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2021 Annual INCOSE international workshop
Virtual Event
January 29 - 31, 2021

www.nafems.org

Systems Modeling & Simulation (SMS) Working Group Overview for SMS Community Meeting #43 – 01 Feb 2021

Peter Coleman, Airbus

MBSE:	*Systems Modeling and Simulation:*	*Engineering Simulation:*
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.	*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 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 behaviour.*

SMSWG – Terms & Definitions: https://www.nafems.org/about/technical-working-groups/systems_modeling/smstermsdefinitions/s-u/

SMSWG supporting INCOSE – NAFEMS collaboration

2011 : INCOSE and NAFEMS agree to develop a collaborative relationship that benefits both organizations and their members

2012 : Joint MoU signed at INCOSE International Symposium with announcement to form the INCOSE/NAFEMS SMSWG

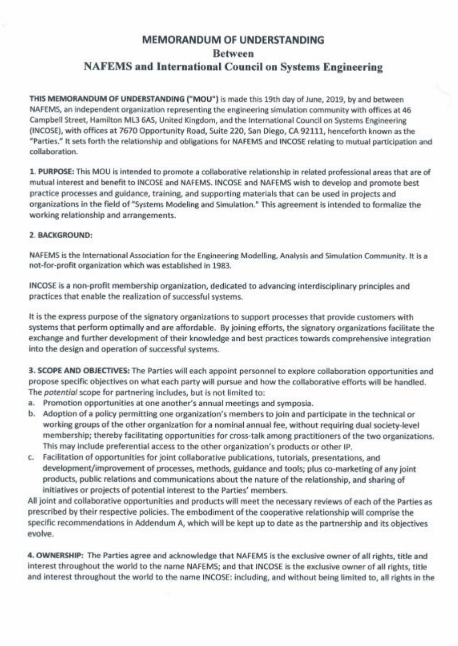
2013 : Founding steering committee to establish SMSWG and promote membership

2019 : Renewed MoU signed at NAFEMS World Congress alongside special "Systems Engineering meets Engineering Simulation" session

2020 : Common INCOSE Charter & NAFEMS Terms of Reference refreshed for SMSWG

Broader level collaboration between INCOSE and NAFEMS

- Mutual recognition of the certifications offered by each organisation
  - NAFEMS Professional Simulation Engineer (PSE)
  - INCOSE Systems Engineering Professional (ASEP, CSEP, ESEP)
- Ongoing discussions on membership and training opportunities
- Supporting flagship events e.g. INCOSE IS and NAFEMS World Congress



MEMORANDUM OF UNDERSTANDING
Between
NAFEMS and International Council on Systems Engineering

THIS MEMORANDUM OF UNDERSTANDING ("MOU") is made this 19th day of June, 2019, by and between NAFEMS, an independent organization representing the engineering simulation community with offices at 46 Campbell Street, Hamilton ML3 6AS, United Kingdom, and the International Council on Systems Engineering (INCOSE), with offices at 7670 Opportunity Road, Suite 220, San Diego, CA 92111, henceforth known as the "Parties." It sets forth the relationship and obligations for NAFEMS and INCOSE relating to mutual participation and collaboration.

1. PURPOSE: This MOU is intended to promote a collaborative relationship in related professional areas that are of mutual interest and benefit to INCOSE and NAFEMS. INCOSE and NAFEMS wish to develop and promote best practice processes and guidance, training, and supporting materials that can be used in projects and organizations in the field of "Systems Modeling and Simulation." This agreement is intended to formalize the working relationship and arrangements.

2. BACKGROUND:

NAFEMS is the International Association for the Engineering Modelling, Analysis and Simulation Community. It is a not-for-profit organization which was established in 1983.

INCOSE is a non-profit membership organization, dedicated to advancing interdisciplinary principles and practices that enable the realization of successful systems.

It is the express purpose of the signatory organizations to support processes that provide customers with systems that perform optimally and are affordable. By joining efforts, the signatory organizations facilitate the exchange and further development of their knowledge and best practices towards comprehensive integration into the design and operation of successful systems.

3. SCOPE AND OBJECTIVES: The Parties will each appoint personnel to explore collaboration opportunities and propose specific objectives on what each party will pursue and how the collaborative efforts will be handled. The *potential* scope for partnering includes, but is not limited to:

a. Promotion opportunities at one another's annual meetings and symposia.
b. Adoption of a policy permitting one organization's members to join and participate in the technical or working groups of the other organization for a nominal annual fee, without requiring dual society-level membership; thereby facilitating opportunities for cross-talk among practitioners of the two organizations. This may include preferential access to the other organization's products or other IP.
c. Facilitation of opportunities for joint collaborative publications, tutorials, presentations, and development/improvement of processes, methods, guidance and tools; plus co-marketing of any joint products, public relations and communications about the nature of the relationship, and sharing of initiatives or projects of potential interest to the Parties' members.

All joint and collaborative opportunities and products will meet the necessary reviews of each of the Parties as prescribed by their respective policies. The embodiment of the cooperative relationship will comprise the specific recommendations in Addendum A, which will be kept up to date as the partnership and its objectives evolve.

4. OWNERSHIP: The Parties agree and acknowledge that NAFEMS is the exclusive owner of all rights, title and interest throughout the world to the name NAFEMS; and that INCOSE is the exclusive owner of all rights, title and interest throughout the world to the name INCOSE: including, and without being limited to, all rights in the

SMSWG Purpose, Mission & Goal (ref Charter / ToR)

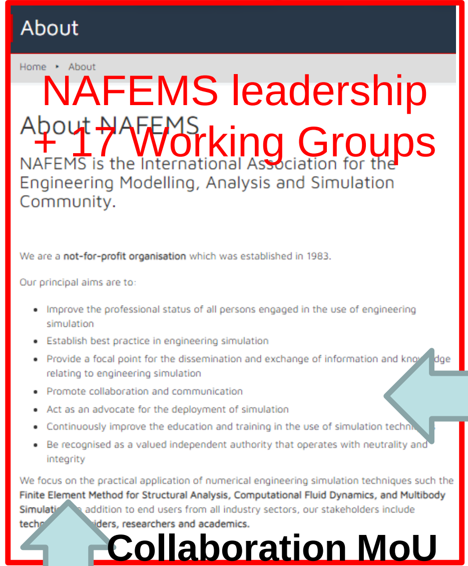
Purpose

- **Systems Engineering** has recognized the importance of models in a wide range of roles. Early in the development of a system, models may be used to understand the user domain, to define functions and concepts, and to capture system requirements across the levels of a system architecture. Such models may specify functional, interface, performance, and physical requirements, as well as other non-functional requirements such as reliability, maintainability, safety, and security.
- **Engineering Simulation** has been an essential part of product development engineering across many industries and disciplines for decades. This work is typically performed by technical specialists with deep knowledge in their respective domains, and with expertise in specialized mathematical and analytical tools.
- **Combining the Modeling and Simulation perspectives of both Systems Engineering and Engineering Simulation can improve communications and coordination across the product development life cycle.**

Mission & Goal

- 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 simulation and systems engineering**, but also acts as the advisory body to drive strategic direction for **technology development and international standards** in the space of complex engineering.
- The SMSWG supports activities that **bridge engineering simulation and systems engineering** to optimize the integration of Systems Engineering and Engineering Simulation solutions for both OEM and supplier. This includes education, communication, promotion of international standards, and development of requirements that will have general benefits to the Engineering Simulation and Systems Engineering communities.

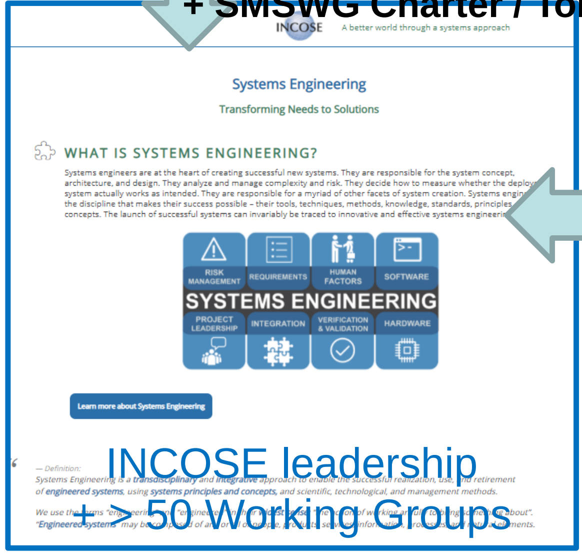
SMSWG organisation



NAFEMS leadership
+ 17 Working Groups

Collaboration MoU

+ SMSWG Charter / ToR



INCOSE leadership
+ >50 Working Groups

WG Members

- Roger Burkhart | INCOSE
- **Peter Coleman | Airbus (Chair)**
- Hans Peter de Koning | DEKonsult
- Rodney Dreisbach | Consultant (NAFEMS Americas)
- David Kaslow | DEKaslow Consulting
- Edward Ladzinski | SMS_Thinktank
- Eric Landel | IRT SystemX / ELC
- **Phyllis Marbach | INCOSE (Assistant Director Transformational Enablers)**
- **Frank Popielas | SMS_Thinktank (Vice Chair)**
- **Ian Symington | NAFEMS (Technical Officer)**
- Don Tolle | CIMData
- Hubertus Tummescheit | Modelon
- Mark Williams | The Boeing Company

+

- Trudy Hoye | NAFEMS (TWG manager)

Focus Team
Roadmap & Best Practices
Frank Popielas ++

Focus Team
SMS Standards Ecosystem
HP de Koning ++

Focus Team
Terms & Definitions
Ed Ladzinski ++

Focus Team
SE Handbook-E5 4.2 M&S
HP de Koning ++

Affiliated
AFIS-NAFEMS SMSWG
Eric Landel ++

SMS Community

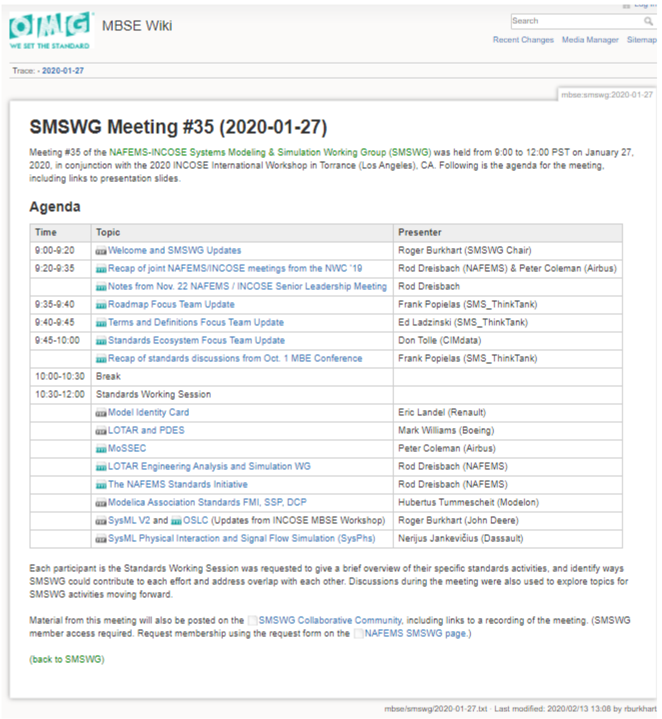
Open to all INCOSE or NAFEMS

322 members at end 2020

- Americas = 47.5%
- Europe = 42.5%
- Asia = 9%
- Rest of the world = 1%

Industry Sector	Number
Aerospace	86
Automotive	32
Defense	13
Consumer Products	11
Industrial Equipment	6
Transportation (other)	6
Architecture & Construction / Civil	4
Marine	4
Power & Energy	4
Process Manufacturing	4
Electronics & High-Tech	3
Additive Manufacturing	2
Oil & Gas	2
Agriculture	1
Civil	1
Life Sciences	1
Bio-medical	0
Geotechnics	0
Rail	0

SMSWG Web Pages + Repository of SMS Community shared material



MBSE Wiki

Trace: · 2020-01-27

mbse:smswg:2020-01-27

SMSWG Meeting #35 (2020-01-27)

Meeting #35 of the NAFEMS-INCOSE Systems Modeling & Simulation Working Group (SMSWG) was held from 9:00 to 12:00 PST on January 27, 2020, in conjunction with the 2020 INCOSE International Workshop in Torrance (Los Angeles), CA. Following is the agenda for the meeting, including links to presentation slides.

Agenda

Time	Topic	Presenter
9:00-9:20	Welcome and SMSWG Updates	Roger Burkhart (SMSWG Chair)
9:20-9:35	Recap of joint NAFEMS/INCOSE meetings from the NWC '19	Rod Dreisbach (NAFEMS) & Peter Coleman (Airbus)
	Notes from Nov. 22 NAFEMS / INCOSE Senior Leadership Meeting	Rod Dreisbach
9:35-9:40	Roadmap Focus Team Update	Frank Popielas (SMS_ThinkTank)
9:40-9:45	Terms and Definitions Focus Team Update	Ed Ladzinski (SMS_ThinkTank)
9:45-10:00	Standards Ecosystem Focus Team Update	Don Tolle (CIMdata)
	Recap of standards discussions from Oct. 1 MBE Conference	Frank Popielas (SMS_ThinkTank)
10:00-10:30	Break	
10:30-12:00	Standards Working Session	
	Model Identity Card	Eric Landel (Renault)
	LOTAR and PDES	Mark Williams (Boeing)
	MoSSEC	Peter Coleman (Airbus)
	LOTAR Engineering Analysis and Simulation WG	Rod Dreisbach (NAFEMS)
	The NAFEMS Standards Initiative	Rod Dreisbach (NAFEMS)
	Modelica Association Standards FMI, SSP, DCP	Hubertus Tummescheit (Modelon)
	SysML V2 and OSLC (Updates from INCOSE MBSE Workshop)	Roger Burkhart (John Deere)
	SysML Physical Interaction and Signal Flow Simulation (SysPhs)	Nerijus Jankevičius (Dassault)

Each participant is the Standards Working Session was requested to give a brief overview of their specific standards activities, and identify ways SMSWG could contribute to each effort and address overlap with each other. Discussions during the meeting were also used to explore topics for SMSWG activities moving forward.

Material from this meeting will also be posted on the SMSWG Collaborative Community, including links to a recording of the meeting. (SMSWG member access required. Request membership using the request form on the NAFEMS SMSWG page.)

(back to SMSWG)

mbse/smswg/2020-01-27.txt · Last modified: 2020/02/13 13:08 by rburkhart

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

TO BE UPDATED

A better world through a systems approach

Transformational Application Domains Analytic Enablers Process Enablers

NAFEMS-INCOSE Systems Modeling & Simulation WG

Mission & Objectives

Systems Engineering has recognized the importance of models in a wide range of roles. Early in the development of a system, models may be used to understand the user domain, to define functions and concepts, and to capture system requirements across the levels of a system architecture. Such models may specify functional, interface, performance, and physical requirements, as well as other non-functional requirements such as reliability, maintainability, safety, and security. Engineering Simulation has been an essential part of product development engineering across many industries and disciplines for decades. This work is typically performed by technical specialists with deep knowledge in their respective domains, and with expertise in specialized mathematical and analytical tools. Combining the modeling and simulation perspectives of both Systems Engineering and Engineering Simulation can improve communications and coordination across the product development life cycle.

The Systems Modeling & Simulation Working Group (SMSWG) is a collaboration between NAFEMS (The International Association for the Engineering Modelling, Analysis and Simulation Community) and INCOSE (the International Council on Systems Engineering). The **mission** of the SMSWG is 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 simulation and systems engineering, but also acts as the advisory body to drive strategic direction for technology development and international standards in the space of complex engineering.

Leadership

SMSWG Chair – Peter Coleman - peter.coleman@airbus.com

Responsible for:

- providing leadership to the SMSWG
- acting as the focal point of the SMSWG
- ensuring that SMSWG meetings are run effectively.

SMSWG Vice Chair – Frank Popielas - frank.popielas@smsthinktank.com

Responsible for:

- providing leadership to the SMSWG
- chairing SMSWG and SMSWG Community meetings in the absence of the Chair.
- supporting the SMSWG Chair.

NAFEMS Technical Working Group Manager – Trudy Hoye - trudy.hoye@nafems.org

Responsible for:

- acting as the primary point of contact between the SMSWG and NAFEMS
- SMSWG meeting logistics, processing new member requests
- producing the minutes for SMSWG meetings

INCOSE Central Office - Secretary@incose.org

Responsible for:

- acting as the INCOSE focal point for membership enquiries

INCOSE Assistant Director for Transformational Enablers – Phyllis Marbach - prmarbach@gmail.com

Responsible for:

- acting as the primary point of contact between the SMSWG and INCOSE
- acting as the INCOSE point of contact for SMSWG funding
- acting as the INCOSE point of contact for approving SMSWG output

NAFEMS Technical Officer – Ian Symington - ian.symington@nafems.org

Responsible for:

- acting as the NAFEMS point of contact for SMSWG funding
- acting as the NAFEMS point of contact for approving SMSWG output

INCOSE Technical Director - Christopher D Hoffman - christopher.d.hoffman@cummins.com

Responsible for:

- providing the authority to terminate or request a change of scope for the SMSWG

NAFEMS CEO – Tim Morris - tim.morris@nafems.org

Responsible for:

- providing the authority to terminate or request a change of scope for the SMSWG

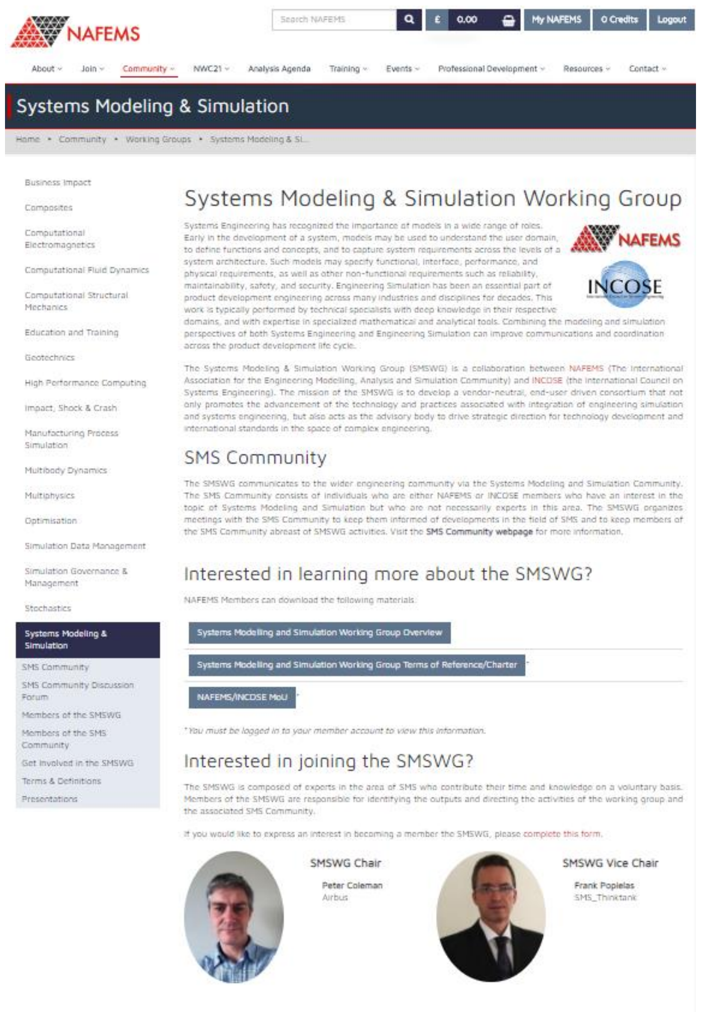
Working Group Products

Working group outputs in the area of Systems Modeling and Simulation include:

- guidance in the form of processes and methods;
- support for flagship NAFEMS & INCOSE events including the NAFEMS World Congress and the INCOSE Symposium. Such support will include invitations to each organization's meetings on subjects of mutual interest;
- providing content that should be hosted on both NAFEMS and INCOSE websites. Such content would include presentations shared at meetings and a synopsis of the SMSWG's activity;
- provide assistance, support and promotion for international standards relevant to SMS;
- develop and publish jointly a glossary of terms in use across the field of SMS;
- develop a competency framework for practitioners of SMS.

The outputs of the joint SMSWG are strengthened by carrying both the NAFEMS and INCOSE branding. Potential outputs should be discussed with the NAFEMS Technical Officer and INCOSE Director for Transformational Enablers to ensure a smooth publication process.

https://www.incose.org/incose-member-resources/working-groups/transformational/incose-nafems-collaboration



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Systems Modeling & Simulation

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Business Impact
Composites
Computational Electromagnetics
Computational Fluid Dynamics
Computational Structural Mechanics
Education and Training
Geotechnics
High Performance Computing
Impact, Shock & Crash
Manufacturing Process Simulation
Multibody Dynamics
Multiphysics
Optimisation
Simulation Data Management
Simulation Governance & Management
Stochastics
Systems Modeling & Simulation
SMS Community
SMS Community Discussion Forum
Members of the SMSWG
Members of the SMS Community
Get Involved in the SMSWG
Terms & Definitions
Presentations

Systems Modeling & Simulation Working Group

Systems Engineering has recognized the importance of models in a wide range of roles. Early in the development of a system, models may be used to understand the user domain, to define functions and concepts, and to capture system requirements across the levels of a system architecture. Such models may specify functional, interface, performance, and physical requirements, as well as other non-functional requirements such as reliability, maintainability, safety, and security. Engineering Simulation has been an essential part of product development engineering across many industries and disciplines for decades. This work is typically performed by technical specialists with deep knowledge in their respective domains, and with expertise in specialized mathematical and analytical tools. Combining the modeling and simulation perspectives of both Systems Engineering and Engineering Simulation can improve communications and coordination across the product development life cycle.

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SMS Community

The SMSWG communicates to the wider engineering community via the Systems Modeling and Simulation Community. The SMS Community consists of individuals who are either NAFEMS or INCOSE members who have an interest in the topic of Systems Modeling and Simulation but who are not necessarily experts in this area. The SMSWG organizes meetings with the SMS Community to keep them informed of developments in the field of SMS and to keep members of the SMS Community abreast of SMSWG activities. Visit the **SMS Community webpage** for more information.

Interested in learning more about the SMSWG?

NAFEMS Members can download the following materials.

Systems Modelling and Simulation Working Group Overview

Systems Modelling and Simulation Working Group Terms of Reference/Charter *

NAFEMS/INCOSE MoU *

** You must be logged in to your member account to view this information.*

Interested in joining the SMSWG?

The SMSWG is composed of experts in the area of SMS who contribute their time and knowledge on a voluntary basis. Members of the SMSWG are responsible for identifying the outputs and directing the activities of the working group and the associated SMS Community.

If you would like to express an interest in becoming a member the SMSWG, please complete this form.

SMSWG Chair
Peter Coleman
Airbus

SMSWG Vice Chair
Frank Popielas
SMS_Thinktank

https://www.nafems.org/community/working-groups/systems-modeling-simulation/

2020 retrospective

January – incose.org/iw2020
IW MBSE wshop + SMS#35

- **Recap NWC'19**
- **Focus Teams updates**
- **Standards session**

March - SMS#36

- **SMSWG ToR / Charter update**
- **Model Characterization Pattern (MCP)** - Bill Schindel (ICTT)

June – SMS#37

- CAASE20 overview
- **Digital Twin Maturity & Impact** – Frank Popielas (SMS_ThinkTank)

June – nafems.org/caase20
Advancing Analysis & Simulation in Engineering

- SMSWG – Frank Popielas
- Inc. tracks on SMS & MBE

July – SMS#38

- **Coherent Digital Thread as enabler for Systems Thinking** - M.Panthaki (Aras) + R.Mottola (Toyota)

September – SMS#39

- **SE driven M&S method** – Pascal Paper (Airbus)

October – SMS#40

- **LOTAR for MBSE Data + How MoSSEC (STEP AP243) supports model-based collaboration** - Adrian Murton (Airbus)

November – SMS#41

- **Progress on SysML v2** – HP de Koning (DEKonsult)

December – SMS#42

- **Model Identity Card (MIC)** – Eric Landel (IRT SystemX / ELC)

WG#01

WG#02

WG#03

WG#04

WG#05

WG#06

SEH-E5 4.2 M&S

INCOSE
International Council on Systems Engineering

NAFEMS

SMSWG “What is FMI?” publication 2018

- Short guide promoting awareness on the Modelica FMI standard for Model Exchange and Co-simulation
- NAFEMS branded product freely available via: https://www.nafems.org/publications/resource_center/wt06/

NAFEMS

What is

The Functional Mock-up Interface?

The FMI Standard for Systems Modeling

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

What is the FMI?

Modeling and simulation have been an essential part of product development engineering across all industries and disciplines for decades. This work has been typically conducted by subject matter experts where too often the fruits of their labor have been largely inaccessible to other members of their enterprise who need these data to perform their tasks. Additionally, different CAE simulation vendors typically rely upon their own proprietary formats and interfaces for software tools that they have developed and maintain. This further complicates the ability for end users to share data among different engineering groups and across different engineering disciplines. To overcome these problems, the Functional Mock-up Interface (FMI) was developed as an international standard for systems modeling. It addresses many of the issues associated with sharing of simulation information both inside and outside the enterprise.

The initial FMI standard was the result of a European automotive project aiming to improve the design of systems and embedded software in vehicles. Another important objective was to improve the collaboration and exchange of automotive simulation models between suppliers and OEMs. Since then, development of the FMI standard continues through the participation of companies and research institutes in a development process managed by the Modelica non-profit organization. As of June 2017, FMI is supported by more than 100 software vendor tools and is used across different industries globally.

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). FMI can indeed be used to couple the scalar solution results between 3-D models and 1-D models, but not to couple several 3-D models with each other as would be needed to solve, for example, fluid-structure interaction problems. When multiple dynamic models associated with different disciplines are used to simulate a system, the overall solution is typically performed by using a co-simulation approach as described in the following section.

An FMI-compatible software code generates a Functional Mock-Up Unit (FMU) which is the vehicle by which dynamic simulation model data and model executions can be exchanged between different FMI-compatible codes. FMUs are comprised of either .xml files and compiled code, or C-code for source code FMUs. The simulation models defined in this manner can be large and can be used in embedded control systems on microprocessors when developing integrated cyber-physical systems. The models can also be utilized for multiple instances within a larger model and they can be connected hierarchically to define an aggregated model.

As described below, FMI supports (a) sharing (exchange) of dynamic models, and (b) co-simulation of dynamic models via the transfer of solution results from one dynamic model as input to one or more other dynamic models.

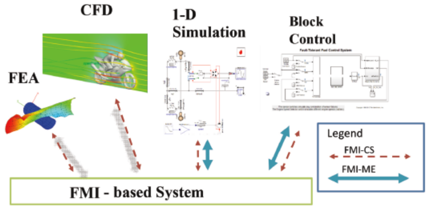

Figure 1: Integration of Multiple Models from Different Engineering Disciplines.

FMI for Model Exchange (FMI-ME)

FMI-compatible tools can be used either to export an FMU to make a model available to another platform, or to import an FMU to execute a model using a different platform, or both. Specialized tools are available for performing the aggregation and co-simulation of multiple models from different sources.

Different system and component suppliers may utilize different software tools and modeling environments to deliver the simulation results requested by their OEM. By using the FMI standard, the suppliers can provide their dynamic model FMUs to their OEM for integrating (amalgamating) the various simulation models. This approach allows the OEM to construct a system-level simulation model for analyzing the performance characteristics of the final product or a sub-system of the final product (see Figure 2). It should be noted that the models may originate from one or more different domain-specific simulation tools. With FMI-ME, the FMU does not contain a solver. Instead, the solver is provided by the tool which imports and assembles the overall system model. A single solver can be used for multiple FMUs. The joint simulation is therefore not a co-simulation.

FMI for Co-Simulation (FMI-CS)

The co-simulation solution approach is used when multiple dynamic models associated with different engineering disciplines are used to simulate a time-dependent coupled system or subsystem. In this case, the models associated with each particular discipline are solved each by their respective solvers in a distributed way during runtime. The solution results from the individual solvers are then coupled to create the overall solution through a "master" algorithm using specified communication time steps that can be different from the internal time steps of the participating solvers. Each solver is executed to simulate the partial system response during each time interval, where the start/stop end points of a time interval are called "communication points." The Master algorithm has the task of sending signals at the communication points and supervising the overall solution. Advanced master algorithms can deal with variable communication steps sizes and perform error control for the overall system level solution, but only when all participating FMUs are at least FMI version 2.0 or higher.

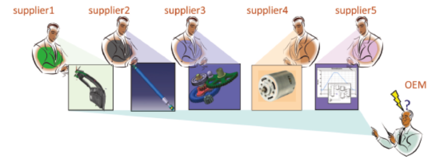

Figure 2: Integration of Independently-Developed Subsystem Models

Business Model Innovation

FMI-compliant software tools often allow liberally licensed export of models for sharing across an organization. This means that exported FMUs often don't require a license from the model-authoring tool. A significant business benefit from using the FMI standard is that the tool used to create a model that is encapsulated by an FMU may be different from the tool that is used to execute the model. Not only can an FMU be used by any FMI-compliant tool, it can be used by many people without added licensing costs. Collaboration between engineers in different groups or departments across an enterprise is thereby possible with little or no additional training. These business benefits empower the user community to exploit a combination of different FMI-compliant tools of their choice that best meets their needs. Typically, by employing the FMI standard in the engineering environment, simulation tool integration and test results verification are now possible earlier in the product development cycle, thus reducing the financial risk associated with discovering errors later in product development. In addition, statistical studies to analyze product performance can be performed at reasonable cost, e.g. manufacturing variation with thousands of simulation runs.

Industry Adoption of the FMI Standard

Not only are Systems Engineering and CAE software vendors adopting FMI, but also industry groups and technical standards groups as noted below:

- The **System Modeling and Simulation Workgroup (SMSWG)** is a joint working group of INCOSE www.incose.org and NAFEMS www.nafems.org which strongly endorses FMI as a key standard for system simulation and model exchange: www.nafems.org/about/technical-working-groups/systems_modeling Please provide any feedback on the content of this flyer by sending an email to sms@nafems.org
- **prostep ivip** is a non-profit organization that has been fundamental in driving standards in the CAD industry, and supports FMI as part of their effort to implement standards for Product Lifecycle Management (PLM), www.prostep.org
- The **Global Automotive Advisory Group (GAAG)** is an internal working group of essentially all automotive OEMs which is committed to making FMI a de-facto standard for model exchange between suppliers and the OEMs.
- The "Systems Engineering interoperability" working group, within the Strategic Standardisation Group (SSG) of the Aerospace and Defence Industries Association of Europe (ASD), recognizes FMI as an emerging standard for an A&D strategy in terms of methods and standards to specify, exchange and integrate systems simulation models: www.asd-ssg.org/systems-engineering-interoperability
- The **NDIA Modeling Simulation Committee** has recognized the importance of open standards and is tracking the overall adoption and implementation of FMI as an international standard: www.ndia.org/divisions/systems-engineering/committees/modeling-simulation-committee

Further Reading

1. The home page of the FMI standard is at www.fmi-standard.org. Illustrations in this document were adapted from FMI project presentations at www.fmi-standard.org/literature. FMI support in tools is summarized at www.fmi-standard.org/tools
2. Co-simulation – Art or Science?" by Hubertus Tummescheit provides an overview of co-simulation with a focus on best practices with special attention to the Functional-Mockup-Interface. Technical note at www.nafems.org/publications/resource_center/bm_jan_19_01/.
3. Wikipedia article on FMI at en.wikipedia.org/wiki/Functional_Mock-up_Interface.

Glossary

A&D	Aerospace & Defense
CAE	Computer Aided Engineering
CFD	Computational Fluid Dynamics
FEA	Finite Element Analysis
FMI	Functional Mock-up Interface
FMI-CS	FMI for Co-Simulation
FMI-ME	FMI for Model Exchange
FMU	Functional Mock-up Unit, a model conforming to FMI
NDIA	National Defense Industry Association
1-D	1-dimensional
3-D	3-dimensional
OEM	Original Equipment Manufacturer

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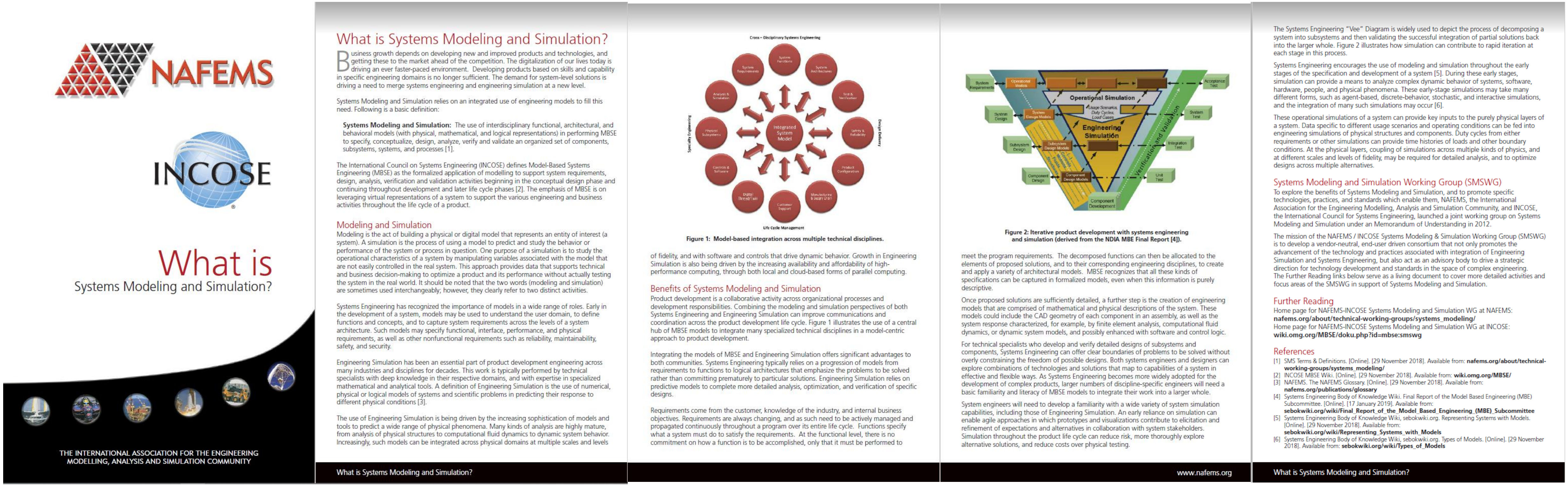
SMSWG “What is SMS?” publication 2019

- Short guide promoting awareness of both MBSE and Engineering Simulation for successful product development and Model-based integration across multiple disciplines
- First co-branded product available for INCOSE or NAFEMS members via:
- https://connect.incose.org/Pages/Product-Details.aspx?ProductCode=what_is_sms
- https://www.nafems.org/publications/resource_center/bm_apr_19_11/



SMSWG identify and promote SMS related standards

A&D PLM Action Group

INCOSE – PDES MoU

Standardization Days

MoSSEC

prostep ivip SmartSE

MBSE for PDES

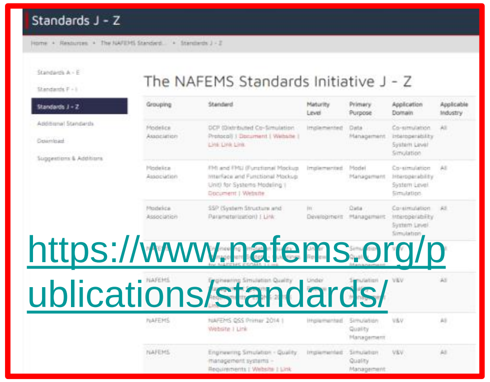
GLOBAL PRODUCT DATA INTEROPERABILITY SUMMIT 2020

LOTAR for MBSE

SE Handbook

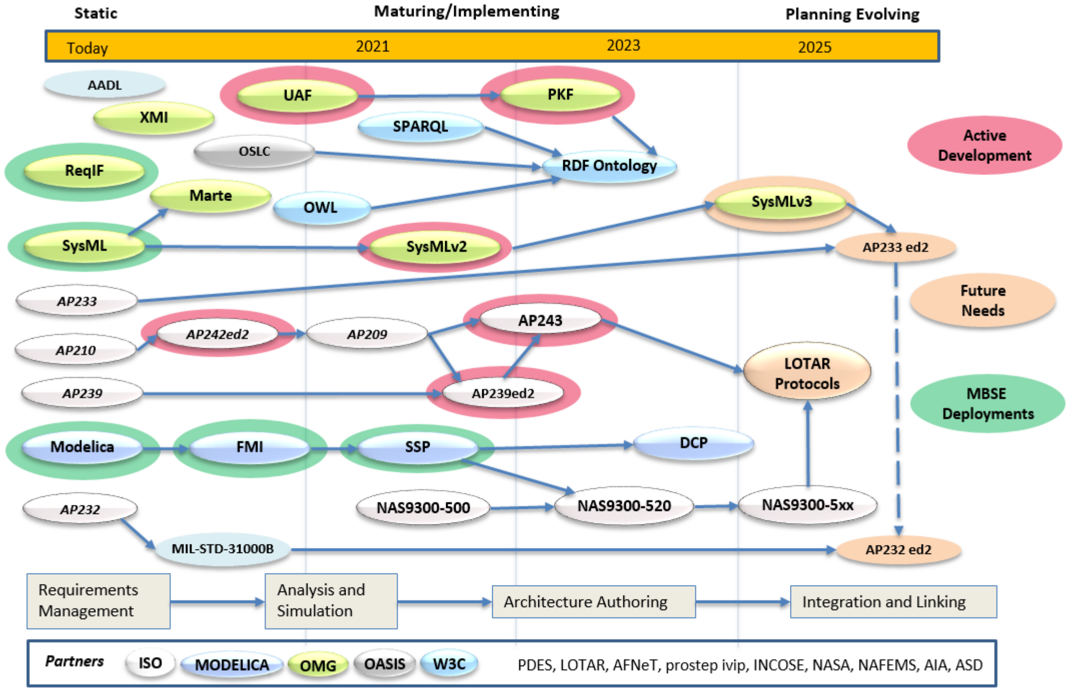
NAFEMS

INCOSE TIMLM and DEIX WGs



https://www.nafems.org/publications/standards/

- SMSWG aim to identify and promote the maturity and industry adoption of relevant international standards that enable Systems M&S and the integration of MBSE with engineering simulation
- “Unknown or no standards” identified as major gap in survey from MBSE workshop at 2018 GPDIS
- Need for improved model/data interoperability and cross-domain engineering collaboration
- Connect with industry groups working on developing or promoting adoption of standards for MBSE and Engineering Simulation
- Ongoing liaison with NAFEMS Standards Initiative
- Examples:
  - Modelica Assoc. standards e.g. FMI/FMU, SSP …
  - ISO STEP standards e.g. AP209ed2, AP243 DIS (MoSSEC), link with LOTAR
  - Web standards e.g. OSLC, RDF, XML/XMI, UML
  - OMG standards e.g. ReqIF, SysML v2, UAF



from PDES-LOTAR MBSE Conference, May 8th, 2019. Revised Nov 20th, 2019

Reference ASD Radar Chart for detailed descriptions

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SMSWG maintain and evolve the SMS Terms & Definitions

- First published 2016 with regular updates on dedicated pages via NAFEMS website:
  - https://www.nafems.org/community/working-groups/systems-modeling-simulation/smstermsdefinitions/

- 12 additions in 2020:
  - Democratization of Simulation
  - Digital Twin
  - Engineering Simulation
  - Generative Design
  - Model-Based Definition (MBD)/(MBDef)
  - Model-Based Design (MBD)
  - Model Based Development (MBDev)
  - Model-Based Engineering (MBE)
  - Model-Based Enterprise (MBE)
  - Model-Based Safety Analysis (MBSA)
  - Model-Based Systems Engineering (MBSE)
  - Simulation Governance

Systems Modeling & Simulation Working Group

The following was compiled by members of the Systems Modeling & Simulation Working Group to provide the model-based systems engineering community with a common set of shared terms and definitions.

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

Terms & Definitions (M-O)

Term	Definition	Source	Comments
Mathematical Model	A symbolic model whose properties are expressed in mathematical symbols and relationships. (IEEE 610.3-1989)	Modeling & Simulation Coordination Office	
Measure Of Effectiveness (MOE)	A metric used to quantify the performance of a system, product or process in terms that describe a measure to what degree the real objective is achieved.	Modeling & Simulation Coordination Office	
Measure Of Outcome (MOO)	A qualitative or quantitative measure that defines how operational requirements contribute to end results at higher levels, such as campaign or national strategic outcomes.	Modeling & Simulation Coordination Office	
Measure Of Performance (MOP)	A qualitative or quantitative measure of how the system/individual performs its functions in a given environment (i.e., number of targets detected, reaction time, number of targets nominated, susceptibility of deception, task completion time). It is closely related to inherent parameters (physical and structural) but measures attributes of system behavior.	Modeling & Simulation Coordination Office	
Measures of Effectiveness Data	Data provided to quantify Measures of Effectiveness.	INCOSE	
Measures of Effectiveness Needs	The "operational" measures of success that are closely related to the achievement of the mission or operational objective being evaluated, in the intended operational environment under a specified set of conditions (i.e., how well the solution achieves the intended purpose).	INCOSE	
Measures of Performance Data	Data provided to quantify the Measures of Performance.	INCOSE	
Measures of Performance Needs	Key performance characteristics the system should have when fielded and operated in its intended operating environment.	INCOSE	
Metadata	Information describing the characteristics of data; data or information about data; descriptive information about an organization's data, data activities, systems, and holdings. For example, discovery metadata is a type of metadata that allows data assets to be found using enterprise search capabilities. (DoDD 8320.02)	Modeling & Simulation Coordination Office	
Metamodel	A model of a model or simulation. Metamodels are abstractions which use functional decomposition to show relationships, paths of data and algorithms, ordering, and interactions between model components and subcomponents. Metamodels allow the developer to abstract details to a level that subject matter experts can validate.	Modeling & Simulation Coordination Office	

SMSWG update of 4.2 Modeling and Simulation content for INCOSE SE Handbook E5

- SMS WG & Community team started revision from Dec’20
  - Hans Peter de Koning + Peter Coleman, Alexander Karl, Maurice Theobald, Hubertus Tummescheit, Rod Dreisbach
- Target: reduction from 7.5 pages to 4
  - Currently ~6 pages text (excluding figures) – challenge to reduce further more without compromising content!
- Proposed adapted title: Modeling, Analysis and Simulation
- Initial R1 draft submitted on 4 Jan 2021 + improved R2 draft submitted on 22 Jan 2021
  - Major re-write – streamlining content & narrative
  - Reference to "What is SMS" flyer –
  - Proposed additional terms & definitions (table)
- First review & feedback with Editorial team done 28 Jan.
- Next steps - coordination and cross-check with other author teams & next round of revision from Feb to March

SMSWG roadmap outlook for 2021

- SMS Community webinars 2nd Tuesday each month 17.00 CET / 11.00 ET
  - Proposals for topics & speakers are welcome
- Maintain & streamline availability of SMSWG content across INCOSE and NAFEMS platforms
- SE Handbook-E5 focus team to improve 4.2 M&S for next draft in March
- Terms & Definitions focus team to refine & evolve content of SMS T&D’s
- SMS related standards focus team to monitor & promote standardisation efforts
- Launch new focus team on SMS modelling metadata in collaboration with related initiatives
- Potential publication to help clarify “What is MBx”
- Opportunities to connect & collaborate with other working groups and initiatives
  - INCOSE TIMLM, SETDB, MBSE patterns MCP, Standards Dev, …
  - NAFEMS Business Impact, SDM, SG&M, …
  - ASSESS
- Propose and further develop Engagement Strategy
  - Support NAFEMS to develop a strategy that improves their visibility, awareness, engagement and participation in relevant INCOSE activities and deliverables
  - Support INCOSE to develop a strategy that improves their visibility, awareness, engagement and participation in relevant NAFEMS activities and deliverables

Interested to join the SMSWG or SMS Community?

Get Involved in the Systems Modeling & Simulation Working Group

If you are an expert in the area of SMS and would like to get involved in the **Systems Modeling & Simulation Working Group** activities, please complete the form below.

First Name

First Name

Last Name

Last Name

Company

Company

Email

Email

My organisation is a NAFEMS member

Please Select

I am a member of INCOSE

Please select

If your organisation is not already a member of NAFEMS, would you be interested in receiving information on membership?

Please Select

If you are not already a member of INCOSE, would you be interested in receiving information on membership?

Please select

Submit

By clicking submit and providing us with your contact details, you are giving NAFEMS your explicit consent to contact you using these details regarding your enquiry and our related products and services. You can view our privacy policy here

www.nafems.org/community/working-groups/systems-modeling-simulation/get_involved/

Join the SMS Community

If you are an INCOSE member please complete the form below in order to join the SMS Community.

If you are a NAFEMS member and wish to join the SMS Community please visit the Technical Communities tab in the "My NAFEMS" section of the website.

Visit the SMS Community page to find out about SMS Community events.

First Name

First Name

Last Name

Last Name

Company

Company

Email

Email

Are you a member of INCOSE?

Please select

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By clicking submit and providing us with your contact details, you are giving NAFEMS your explicit consent to contact you using these details regarding your enquiry and our related products and services. You can view our privacy policy here

www.nafems.org/community/working-groups/systems-modeling-simulation/get_involved_sms_community/