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# Utilizing MBSE Patterns to Accelerate System Verification

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***Abstract.*** In aerospace, automotive, health care, and other domains, the capability to effectively plan and perform system verification tests is increasingly a strategic differentiator. This paper reports on methods used to improve effectiveness of complex aircraft system tests, the gains achieved, and their connection to underlying methods and trends. These include use of Model-Based Systems Engineering (MBSE), leveraged by Pattern-Based Systems Engineering (PBSE) to generate configurable, re-usable system models--the focus of the INCOSE MBSE Patterns Challenge Team. (PBSE Team, 2014)

Distinctive aspects include (1) use of configurable, model-based patterns of system descriptions, including configurable system verification tests, (2) improved ability of model-based descriptions to integrate modeling tools and automated systems for test management, (3) use of models to describe both system under development and the development process, and (4) ability of these models to be integrated with other system life cycle management processes and information systems, for increased leverage.

# When two is good company, but more is not a crowd

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**Abstract**: This paper summarizes an approach to improve the effectiveness of the review (inspection) process. Effectiveness here is defined as the ability to reduce the number of defects escaping a review activity.

By carefully pairing up developers and reviews, Rolls-Royce was able to halve the rate of occurrence of defects in software, with no change to the process or tools, and with no changes to the team or the effort required to perform the reviews

The method hinges on an understanding of the capability of the developers and reviewers and making sure that only select pairings of team members will be allowed. The paper illustrates an example of the practice when applied to software code review but the principle can be applied to any development process. The paper ends by illustrating other ways to benefit from this approach.

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# Model-Based System Patterns for Automated Ground Vehicle Platforms

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**Abstract.** Automated Ground Vehicle (AGV) platforms are proliferating across commercial, military, and consumer applications. Beyond diversity of form and application, AGVs can be manned or unmanned, and exhibit a broad range of automated control, from partial to fully autonomy, making these vehicles strikingly diverse.

This paper reports on application of Pattern-Based Systems Engineering (PBSE) to representation of automated ground vehicle platforms. PBSE is based upon reusable, configurable S*Models conforming to the S*Metamodel, expressed in any modeling language and toolset. The Patterns Challenge Team of the INCOSE/OMG MBSE Initiative has been practicing PBSE across applications, reported in this and other IS2015 papers.

A specialized class of Cyber-Physical Systems, AGVs are subject to intense interest, creating new opportunities, risks, and complexities. To address the diversity and complexity of these systems, the Embedded Intelligence (EI) Pattern, another S*Pattern, is being applied by the team to illustrate its applicability to an AGV Platform Pattern.

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# Accelerating MBSE Impacts Across the Enterprise: Model-Based S*Patterns

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**Abstract.** Model-Based Systems Engineering (MBSE) methods can directly address "organizational silos" problems. This paper reports on work by the INCOSE/OMG MBSE Initiative Patterns Challenge Team. This group focuses on Pattern-Based Systems Engineering (PBSE) using model-based system patterns based on the S*Metamodel, reported in multiple IS2015 papers.

Distinctive are (1) the configurable, model-based nature of the patterns (not all historical patterns work has been model-based), (2) the technical scope of the models, encompassing requirements, design, failure mode, verification, and other aspects, (3) the system scope of the models, encompassing whole systems, configurable product lines, and platforms, not just libraries of components, (4) the diverse and integrating cross-enterprise domains of the patterns, encompassing products, innovation processes, manufacturing, packaging/distribution, and other domains, and (5) the ability to enable a variety of COTS modeling languages and tools, PLM, and other enterprise information systems to integrate support of management and application of S*Patterns across enterprises.

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# Maps or Itineraries? A Systems Engineering Insight from Ancient Navigators

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**Abstract.** Processes and procedures are the heart of current descriptions of Systems Engineering. The "Vee Diagram", ISO 15288, the INCOSE SE Handbook, and enterprise-specific business process models focus attention on process and procedure.

However, there is a non-procedural way to view systems engineering. This approach is to describe the configuration space "navigated" by systems engineering, and what is meant by system trajectories in that space, traveled during system life cycles.

This sounds abstract because we have lacked explicit maps necessary to describe this configuration space. We understand concrete steps of a procedure, so we focus there. But where do these steps take us? And, what does "where" mean in this context? Clues are found in recent discoveries about ancient navigation, as well as later development of mathematics and physics.

This paper (Part I of a Case for Stronger MBSE Semantics) focuses on the underlying configuration space inherent to systems.

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# System Life Cycle Trajectories: Tracking Innovation Paths Using System DNA

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**Abstract.** In-service systems change configuration across life cycles. Systems in development change in-progress developmental configurations. Evolving product lines and competing product models change configurations, over lives of product lines. Understanding system trajectories (paths of changing configurations) is important to understanding installation history, developmental progress, and competitive evolution.

What to track? For living systems, physical form (phenotype) was the initial focus, but the study of genetic information (genotype) became vital. MBSE, Configuration Management (CM), Product Lifecycle Management (PLM), Model Management (MM) disciplines and tools partially address engineered system needs. However, cyber warfare, epidemics, and other threats raise pressure to accelerate rates and efficacy of system evolution, increasing interest in agility.

This paper (Part II of a Case for Stronger MBSE Semantics) outlines "system DNA" trajectories, follows work reported by a System Sciences Working Group project at IW2014, and prepares support for the IW2015 MBSE Workshop session on patterns in Agile Systems.