INCOSE Semantic Patterns for Systems Engineering (SP4SE) Deliverables Technical Product Plan (TPP)

1 PROJECT NAME

Semantic Patterns for Systems Engineering (SP4SE) Project

2 PROBLEM STATEMENT

MBSE models can be generated from, or validated against, model-based MBSE Patterns, as practiced by the INCOSE MBSE Patterns Working Group. This reduces effort and cycle time in re-generating and re-validating high credibility models and re-correcting oversights and discoveries that have been made in the past by others. The related problem to be addressed is that MBSE is frequently viewed as many engineers learning modeling languages and tools and creating models for their projects "from scratch" or from accumulated informal experience. As demand increases for model-based representations but simultaneously for validation and verification of authoritative models of critical systems for related high impact decisions, this is not a competitively sustainable paradigm. A key part of the problem statement is that "everyone creating their own models" is a currently dominant paradigm in the emerging MBSE practice, so that demonstration and facilitation of the MBSE Pattern alternative is needed. Addressing that need, this project is an outgrowth of INCOSE MBSE Patterns Working Group external INCOSE partner interactions with OMG (for SysML V2.0), NASA JPL (Mission Ontology and Semantic Technologies), ASME (Model V&V Standards Committee VV50 Model Life Cycle Working Group), V4 Institute (Virtual Model capability advancement and the ASELCM Pattern), and ASSESS (application of Model Characterization Pattern).

3 TARGET AUDIENCE

The target audience includes (1) MBSE Model Authors, (2) MBSE Model Users, (3) Engineering Leaders who influence methods and practices, and (4) System Acquirers and Owners who influence methods and practices. The INCOSE Patterns Working Group already involves some outside of U.S. participants, but this project is initially staffed by US-based individuals. The initial domain of interest is System Engineering itself (Systems 2 and 3 of the ASELCM Pattern discussed below), as opposed to individual product or other engineered system domains.

4 PRODUCT CONCEPT & PROPOSED SOLUTION

Figure 1 is an OV-1 level context reference diagram used in the MBSE Patterns Working Group.

The project's initial deliverables are model-based semantic patterns (data content at the top of the pyramid in Figure 1) of use to address the above problem statement, along with documentation and examples of use in various environments of use. Those environments, while not the deliverable of this project, include use of Semantic Technologies.

"Semantic Technologies" refers to information technologies (language standards, automated tooling, and related methodologies) that are concerned with explicated meaning represented by model data structures. Examples include OMG SysML® modeling language and tools, W3C OWL DL web ontological language and tools, and automated semantic reasoners or other Semantic Web technologies.

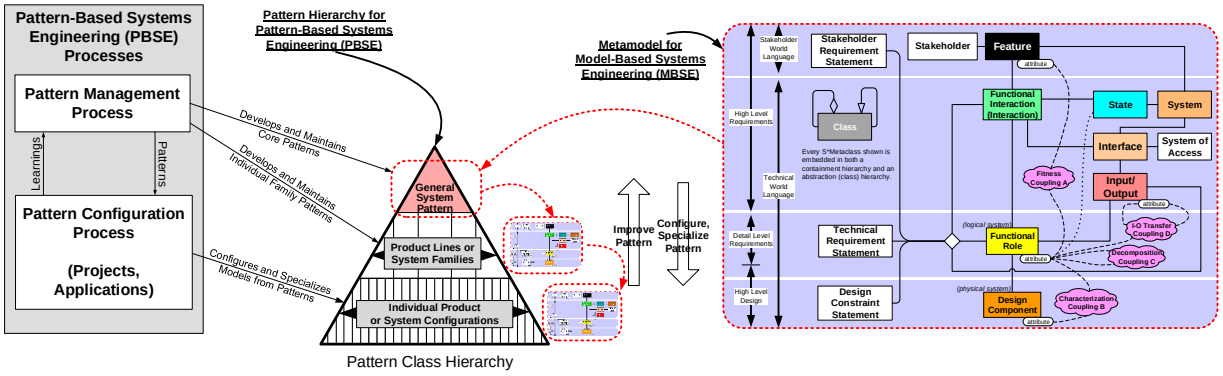

Figure 1: PBSE Diagram

The resulting class hierarchy of existing or typical MBSE Patterns is illustrated in Figure 2. Although the MBSE Patterns Working Group is sometimes involved in domain-specific product or similar example patterns (at the bottom of Figure 2), the main concern of Patterns Working Group as well as this project is the general methodology and therefore the more general patterns common across systems engineering as a discipline. Those general patterns fit in the sections above the lowest level shown in Figure 2. Like the MBSE Patterns at all levels of Figure 2, these data structures become the points of accumulation of organizational or group learning and common understanding (as well as variability) about the subject matter at that level. They are effectively reusable, configurable "product line" patterns for accumulation of learning across individuals, teams, enterprises, supply chains, and industry groups.

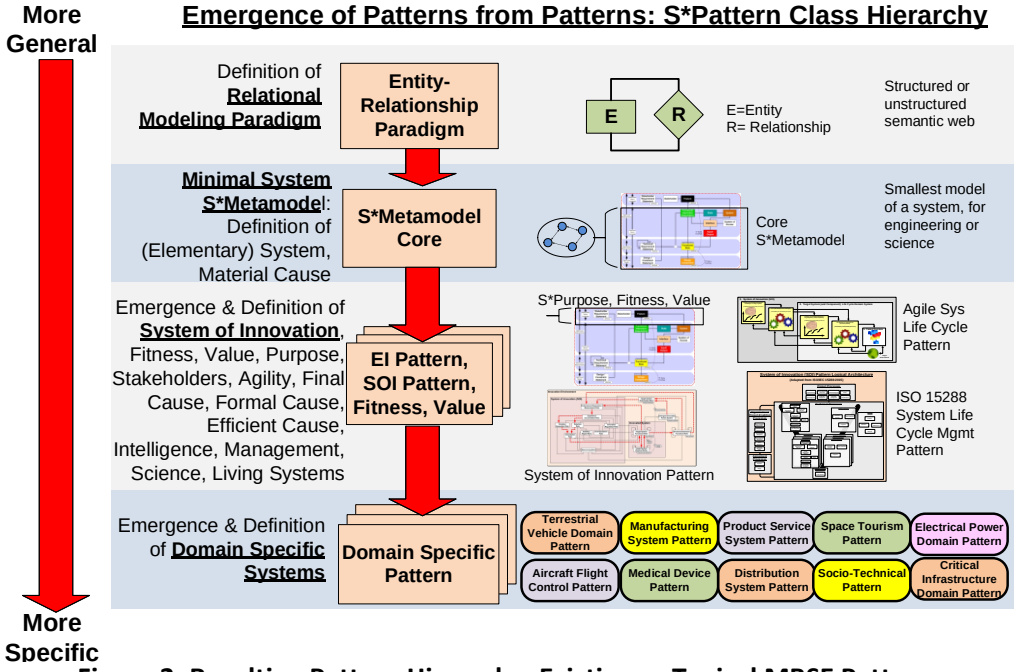

Figure 2: Resulting Pattern Hierarchy, Existing or Typical MBSE Patterns

4.1 FIRST (2019) DELIVERY: GAINING INCOSE EXPERIENCE IN NEW TERRITORY

This project is to deliver a series of MBSE Patterns, for use by both INCOSE members and others in their advance of systems engineering practice and outcomes. While MBSE Patterns, over the last twenty years, is itself relatively novel, this project includes additional aspects that are additionally novel (and therefore unfamiliar) for INCOSE, and are intended to be tested in themselves by this project:

1. The non-exclusive distribution of content through multiple channels in addition to INCOSE itself, even though INCOSE will hold a copyright for an INCOSE branded version
2. The ability of users to derive their own versions of the distributed items
3. The use of techniques associated with open software development and distribution, including public license to use at no license charge to the user

It is recognized that these aspects in themselves may present perceived risks through their relative unfamiliarity in INCOSE's experiences. Therefore, this project is structured to explore that space incrementally, beginning with a limited first asset distribution that has been targeted all year by the project team for December, 2019. The simple pattern asset to be distributed is the System Interface Pattern. It is a general MBSE pattern that can be specialized to individual interface types and has been studied by both a special Interface Patterns Team and the subsequent ST4SE JPL-OMG-INCOSE team. This simple pattern will allow the less familiar operational or business aspects listed above to become more familiar to INCOSE through experience.

4.2 SECOND (2020) DELIVERY: MODEL CHARACTERIZATION PATTERN (MODEL METADATA WRAPPER)

After evaluation of the experience of the first delivery described above, it is expected that the second pattern delivery in early 2020 will be chosen from a number of candidates in the pipeline of the team already. A leading candidate is the Model Characterization Pattern (MCP), developed in a Patterns Working Group collaboration with ASME, V4I, and ASSESS. This was previously briefed to the INCOSE Corporate Advisory board in 2017:

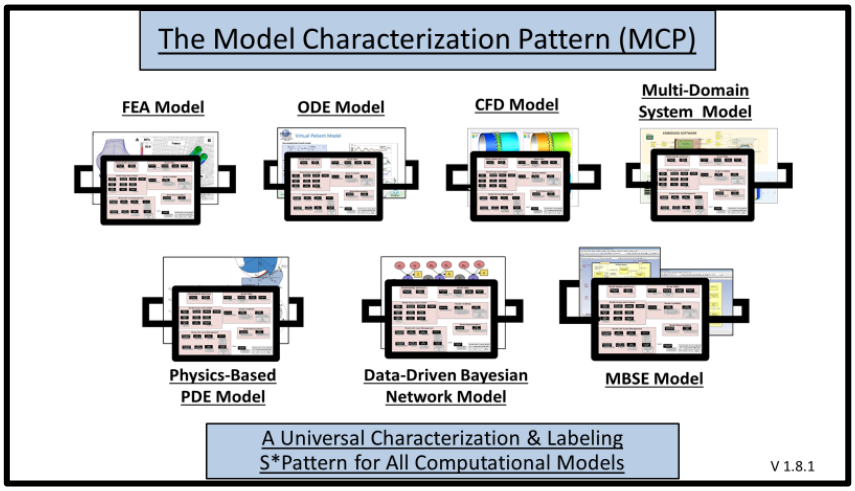

Figure 3: Model Characterization Pattern (MCP) – The "Model Wrapper"

As further described in the MCP Reference publication, this pattern enables the following uses:

1. Rapidly generate very systematic model requirements for new or existing models, for use in model development, verification, validation, and life cycle management.
2. More effectively plan new or improved computational models, and know when you need them, versus making use of existing model assets.
3. Lower the experience threshold needed to plan and manage computational models, including model VVUQ.
4. More effectively manage large collections of diverse computational models and related information.
5. Improve access to collections of models by exposing their characteristics to users more effectively.
6. More effectively share models across supply chains and regulatory domains.
7. Lower the cost and time necessary to obtain trusted/credible models in regulated or other domains.
8. Use or manage models that were generated by others; increase the range of others who can effectively use models that you generate; reduce the likelihood of model misuse.
9. Improve the accumulation and effective use of model-based enterprise knowledge.
10. Improve the integration of model-related work across specific engineering disciplines and overall systems engineering.
11. Increase ability to manage the integration of multiple computational models (e.g., using FMI), including their integrated VVUQ.

4.3 SIMILAR OFFERINGS, DIFFERENTIATIONS, OTHER OPTIONS CONSIDERED

Examples of other open source offerings:

Mozilla Firefox® web browser.
Thunderbird® email client.
PHP scripting language.
Python programming language.
Apache HTTP web server.

The above are executable computer software, not MBSE Pattern data structures.

Protégé® downloadable ontologies:

https://protegewiki.stanford.edu/wiki/Protege_Ontology_Library

The above pattern data structures are numerous specific domain ontologies, but not a systems engineering ontology.

There are model metadata lists, and a related ISO subproject within MOSSEC, but these are not of the same scope as the Model Wrapper Pattern, which may also inspire those efforts to improve their plans, of value the INCOSE community:

https://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:smswg:smswg_19:mossec_ap243_standard.pdf

The project team is also considering non-INCOSE alternatives, but would prefer INCOSE as a copyright holder over other parties under consideration, on the condition of the team's goal that a first example copyright (for the simple Interface Pattern asset) can be established by the end of 2019.

4.4 ADDITIONAL DETAILS: RELATED REFERENCES

Additional information about MBSE Patterns in general and the initially targeted patterns for this project may be found in the following references:

1. Methodology Summary: Pattern-Based Systems Engineering (PBSE), Based On S*MBSE Models https://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:pbse_extension_of_mbse--methodology_summary_v1.5.5a.pdf
2. INCOSE MBSE Patterns WG Web Site: https://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:patterns
3. Accelerating MBSE Impacts Across the Enterprise: Model-Based S*Patterns https://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:accelerating_mbse_impacts_across_the_enterprise_using_model-based_s-patterns_v2.1.1.pdf
4. Model Characterization Pattern: https://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:model_characterization_pattern_mcp_v1.8.1.pdf
5. Patterns in the Public Square" INCOSE Washington, DC, Panel with Regulators and DoD: https://www.omgwiki.org/MBSE/lib/exe/fetch.php?media=mbse:patterns:panel--is2018_schindel_et_al_v1.6.1.pdf

4.5 KEYWORDS

MBSE Patterns, Interfaces, Model Metadata, Open Source, Public Licensing

5 COMPETITVE ANALYSIS

(Covered in Section 4.3 above.)

6 STAKEHOLDERS

The INCOSE MBSE Initiative identified the stakeholders in Figure 4 as having stakes in the success of the MBSE Transformation.

7 PRODUCT DISTRIBUTION APPROACH

Refer first to the discussion of multiple non-exclusive distribution channels in Sections 2 and 4.

☒ INCOSE online bookstore (this is optional to team; INCOSE holding a copyright is mandatory)

☐ Printed copies at local events

☐ Printed copies at international events

☒3rd party online distribution by: identify the 3rd party (ST4SE Team git hub site) (ASME) (ASSESS)

☐ 3rd party hard copy distribution by: identify the 3rd party

☒ Other: describe other distribution channel

Population <-- Size (Log)	Stakeholders in A Successful MBSE Transformation (showing their related roles and parent organizations)	Industry & Gvmt. Initiatives Orgs. Internalizing MBSE, Including Gvmt. Contractors & Consultants	Commercial Vendors of MBSE Tooling and Services	Academia and Researchers	Technical Societies, Other Non-Technical Organizations	
Model Consumers (Model Users):						
****	Non-technical stakeholders in various Systems of Interest, who acquire / make decisions about / make use of those systems, and are informed by models of them. This includes mass market consumers, policy makers, business and other leaders, investors, product users, voters in public or private elections or selection decisions, etc.	X	X		X	
**	Technical model users, including designers, project leads, production engineers, system installers, maintainers, and users/operators.	X	X		X	
*	Leaders responsible to building their organization's MBSE capabilities and enabling MBSE on their projects	X	X		X	
Model Creators (including Model Improvers):						
*	Product visionaries, marketers, and other non-technical leaders of thought and organizations	X	X	X	X	
*	System technical specifiers, designers, testers, theoreticians, analysts, scientists	X	X	X	X	
*	Students (in school and otherwise) learning to describe and understand systems			X	X	
*	Educators, teaching the next generation how to create with models	X	X	X		
*	Researchers who advance the practice		X	X		
*	Those who translate information originated by others into models	X	X	X	X	
*	Those who manage the life cycle of models	X	X	X	X	
Complex Idea Communicators (Model "Distributors"):						
**	Marketing professionals	X	X	X	X	
**	Educators, especially in complex systems areas of engineering and science, public policy, other domains, and including curriculum developers as well as teachers	X	X	X		
**	Leaders of all kinds	X	X	X	X	
Model Infrastructure Providers, Including Tooling, Language and Other Standards, Methods:						
*	Suppliers of modeling tools and other information systems and technologies that house or make use of model-based information		X			
*	Methodologists, consultants, others who assist individuals and organizations in being more successful through model-based methods	X	X	X		
*	Standards bodies (including those who establish modeling standards as well as others who apply them within other standards)	X			X	
INCOSE and other Engineering Professional Societies						
*	As a deliverer of value to its membership				X	
*	As seen by other technical societies and by potential members				X	
*	As a great organization to be a part of				X	
*	As promoter of advance and practice of systems engineering and MBSE				X	

Figure 4: Stakeholders

8 PRODUCT MAINTENANCE APPROACH

The materials to be addressed are expected to be the above-listed MBSE Patterns. Two key considerations are the use of open software development and distribution methods and the intention that the subject patterns be the focus of group learning. Therefore, the paradigm of ongoing attention is somewhat different than traditional “develop, release, maintain”. Instead, a “develop, develop, develop” approach is expected, as long as there is a community of users interested in updates. Beyond that demand-driven approach, a quarterly or annual review will be appropriate, dependent upon intensity of interest.

9 PRODUCT RETIREMENT CRITERIA

Relevance and applicability can best be ascertained based on frequency of download. Lack of interest over a period of two years would be a reasonable cause to consider retirement, with consultation to include partner organizations.

10 TEAM MEMBERS

10.1 TEAM LEADER

The chair of the MBSE Patterns Working Group providing this plan is Bill Schindel. Other team members are listed below.

10.2 CONTENT CONTRIBUTORS

Steve Jenkins (NASA JPL), Hans Peter deKoning (ESA), Bill Schindel (ICTT System Sciences)

10.3 INDEPENDENT PEER REVIEWERS

Troy Peterson (MCP and Interface Pattern), Chris Paredis (Interface Pattern and MCP), Ann Hodges (MCP), Frank Salvatore (Interface Pattern)

10.4 CORE TEAM MEMBERS

Mark Blackburn (Stevens Institute)

11 PROJECT ASSUMPTIONS/GROUND RULES

Deliverables are for distribution without charge and may include INCOSE branding. INCOSE will hold a CC BY SA copyright and provide the CC BY SA license under which users may create their own versions, also copyrighted. Items brought to INCOSE hereunder may already be under a CC BY SA copyright license from their authors or other upstream parties, but this does not prevent INCOSE from packaging its own copyrighted version as long as offered by INCOSE under equivalent CC BY SA.

12 PROJECT STRATEGIES/APPROACH

Use of open software development methods.

Team's goal is that initial (Interface Pattern) asset must be under INCOSE copyright no later than end of 2019 in order to proceed.

Different pattern assets may involve work with different collaborating societies or partners, as discussed earlier above.

13 MILESTONES & ACTION PLAN

Specify the expected milestones to be met, tasks to be accomplished, and planned completion dates. At a minimum, the following milestones must be addressed. Note that required milestones may be combined. Required INCOSE process reviewers are in parentheses, more can be added.

1. Create the initial version of the first two pattern deliverables and beta test them. (This was already accomplished by the team in 2019 or earlier)
2. Determine whether there is INCOSE leadership willingness serve as a copyright owner and allow for public distribution (at least by others) without license fees. (This does not require INCOSE distribution or INCOSE branding, but is mandatory to the existing project team if INCOSE is going to be copyright owner, and under CC BY SA licensing) (By end of November.)
3. Place first experimental asset (Interface Pattern) under an INCOSE copyright CC BY SA license style. (Must occur by first week of December, or activate alternative partner and rest of TPP is not applicable from an INCOSE product point of view.)
4. Initial Acceptance of Technical Product Plan:

   •Intellectual Property Review with the Publications Office (Associate Director for Publications)

   •Quality Review of Review Process with Technical Operations (Assistant Director for Technical Review)

   •IT & Distribution Review with INCOSE Information Technology (INCOSE Chief Information Officer)

   •Branding, Marketing, & Commercialization Review with Marketing/Communications (Director of Marketing and Communications)

   •Technical Operations Process Review (Assistant Director for Technical Information)
5. Final Acceptance of Technical Product Plan (Director Technical Operations)
6. Final Product Release Review (Director Technical Operations)

7. Periodic Reviews for Learning updates, Maintenance, Obsolescence, Improvement, and Retirement Assessment (e.g., yearly)

Note: During project planning, the author of the Technical Product Plan should check with each reviewer individually to determine how much review time will be required and account for this review time in the project schedule.

14 REQUIRED RESOURCES (INCLUDING VOLUNTEER TIME AND BUDGET)

It is estimated that 64 hours per year per pattern author will be required, for each new pattern.

It is estimated that 8 hour per year per pattern reviewer will be required, for each new pattern.

These investments have already been made for the first two patterns.

It is estimated that four patterns per year will be authored and reviewed.

This project is not requesting INCOSE distribution, but allows for it if that is leadership's wish.

15 COMMUNICATION OF PROJECT STATUS AND RISKS

This project team already meets twice monthly, and has been doing so for well over a year. We also have been holding full day face to face meetings at least twice annually.

The Patterns Working Group as a whole meets at least twice annually, and can report on the project at both the IW and IS meetings where we are already regular participants in the MBSE Workshops there.

The main risks of this project are believed to be lack of INCOSE experience with open source methods, which are conducted more "bottom up" than "top down". The primary goal for the first period is for all parties to learn by experience whether this is a "fit", and to be forthright with each other in that assessment.

16 SIGNATURES

1st Level of Approval by Assistant Director for Technical Information:

Typed name of AD for
Technical Information

Name	Signature	Date

2nd Level of Approval by Director Technical Operations:

Typed name

Name	Signature	Date

Typed name

Name	Signature	Date

Typed name

Name	Signature	Date

Typed name

Name	Signature	Date

Technical Product Plan Revision History

Date	Revision	Description	Author
14 Nov 2019	1.2.1	Original draft, for feasibility determination with INCOSE leadership.	Bill Schindel