

# A Model-based Engineering (MBE) Manifesto

## Introduction

In April 2018, a small group of senior systems engineers, scientists, and researchers assembled at the 19th International Federation for Systems Research (IFSR) Conversation in Linz, Austria, to model a Systems Engineering approach that would optimize modern model-based engineering methods and tools.

The complex system development industry is in a transformation to a model-based engineering (MBE) approach, and this is a major paradigm change for everyone associated. What do we mean by MBE? We mean this term, model-based engineering (MBE), to be inclusive of all engineering domains and related modeling disciplines, including System Dynamics. The IFSR Conversation offered us a rare opportunity to thoroughly discuss this really large intractable challenge. The outcome of those long hours of Conversation into many diverse topics was our MBE Manifesto. We would like to propose this manifesto as a guide to motivate and possibly drive our industry toward a fully integrated digital engineering capability. We recognize that you may not see this as the end goal. Great, let's have a conversation about this. What are your thoughts?

## Conversation Agenda

The agenda ebbed into areas that needed to be drilled into and flowed over others where we all agreed.

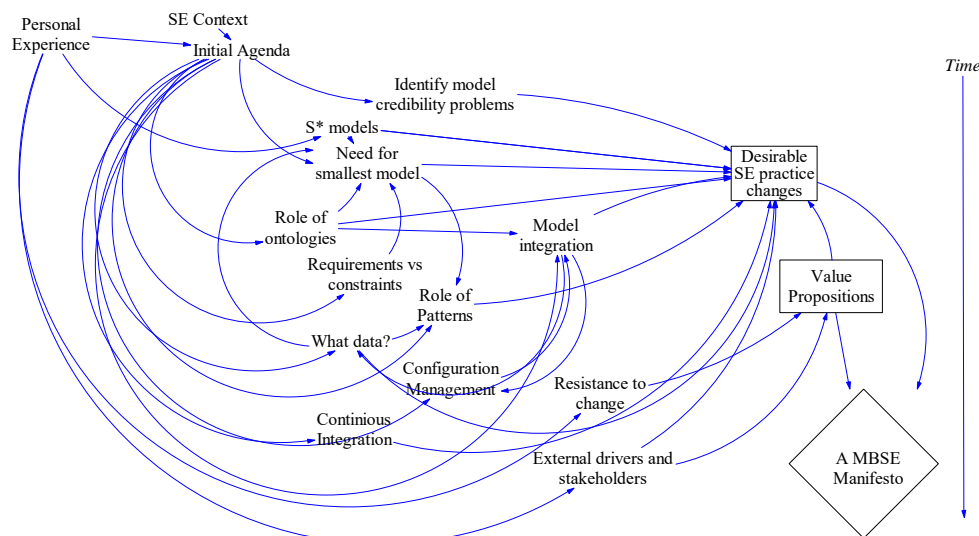


Figure 1: System dynamics model of our Conversations

Our agenda flowed through the S\*Space paradigm, starting with the model of the target system – the thing being developed (S1), working upward toward the model of life cycle domain – the system that manages the target system model (S2), and on to the model of innovation – the system that evolves the life cycle domain (S3).

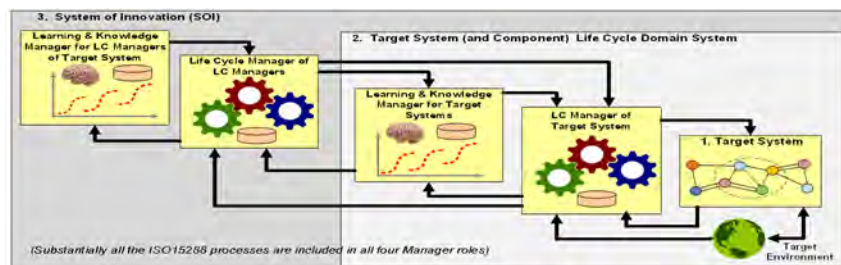


Figure 2: System of Innovation Reference Pattern (© 2016, Schindel and Dove)

The result of our week-long Conversation culminated into our manifesto on model-based engineering (see the full manifesto in Figure 3 below). We have nailed our manifesto to: the front door at the MORS 86th Symposium (June, 2018), Monterey, CA; the INCOSE International Symposium, (July, 2018), Washington D.C.; the 36th International Conference of the System Dynamics Society, (August, 2018), Reykjavik, Iceland; and the NDIA 21st Annual Systems Engineering Conference, (October, 2018), Tampa, FL; as well as several smaller and local conferences and venues. Our manifesto is currently posted in the Pentagon, Washington, D.C., as well as at each of our respective organizations.

We have received considerable feedback on this manifesto, but the ideals that originated this manifesto have held steady. It is our specific intent to spark broad conversation about these ideals. To that end, you (the reader) may or may not agree with the values and principles stated, but our hope is that you will converse about those issues, even argue about them, either with us or with your own colleagues. It is through that conversation that we believe change will happen (whether positive or not remains to be seen).

**A MODEL-BASED ENGINEERING (MBE) MANIFESTO**

**PURPOSE:** *To motivate the transformation to Model-Based Engineering.*

**Faced with increasing system complexity, interdependencies, breakdown of document-based methods, and other challenges, MBE provides the transformation in which we value:**

- 1 Information over artifacts
- 2 Integration over independence
- 3 Expressiveness with rigor over flexibility
- 4 Model usage over model creation

*We value the items on the right, but not at the sacrifice of the items on the left.*

**WITH THESE PRINCIPLES:**

*On behalf of stakeholders, MBE increases emphasis on **describing** the nature and content of the **information** produced and consumed, compared to the traditional emphasis on engineering process and procedure.*

*We recognize that—**independent** of specific Information format, structure, language, syntax, the sequence or order of its production and consumption, and the domains and environments of our projects—the underlying nature (**semantics**) of the **essential** information we seek to discover and produce is **invariant** because of the very nature of engineering.*

*An essential and dynamically changing property of model information is its **credibility** to those people and processes which will **consume** that information. The critical nature of some **intended uses** of model information sets a higher bar on required investment in model **verification, validation** and **uncertainty quantification**.*

*Principles of **human-machine interaction** applied to the targeted stakeholders are vital to success. Application of advanced visualization methods and **augmented intelligence** capabilities can advance that success.*

*We seek an extended team across engineering disciplines with **common and integrated understanding** of the identity and nature of the model information as well as its content.*

*We seek effective **enterprise-wide reuse** of model-based information to more fully leverage past individual or local learning.*

*Systems engineering performed according to the above principles is required for the Engineering System itself, a complex and evolving system.*

**THE TEAM:**  
*The team was assembled by invitation, intentionally drawing together different perspectives.*

- Ed Carroll  
Teams lead-Sandia National Laboratories – Engineering Methods Research
- Nancy Hayden  
SNL- Autonomous Systems/ Engineering Policy
- Sharon Trauth  
SNL- Systems Engineering/ MBSE Practice
- Dana Grisham  
SNL- Data Governance/Agile Methods
- Chris Schreiber  
Lockheed Martin Space Systems- Systems Engineering Modernization
- Bill Schindel  
ICTT System Sciences – Systems Sciences
- Frank Salvatore  
Engility Corp- Systems Engineering/ Data Taxonomy
- Eliot Rich  
UNIVERSITY OF ALBANY  
 Univ at Albany, SUNY- System Dynamics
- Teleconference participation from:
- Steve Jenkins  
JPL- Systems Semantics
- Anne O’Neil  
AOO  
 Anne O’Neil Consultants- Organizational Transformation

Figure 3: MBE Manifesto

## Author Biographies:

Ed Carroll: Principal R&D Systems Research Analyst at Sandia National Laboratories, and former CTO for Egghead.com. His research is focused on understanding the optimal application of advanced engineering approaches.

Dana Grisham: Principal Solutions Architect at Sandia National Laboratories. Her focus is on data architecture, software infrastructure, and governance enabling transformation to data-driven systems engineering.

Nancy Hayden, PhD: Principal R&D Systems Analyst at Sandia National Laboratories, and Research Fellow, Center for International and Security Studies at Maryland. Research focus is intersection of complexity, system dynamics, technology innovation, policy, and strategic stability.

Eliot Rich, PhD.: Associate Professor of IS and Business Analytics, School of Business, University at Albany, SUNY. He leads the University of Albany System Dynamics Group and is an ACM Senior Member.

Frank Salvatore: Technical Fellow at Engility Corporation. Expert System Engineering Professional (ESEP) and OMG Certified Modeling Professional (OCSMP). Frank supports DOD organizations in digital engineering transformation initiatives and supports programs.

Bill Schindel, President of ICTT System Sciences, is an INCOSE Fellow, co-chair of the INCOSE MBSE Patterns Working Group, and leads application of the S\*Metamodel and S\*Patterns across multiple domains.

Chris Schreiber: a Systems Engineering Senior Manager for Lockheed Martin Space Systems Company with responsibility for the Systems Engineering Modernization department focused on supporting Space Systems programs with Model-Based Systems Engineering.

Sharon Trauth: Principal R&D Systems Engineer at Sandia National Laboratories, leading MBSE application to weapons, and innovating a new method to model the relationships between environmental constraints, components and their allocated functions.

Steve Jenkins: Principal Engineer at Jet Propulsion Laboratory and California Institute of Technology. Steve has been instrumental in developing and evangelizing an ontology-based MBSE transformation and innovation at the lab.

Anne O'Neil: Systems Catalyst and Strategist with Anne O'Neil Consultants, LLC. Anne advises organizations world-wide seeking to adopt systems practices and leverage systems engineering capability to achieve and improve business outcomes.

