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# SMSWG - *SMS Terms & Definitions* Committee (SMSTDC)

February 2, 2021

*Systems Modeling and Simulation\*:*

*The use of interdisciplinary functional, architectural, and behavioral models (with physical, mathematical, and logical representations) in performing MBSE to specify, conceptualize, design, analyze, verify and validate an organized set of components, subsystems, systems, and processes.*

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# Purpose

The Systems Modeling and Simulation Terms and Definitions Committee is to be the authoritative source for systems modeling and simulation terms and definitions and provide ongoing strategic direction for the initiative.

# Members Update

- Ed Ladzinski (chair)
- Paul Barnard
- Frank Popielas
- Joe Walsh
- Rod Dreisbach (new member)

# Results

Proposed Term	Definition Proposal	Source	Comments	Sign-off
Model Based Development (MBDev)	The systematic use of models and modeling techniques as an integral part of the overall development engineering process.	NAFEMS SMSWG T&D Focus Team	Model-Based Development (MBDev) is a subset of Model Based Engineering (MBE).	7/21/2020
Democratization of Simulation	Expanding significantly the user community of Engineering Simulation capabilities that result in benefits of reduced time and cost, and more reliable product lifecycle studies.	NAFEMS SMSWG T&D Focus Team		7/21/2020
Engineering Simulation	The use of physics-based mathematical (numerical) models and/or logical models, including relevant data derived from their physical model counterparts, as representations of a conceptual or real-world system, phenomenon, or process in studying its technical requirements and operational behavior.	ASSESS and NAFEMS SMSWG T&D Focus Team		7/21/2020
Digital Twin	A digital surrogate that is a description of a physical asset such as one or more products, processes, systems, people and devices that can be used for various purposes. It makes use of data to/from its real-world asset and may change in tandem throughout the lifecycle of the physical asset.	NAFEMS SMSWG T&D Focus Team		7/21/2020
Generative Design	The use of algorithmic methods to create feasible designs of assemblies and components or outcomes from a set of performance requirements, objectives, constraints and specified use cases.	ASSESS initiative and NAFEMS SMSWG T&D Focus Team		7/21/2020
Simulation Governance	Executive management policies and procedures assuring that the business benefits of engineering modeling and simulation across the product lines are aligned with the strategic vision and goals of a company.	NAFEMS SGMWG Flyer		7/21/2020

# Results

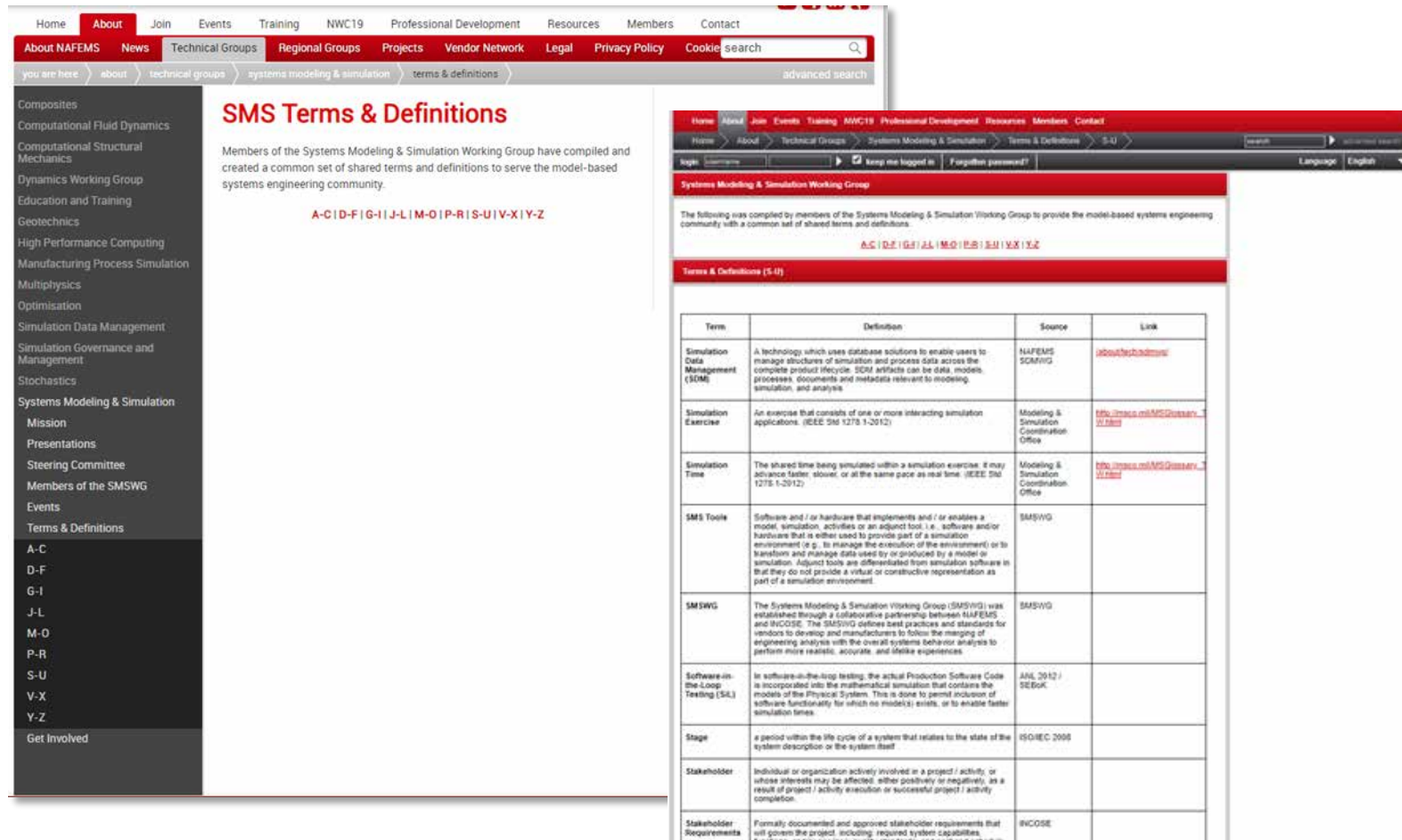
Term Candidate	Definition Proposal from the T&D Focus Team	Origin
Model-Based Engineering (MBE)	An approach to engineering that uses models as an integral part of the engineering processes that includes the requirements, design, analysis, implementation, and the verification and validation of a capability, system, and/or product throughout its life cycle." It is the umbrella for many other MBx activities.	Derived from (Final Report, Model-Based Engineering Subcommittee, NDIA, Feb. 2011).
Model-Based Systems Engineering (MBSE)	"The formalized application of modeling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout development and later life cycle phases." MBSE is a subset of Model Based Engineering (MBE) and Systems Engineering (SE).	INCOSE SE Vision 2020 (INCOSE-TP-2004-004-02, Sep 2007)
Model-Based Design (MBD)	The use of models and modeling techniques as an integral part of the design phase of a development process. Model-Based Design is a subset of Model Based Engineering (MBE).	SMSWG T-D Committee
Model-Based Definition (MBD)/(MBDef)	The practice of using 3D models (such as solid models, 3D PMI and associated metadata) within 3D CAD software to define (provide specifications for) individual components and product assemblies. The types of information included are geometric dimensioning and tolerancing (GD&T), component level materials, assembly level bills of material, engineering configurations, design intent, etc." Model Based Definition is a subset of Model Based Design.	Derived from Wikipedia
Model-Based Safety Analysis (MBSA)	"An approach in which the system and safety engineers share a common system model created using a model-based development process. By extending the system model with a fault model as well as relevant portions of the physical system to be controlled, automated support can be provided for much of the safety analysis." Model Based Safety Analysis is a subset of Model Based Engineering.	Model-BaseC1:C16d Safety Analysis, NASA, Feb. 2006
Model-Based Enterprise (MBE)	An organization where models serve as the authoritative information source for processes beyond engineering. Model Based Enterprise is the culmination of Model Based Engineering.	Derived from Wikipedia

# New T&Ds in the Pipeline

Proposed Term	Definition Proposal	Source	Comments
Hardware In the Loop (HIL or HIWL)	Hardware-in-the-loop (HIL) simulation, or HWIL, is a technique that is used in the development and test of complex real-time embedded systems. HIL simulation provides an effective platform by adding the complexity of the plant under control to the test platform. The complexity of the plant under control is included in test and development by adding a mathematical representation of all related dynamic systems. These mathematical representations are referred to as the "plant simulation". The embedded system to be tested interacts with this plant simulation.	Hardware-in-the-loop simulation - Wikipedia	[ROD] An approach for testing a real embedded controller running interactively with electrical emulations of any sensors and actuators acting as interfaces with a digital plant simulation.
Software in the Loop (SIL)	Software-in-the-Loop (SIL) simulation represents the integration of a compiled production source code into a mathematical model simulation, providing engineers with a practical, virtual simulation environment for the developing and testing of detailed control strategies for large and complex systems.	www.opal-rt.com/software-in-the-loop/	[ROD] The integration of a compiled production source code of a controller into a mathematical plant model simulation, providing engineers with a practical, virtual simulation environment for developing and testing detailed control strategies for large and complex systems.
Model in the Loop (MIL)	Model-in-the-loop testing (MIL) and simulation is a technique used to abstract the behaviour of a system or sub-system in a way that this the model can be used to test, simulate, and verify the model.	Model-in-the-loop Testing Applications & Concepts (add2.co.uk)	[ROD1] A technique used to abstract the behaviour of a system or sub-system in a way that the model can be used to test, simulate, and verify the model.
Human in the Loop (HITL)	Human-in-the-loop or HITL is defined as a model that requires human interaction. HITL is associated with modeling and simulation (M&S) in the a live, virtual, and constructive taxonomy. HITL models may conform to human factors requirements as in the case of a mockup. In this type of simulation a human is always part of the simulation and consequently influences the outcome in such a way that is difficult if not impossible to reproduce exactly. HITL also readily allows for the identification of problems and requirements that may not be easily identified by other means of simulation.	Human-in-the-loop - Wikipedia	[ROD] A model that requires human interaction with modeling and simulation (M&S) in a live, virtual, and constructive taxonomy.
Processor in the Loop (PIL)	Processor-in-the-loop (PIL) is a physical test technique that allows designers to evaluate a real controller code running on a dedicated processor in conjunction with a simulated of a plant which runs in running on an offline simulation platform. By the other side, Hardware-in-the-Loop (HIL) is an approach to test a plant or controller running in a digital platform which interacts with the real controller or plant.	Processor-in-the-loop and hardware-in-the-loop simulation of electric systems based in FPGA - IEEE Conference Publication	[ROD] A physical test technique that allows designers to evaluate a real controller code running on a dedicated processor in conjunction with a simulated plant running on an offline simulation platform.

# Where Does One Find the NAFEMS Site T-Ds

[https://www.nafems.org/about/technical-working-groups/systems\\_modeling/smstermsdefinitions/](https://www.nafems.org/about/technical-working-groups/systems_modeling/smstermsdefinitions/)



**SMS Terms & Definitions**

Members of the Systems Modeling & Simulation Working Group have compiled and created a common set of shared terms and definitions to serve the model-based systems engineering community.

A-C | D-F | G-I | J-L | M-O | P-R | S-U | V-X | Y-Z

**Terms & Definitions (S-U)**

Term	Definition	Source	Link
Simulation Data Management (SDM)	A technology which uses database solutions to enable users to manage structures of simulation and process data across the complete product lifecycle. SDM artifacts can be data, models, processes, documents and metadata relevant to modeling, simulation, and analysis.	NAFEMS SMO/IVG	<a href="#">about/technical-working-groups/systems_modeling/sdm/</a>
Simulation Exercise	An exercise that consists of one or more interacting simulation applications. (IEEE Std 1278.1-2012)	Modeling & Simulation Coordination Office	<a href="#">http://naems.org/ivg/systems_modeling/simulation_exercise/</a>
Simulation Time	The shared time being simulated within a simulation exercise. It may advance faster, slower, or at the same pace as real time. (IEEE Std 1278.1-2012)	Modeling & Simulation Coordination Office	<a href="#">http://naems.org/ivg/systems_modeling/simulation_time/</a>
SMS Tools	Software and / or hardware that implements and / or enables a model, simulation, activities or an adjunct tool, i.e. software and/or hardware that is either used to provide part of a simulation environment (e.g. to manage the execution of the environment) or to transform and manage data used by or produced by a model or simulation. Adjunct tools are differentiated from simulation software in that they do not provide a virtual or constructive representation as part of a simulation environment.	SMS/IVG	
SMS/IVG	The Systems Modeling & Simulation Working Group (SMS/IVG) was established through a collaborative partnership between NAFEMS and INCOSE. The SMS/IVG defines best practices and standards for vendors to develop and manufacturers to follow the merging of engineering analysis with the overall system behavior analysis to perform more realistic, accurate, and usable experiences.	SMS/IVG	
Software-in-the-Loop Testing (SIL)	In software-in-the-loop testing, the actual Production Software Code is incorporated into the mathematical simulation that contains the models of the Physical System. This is done to permit inclusion of software functionality for which no model(s) exists, or to enable faster simulation times.	ANSI 2012 / IEEE604	
Stage	a period within the life cycle of a system that relates to the state of the system description or the system itself	ISO/IEC 2006	
Stakeholder	Individual or organization actively involved in a project / activity, or whose interests may be affected, either positively or negatively, as a result of project / activity execution or successful project / activity completion.		
Stakeholder Requirements	Formally documented and approved stakeholder requirements that will govern the project including required system capabilities, <a href="#">functional, interface, analysis, security, constraints, and code and test cases.</a>	INCOSE	

**First issued in 2016**



# Thank You