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.

• 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.”
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.”
## SMSWG Members

### Members:

162* members

### Unique Member Companies:

92 unique member companies

* (as of Sep. 2016)

### Regional Breakdown:

<table>
<thead>
<tr>
<th>Region</th>
<th>Percentage</th>
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<tr>
<td>Americas</td>
<td>70%</td>
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<td>Europe</td>
<td>19%</td>
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<tr>
<td>Asia / Pacific</td>
<td>8%</td>
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<tr>
<td>other/undeclared</td>
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</table>

### Industry Breakdown:

<table>
<thead>
<tr>
<th>Industry</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>aerospace or defense</td>
<td>22%</td>
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<tr>
<td>automotive</td>
<td>16%</td>
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<tr>
<td>academia</td>
<td>3%</td>
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<tr>
<td>consulting</td>
<td>10%</td>
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<tr>
<td>energy</td>
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<tr>
<td>medical</td>
<td>1%</td>
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<tr>
<td>other industry</td>
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<tr>
<td>solutions &amp; services</td>
<td>34%</td>
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<tr>
<td>standards</td>
<td>4%</td>
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<tr>
<td>undeclared</td>
<td>2%</td>
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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.
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?
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
NAFEMS Members-Only Site
https://sites.google.com/a/nafems.org/smswg/

SMSWG Collaborative Community

SMSWG Files

Content generated and owned by members of the SMSWG.

Add file  Add link  Add from Drive  Move to  Delete  Subscribe to changes

2016 NAFEMS Americas Conference

- 3_1-a_baroux.pdf
  View  Download  8379k  v.2  Jun 21, 2016, 11:16 AM  Matthew Ladzinski

- 3_1-a_croegaert.pdf
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- 3_1-a_szarazi.pdf
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Misc

- MOU-NAFEMS-INCOSE.pdf
  View  Download  795k  v.2  Sep 23, 2015, 11:30 AM  Matthew Ladzinski

- SMSWG-Collaborative-Community-Instructions.pdf
  View  Download  281k  v.2  Nov 21, 2014, 2:25 PM  Matthew Ladzinski

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My recent activity

INCOSE
2020-01-27
2019 Accomplishments

• Initial two products of SMSWG, in the form of “What Is?” trifold handout flyers, now published as part of a NAFEMS series
  – What is Functional Mockup Interface (FMI)? (published January 2018)

• Launched Focus Teams to keep work moving forward throughout year
  – Roadmap and Sharing of Best Practices
  – Terms & Definitions
  – Standards Ecosystem

• Maintained schedule of monthly members meetings throughout year

• NAFEMS-INCOSE Collaboration highlighted at biannual NAFEMS World Congress, June 2019 in Quebec City, Canada
  – Renewal of 3-year Memorandum of Understanding
  – New NAFEMS “Terms of Reference” / INCOSE WG Charter completed
NAFEMS-INCOSE Collaboration at NAFEMS World Congress (June 2019)

NAFEMS and INCOSE (International Council on Systems Engineering) are collaborating to accelerate innovation for engineering simulation and model based systems engineering. This collaboration includes the implementation of a joint cross organizational working group on Systems Modeling & Simulation.

More information can be found at
www.nafems.org/about/technical-working-groups/systems_modeling

Tuesday 18th 10:00
Heinz Stoewer
INCOSE Past President
and Professor TU Delft (GER)

Systems and Complementary Engineering Disciplines Interactions

Heinz Stoewer is a Past President of INCOSE and Professor at TU Delft. Over his career, he has received multiple national & international honours, produced over 90 publications, and worked at Boeing, ESA, the German & Dutch National Space Agencies, and is Founder/President Space Associates GmbH.
NAFEMS-INCOSE Collaboration at NAFEMS World Congress (June 2019)

Wed.,
June 19

5C INCOSE - NAFEMS Leadership

Systems Engineering meets Engineering Simulation

A special session, inspired by the Systems Modelling and Simulation Working Group, as part of the INCOSE-NAFEMS programme of collaboration.

Introduction by C. Stavrinidis (NAFEMS Chairman) and G. Roedler (INCOSE President)

Presentations by

- W. Miller (USA)
- R. Hartmann (Airbus Defense and Space, GER)
- E. Landel (Renault, FRA): Model Architecture & Model Indentity Cards to Ensure the Simulation of Complex Systems
- P. Coleman (Airbus, GBR)

6C INCOSE - NAFEMS Discussion

Progress in Modelling and Simulation for Systems Engineering

Integrating Modelling and Simulation at all Levels of Engineering: Element, System and System-of-System

Overview of the joint NAFEMS/INCOSE System Modelling and Simulation Working Group
R. Dreisbach (formerly Boeing, USA)

Panel discussion:
K. Lunney (INCOSE President-Elect of INCOSE, AUS) - moderator
P. Coleman (Airbus, GBR)
R. Dreisbach (formerly Boeing, USA)
R. Hartmann (Airbus Defense and Space, GER)
E. Landel (Renault, FRA)
NWC19 SMS Summary: Peter Coleman

Special session with INCOSE – NAFEMS leadership and SMS WG + lively panel discussion with audience, exploring issues around integration of SE and ES all along the lifecycle

12 papers on Systems topics presented in 3 sessions (1C, 2C, 3C)

Some impressions

- Interesting mix between practical use of system simulation in industry and tools capabilities
- Good surprise to see Systems topics well represented
- Suggestion for next NWC – short training course(s) on system simulation and MBSE

Renewed MoU signing on June 19, 2019 between INCOSE and NAFEMS to continue our collaborations on Systems Engineering and Engineering Simulation!
Integrating Modelling & Simulation at all Levels of Engineering: Element, System, System-of-Systems

Joint Panel Session with International Council on Systems Engineering (INCOSE) & International Association for Engineering Modelling, Analysis & Simulation (NAFEMS)

June 19, 2019
INCOSE-NAFEMS Joint SMS Panel Program

• Towards New Collaboration Schemes Through Digital Twins
  – Panellist 1: Ralf Hartmann (Airbus, DE)

• A Bridge Between Two Worlds – Simulation & MBSE
  – Panellist 2: Eric Landel (Renault, Fr)

• Interoperability Standards
  – Panellist 3: Peter Coleman (Airbus, UK)

• What is Simulation Governance & Management?
  – Panellist 4: Rod Dreisbach (formerly Boeing, US)

• Discussion Time
  – Moderator: Kerry Lunney (Thales, Au)
Discussion Attendees

• Peter Coleman - peter.coleman@airbus.com
• Rod Dreisbach - roddreisbach@comcast.net
• Ralf Hartmann - ralf.hartmann@airbus.com
• Eric Landel - eric.landel@renault.com
• Kerry Lunney - kerry.lunney@thalesgroup.com.au – INCOSE President-Elect
• Garry Roedler – (Lockheed Martin Corp.) - INCOSE President
• Prof. Heinz Stoewer - (Space Associates)
• Costas Stavrinidis – NAFEMS Chairman
• Tim Morris – NAFEMS CEO
• Ian Symington – NAFEMS Technical Officer
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?
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

Derived from NDIA MBE Final Report
February 2011
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/

References
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.

• Roadmap and Sharing of Best Practices
• Terms & Definitions
• Standards Ecosystem
  – Modelica Association Standards, including FMI and SSP
  – PDES/STEP and MoSSEC
  – SysML V2
  – OSLC
Roadmap Focus Team: 2019-2020

• The flyer is the foundation – completed
• Providing a better focus around “What is Model-Based…?”
  – Working together with T&D Focus Team to update / create proper
definitions: *7 definitions finalized, more in progress*
  – Create a joint NAFEMS/INCOSE flyer on this topic: include the
    various model definitions when writing it (where needed)
• Continue rolling out SMS Presentation Topics and combine
  with company experiences (use cases from end users)
• Support upcoming events
SMSWG Roadmap – high level

Defining a new Culture
- Shifting toward a comprehensive advanced virtual engineering environment

Membership reached:
- > 100 members
- > 75 companies

SMSWG Begins work

Established:
- Bylaws
- Framework of activities
- Website

Joint NAFEMS/INCOSE MoU signed, 2012

Published online 1st issue of T&D

1st own session within the IV ’15 in MBSE track

3 sessions during NWC 2015

SMS Sessions (NAFEMS Americas 2016)

SMS Sessions integral part now (NAFEMS Americas 2018)

Focus Teams announced (IV 2018)

Focus on Emerging SMS Standards (IV 2019)

SMSWG Roadmap
- Terms & Definitions
- Emerging SMS Standards

Terms & Definitions Focus Team regular update releases

Coordinated by the SMS Standards Focus Team

Identify key integration technologies between areas

Identify / support emerging standards

2013 2014 2015 2016 2017 2018 2019 2020 beyond...

SMS Vision 2025 and beyond...

Issue additional flyers on specific topics of interests

Presentation / best practices series

Provide more forums for SMS (MBSE, MBE, ...
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.
Events Support by SMSWG

- Model-Based Engineering: What Is It & How Will It Impact Engineering Simulation? – October 1, 2019; Columbus, OH
  - Frank Popielas, Ed Ladzinski, Rod Dreisbach
- Simulation in the Automotive Industry: Creating the Next Generation Vehicle – November 14, 2019; Troy, MI
  - Frank Popielas
- INCOSE IW 2020; Torrance, CA; January 25-28, 2020
  - https://www.incose.org/iw2020/home/when-where
  - Roger Burkhart
- CAASE 2020: June 16-18, 2020; Indianapolis, IN
  - https://www.nafems.org/events/nafems/2020/caase20/
  - Frank Popielas, Rod Dreisbach, Ed Ladzinski
  - Frank and Roger in contact with Matt Ladzinski to represent SMSWG and provide input what we would like to do as WG
    - “SMS Vision 2025 and beyond”
# SMSWG Members Meeting

**Monday, Jan. 27, 2020 (Pier 9 + 11)**

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