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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.
- [Memo of understanding signed by both organisations at the 22<sup>nd</sup> INCOSE International Symposium, Rome, 2012:](http://www.nafems.org/about/media/news/latest1007/nafems_announces_collaboration_with_incose/)  
[http://www.nafems.org/about/media/news/latest1007/nafems\\_announces\\_collaboration\\_with\\_incose/](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

## [www.nafems.org](http://www.nafems.org)



- 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

## [www.incose.org](http://www.incose.org)



- 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

162\*

members

92

unique member  
companies

\* (as of Sep. 2016)

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

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

**NAFEMS**

Home **About** Join World Congress 2017 Events E-learning Professional Development Publications Members Area Contact

About NAFEMS News Technical Groups **Regional Groups** Projects Vendor Network Legal search

you are here > about > technical groups > systems modeling & simulation > advanced search

Analysis Management  
Composites  
Computational Fluid Dynamics  
Computational Structural Mechanics  
Dynamics and Testing  
Education and Training  
Geotechnics  
High Performance Computing  
Manufacturing Process Simulation  
Multi Body Dynamics  
Multiphysics  
Optimisation  
Simulation Data Management  
Stochastics  
Systems Modeling & Simulation  
Mission  
Presentations  
Steering Committee  
Members of the SMSWG  
Events  
Terms & Definitions  
Get Involved

## 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.

### Chairman



**Roger Burkhardt**  
Technology Architect  
John Deere

### Interested in Learning More about the SMSWG?



# INCOSE MBSE Wiki Page

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

← → ↻ ↗ ⓘ Not secure | wiki.omg.org/MBSE/doku.php?id=mbse:smswg

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

**OMG** MBSE Wiki [Search](#) [Recent Changes](#) [Media Manager](#) [Sitema](#)

Trace: • [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

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- ♦ [Working Subteams](#)
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- ♦ [Mission Statement](#)
  - ♦ [2012 Announcement by NAFEMS and INCOSE](#)

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# NAFEMS Members-Only Site

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

SMSWG Collaborative Community

Search this site

## Navigation

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## My recent activity

## 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 <a href="#">(Remove)</a>	<input type="checkbox"/>		3_1-a_baroux.pdf	8379k	<a href="#">v. 2</a>	Jun 21, 2016, 11:16 AM	Matthew Ladzinski				
		<a href="#">View</a> <a href="#">Download</a>	<input type="checkbox"/>		3_1-a_croegaert.pdf	3485k	<a href="#">v. 2</a>	Jun 21, 2016, 11:16 AM	Matthew Ladzinski				
		<a href="#">View</a> <a href="#">Download</a>	<input type="checkbox"/>		3_1-a_szarazi.pdf	1509k	<a href="#">v. 2</a>	Jun 21, 2016, 11:16 AM	Matthew Ladzinski				
		<a href="#">View</a> <a href="#">Download</a>	<input type="checkbox"/>		Misc <a href="#">(Remove)</a>	<input type="checkbox"/>		MOU-NAFEMS-INCOSE.pdf	795k	<a href="#">v. 2</a>	Sep 23, 2015, 11:30 AM	Matthew Ladzinski	
		<a href="#">View</a> <a href="#">Download</a>	<input type="checkbox"/>		SMSWG-Collaborative-Community-Instructions.pdf	281k	<a href="#">v. 2</a>	Nov 21, 2014, 2:25 PM	Matthew Ladzinski				
		<a href="#">View</a> <a href="#">Download</a>											


# 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)
  - What is Systems Modeling and Simulation? (published January 2019)
- 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-INCOSSE Collaboration at NAFEMS World Congress (June 2019)




**NWC** NAFEMS  
NAFEMSWORLDCONGRESS 2019  
17-20 JUNE | QUEBEC CITY | CANADA  
A WORLD OF ENGINEERING SIMULATION  
incorporating **spdm** INTERNATIONAL CONFERENCE  
Simulation Process & Data Management  
**Final Agenda & Invitation**  
nafems.org/congress



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](http://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-INCOSÉ Collaboration at NAFEMS World Congress (June 2019)

Wed.,  
June 19

## 5C INCOSE - NAFEMS Leadership

SYSTEMS

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 Identity Cards to Ensure the Simulation of Complex Systems
- P. Coleman (Airbus, GBR)

## 6C INCOSE - NAFEMS Discussion

SYSTEMS

Progress in Modelling and Simulation for Systems Engineering

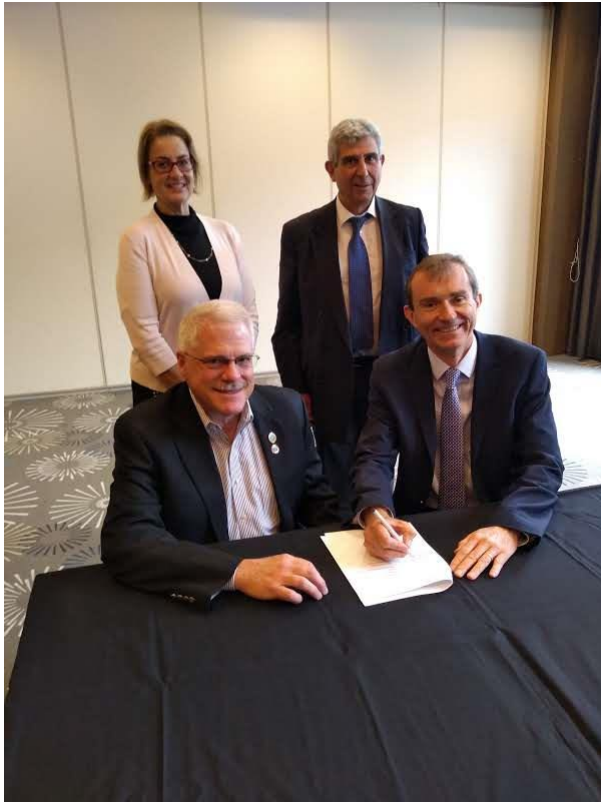
Integrating Modelling and Simulation at all Levels of Engineering: Element, System and System-of-System

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)





**Renewed MoU signing on June 19, 2019  
between INCOSE and NAFEMS to continue  
our collaborations on Systems Engineering  
and Engineering Simulation!**

### **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

# 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](mailto:peter.coleman@airbus.com)
- Rod Dreisbach - [roddreisbach@comcast.net](mailto:roddreisbach@comcast.net)
- Ralf Hartmann - [ralf.hartmann@airbus.com](mailto:ralf.hartmann@airbus.com)
- Eric Landel - [eric.landel@renault.com](mailto:eric.landel@renault.com)
- Kerry Lunney - [kerry.lunney@thalesgroup.com.au](mailto: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).

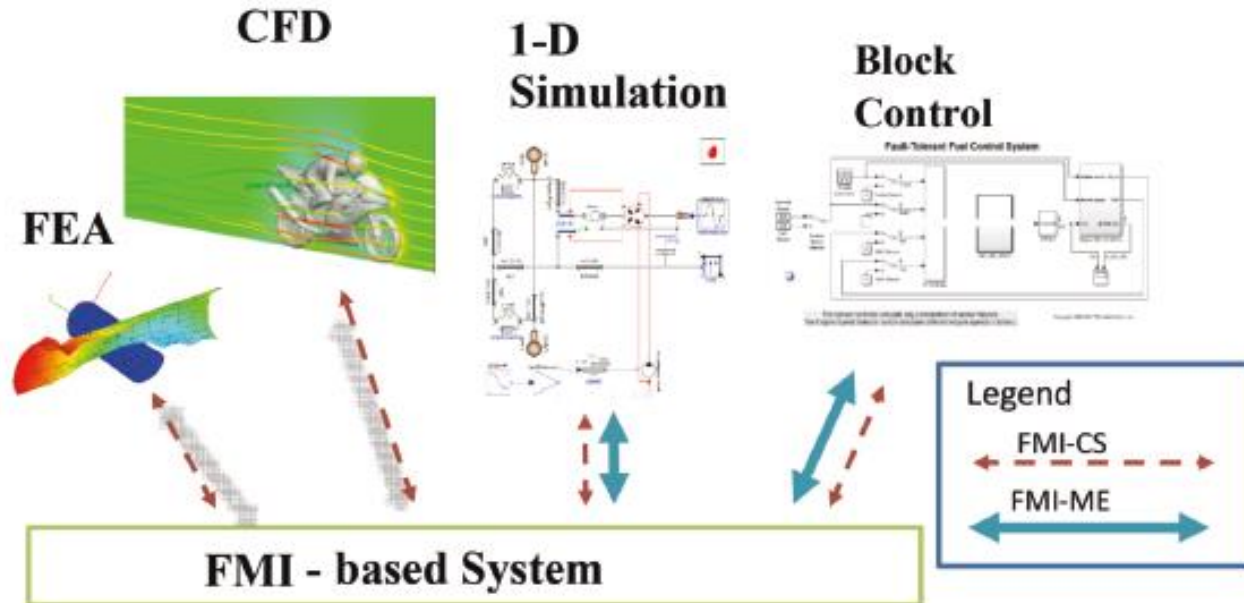


Figure 1: Integration of Multiple Models from Different Engineering Disciplines.

# 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/](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?



What is  
Systems Modeling and Simulation?

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Order Ref: WT10



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[Info@nafems.org](mailto:Info@nafems.org)

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

# 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.

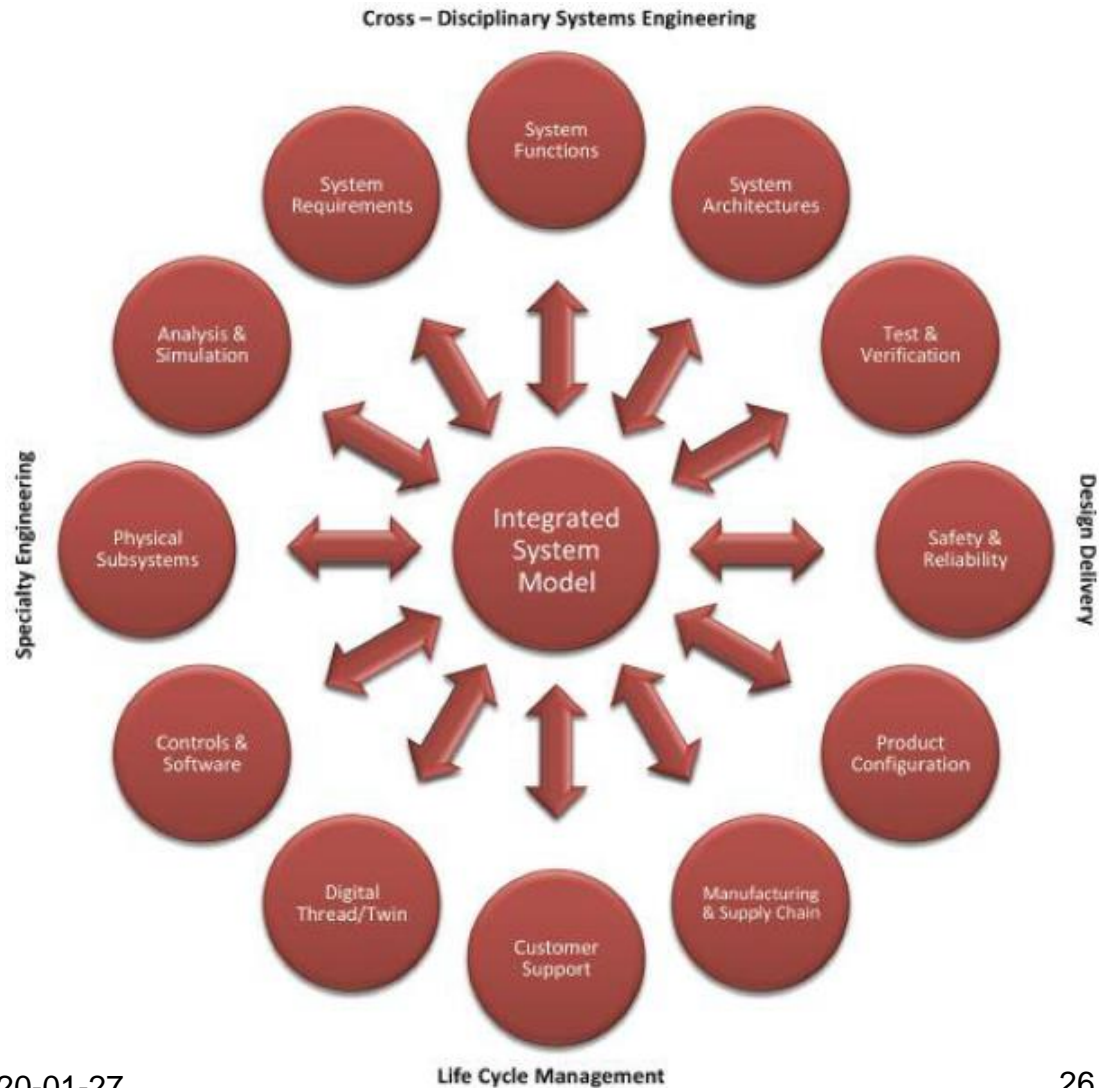
The International Council on Systems Engineering (INCOSE) defines **Model-Based Systems Engineering (MBSE)** as the formalized application of modelling to support system requirements, design, analysis, verification and validation activities beginning in the conceptual design phase and continuing throughout 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).

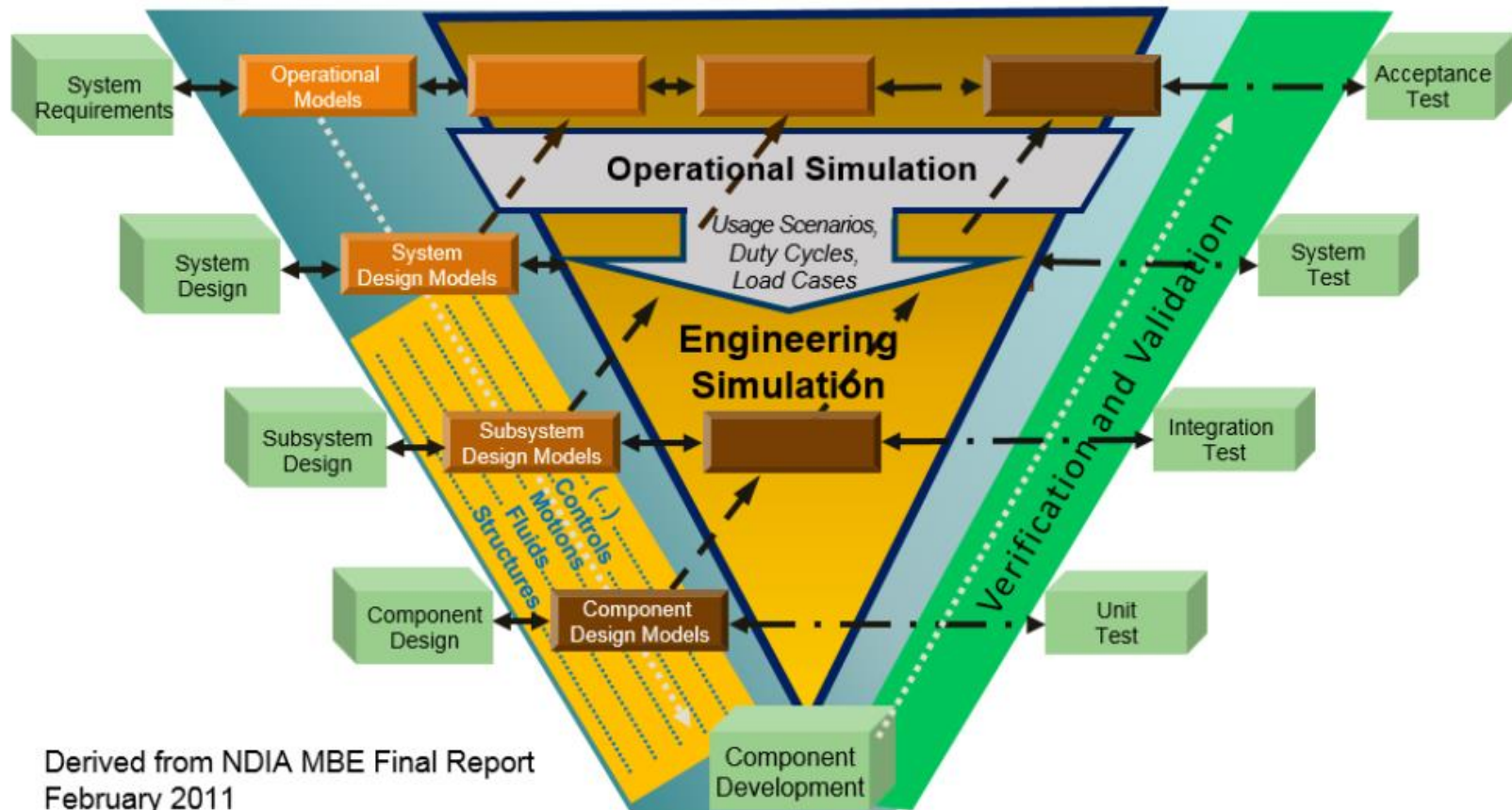
# Benefits of Interaction between SE & ES

- 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/](http://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](http://wiki.omg.org/MBSE/doku.php?id=mbse:smswg)**

## References

- [1] SMS Terms & Definitions. [Online]. [29 November 2018]. Available from:  
**[nafems.org/about/technical-working-groups/systems\\_modeling/](http://nafems.org/about/technical-working-groups/systems_modeling/)**
- [2] INCOSE MBSE Wiki. [Online]. [29 November 2018]. Available from: **[wiki.omg.org/MBSE/](http://wiki.omg.org/MBSE/)**
- [3] NAFEMS. The NAFEMS Glossary. [Online]. [29 November 2018]. Available from:  
**[nafems.org/publications/glossary](http://nafems.org/publications/glossary)**
- [4] Systems Engineering Body of Knowledge Wiki. Final Report of the Model Based Engineering (MBE) Subcommittee. [Online]. [17 January 2019]. Available from:  
**[sebokwiki.org/wiki/Final\\_Report\\_of\\_the\\_Model\\_Based\\_Engineering\\_\(MBE\)\\_Subcommittee](http://sebokwiki.org/wiki/Final_Report_of_the_Model_Based_Engineering_(MBE)_Subcommittee)**
- [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](http://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](http://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.

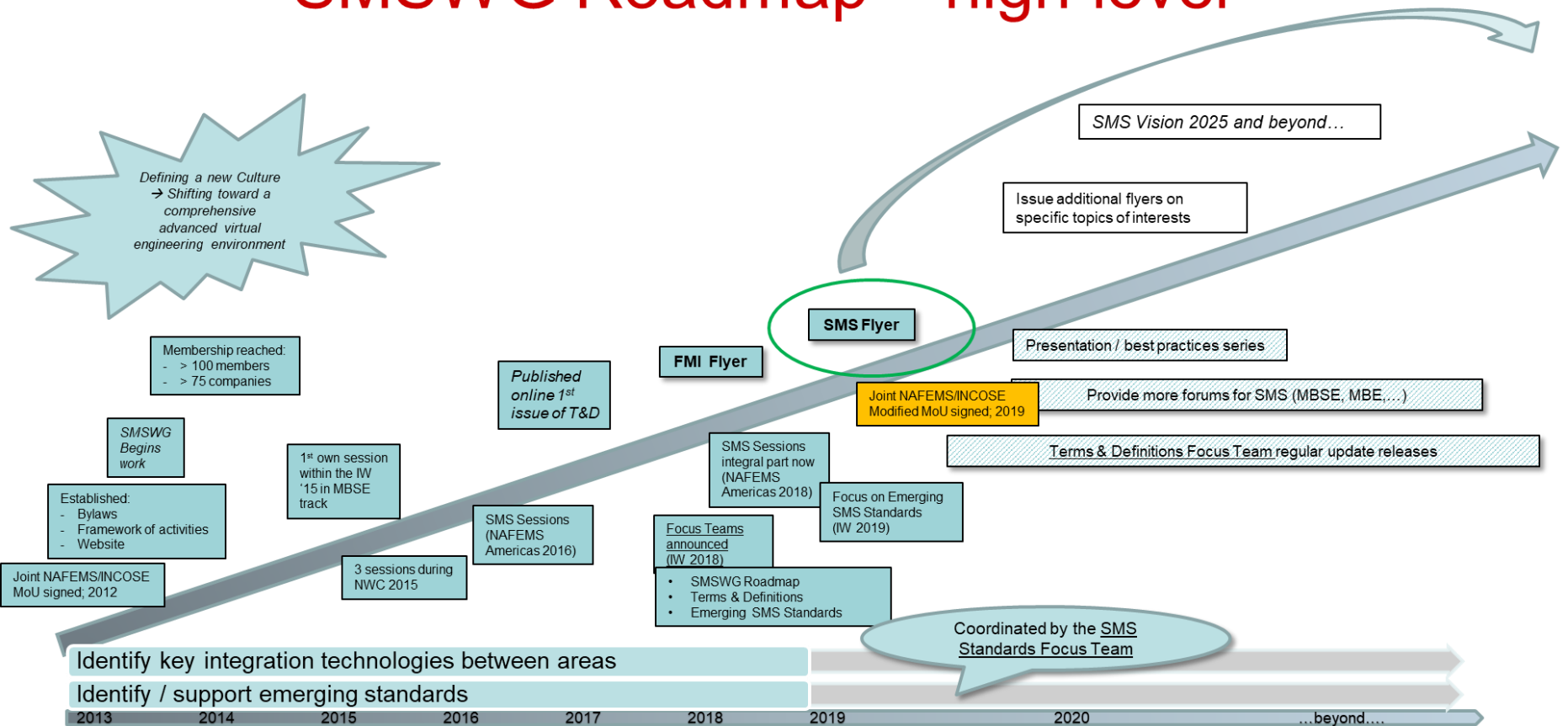
- Roadmap and Sharing of Best Practices
- Terms & Definitions
- Standards Ecosystem
  - Modelica Association Standards, including FMI and SSP
  - PDES/STEP and MoSSEC
  - SysML V2
  - OSLC



# 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



# 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
  - <https://www.nafems.org/events/nafems/2019/model-based-engineering/>
  - Frank Popielas, Ed Ladzinski, Rod Dreisbach
- Simulation in the Automotive Industry: Creating the Next Generation Vehicle – November 14, 2019; Troy, MI
  - <https://www.nafems.org/events/nafems/2019/simulation-in-the-automotive-industry-creating-the-next-generation-vehicle-2019/>
  - 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)

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)
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) and Frank Popielas (SMS_ThinkTank)
	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	Roger Burkhart (John Deere)
	SysML Physical Interaction and Signal Flow Simulation (SysPhs)	Nerijus Jankevičius (Dassault)