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NAFEMS / INCOSE Systems Modeling & Simulation Working Group

A unique opportunity for the international
Engineering Analysis (CAE) and Model Based
Systems Engineering (MBSE) communities
to work together

Systems Modeling and Simulation Working Group (SMSWG) Mission

To develop a **vendor-neutral, end-user driven consortium** that not only promotes the advancement of the technology and practices associated with integration of engineering analysis and systems engineering, but also acts as the advisory body to **drive strategic direction for technology development and standards** in the space of complex engineering.

This group will support activities that **bridge engineering analysis and systems engineering** to provide digital solutions to represent real life experiences; and optimize the integration of systems engineering and simulation solutions for both OEM and supplier.

This includes education, communication, promotion of standards, and development of requirements that will have general benefits to the simulation and analysis community with the identification of benchmarks and major strategic issues (grand challenges).

Formation of the SMSWG



- In 2011, NAFEMS and INCOSE agreed a mutually beneficial strategy to develop a collaborative relationship to benefit both organizations and their members
- In 2012, NAFEMS and INCOSE announced* a collaboration to accelerate innovation for engineering simulation and model based systems engineering:
 - Implementation of a joint cross organizational WG on Systems Modeling & Simulation;
 - NAFEMS to launch a new international Technical Working Group (TWG) in concert with INCOSE to promote a deeper understanding of lifelike behavior to integrate mechanical analysis and simulation within their Model Based System Engineering initiative;
 - To mutually support specific, non-funded, events of each organization;
 - To provide mutual assistance and support for international standards and develop a joint approach for interfacing with other organizations in related professional areas.
- http://www.nafems.org/about/media/news/latest1007/nafems_announces_collaboration_with_incose/
<http://www.incose.org/newsevents/news/details.aspx?id=266>

NAFEMS Motivation

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- NAFEMS is the International Association of the Engineering Modelling, Analysis and Simulation Community; a not-for-profit organisation which was established in 1983. In addition to end users from all industry sectors, our stakeholders include technology providers, researchers and academics.
- *"We're delighted to have agreed to collaborate with INCOSE on this initiative", commented **Tim Morris, NAFEMS CEO**. "For the past 30 years, NAFEMS has been at the forefront of the international engineering analysis community, and represents the interests of over 1000 multinational organizations who are involved in CAE. At the very heart of our mission statement is a desire to push forward knowledge, skills and technology in the CAE arena, and it is through working together with other similarly-minded organizations that we can truly accelerate innovation and the development of new technologies on an international basis."*

INCOSE Motivation

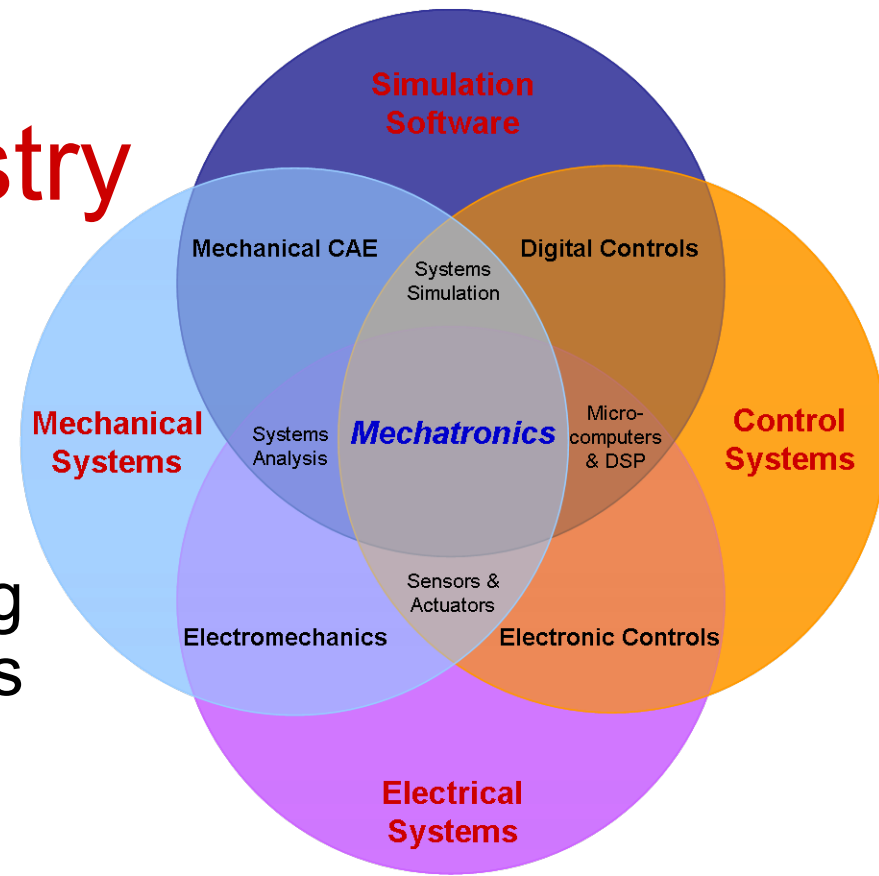
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- The International Council on Systems Engineering (INCOSE) is a not-for-profit membership organization founded in 1990 to develop and disseminate the interdisciplinary principles and practices that enable the realization of successful systems.
- *“This agreement with NAFEMS marks a new step in the collaboration with partner organizations”, said **Ralf Hartmann, INCOSE Director for Strategy.** “Up to now INCOSE has primarily established liaison and cooperation schemes with other societies in the area of the engineering and management of systems. The successful evolution of Model Based Systems Engineering (MBSE) under the leadership of INCOSE has unveiled the significant opportunities which emerge from a stronger cooperation with key engineering disciplines such as software and CAE. I am looking forward to the enrichment of our MBSE initiative through this collaboration with NAFEMS.”*

Challenges for industry

- Increased product complexity
- Reduce time-to-market
- Promoting collaboration among multiple engineering disciplines
- Integrating complex systems engineering processes
- Enabling the sharing of intellectual property among globally dispersed teams, companies and industries.
- Managing costs while still ensuring that performance objectives can be met.



Objectives for SMSWG

- To address the challenges, SMSWG will define best practices and identify standards for both manufacturers and vendors to follow.
- SMSWG will focus on merging of engineering analysis with overall systems analysis to perform more realistic, accurate, and lifelike behavior modeling & simulation.
- Successful execution will result in new opportunities for industries to fundamentally transform their business processes and reduce development cycle time and cost by providing an upfront optimization of the product for the complete product life cycle

Governance

The activities of the SMSWG and its Steering Committee are governed by the respective NAFEMS and INCOSE regulations

- **Steering Committee:**
 - Roger Burkhart (John Deere) – Chair
 - Conrad Bock (NIST)
 - Peter Coleman (Airbus)
 - Jian Dong (Boeing)
 - Rod Dreisbach – INCOSE MBSE Initiative
 - Dr. Rui Gao (Modelon)
 - Ed Ladzinski (SMS_ThinkTank)
 - Kim Murphy (Ford)
 - Frank Popielas (SMS_ThinkTank & CIMdata)
 - Mark Sampson (Siemens PLM) – INCOSE MBSE Initiative
 - Hubertus Tummescheit (Modelon)
 - Mark Williams (Boeing)
- **By-laws covering Mission; General Powers; Members, Tenure, Qualifications; Elections; Contracts; Publications; Amendments; etc.**

SMSWG Members

162*

members

92

unique member
companies

* (as of Sep. 2016)

Americas	70%
Europe	19%
Asia / Pacific	8%
other/undeclared	3%

aerospace or defense	22%
automotive	16%
academia	3%
consulting	10%
energy	2%
medical	1%
other industry	6%
solutions & services	34%
standards	4%
undeclared	2%

How to join and learn more about this Volunteer Community

Complete [the request form](#) on the [NAFEMS SMSWG website](#).

Indicate if your organization is a member of NAFEMS and/or you are a member of INCOSE.

(Approval is automatic if your organization is a member of NAFEMS or if you are an individual member of INCOSE.)

Once signed up, you will receive announcements of ongoing meetings and other news, and also have access to the [SMSWG Collaborative Community](#).

The INCOSE MBSE Initiative also maintains an [SMSWG wiki page](#), with publicly available meeting materials.



NAFEMS Website Page

https://www.nafems.org/about/technical-working-groups/systems_modeling/



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Systems Modeling & Simulation Working Group (SMSWG)

In July 2012, NAFEMS and the International Council on Systems Engineering (INCOSE) announced a joint relationship for mutual participation and collaboration for the advancement of engineering simulation and model based systems engineering.



This collaboration includes the implementation of a joint cross organizational working group on Systems Modeling & Simulation. NAFEMS will launch a new international Technical Working Group (TWG) in concert with INCOSE to promote a deeper understanding of lifelike behaviour to integrate mechanical analysis and simulation within their Model Based System Engineering initiative.

Additionally, through this collaboration NAFEMS and INCOSE will provide mutual assistance and support for international standards and develop a joint approach for interfacing with other organizations in related professional areas.

Interested in Learning More about the SMSWG?

Chairman



Roger Burkhart
Technology Architect

John Deere

NAFEMS Members-Only Site

<https://sites.google.com/a/nafems.org/smswg/>

SMSWG Collaborative Community

Search this site

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SMSWG Files

Content generated and owned by members of the SMSWG.


<input type="checkbox"/>		Add file	<input type="checkbox"/>		Add link		Add from Drive		Move to		Delete		Subscribe to changes
<input type="checkbox"/>		2016 NAFEMS Americas Conference (Remove)	<input type="checkbox"/>		3_1-a_baroux.pdf	8379k	v. 2	Jun 21, 2016, 11:16 AM	Matthew Ladzinski				
		View Download	<input type="checkbox"/>		3_1-a_croegaert.pdf	3485k	v. 2	Jun 21, 2016, 11:16 AM	Matthew Ladzinski				
		View Download	<input type="checkbox"/>		3_1-a_szarazi.pdf	1509k	v. 2	Jun 21, 2016, 11:16 AM	Matthew Ladzinski				
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INCOSE MBSE Wiki Page

<http://wiki.omg.org/MBSE/doku.php?id=mbse:smswg>

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Logged in as: Roger Burkhart (rburkhart) [Update Profile](#) [Log O](#)

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Systems Modeling & Simulation Working Group (SMSWG)

This joint working group was formed under an agreement between the International Council on Systems Engineering ([INCOSE](#)) and the International Association of the Engineering Modelling, Analysis and Simulation Community ([NAFEMS](#)). For more information, please see the June 2012 announcement by both groups ([NAFEMS](#), [INCOSE](#)). The complete text of the original announcement appears below.

Working Subteams

These subteams are open for participation to all SMSWG members. Please contact the subteam lead(s) to be included in email communications, meetings, and activities. Each subteam can maintain their own wiki subpages for further information.

- SMSWG Roadmap and Sharing of Best Practices
- [Terms & Definitions](#)
- Standards Ecosystem
 - Modelica Association Standards, including FMI and SSP
 - PDES/STEP and MoSSEC
 - SysML V2
 - OSLC

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New monthly schedule of SMSWG member meetings

- One-hour meetings are held the second Tuesday of each month at 11:00 AM ET
- Agenda and presentations are posted for public access from our [SMSWG wiki page](#).
- Recordings and minutes are posted in our [SMSWG Collaborative Community](#).

2017-2018 Accomplishments

- Half-day meetings at INCOSE IW 2017 and IW 2018
 - Presentations and Discussion on Emerging Standards for SMSWG
 - Formation of working subteams
 - Start of new monthly schedule of SMSWG members meetings
- Presentations and Panel on OSLC (May 2017, Online)
- Activities at biannual NAFEMS World Congress (June 2017)
- Update to Terms and Definitions on SMSWG Website
- Initial two products of SMSWG, in the form of 6-page “What Is?” flyers published as a series by NAFEMS
 - What is Functional Mockup Interface (FMI)? (published January 2018)
 - What is Systems Modeling and Simulation? (published January 2019)

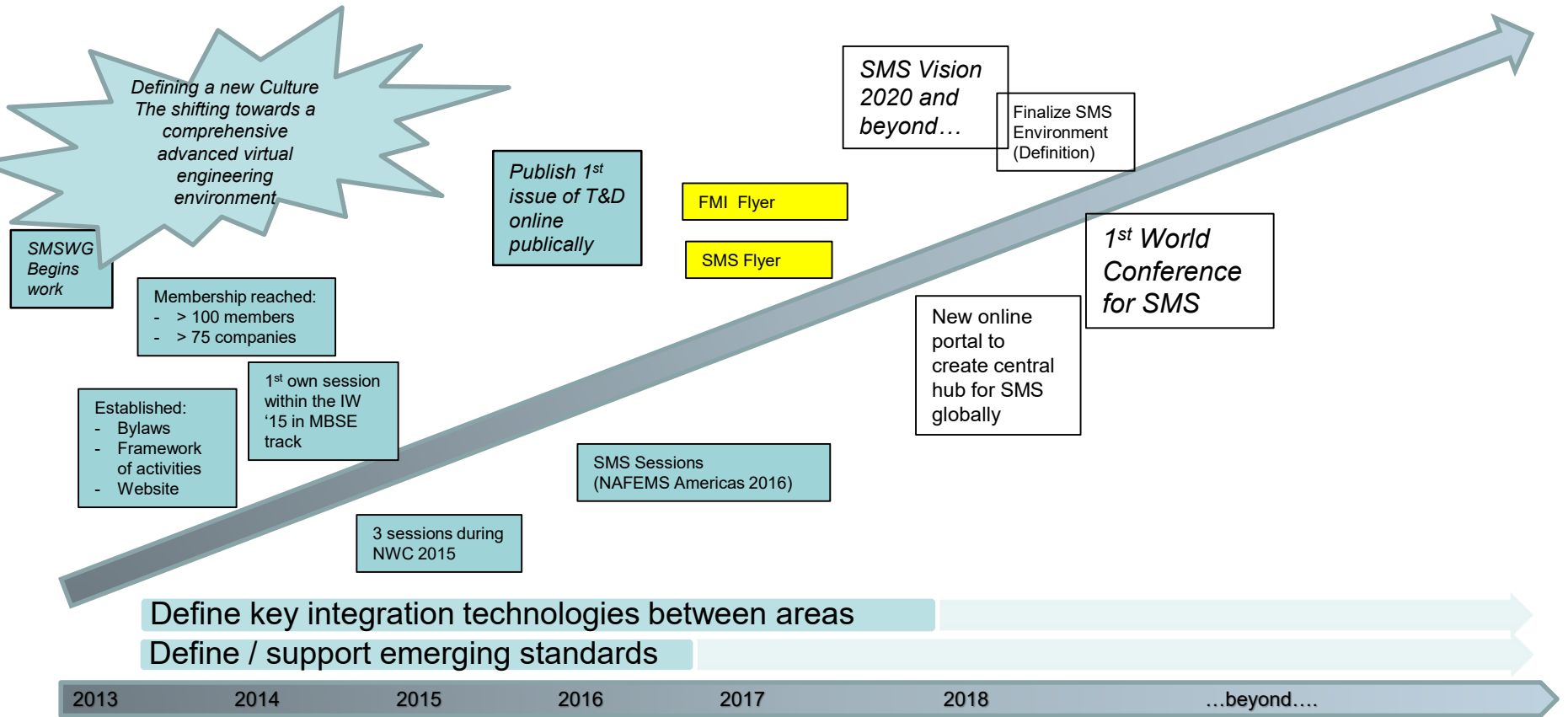
*(From NAFEMS World Congress 2017,
June 11-14, Stockholm, Sweden)*

NAFEMS & INCOSE joint working group
System Modeling and Simulation Working Group
(SMSWG)

Q2 2017

(From NAFEMS World Congress 2017,
June 11-14, Stockholm, Sweden)

Roadmap: High Level*



* Details are being developed and will find its way here through SMSWG meetings, contributions of members, consulting, etc.



What is

The Functional Mock-up Interface?

The FMI Standard for Systems Modeling



Overview of FMI

FMI is an open, vendor-independent and tool-independent engineering modeling standard that is focused on the creation and management of dynamic mathematical models. A dynamic model of a system or subsystem is defined by differential, algebraic and discrete equations with time and state variables to represent its time-varying state of events. The FMI standard provides the capability of amalgamating (coupling) multiple models that are associated with either the same or different engineering technical disciplines. These models could be based on a wide range of engineering disciplines such as FEA, CFD, 1-D System Simulation, Block Diagrams for Control, and many more (see Figure 1).

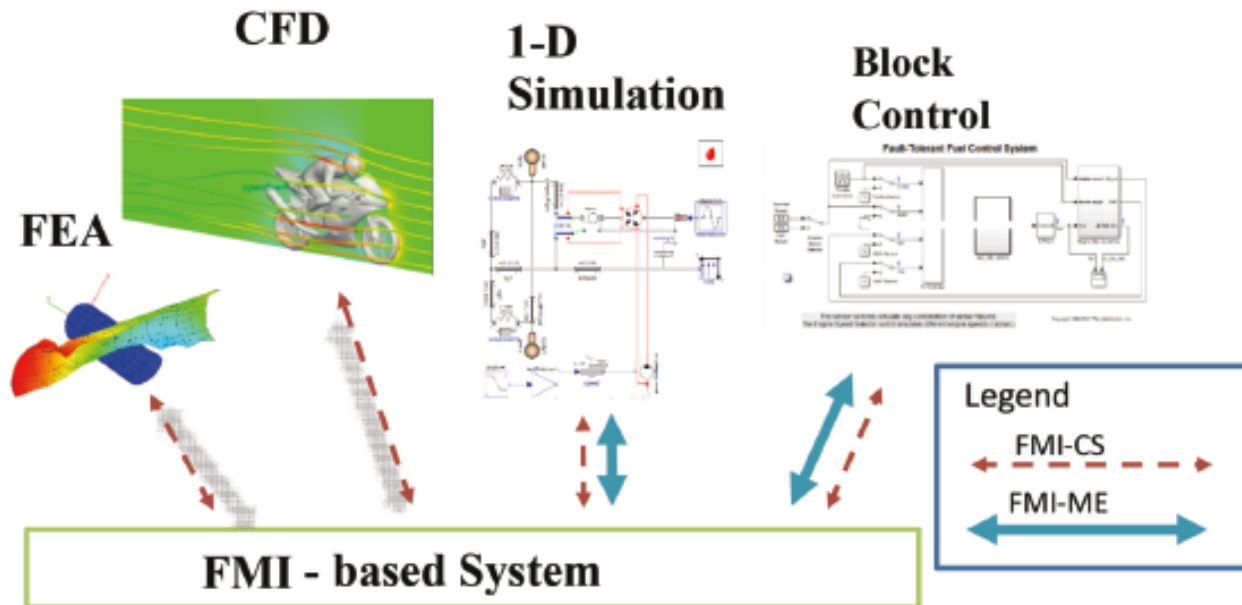


Figure 1: Integration of Multiple Models from Different Engineering Disciplines.

What is Systems Modeling and Simulation?

- Second of two SMSWG flyers in NAFEMS “What is?” series (to be printed in a trifold format)
 - First was “What is The Functional Mockup Interface?” (available at https://www.nafems.org/publications/resource_center/wt06/)
- A subgroup of the SMSWG Steering Committee drafted this new flyer
 - Used to build **consensus on the scope of this WG**
 - Summary of reasons for **why this group needs to exist**
 - **Basis for ongoing roadmap**, with links to online resources for SMSWG activities and subteams

What is Systems Modeling and Simulation?



THE INTERNATIONAL ASSOCIATION FOR THE ENGINEERING
MODELLING, ANALYSIS AND SIMULATION COMMUNITY



THE INTERNATIONAL COUNCIL ON SYSTEMS ENGINEERING

DRAFT

What is

Systems Modeling and Simulation?

Highlights of flyer

“The demand for system-level solutions is driving a need to merge systems engineering and engineering simulation at a new level.”

- Intersection of Systems Engineering (SE) and Engineering Simulation (ES)
- Varieties of models in both communities
- Drivers of growth in both systems engineering and engineering simulation
- Benefits to both communities
- Emerging standards to enable this collaboration

Drivers

- Demand for system-level solutions
- Increasing maturity of tools and resources for physical simulation
- Need to collaborate across disciplines
- Opportunity to integrate simulation throughout the systems development “Vee” process
- Enabling standards, frameworks, and tools to integrate simulation with systems engineering

Definitions (from flyer)

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.

The International Council on Systems Engineering (INCOSE) defines **Model-Based Systems Engineering (MBSE)** as the formalized application of modelling 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 (INCOSE-TP-2004-004-02, Version 2.03, September 2007).

Engineering Simulation is the use of numerical, physical or logical models of systems and scientific problems in predicting their response to different physical conditions (NAFEMS Glossary of Terms).

Benefits of Interaction between SE & ES

- Collaborate across organizational roles and responsibilities
 - Reach out to larger communities of discipline-specific engineers
- Establish clear boundaries of problems to be solved
 - Communicate “what” not “how”
 - Design freedom for technical solutions
 - Integrate successfully the first time
- Simulation throughout the life cycle
 - Enable agile methods and iterate faster at any stage
 - Create virtual prototypes including visualization and interaction
 - Explore larger design space
 - Reduce risk and cost

Figure 1. Model-based integration across multiple technical disciplines

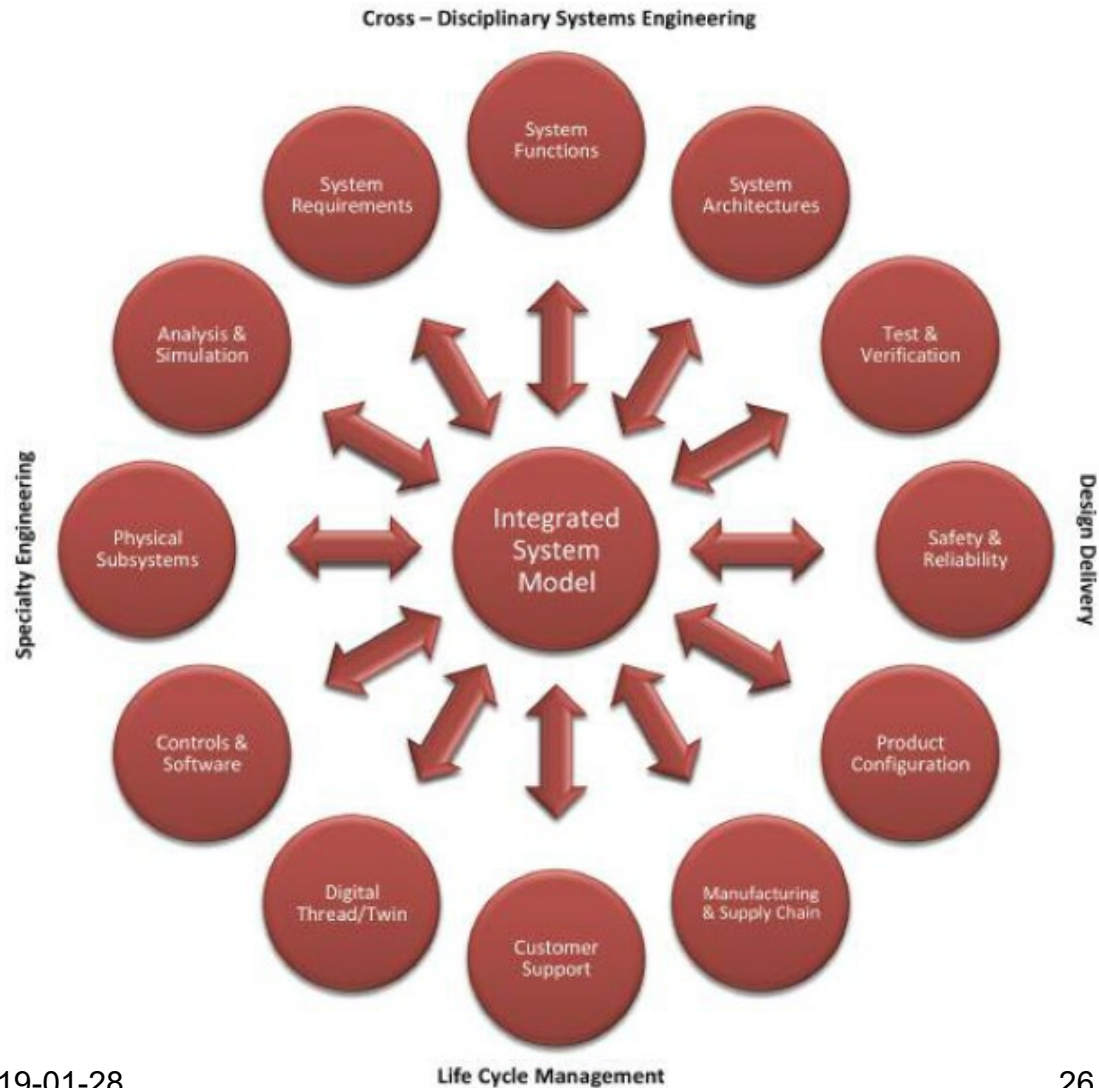
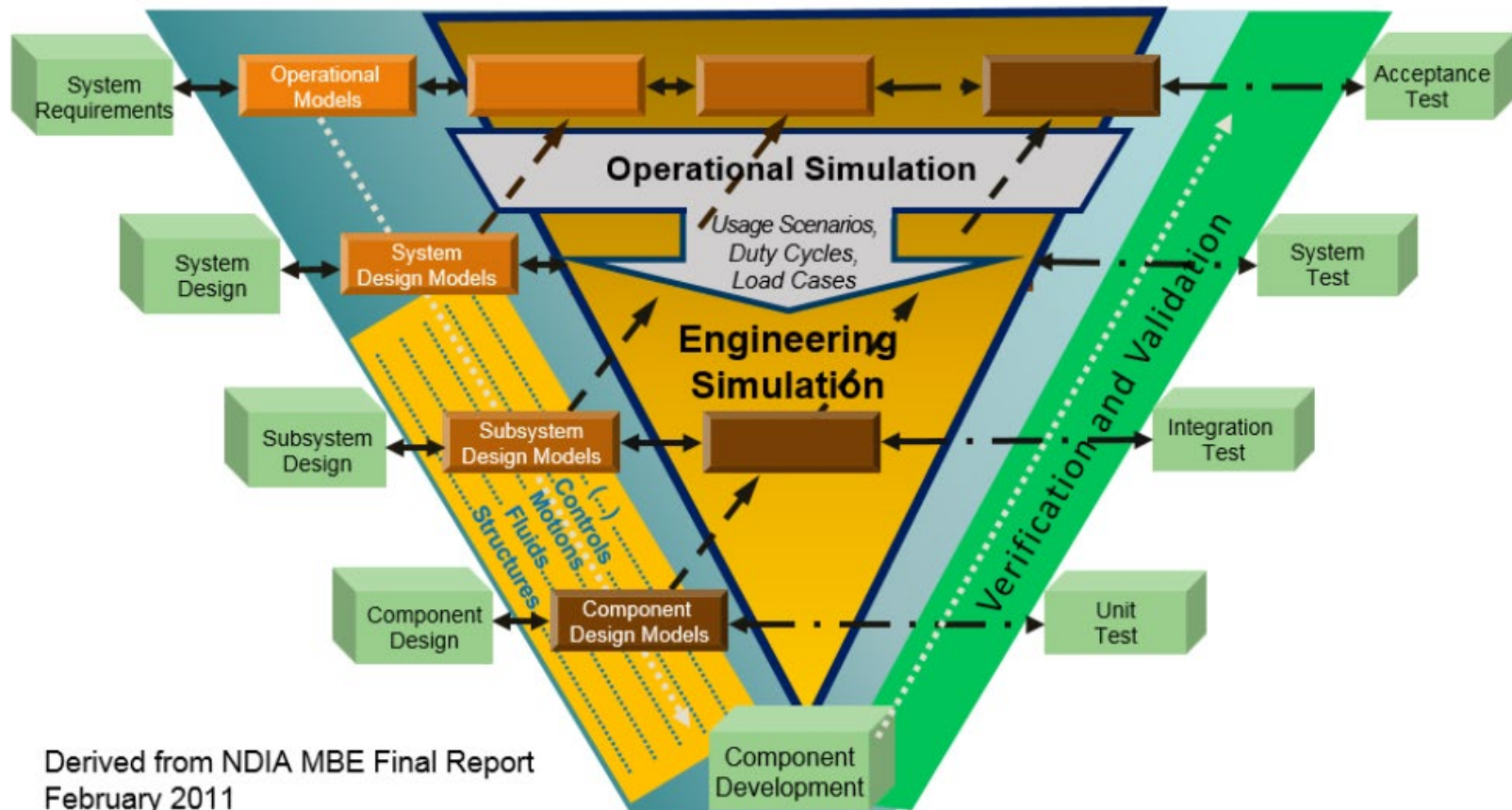


Figure 2. Iterative product development with systems engineering and engineering simulation



Links from document

Further Reading

Home page for NAFEMS-INCOSE Systems Modeling and Simulation WG at NAFEMS:
nafems.org/about/technical-working-groups/systems_modeling/

Home page for NAFEMS-INCOSE Systems Modeling and Simulation WG at INCOSE:
wiki.omg.org/MBSE/doku.php?id=mbse:smswg

References

- [1] SMS Terms & Definitions. [Online]. [29 November 2018]. Available from:
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- [2] INCOSE MBSE Wiki. [Online]. [29 November 2018]. Available from: wiki.omg.org/MBSE/
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- [4] Systems Engineering Body of Knowledge Wiki. Final Report of the Model Based Engineering (MBE) Subcommittee. [Online]. [17 January 2019]. Available from:
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- [5] Systems Engineering Body of Knowledge Wiki, sebokwiki.org. Representing Systems with Models. [Online]. [29 November 2018]. Available from:
sebokwiki.org/wiki/Representing_Systems_with_Models
- [6] Systems Engineering Body of Knowledge Wiki, sebokwiki.org. Types of Models. [Online]. [29 November 2018]. Available from: sebokwiki.org/wiki/Types_of_Models

Initial lineup of working subteams

From [SMSWG page](#) on [INCOSE MBSE wiki](#)

Working Subteams

These subteams are open for participation to all SMSWG members. Please contact the subteam lead(s) to be included in email communications, meetings, and activities. Each subteam can maintain their own wiki subpages for further information.

- SMSWG Roadmap and Sharing of Best Practices
- [Terms & Definitions](#)
- Standards Ecosystem
 - Modelica Association Standards, including FMI and SSP
 - PDES/STEP and MoSSEC
 - SysML V2
 - OSLC

Model-Based Definitions

- **Model-Based Engineering (MBE)** - a.k.a., Model-Driven Engineering (MDE) and Model-Driven Development (MDD). “An approach to engineering that uses models as an integral part of the technical baseline that includes the requirements, analysis, design, implementation, and verification of a capability, system, and/or product throughout the acquisition life cycle.” (Final Report, Model-Based Engineering Subcommittee, NDIA, Feb. 2011). It is the umbrella for many other MBx activities.
- **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.” (INCOSE SE Vision 2020 (INCOSE-TP-2004-004-02, Sep 2007). MBSE is a subset of Model Based Engineering (MBE) and Systems Engineering (SE).
- **Model-Based Design (MBD)** – “Real-time, high fidelity systems models that use mathematical, acausal, and visual methods to define system behavior, and performance. Often constructed as lumped parameter models supporting designs for complex controls, signal processing, and communication systems.” (Wikipedia) It is a subset of Model Based Engineering.
- **Model-based definition (MBD)** “is 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.” (Wikipedia) It is a subset of Model Based Design.
- **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, NASA, Feb. 2006). It is a sub-set of Model Based Engineering.
- **Model-Based Enterprise (MBE)** – “A strategy where an annotated digital three-dimensional (3D) model of a product serves as the authoritative information source for all activities in that product’s lifecycle.” (Wikipedia) It is the culmination of MBE.

Members of the **Systems Modeling & Simulation Working Group (SMSWG)** have compiled and created a common set of shared “*Terms and Definitions*”* to serve the model-based systems engineering community.

https://www.nafems.org/about/technical-working-groups/systems_modeling/smstermsdefinitions/

SMSWG Members Meeting

Monday, Jan. 28, 2019 (Salon BC)

Time	Topic	Presenter
9:00-9:20	Welcome and SMSWG Updates	Roger Burkhart (SMSWG Chair)
9:20-11:50	Reports and working sessions from SMSWG subteams	
9:20-9:40	Roadmap and Sharing of Best Practices	Frank Popielas (SMS ThinkTank)
9:40-10:00	Terms and Definitions	Ed Ladzinski (SMS ThinkTank)
10:00-10:30	Break	
10:30-11:00	Custom Integration Framework for MBSE and CAE using Open Standards	Aditya Shah (John Deere)
11:00-11:50	Panel on Standards Ecosystem	Don Tolle (CIMdata) (facilitator)
11:50-12:00	Discussion and Prioritization of 2019 Activities	All