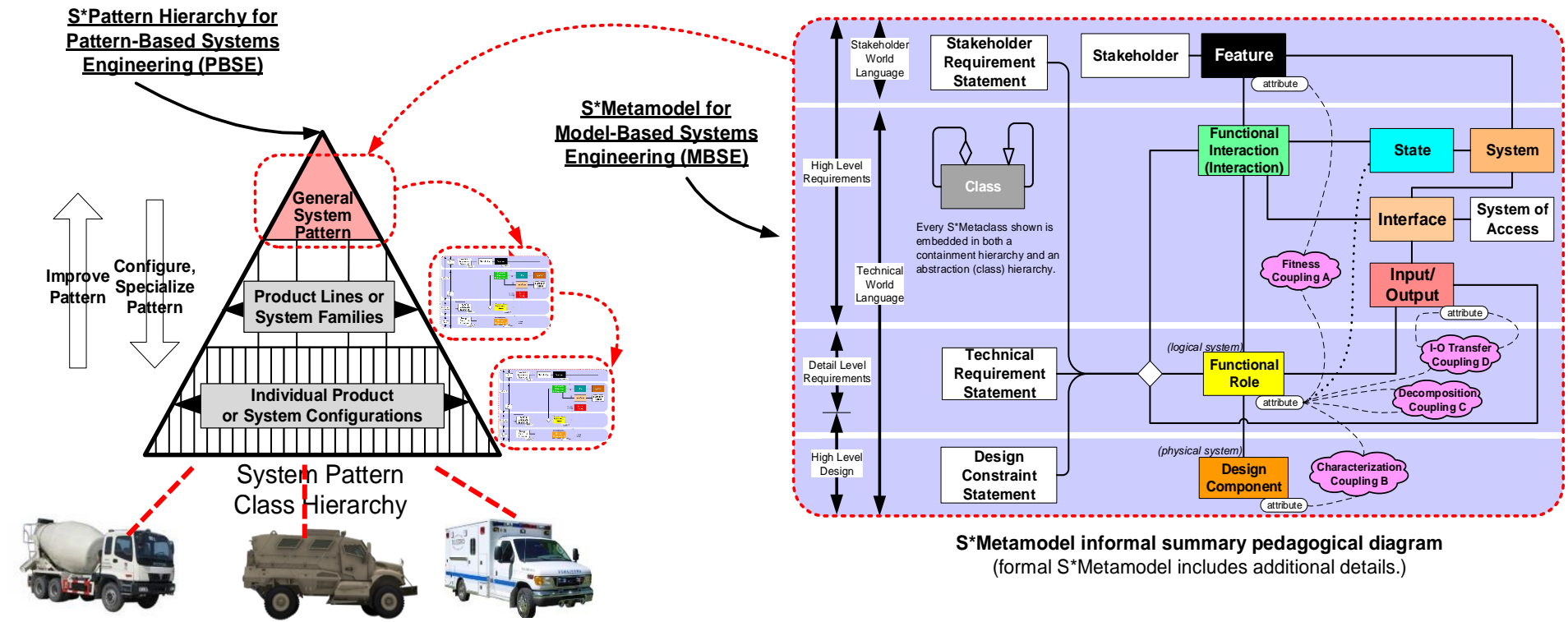
Universal Model Metadata Wrapper: The Model Characterization Pattern (MCP), w/ASME VV Standards Committee & V4 Institute

- Collaborating with ASME Standards Committee on Model Credibility, VV50 Subcommittee, Patterns WG created a configurable pattern for representing metadata on any virtual model, including Machine Learning, Simulation (FEA, CFD, SD, ODE), MBSE, otherwise. Auto generates Reqs for models. (ASME WG led by Joe Hightower.)
- This universal metadata framework includes Model Identify and Focus, Model Utility, Model Scope and Content, Model Credibility, Model Representation, and Model Life Cycle Management.
- Those interested in participating can be a part of continued testing and feedback on the application of the MCP to model library organization and management, model exchanges and markets, and model life cycle credibility management.



S*Pattern Configuration Wizard

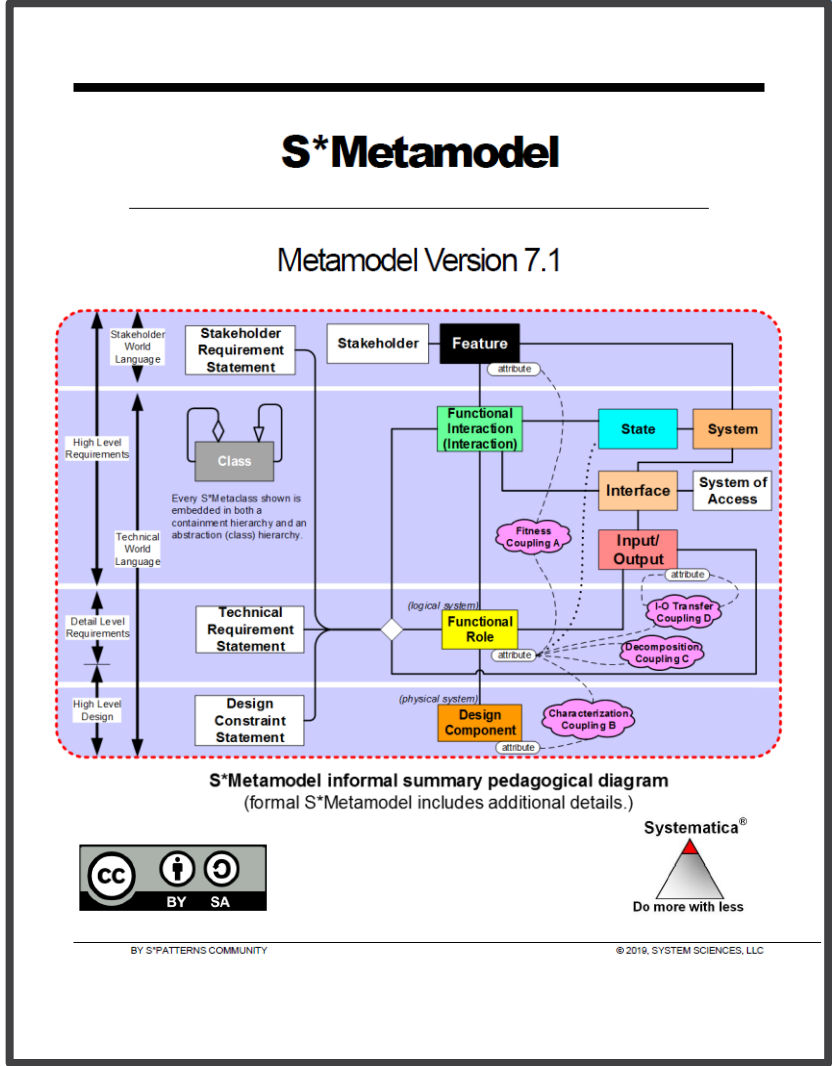
- Auto-generates MBSE model in SysML tool, as configuration of Pattern.
- Extendable to any modeling tool.
- Configuration algorithm encodable in any JOIN-supporting environment.
- Configurable patterns for products, enterprise ecosystems, other models.
- Currently in use in ST4SE Project, to be distributed with its deliverables.





Minimal S*Models—A Primer

- Introduction to S*Metamodel & its mapping to 3rd party COTS modeling tools.
- The laws of nature which are the basis of the natural sciences are all formal descriptions of recurring patterns associated with observable phenomena.
- Finding the smallest model-based representation of those patterns has important practical as well as theoretical importance.
- The practical importance is reduction of unnecessary proliferation of information that is redundant and often inconsistent or conflicting.
- The theoretical importance is that size of minimal models is one of formal measures of (Kolmogorov) complexity.
- Independent of choices of modeling languages, tools, and methods, we want to base our representation of system patterns on the simplest framework necessary for the purposes of engineering and science over the life cycle of systems.
- This Primer is to describe the S*Metamodel—a long-tested pattern based on the history of physical sciences and engineering, focused on the minimal information set.
- Those interested in participating can be a part of writing and review of this S*Metamodel Primer—including examples.



This formal Metamodel Ref is not the Primer.
https://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:systematica_5_metamodel_v7.1.6a.pdf



S*Patterns Primer (second edition)

- The Patterns WG generated an introduction and overview of pattern-based methods and their relationships with other subjects—this was several years ago and before the emergence of newer INCOSE Tech Ops approaches to INCOSE Technical Product “primers” on various subjects supported by the working groups.
- This project is concerned with recasting the earlier publication in the form of an updated “Primer” on model-based patterns and related subjects.
- Those interested in participating can be a part of review of the earlier document and newer INCOSE primers, regeneration of an updated primer form asset, or review of the resulting document for submission as a Technical Product.

MBSE Methodology Summary:
Pattern-Based Systems Engineering (PBSE), Based On S*MBSE Models

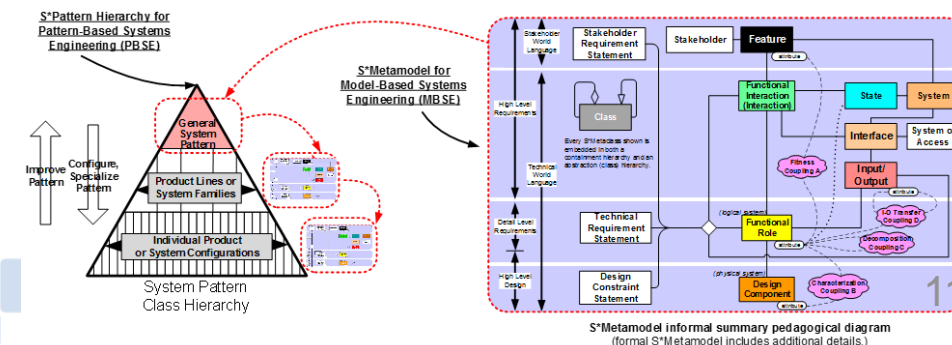
Document Purpose:

This document is a methodology summary for Pattern-Based Systems Engineering using S*MBSE models. The material below, resulting from Patterns Challenge Team review, feedback, and related updates, is for contribution to the INCOSE-maintained on-line directory “MBSE Methodology: List of Methodologies and Methods”.

The current content of that on-line directory may be found at
http://www.omgwiki.org/MBSE/doku.php?id=mbse:methodology#mbse_benchmarking_survey

The sectional structure of the following sections conforms to the standard summary outline template used by the referenced methodology directory. The typical methodology descriptions in that directory are currently summaries, not detailed “how to” manuals, for each methodology.

http://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:pbse_extension_of_mbse-methodology_summary_v1.6.1.pdf



ASME Guideline for Managing Credibility of Models for Adv. Manufacturing, w/ASME VV50 Standards Working Grp.

- ASME VV50 Standards-writing project supported by INCOSE began 2016.
- Combining lessons of computational model VVUQ with lessons of MBSE model learning and credibility, supported by model metadata pattern.
- Balloting in 2022.

Verification and Validation Interactions
with the Model Life Cycle:
Status of a VV50 Working Group

*Bill Schindel, ICTT System Sciences, schindel@icct.com
on behalf of*

*Joe Hightower, The Boeing Company joe.c.hightower@boeing.com, working group chair
Gordon Shao, NIST, quodong.shao@nist.gov, working group vice-chair*

ASME Virtual Symposium on
Verification and Validation,
May 19-20, 2021

AMSE Virtual Symposium on Verification and Validation, May
19-20, 2021

https://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:model_life_cycle_working_group_status_v1.2.5.pdf

AIAA Aerospace Digital Twins Case Studies Publication and AIAA Aerospace Digital Thread Position Publication— Supported by INCOSE ASELCM Reference Pattern AIAA-INCOSE Collaboration producing Aerospace Digital Twin and Aerospace Digital Thread references, based on ASELCM Pattern

AIAA DEIC
DGE-02: Report on the Digital Twin Implementation Paper

Panel Chairs:
John Matlik (Rolls Royce Corporation) – john.f.matlik@rolls-royce.com
Olivia Pinon Fischer (Georgia Institute of Technology) – olivia.pinon@asdl.gatech.edu

AIAA SCITECH 2022
San Diego, CA
January 3rd, 2022

AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS | AIAA.ORG

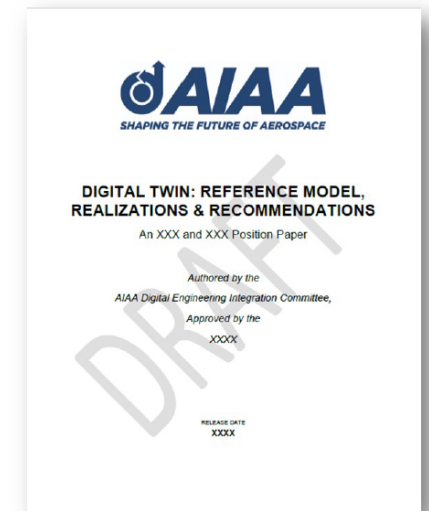


OUTLINE & CONTENT

1. Purpose
 - Articulate the need for such paper
2. Descriptive Reference Model for Digital Twins
 - Provide a generic reference model and framework (INCOSE's Agile Systems Engineering Life Cycle Management (ASELCM) Pattern) for describing how Digital Twins integrate with the broader digital enterprise
3. Summary of Realization Case Studies
 - Provides context for demonstrating specific instance of the reference model
 - Industry prioritized case studies for Space, Air & Ground
4. Summary of ASELCM Applications
 - Synthesize how the generic reference model supports the various use case applications
5. Recommendations & Next Steps
 - Stay consistent with & integrate "recommendations/next steps" agreed as part of the AIA/AIAA Digital Twin Position Paper
6. Appendices
 - Full descriptions of the 7 use cases

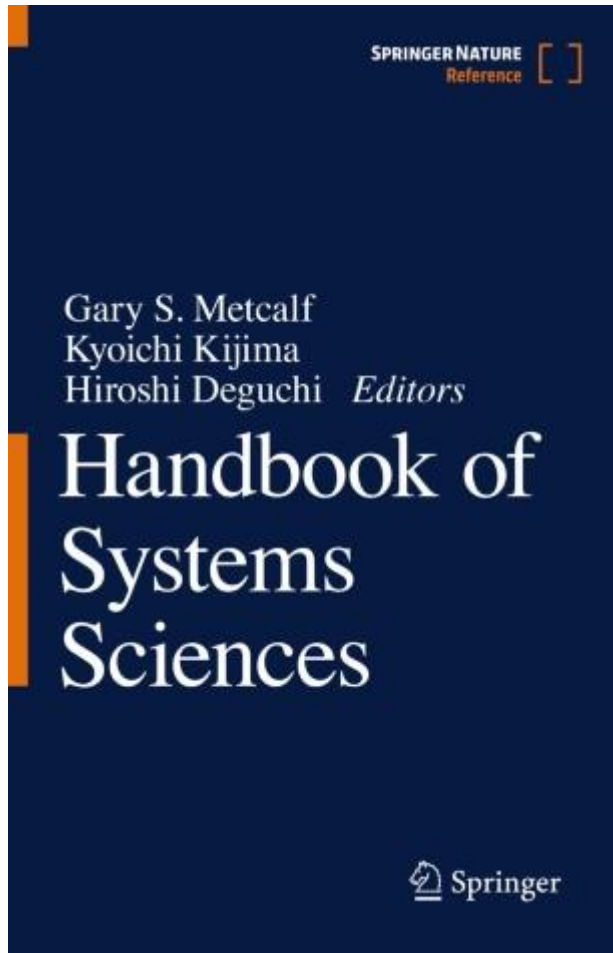
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https://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:aiaa_deic_dtw_implementation_paper_scitech2022panel_distribute.pdf

Handbook of System Sciences, for ISSS via Springer-- Chapter: “Patterns in Science and Engineering”, w/ISSS



SpringerLink

[Handbook of Systems Sciences](#) pp 1-43 | [Cite as](#)

System Patterns in Engineering and Science

Authors Authors and affiliations

William D. Schindel

Living reference work entry
First Online: 02 September 2020

2 Mentions 186 Downloads

Abstract

Human life is experienced as recurring system patterns – the informal events of everyday living, expression of creativity and aesthetic experiences of the arts, organized observation and discovery in the physical sciences, and technically engineering the systemic improvement of the human condition. Patterns have been expressed and analyzed across these diverse domains in the languages native to each. In the case of science and engineering, the subject of this chapter, explicit formal methods for discovering, synthesizing, representing, analyzing, and applying patterns, have reached great heights, transforming human life over three centuries. In spite of successes, diversity of language and perspective across individual physical science and engineering disciplines has masked the common thread of system patterns running through these scientific and engineering works. The more recent attention to the science and engineering of systems in general, including explicit models of general systems, illuminates the nature of general system patterns and their fundamental contribution to representation and progress in science and engineering of systems. In addition to providing a unifying perspective to historical accomplishments of specialized disciplines, system patterns also simplify the complexity of existing engineering environments while advancing ability to develop new scientific and engineering disciplines for more complex domains, including markets, networks, distribution systems, the Internet of Things, communities, and the innovation process itself. This chapter and references provide an actionable perspective for readers interested in this revolution. A key lesson of this chapter is that system patterns reduce the challenge of accomplishing nearly any goal in the life of systems.

- ISSS Reference Textbook project supported by Patterns Working Group.
- Chapter on “System Patterns in Engineering and Science”
- An ISSS-INCOSE effort.

Handbook of Model-Based Systems

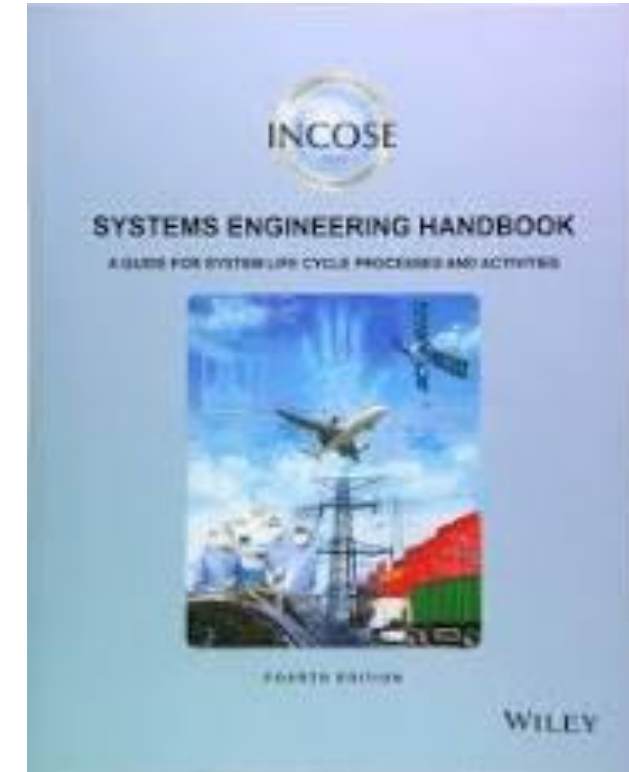
Engineering, Madni & Augustine, eds, Springer,
Chapter: “MBSE Patterns”.



- Patterns Working group generation of “MBSE Patterns” chapter for new *Handbook of Model-Based Systems Engineering*.
- Editors: A. Madni and N. Augustine.

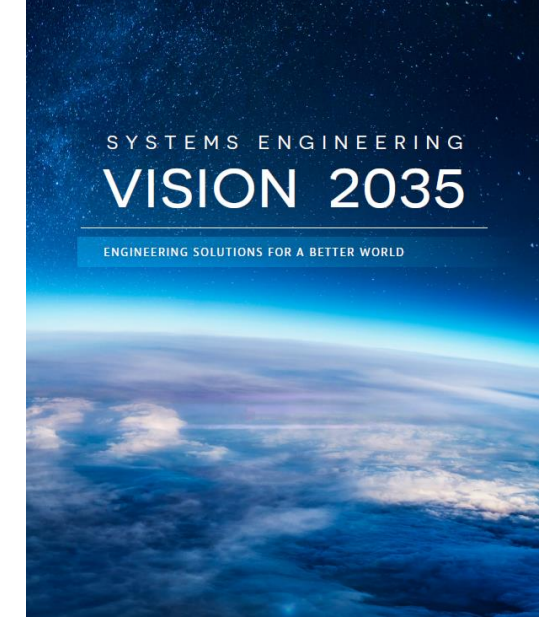
Contributed invited material on ASELCM Pattern, Pattern-Based Methods, and S*Metamodel

- The Patterns Working Group is contributing invited content on pattern-based methods to the INCOSE SE Handbook, 5th edition project, now in generation.
- The structure of the 5th Edition of the SE Handbook is re-architected compared to past editions, based on progress and needs of the community.
- Those interested in participating can contribute to review of the related handbook material during defined project phases, as the overall SE Handbook 5th Edition progresses during 2021-2022.
- Initial review held during IW2021 meetings; more at IW2022.
- Overall project is led by INCOSE Handbook Editorial Team, chaired by Dave Walden.



**Current (4th)
Edition**

INCOSE Vision 2035 contributions, from SE Theoretical Foundations Project



- The Patterns Working Group provided invited content on SE Theoretical Foundations for the *INCOSE Vision 2035* publication project, completed for IW2022.
- Publication project led by editorial team chaired by S. Friedenthal.
- Material drawn from the ongoing SE Theoretical Foundations Project of the Patterns Working Group.
- Continued participation in this project invited by the working group.

http://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:science_math_foundations_for_systems_and_systems_engineering-1_hr_awareness_v2.3.2a.pdf

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V2.3.2

INCOSE

Implications for Future SE Practice, Education, Research:
SE Foundation Elements

Discussion Inputs to *INCOSE Vision 2035* Theoretical Foundations Section

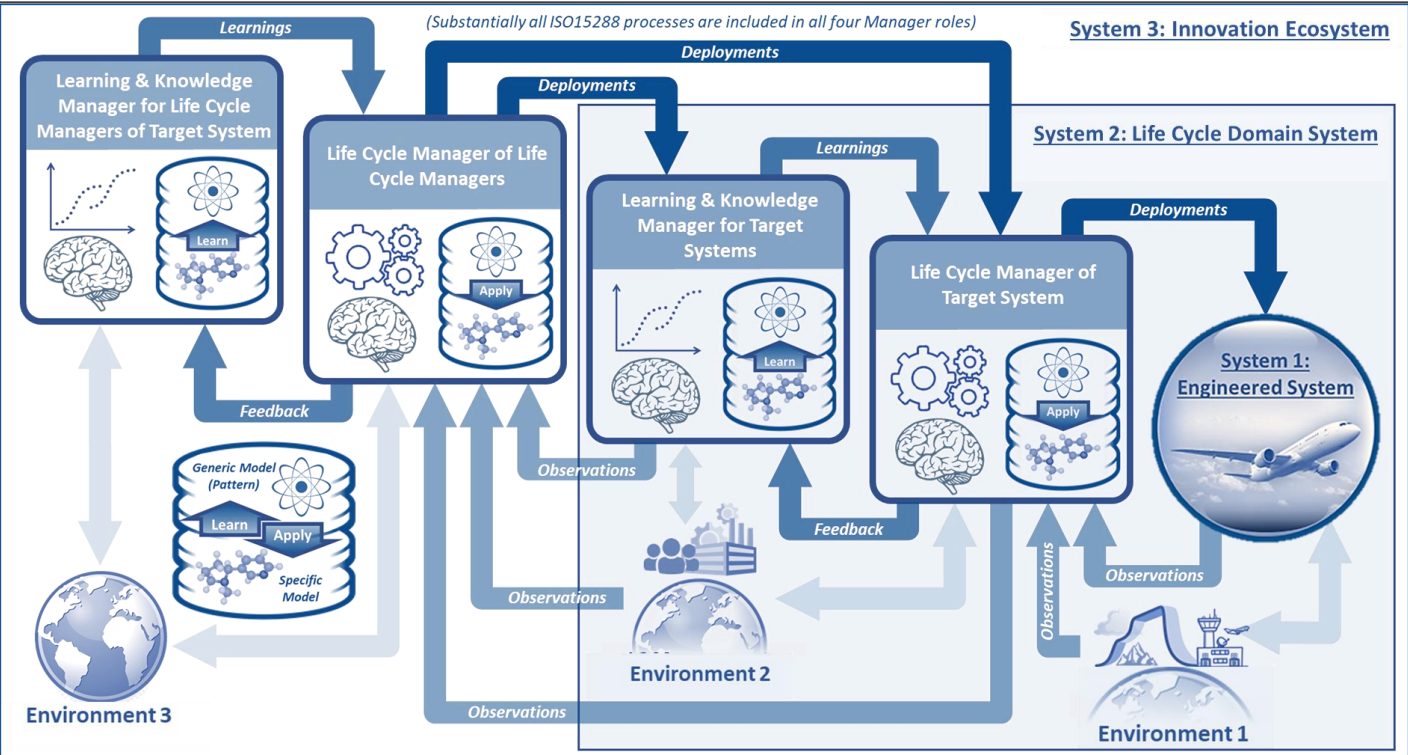
(awareness version, 1 hour) Copyright © 2020 by W. D. Schindel. Permission granted to INCOSE to publish and use.

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INCOSE INSIGHT, Digital Engineering Issue, March, 2022



- Contributed invited article: “Realizing the Value Promise of Digital Engineering: Planning, Implementing, and Evolving the Ecosystem”
- Based on the INCOSE ASELCM Ecosystem Pattern:



F. Salvatore and T. Gilbert,
special issue editors