INCOSE MBSE Patterns Working Group Charter

1 PURPOSE

The purpose of the INCOSE MBSE Patterns Working Group is to advance the availability and awareness of practices and resources associated with the impactful creation, application, and continuous improvement of MBSE Patterns over multiple system life cycles. The practice of MBSE using System Patterns is also referred to as Pattern-Based Systems Engineering (PBSE).

This is a 2016 re-chartering of the former INCOSE MBSE Patterns Challenge Team, originally chartered in 2013 as a part of the INCOSE MBSE Initiative, which it continues to closely support. This Working Group Charter closely follows the original Challenge Team Charter (Attachment 1), updated here to mark the INCOSE organizational re-classification of this Challenge Team as a Working Group, while continuing the general mission of this historically active team.

As used here, System Patterns are configurable, re-usable System Models that would otherwise be like those expected and found in the practice of MBSE (not limited to, but including, OMG SysML models). Through the availability and use of System Patterns, the outcomes targeted by MBSE models are made more accessible, in terms of ease (and skill requirements) of generation and use, associated modeling cost, schedule, risk, completeness, and consistency, etc. Over time, System Patterns become points of accumulation of organizational learning and expertise. Because they are configurable and re-usable models of families or classes of systems, model-based System Patterns involve some additional methods and disciplines that extend the ideas of MBSE (e.g., Pattern Management, Configuration Rules, model minimality, etc.).

INCOSE has recognized the importance of model-based methods, in establishing the strategic objective to accelerate systems engineering transformation to a model-based discipline. The work of the MBSE Patterns Working Group increases the value, leverage, and applicability of system models as further described below.

2 GOALS

2.1.1 Stakeholders and Their Measures of Success

The following summarizes types of stakeholders in the work of this group, and the general areas of impact that measure related successes. Attachment 2 provides further discussion of the state of these measures:

System Innovation / Development Teams: Enjoy the benefits of MBSE with lower per-project model-origination and refinement time, effort, skill load, and risk, by employing configured System Patterns as early draft models.

System Modelers: Extend the span of influence of skilled individual modelers by making their models effectively available, applicable, and impactful to more projects, systems, and products.

Product Line Managers, Platform Managers, Portfolio Managers: Improve the effectiveness of families-of-systems disciplines, measured in terms of economic leverage.

System Verification Teams: Improve the performance of system verification planning and execution in high risk or complexity systems.

System Life Cycle Groups: Improve satisfaction with the early fit of systems to the learned needs of system life cycle communities, including manufacturing, distribution, end user, operations, and maintenance, over a broad range of issues that should not be re-discovered each generation (functionality, safety, many other aspects).

Tool Suppliers: Improve the ROI demonstrated by tools.

Enterprises: Improve organizational-level learning across individual people and projects, reducing occurrences of re-learning the same lessons and repeating the same mistakes.

2.1.2 PROJECTS AND DELIVERABLES:

Projects and Related Deliverables	Time Period
Generate multiple introductory and domain case study INCOSE papers, presentations, and tutorials across the team, on MBSE Patterns and PBSE, elucidating the approach and examples, at INCOSE IS, IW, and regional events, along with NDIA and other conferences.	2013-2016
Support the INCOSE MBSE Workshop with MBSE patterns-related IW sessions	2013-2016
Maintain a team web site providing access to team meeting minutes and PBSE reference materials and work products	2013-2016
Team generation of a submission to the INCOSE MBSE Methodologies Survey, posted for access by INCOSE membership	2014-2015
Perform joint projects with other INCOSE Working Groups, where PBSE and other subjects are natural partners, as follows:	
• **With System Sciences WG**: Project and publication on Patterns of Health and Pathology in Systems of Innovation	2014-2015
• **With Agile Systems WG:** Member of ASELCM Project Lead Team supporting the parent society ASELCM Project	2015-2016
• **With Health Care WG:** Support for planning and execution of INCOSE Conference on Agile Health Care Systems	2015-2016
• **With Product Line Engineering WG:** Joint project demonstrating method for harvesting an MBSE Pattern representing a product line from a legacy product set	2016-2017
• **With System of Systems WG:** Joint project demonstrating S*Pattern extensions to historical SoS WG activities	2016-2017
• **With ISSS:** Participation in / support of General Systems Theory plenary at international annual meeting	2016
• **With ASME V&V Standards Committees:** Patterns in Virtual Certification and Model Validation and Uncertainty Quantification	2016-2018
Support for deliverables of the INCOSE MBSE Transformation Lead Team	2015-2017
Additional targeted system application domain patterns	Future
Targeted science domain patterns	Future
ISO 15288 Implications of PBSE	Future

PBSE support for COTS Tools and Information Systems	Future
PBSE Implementation strategies & roadmaps, scenarios	Future
PBSE contribution to SEBoK	Future

3 SCOPE

The range and limitations on the scope of the work of this Working Group are closely associated with the range and limitations of scope of Pattern-Based Systems Engineering. Those scope boundaries are discussed at some length in Reference 1, a product of the original Challenge Team that compares and contrasts to a number of other related subjects and activities that are joint work opportunities with other INCOSE Working Groups.

4 SKILLS AND EXPERTISE REQUIRED

Although some background in MBSE may be helpful, this working group also provides a path for member learning about MBSE, so it is not a pre-requisite. Background in a specific domain (e.g., medicine, aerospace, etc.) or special enabling subject (e.g., agile systems, verification, etc.) are not required pre-requisites, but may add perspective for members wishing to apply PBSE on an impactful basis in their enterprises. Good collaboration skills and teamwork, along with interest in learning and willingness to share experience are valued skills and traits for this working group. An understanding the of breadth of system life cycles (as in ISO 15288, INCOSE Handbook, etc.) and the needs and challenges found there will likewise inform the member with a perspective on the impactful application of MBSE Patterns. An understanding of the essential nature of systems and the information used to describe them is likewise helpful, however this foundational knowledge is also detailed within the WG products and activities and can be acquired or improved by participation in this working group. PBSE provides a strong foundational metamodel and ontology to underpin and enable MBSE.

5 MEMBERS, ROLES AND RESPONSIBILITIES

List the names of members and briefly describe their responsibilities.

- Lead: (Currently Bill Schindel)
    - Responsibilities: Identify relevant priorities and projects from the membership and related teams; solicit members and required resources to conduct projects; provide direction, feedback, and prioritization as needed to maintain the group's plan and its pursuit of it; chair meetings; report to the assigned Technical Operations Assistant Director.
- Co-Lead: (Currently Troy Peterson)
    - Responsibilities: Connect working group to the INCOSE MBSE Transformation; support member communication; co-chair meetings; liaison to other working groups & societies & OMG; connect working group to the INCOSE MBSE Workshop; act in the absence of chair.
- Board Sponsor(s)/Champion(s): Mark Sampson, Troy Peterson
    - Responsibilities: Connect this working group to the INCOSE/OMG MBSE Initiative; connect to the INCOSE Board of Directors.

- Members:
    - Over 100 individuals have participated in this group's activities over the first three years of operation—refer to minutes of those activities on the team web site (Reference 2 below).

6 OUTCOMES (PRODUCTS/SERVICES)

Refer to Section 2.1.2 Projects and Deliverables, above.

7 APPROACH

This working group meets as a whole at least twice annually, plus additional working sessions by project team during the year as needed. All meetings include web conferencing for remote access. All meetings result in minutes posted to the team web site.

This working group makes heavy use of joint projects with other INCOSE Working Groups that are natural partners, also increasing the effectiveness and integration of INCOSE.

8 MEASURES OF SUCCESS

Specific measures of project success are identified by project. General measures of success of this working group include the size of its membership and number of engaged joint activity partners, and the number of activities successfully completed over the long term (years) period. In additional refer to section 2.1.1 "Stakeholders and Their Measures of Success" above.

9 RESOURCE REQUIREMENTS

COTS MBSE tooling, and is supporting documentation, training, or technical support may be required from time to time by this working group. If needed, these will be initially requested of the commercial suppliers of such resources, as a professional society support offering. Should funding be required, it will be requested by this working group.

An ongoing INCOSE web conferencing account (e.g., Adobe Global Meet or equivalent) will be needed for use in the working group's regular meetings and collaborative work sessions.

An ongoing INCOSE web site facility will be needed (and is already in use), administered by the working group membership, for posting of news and information as well as work products and collaboration materials.

Special travel expense or other funds needed will be requested, if they arise, on an as-needed basis. This team has functioned without such additional funds for several years, based on membership investment.

Should outreach to other societies warrant it, arrangement of inter-society MOU will be arranged through INCOSE.

10 DURATION

This Charter will remain in effect until rescinded by the signatory.

11 SIGNATURES

Enter the signature block of the submitter Date

1st Level of Approval

Technical Director, INCOSE Date

2nd Level of Approval (Note this will be added by the INCOSE Technical Director when deemed appropriate.)

INCOSE President Date

Revision History

Date	Revision	Description	Author
August, 2013	1.3.3	Originated as INCOSE MBSE Initiative Challenge Team Charter	Bill Schindel, Troy Peterson
May, 2016	2.1.2	Updated as INCOSE Working Group Charter, for INCOSE Tech Ops review and approval	Bill Schindel, Troy Peterson
June, 2016	2.2.1	Updated INCOSE Board Champions and Measures of Success to gain INCOSE Tech Ops approval	Bill Schindel, Troy Peterson

12 REFERENCES

1. MBSE Patterns Challenge Team, “MBSE Methodology Summary: Pattern-Based Systems Engineering (PBSE), Based On S*MBSE Models”, 2015.

2. MBSE Patterns Challenge Team web site: http://www.omgwiki.org/MBSE/doku.php?id=mbse:patterns:patterns

13 ATTACHMENT 1

"INCOSE 2013 Charter of the MBSE Patterns Challenge Team"

Charter: Pattern-Based Systems Engineering (PBSE) Challenge Team

The Pattern-Based Systems Engineering (PBSE) Challenge Team is a component of the INCOSE/OMG Model-Based Systems Engineering (MBSE) Initiative (http://www.omgwiki.org/MBSE/doku.php). This Charter is a draft proposed by the founding team members, for review and update by the team in formation and INCOSE MBSE Initiative leadership.

1. Purpose:

1.1. Conceptual Summary:

As used here, System Patterns are configurable, re-usable System Models that would otherwise be like those expected and found in the practice of MBSE (not limited to, but including, SysML models). Through the availability and use of System Patterns, the outcomes targeted by MBSE models are made more accessible, in terms of ease (and skill) of generation and use, associated modeling cost, schedule, risk, completeness, and consistency, etc. Over time, System Patterns become points of accumulation of organizational learning and expertise. Because they are configurable and re-usable models of families or classes of systems, model-based System Patterns involve some additional methods and disciplines that extend the ideas of MBSE (e.g., Pattern Management, Configuration Rules, model minimality, etc.).

This model-based PBSE approach has been in use for a number of years, applied across enterprises and domains that include mil/aerospace, communications, automotive, medical/health care, advanced manufacturing, consumer products, along with business processes including sales, engineering, production, and general innovation. The first INCOSE PBSE tutorial was provided at IS2005, another given at GLRC2012, and another at IS2013, with those attending the latter responding positively to interest in an ongoing PBSE group of some kind. We have also published a number of papers on this approach. Another PBSE workshop is currently planned for GLRC2013 in October.

1.2. Specific Challenge:

The PBSE Challenge Team will advance the availability of model-based System Patterns and related PBSE resources, and awareness of them, increasing the availability and successful use of System Models across the life cycle of systems. Specifically, this will be accomplished by meeting the following challenge:

> *Generating two or more MBSE models across multiple systems and system domains from single system pattern asset(s) leveraged across them. The specific domains and systems will be chosen based on the team membership's priority interests, but are currently expected to include at least one multiple-configuration manufactured product line system, as well as the manufacturing system that produces it. This challenge will include quantification of the demonstrated economies or other gains obtained through pattern asset leverage, and the infrastructure (e.g., tools, processes) necessary to support those gains.*

2. Measures of Success:

Targeted stakeholder and related measures of success are:

System Innovation / Development Teams: Enjoy the benefits of MBSE with lower per-project model-origination and refinement time, effort, skill load, and risk, by employing configured System Patterns as early draft models.

System Modelers: Extend the span of influence of skilled individual modelers by making their models effectively available, applicable, and impactful to more projects, systems, and products.

Product Line Managers, Platform Managers, Portfolio Managers: Improve the effectiveness of families-of-systems disciplines, measured in terms of economic leverage.

System Verification Teams: Improve the performance of system verification planning and execution in high risk or complexity systems.

System Life Cycle Groups: Improve satisfaction with the early fit of systems to the learned needs of system life cycle communities, including manufacturing, distribution, end user, operations, and maintenance, over a broad range of issues that should not be re-discovered each generation (functionality, safety, many other aspects).

Tool Suppliers: Improve the ROI demonstrated by tools.

Enterprises: Improve organizational-level learning across individual people and projects, reducing occurrences of re-learning the same lessons and repeating the same mistakes.

3. Plan Overview / Description:

Phase 1: (Time period to be established)

1. Supplement start-up team membership with other interested team members, sharing and refining charter and gaining team buy-in to this plan.
2. Bring team membership to a common level of PBSE understanding, using PBSE Tutorials conducted in recent years at IS, GLRC, and chapter levels, including example System Pattern content.
3. Identify target products for near-term work by the team:
    a. Target System Patterns
    b. Target System Pattern Applications
    c. Business Process Implications Model of PBSE
    d. Demonstration of PBSE support in Tools and Information Systems
    e. PBSE Tutorials
    f. Other target products

Phase 2: (Time period to be established)

4. Create and validate targeted Challenge Team products, prioritized from above

Phase 3: (Time period to be established)

5. Make Challenge Team products available to INCOSE membership, extending benefits.

4. Schedule

Date	Milestone	Status	Point of Contact
Aug, 2013	Gain agreement of MBSE leadership	Done	Bill Schindel
Jul-Aug 2013	Collect initial team members, refine charter	Done	Bill Schindel
Oct, 2013	Provide PBSE Tutorial at GLRC2013	Done	Bill Schindel
Jan, 2014	Provide PBSE introductory report and announce start up at IW2014	Arranged in principle, details being generated	Bill Schindel
	(To be filled in based on schedule planned above)		

5. Team Members

Name	Organization	Contact Information
Bill Schindel	ICTT System Sciences	Schindel@ictt.com
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Wishing to be kept informed of team plans:		
Sandy Friedenthal	SAF Consulting	Safriedenthal@gmail.com

6. References and Links

1. Bill Schindel, Troy Peterson, "Introduction to Pattern-Based Systems Engineering (PBSE): Leveraging MBSE Techniques", INCOSE IS2013 Tutorial, June, 2013.
2. W. Schindel, "What Is the Smallest Model of a System?", *Proc. of the INCOSE 2011 International Symposium*, International Council on Systems Engineering (2011).
3. W. Schindel, "Pattern-Based Systems Engineering: An Extension of Model-Based SE", INCOSE IS2005 Tutorial TIES 4, (2005).

4. J. Bradley, M. Hughes, and W. Schindel, “Optimizing Delivery of Global Pharmaceutical Packaging Solutions, Using Systems Engineering Patterns” *Proceedings of the INCOSE 2010 International Symposium* (2010).
5. W. Schindel, and V. Smith, “Results of Applying a Families-of-Systems Approach to Systems Engineering of Product Line Families”, SAE International, Technical Report 2002-01-3086 (2002).
6. W. Schindel, “The Impact of ‘Dark Patterns’ On Uncertainty: Enhancing Adaptability In The Systems World”, INCOSE Great Lakes 2011 Conference, Dearborn, MI, 2011.
7. W. Schindel, “Introduction to Pattern-Based Systems Engineering (PBSE)”, INCOSE Finger Lakes Chapter Webinar, April 26, 2012.
8. W. Schindel, “Integrating Materials, Process & Product Portfolios: Lessons from Pattern-Based Systems Engineering”, *Proc. of 2012 Conference of Society for the Advancement of Material and Process Engineering,* 2012.

14 ATTACHMENT 2: MORE ON THE MEASURES OF SUCCESS

Section 2.1.1 introduces general measures of success related to this working group. The following discusses those measures further, including observations on their status at the start of the original Patterns Challenge Team as well as at the time of transition to the Patterns Working Group:

1) Enjoy the benefits of MBSE with lower per-project model-origination and refinement time, effort, skill load, and risk, by employing configured System Patterns as early draft models:
    a. Existing reports (e.g., Bradley et al, 2010) describe reduced model origination time in projects, where order-of-magnitude gains have been made possible by beginning system projects with a configurable whole system pattern instead of a blank model canvas. The working group has contributed to this by providing INCOSE publication of the MBSE Patterns Methodology on the MBSE Surveys site (MBSE Patterns Challenge Team, 2015), along with reports on results experienced (Schindel and Smith, 2002) and the general structure of ROI for PBSE (Peterson and Schindel, 2013).
    b. The above shows what is possible if practiced, but not the extent of the practice. The more significant challenge to measure is the *diffusion of MBSE and PBSE practice across enterprises and projects*. INCOSE has engaged in only limited measures of the spread of MBSE to date. As of 2016, the INCOSE Transformation to a Model-Based Discipline project is in the process of extending that measure (Peterson, 2016).
2) Extend the span of influence of skilled individual modelers by making their models effectively available, applicable, and impactful to more projects, systems, and products:
    a. As reported in (Merchant and Cook, 2015; Russell, 2015; Lempia et al, 2016) use of MBSE Patterns configured for specific uses has made models available to others. As indicated in (1)(b) above, the larger issue will be measuring the diffusion of MBSE practice in general across industry, and is being pursued by INCOSE as indicated there.
3) Improve the effectiveness of families-of-systems disciplines, measured in terms of economic leverage.
    a. As indicated in the Projects Section above, during 2016-17 the Patterns Working Group has undertaken a joint project with the INCOSE Product Line Engineering (PLE) Working Group in exactly this area.
    b. Earlier reports on the families-of-systems use of MBSE Patterns include (Schindel and Smith, 2002) and financial capitalization of patterns as IP assets (Sherey, 2006).

4) Improve the performance of system verification planning and execution in high risk or complexity systems.
    a. One of the working group's 2015 projects was the IS2015 paper (Cook et al 2015) reporting a >25% gain in productivity of verification planning and execution for safety-critical aircraft primary and secondary flight control systems. Diffusion of related practices remains an INCOSE measure of interest, as noted above.
    b. Another report (Nolan et al, 2015) indicated a halving of the rate of verification review error escapes, based on applying patterns of review), and another on the use of patterns in FMEA risk analysis (Schindel, 2010).
5) Improve satisfaction with the early fit of systems to the learned needs of system life cycle communities, including manufacturing, distribution, end user, operations, and maintenance, over a broad range of issues that should not be re-discovered each generation (functionality, safety, many other aspects).
    a. One of the current projects of the working group is participation in the INCOSE sponsored Agile Systems Engineering Life Cycle Management (ASELCM) Discovery Project, along with the Agile Systems Working Group. The goals of this project include discovery of the principles that enable increased agility in systems through timely learning and re-application of learning that does not have to be re-learned, along with the appropriate measures of that agility. This project is still underway, but initial papers are in the pipeline that have identified Information Debt as a dimension of systems agility to be further defined and understood as a key issue in the systems engineering community's potential adoption of agile methods.
    b. Related publications have also reported on the impact of use of system life cycle patterns across the enterprise in general (Lewis, Sanyal, Schindel, Sherey, 2015) and manufacturing in particular (Schindel, 2012), along with MBSE Patterns in failure analysis (Schindel, 2010). The working group has also undertaken a joint effort with the Health Care Working Group in support of the INCOSE 2016 Agile Health Care Systems Conference (Health Care Working Group, 2016), which included an activity to identify the priority areas of Health Care for systems engineering support of the President's Council on Science and Technology (PCAST) Report on Health Care (Holdren and Lander, 2014). The working group has also undertaken a workshop project with the System of Systems (SoS) Working Group, on SoS Patterns that should not be re-discovered. Other publications have reported on the applicability of patterns of management cross automated and human-controlled embedded and enterprise systems (Peterson and Schindel 2014).

c. Diffusions of these practices, and even the patterns involved, remains the larger issue for future pursuit.

6) Improve the ROI demonstrated by tools.
   a. Work to date has resulted in an initial report on MBSE Patterns support for an initial list of engineering and modeling tools and PLM systems (Lewis, Sanyal, Schindel, Sherey, 2015).
   b. As reported in the Projects and Deliverables section above, the working group has identified a future project on increasing the MBSE Patterns support for COTS Tools and Information Systems. It is expected that this will include measurement of impact.
7) Improve organizational-level learning across individual people and projects, reducing occurrences of re-learning the same lessons and repeating the same mistakes.
   a. A key part of the Patterns Working Group's participation in the INCOSE ASELCM Project (described above) is the build-out of the System 2, System 3 Learning Model, describing this more completely. A preliminary overview of the model is being presented this year in (Schindel and Dove, 2016) at IS2016. We assert that traditional methods of Lessons Learned and After Action Reports are much less effective than what is possible—not because they fail to identify new information, but because the organization of subsequent process and information are not effective to exploit it—a central aspect of the MBSE Patterns Methodology. More methods of measuring this are expected in that effort.

References for the above Attachment 2 Measures of Success:

Bradley, J., Hughes, M., and Schindel, W., "Optimizing Delivery of Global Pharmaceutical Packaging Solutions, Using Systems Engineering Patterns", INCOSE IS2010, Chicago, 2010.

Cook, D. and Schindel, W., "Utilizing MBSE Patterns to Accelerate System Verification", in Proc. of INCOSE 2015 International Symposium, 2015.

Holdren, J. and Lander, E., "Report to the President--Better Health Care and Lower Costs: Accelerating Improvement Through Systems Engineering", President's Council on Science and Technology, Executive Office of the President of the United State, May, 2014.

INCOSE Health Care Working Group, "INCOSE Agile Health Care Systems Conference" Chicago, May, 2016; retrieve from:

http://www.incose.org/ChaptersGroups/WorkingGroups/industry/healthcare/agile-healthcare-conference-2016

INCOSE MBSE Patterns Challenge Team, "MBSE Methodology Summary: Pattern-Based Systems Engineering (PBSE), Based On S*MBSE Models", V1.5.5A, INCOSE Patterns Working Group, retrieved 2015 from INCOSE/OMG MBSE methodologies directory:

http://www.omgwiki.org/MBSE/doku.php?id=mbse:pbse

Lempia, D., Schindel, W., Hrabik, T., McGill, S., and Graber, M., "Use Visual Diagrams and Patterns to Write Consistent and Complete Requirements", in Proc. of the INCOSE 2016 International Symposium, Edinburgh, 2016.

Lewis, S., Sanyal, S., Schindel, W., and Sherey, J., "Accelerating MBSE Impacts Across the Enterprise: Model-Based S*Patterns", in Proc. of INCOSE 2015 International Symposium, Seattle, 2015.

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Nolan, A., Pickard, A., Russell, J, and Schindel, W. "When two is good company, but more is not a crowd", Proc. of INCOSE International Symposium, Seattle, WA, 2015.

Peterson, T., "Systems Engineering Transformation: Accelerating Transformation to a Model-Based Discipline", in No Magic World Symposium, May, 2016.

Peterson, Troy, and Schindel, Bill. "Introduction to Pattern-Based Systems Engineering (PBSE): Leveraging MBSE Techniques", INCOSE IS2013 Tutorial, 2013

Peterson, T., and Schindel, W., "Pattern Based Systems Engineering – Leveraging Model Based Systems Engineering for Cyber-Physical Systems", Proc. of NDIA GVSETS, 2014.

Russell, R., "Systems Engineering in Practice: Complexity Emerges in a Successful Company in a Mature Industry", in Proc. of INCOSE Great Lakes Conference on Systems Engineering, Cleveland, 2015.

Schindel, W., and Smith, V., "Results of applying a families-of-systems approach to systems engineering of product line families", SAE International, TR 2002-01-3086 (2002).

Schindel, W., "Integrating Materials, Process, & Product Portfolios: Lessons from Pattern-Based Systems Engineering", in Proc. of Society for Advancement of Materials and Process Engineering (SAMPE), Baltimore, 2012

Schindel, W., "Failure Analysis: Insights from Model-Based Systems Engineering", in Proc. of INCOSE International Symposium, Chicago, 2010.

Schindel, W. and Dove, D., "Introduction to the Agile Systems Engineering Life Cycle Pattern", Proceeding of INCOSE International Symposium, 2016

Sherey, Jason. “Capitalizing on Systems Engineering”, Proc. of INCOSE International Symposium, Rochester, NY, 2005.