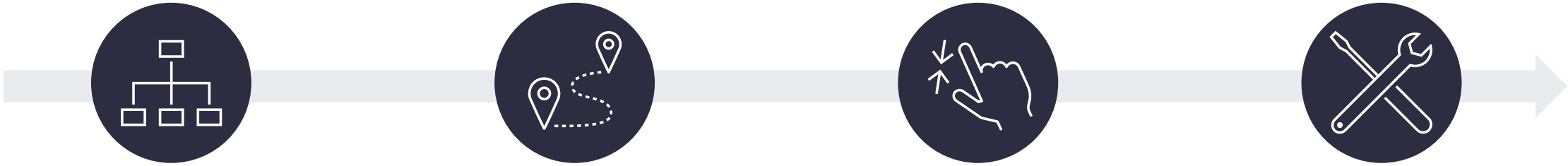
The Future of Systems Engineering: Methodologies Virtual Workshop

A Systems Community Initiative

FuSE Mini-Event: 8:00-10:00 EDT, 20 April 2023

Chris Hoffman
Systems Engineering Methodologies Lead

FuSE Mini-Event Series



MAR 29, 2023
Future of Systems Engineering (FuSE) Introduction and Update and FuSE Foundations Overview

APR 06, 2023
Future of Systems Engineering (FuSE) Vision & Roadmaps

APR 13, 2023
FuSE Application Extensions – SE and Asset Management

APR 20, 2023
FuSE Methodologies Virtual Workshop

Visit https://www.incose.org/fuse or https://www.incose.org/events for details and registration information

Ice-Breaker!

Go to

www.menti.com

Enter the code

7516 7291

Or use QR code

FuSE Mini-Event: Methodologies Virtual Workshop 20 April 2023

- **Future of Systems Engineering (FuSE)**
- Results from IW2023
- Breakout: Reflections
- Breakout: Progress
- Next steps

Systems Engineering Vision 2035

Executive Summary

- The Global Context for Systems Engineering
- The Current State of Systems Engineering
- The Future State of Systems Engineering
- Realizing the Vision

5 Categories:

https://www.incose.org/about-systems-engineering/se-vision-2035

Systems engineering is more important- and more valued- due to rising complexity, increased interconnectivity, and societal impacts.

A better world through a systems approach

Systems engineering will:

- make significant advancements to deal with complexity and enable enterprise agility
- Leverage practices from other disciplines
- be impacted by Artificial Intelligence

Applications

1. Systems engineering contributes innovative solutions to major societal challenges.

2. Systems engineering demonstrates value for projects and enterprises of all scales, and applies across an increasing number of domains.

Practices

3. Systems engineering anticipates and effectively responds to an increasingly dynamic and uncertain environment.

4. Model-based systems engineering, integrated with simulation, multi-disciplinary analysis, and immersive visualization environments is standard practice.

5. Systems engineering provides the analytic framework to define, realize, and sustain increasingly complex systems.

6. Systems engineering has widely adopted reuse practices such as product-line engineering, patterns, and composable design practices.

Tools and Environment

7. Systems engineering tools and environments enable seamless, trusted collaboration and interactions as part of the digital ecosystem.

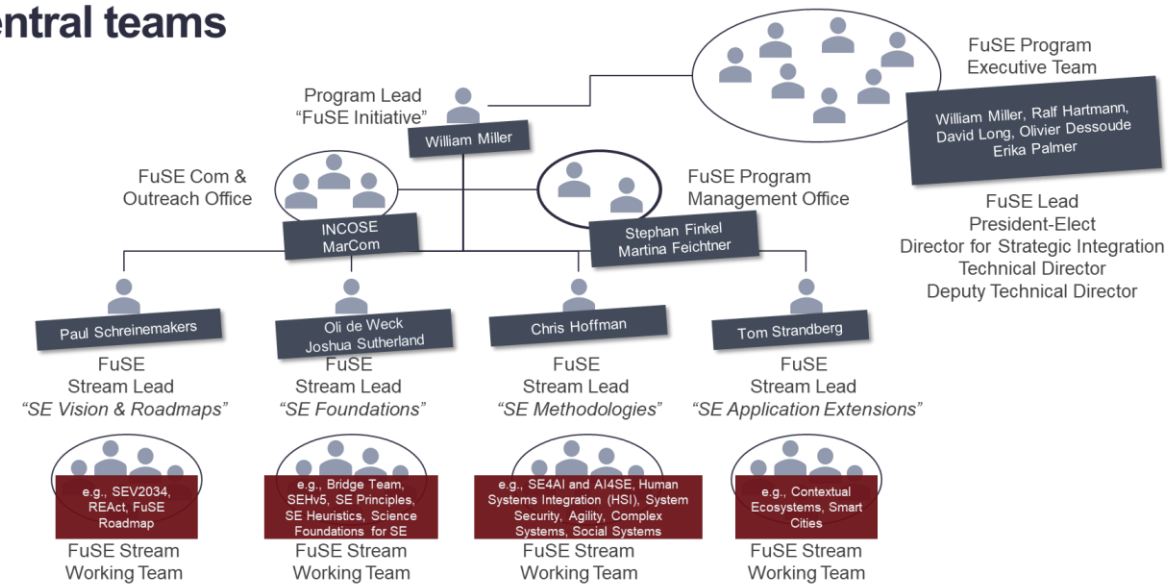
Research

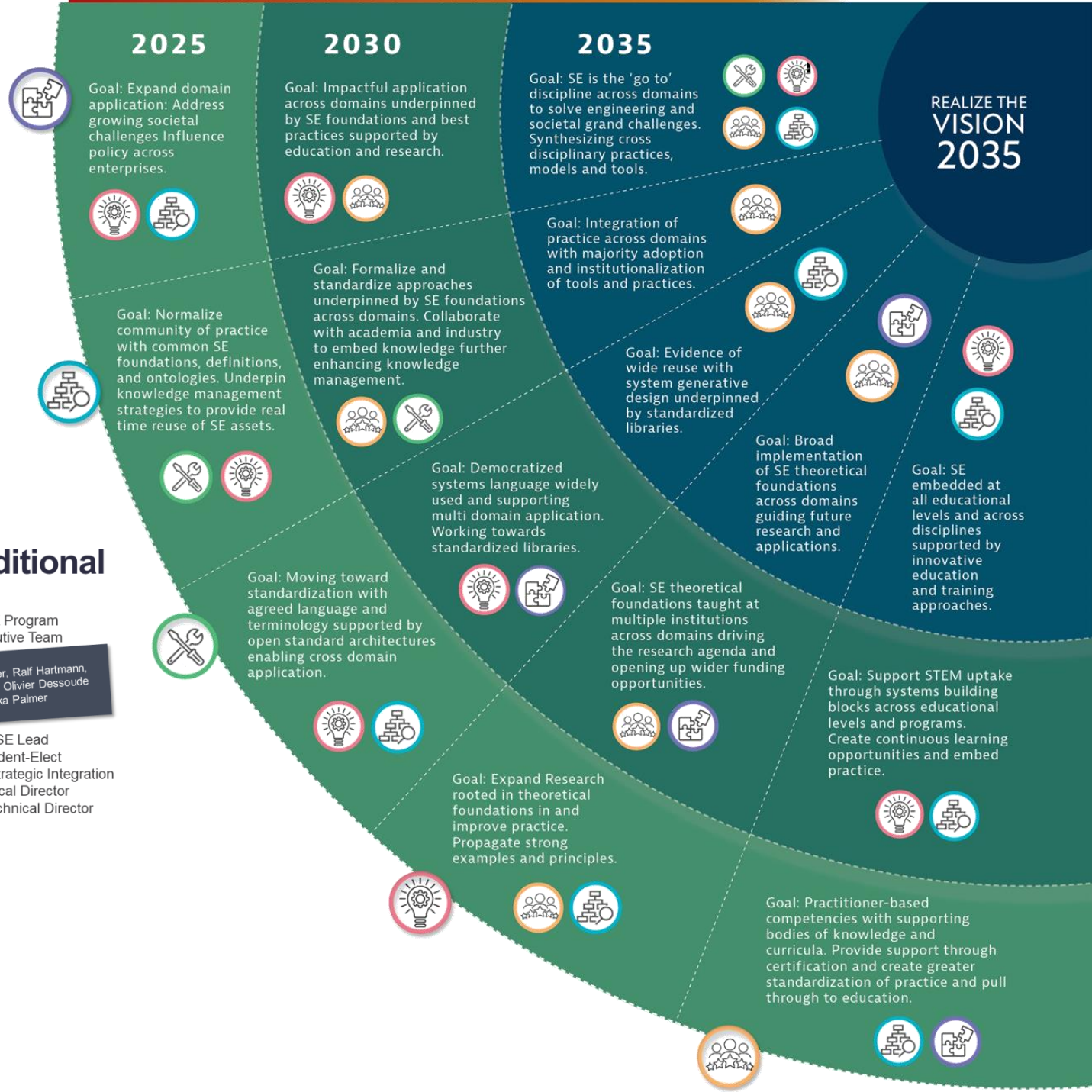
8. Systems engineering practices are based on accepted theoretical foundations and taught as part of the systems engineering curriculum.

Competencies

9. Systems engineering education is part of the standard engineering curriculum, and is supported by a continuous learning environment.

The FuSE program is organized in 4 streams with additional central teams





REALIZE THE VISION 2035

application: Address growing societal challenges Influence policy across enterprises.

across domains underpinned by SE foundations and best practices supported by education and research.

to solve engineering and societal grand challenges. Synthesizing cross disciplinary practices, models and tools.

Goal: Integration of practice across domains with majority adoption and institutionalization of tools and practices.

Goal: Formalize and standardize approaches underpinned by SE foundations across domains. Collaborate with academia and industry to embed knowledge further enhancing knowledge management.

Goal: Normalize community of practice with common SE foundations, definitions, and ontologies. Underpin knowledge management strategies to provide real time reuse of SE assets.

Goal: Evidence of wide reuse with system generative design underpinned by standardized libraries.

Goal: Democratized systems language widely used and supporting multi domain application. Working towards standardized libraries.

Goal: Broad implementation of SE theoretical foundations across domains guiding future research and applications.

Goal: SE embedded at all educational levels and across disciplines supported by innovative education and training approaches.

Goal: Moving toward standardization with agreed language and terminology supported by open standard architectures enabling cross domain application.

Goal: SE theoretical foundations taught at multiple institutions across domains driving the research agenda and opening up wider funding opportunities.

Goal: Support STEM uptake through systems building blocks across educational

FuSE Methodologies Stream
Partial Baseline

Products (various stages):
- DE Measurement Framework,
- SE Principles,
- Model Portfolio Management Guide,
- Digital Systems Engineering Process Model,
- Human Systems Integration Reference,
- Agile SE Decision Guidance Method,
- SE-AI Primer,
- SE Handbook 5th Edition

Other societies and groups (partial):
- IEEE, SERC, OMG, ISO, …

Related INCOSE working groups (partial list):
- Agile Systems and Systems Engineering
- Artificial Intelligence Systems
- Competency
- Complex Systems
- Configuration management
- Digital Engineering Information Exchange
- Enterprise Systems
- Integration, Verification & Validation
- Knowledge Management
- Lean Systems Engineering
- MBSE Initiative
- MBSE Patterns
- NAFEMS-INCOSE Systems Modelling & Simulation
- Product Line Engineering
- Professional Competencies & Soft Skills
- SE Tools Database
- Small Business Systems Engineering
- Social Systems
- System of Systems
- Systems and Software Interface
- Systems Security Engineering
- Tools Integration & Model Lifecycle Management
- Value Proposition Initiative
- SE Handbook Team

FuSE Methodologies Stream Output

Guides the advancement of:

- practices, methods, and tools
- for the effective engineering of systems to be fit for purpose

in the presence of:

- varying scale, interrelatedness, complexity, non-determinism,
- and emerging technology innovations such as AI and agility.

Stimula and support with:

- working groups, initiatives, organizations

Coordination and collaboration on:

- workshops, papers, publications, products

Discussions > Activities > Presentations > Panels > Papers > Periodicals > Products > Practices > Standards

How?

DEFINE BOUNDARIES, GOALS, AND FUNCTIONS TO ADVANCE SE METHODOLOGIES

ENGAGE WITH COMMUNITY TO CAPTURE AS-IS AND CREATE TO-BE SYSTEMS

IDENTIFY THE RESOURCES REQUIRED, INTERNAL AND EXTERNAL TO INCOSE

STIMULATE AND SUPPORT JOINT INITIATIVES

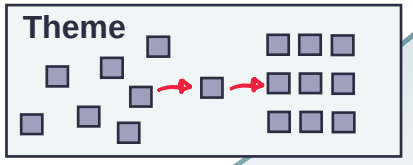
FuSE Mini-Event: Methodologies Virtual Workshop 20 April 2023

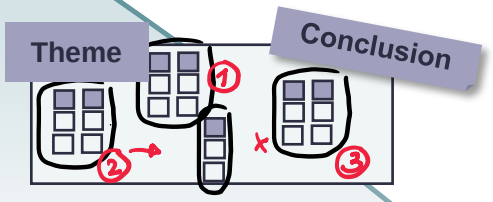
- Future of Systems Engineering (FuSE)
- **Results from IW2023**
- Breakout: Reflections
- Breakout: Progress
- Next steps

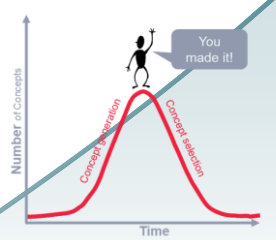
Summary of IW2023 Methodologies Stream

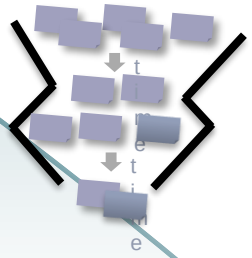
SUNDAY

MONDAY









8 Themes

e.g.:

- What is a successful methodology?
- What is preventing advancement of new technology for SE methodologies?
- What are the obstacles in advancing MBSE?

240 pain points

8 conclusion

e.g.:

- Uncertainty in ecosystem discourages adoption.
- Even if I had the infrastructure and resources, I have tried before and failed, and I don't have time to learn a new way from people I don't trust.

~10 disrupters

~ 180 concepts

~ 25 favorite concepts

e.g.:

- Create value metrics
- Human-System-Interface model
- Promote & research other MBSE methodology that support interoperability natively
- Procedures for generating models

Sunday session group 1

Theme

What is preventing the advancement of practices/methods/tools in the presence of new technologies (e.g., AI, digital ecosystems, ...)?

Conclusion

Uncertainty in ecosystem discourages adoption.

Tool Suites lack maturity
- Tool Suites lack Maturity
- Not address the root causes and needs

Requires marketplace changes
- Marketplace inertia resists change
- Requirements-driven engineering can limit innovation
- Buzzword overpromises make evaluating functionality difficult

Requires organizational change
- Leadership lacks vision
- Organization inertia resists change

Difficulty Integration platforms
- Platform integration difficulties
- Differing terminology and understanding

Human resources costs
- Organization lacks skills
- Costs to implement deter adoption

Sunday session group 2

Theme

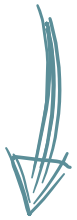
What is preventing advancement of new technology for systems engineering methodologies?

Conclusion

Even if I had the infrastructure and resources, I have tried before and failed, and I don't have time to learn a new way from people I don't trust.

We don't have time to invest in reuse
- Reinventing the wheel is inefficient

People overhype the benefits
- Hindered by inflated expectations



We don't trust what someone else has defined
- We don't want to slow down to think
- My way is better than your way
- Fear of change

We don't have enough supply to implement change
- Insufficient infrastructure that is secure
- Lack of standards causes interoperability issues
- Lack of or insufficient resources

FuSE Methodologies: Disrupters Breakout Summary

Theme	Conclusion
What is preventing the advancement of practices/methods/tools in the presence of new technologies?	Uncertainty in ecosystem discourages adoption.
What is preventing advancement of new technology for systems engineering methodologies?	Even if I had the infrastructure and resources, I have tried before and failed, and I don't have time to learn a new way from people I don't trust.
What are obstacles in advancing practices/ methods/ tools?	Because resources are limited, we are not able to fully understand stakeholder needs to develop mature methods that are practical and implementable.
What are the obstacles in advancing MBSE?	People are incompetent.
What is preventing the advancement of SE practices and methods?	There are three main causes preventing the advancement of SE methodologies: Organizational leadership willingness to changes, lack of training and best practices, challenges to tool interoperability.
What are the attributes of "successful" "methodology"?	Scientific basis with improved intuitiveness is critical to overcoming organizational inertia and leading to rapid organizational acceptance.
What are obstacles related to practices/ methods/ tools?	Without leadership championing using the methodology there are multiple pitfalls that prevent its' successful use.

Key Insights Methodologies Stream

Topics

Introduced the stream´s purpose, content and goals.

Major disrupters and obstacles for advancing systems engineering methodologies were captured.

Selected disrupters were clarified with solution proposals generated.

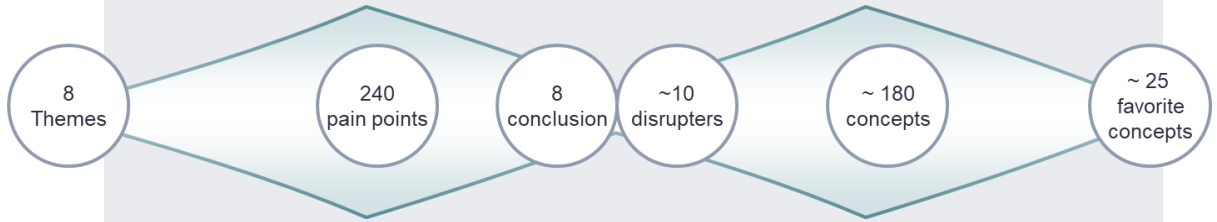
A needs gathering form for solution proposals was shared @ www.incose.org/needs

Key Insights

Disrupters were multi-dimensional and included:

- Lack of training
- Past failures leading to low trust of new items
- Limited resources
- Impeded development of practical SE methods
- Lack of support to change (stagnated culture)

Solution proposals were generated and initially screened. Work remains to form and select the highest potential solutions to focus upon.



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Go to **www.menti.com** and use the code **7516 7291**

What practices or methods should be advanced? *Be specific, list them!*

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How have you ‘seen’ systems engineering outside of your ‘day’ job?

What is your biggest concern or worry regarding systems engineering?

What is your favorite ‘success story’ regarding SE?

What specifically are YOU doing to advance SE methodologies?

What else should we do?

5-minute break

Please network with each other!

Time's Up!

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Which disrupters should be addressed immediately? *~0-12 months*

Questions: *What is preventing…? What are obstacles…?*

Answers: *Abstracted disrupters from previous workshops, in an 'action' form*

- Reduce ecosystem uncertainty (practices/methods/tools)
- 'Good-enough' tooling systems with realistic expectations to sustain them in a commercial organization
- Trustable, locally relevant benefits of SE methodologies (e.g., MBSE, Agile)
- Practicable & implementable (matured) methodologies
- People (Organizational) Change Management in the context of deploying (MBSE) methodologies
- Actionable (MBSE, …) best practices
- Modular tool interoperability standards supportive of frequent tool and method variations
- Close the transdisciplinary gap between mechanistic, deterministic engineering and the social domain (weirdness of people)
- Get rid of the clutter, improve the intuitiveness of SE
- Available methods are inadequate to support SE practice

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Follow up

Documentation will be sent to all who registered for the event with some notes on how to stay in touch

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- MBSE Patterns
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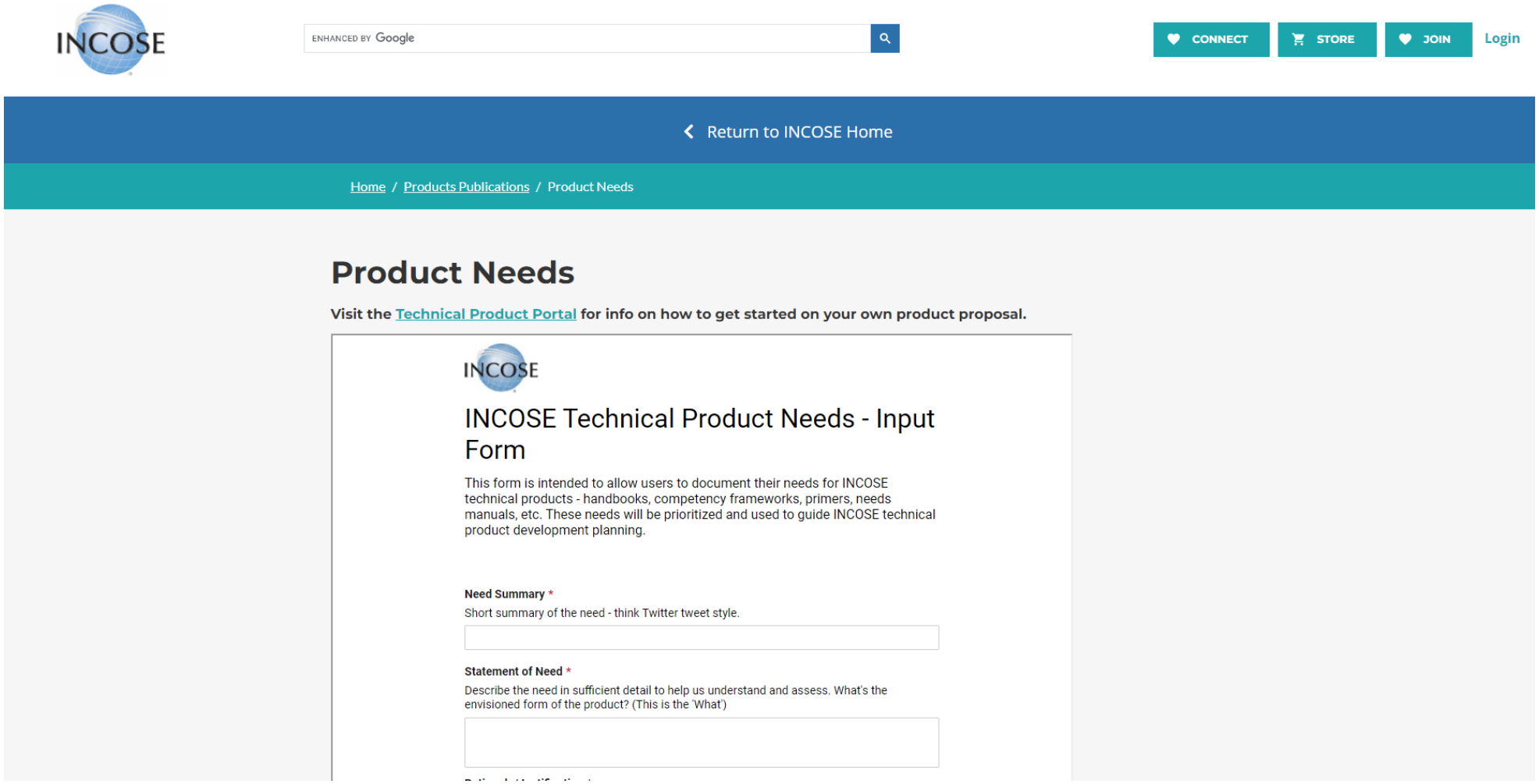
- Product Line Engineering
- Professional Competencies & Soft Skills
- SE Tools Database
- Small Business Systems Engineering
- Social Systems
- System of Systems
- Systems and Software Interface
- Systems Security Engineering
- odel Lifecycle Management

Your input and efforts are key to advancing our methodologies!

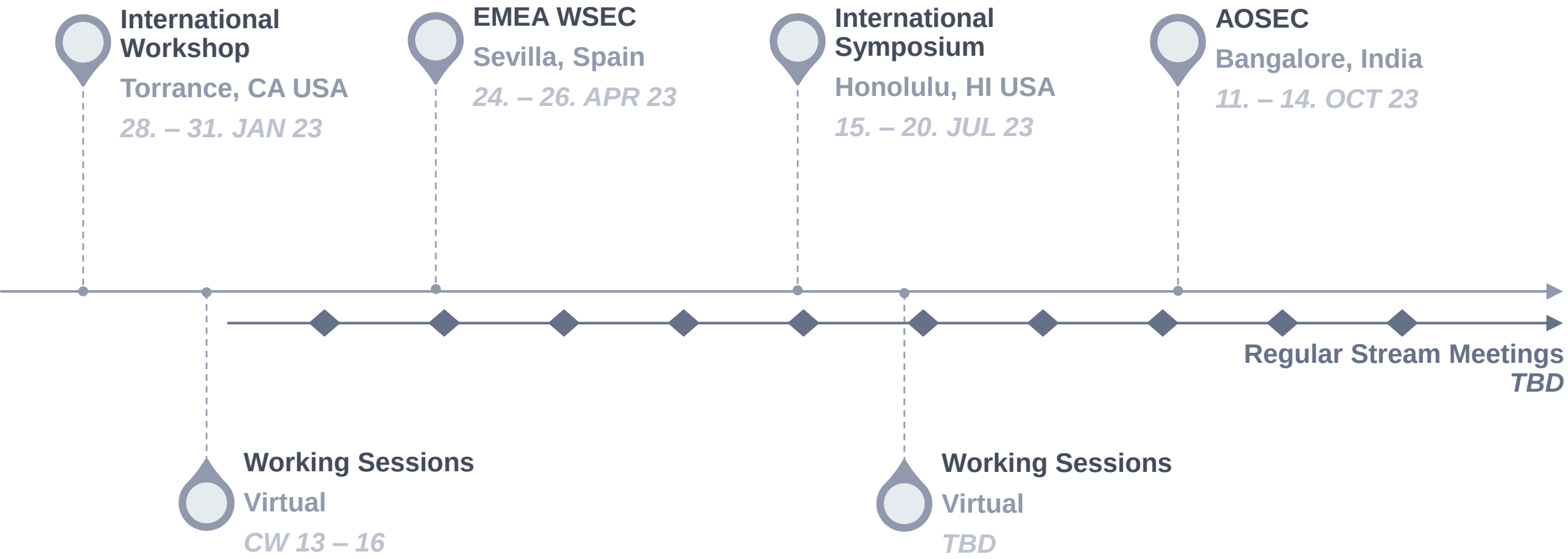
Discussions > Activities > Presentations > Panels > Papers > Periodicals > Products > Practices > Standards

INCOSE Needs Input Form @ incose.org/needs



FuSE Targeted Events in 2023

Where to engage



FuSE Targeted Events in 2023

Where to engage

International Workshop
Torrance, CA USA
28. – 31. JAN 23

EMEA WSEC
Sevilla, Spain
24. – 26. APR 23

International Symposium
Honolulu, HI USA
15. – 20. JUL 23

AOSEC
Bangalore, India
11. – 14. OCT 23

At EMEA WSEC, FuSE will share an update and hold a working session for each stream:

- Invited Content: Introduction of Future of Systems Engineering (FuSE) initiative (Bill & Ralf)
- FuSE Session 1: How might we advance Systems Engineering Methodologies to Engineer a more Sustainable World? (Chris)
- FuSE Session 2: Extend the SE Vision 2035's Systems Engineering Challenges and Roadmap with active contribution by the EMEA participants (Paul)
- FuSE Session 3: Systems Engineering Foundations: An experiment on the Conservation of Complexity. (Joshua)
- FuSE Session 4: Extending systems engineering application to address climate change (Tom, Gerhard)

Regular Stream Meetings
TBD

FuSE Mini Events
Virtual
Planned for CW[illegible]

Working Sessions
Virtual
TBD

FuSE Targeted Events in 2023

Where to engage

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At IS, FuSE will have invited content / panel discussions on:

- Foundations: Measuring and Managing Systems Complexity
- Application Extensions: A Systems Approach to Sustainable Transport and Mobility Solutions
- *Methodologies: driven by Erika & Olivier*

Regular Stream Meetings
TBD

FuSE Mini Events
Virtual
Planned for CW 13 – 16

Working Sessions
Virtual
TBD

FuSE Targeted Events in 2023

Where to engage

International Workshop ✓
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Sevilla, Spain
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International Symposium
Honolulu, HI USA
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FuSE will participate at AOSEC with a presentation and 2 working sessions.

Content yet to be specified.

Regular Stream Meetings
TBD

FuSE Mini Events ✓
Virtual
Planned for CW 13 – 16

Working Sessions
Virtual
TBD

FuSE will participate in additional conferences

	Event	Event Topic / Theme	Link to Event	Type	Mode	Due Date	Start Date	End Date	Ready For Commu...	FuSE Status	Owner	Assigned To	Who is participating?	Contact	Comm
													William Miller		
2	EMEA Workshop & Conference 2023 (EMEA WSEC)	Engineering a Sustainable World	https://www.incose.org/emeawsec2023/call-for-sub	Event	Hybrid	04/24/23	04/24/23	04/26/23	★	FuSE content	INCOSE	Martina Feichtner	Martina Feichtner, Paul Schreinemakers, Stephan Finkel, Tom Strandberg, William Miller	Anabel Fraga	
3	International Symposium 2023 (IS)		https://www.incose.org/symp2023/when-where	Event	Hybrid	07/15/23	07/15/23	07/20/23	★	FuSE content	INCOSE	William Miller		David Long	
4	Asia Oceania Systems Engineering Conference 2023 (AOSEC)	Digitalization for engineering Complex Systems	https://aosec2023.in/	Event	Hybrid	10/11/23	10/11/23	10/13/23	★	FuSE content	INCOSE	Martina Feichtner		Mudit Mittal	
5	IEEE SMC 2023 Conference	Improving the Quality of Life	https://ieeesmc2023.org/	Event	Hybrid	10/01/23	10/01/23	10/04/23	★	FuSE content	External Organization	William Miller	William Miller		Prop Futu "A v INC(
6	International Society for Systems Sciences (ISSS) conference	Systems Practice for Professions	https://www.isss.org/2023-kruger-national-park/	Event	Hybrid	06/17/23	06/17/23	06/23/23	☆	Open	External Organization			Gary Smith	As o parti Bill t at IV "The in cc of va think deve foun
7	INCOSE Western States Regional Conference			Event	Hybrid	09/14/23	09/14/23	09/17/23	☆	Open	Regions / Chapters			Artis Riepnieks	"We and coul lead
9	Nordic Systems Engineering Spring Tour	Empowering the North with Nordic Systems Engineering Experience	https://www.nordic-systems-engineering-tour.com/	Event	In person	05/22/23	05/22/23	05/24/23	☆	Open	Regions / Chapters				
11	Archimedis Stokholm Workshop: Integrating systems engineering into university education and establishing it in academia	Integrating systems engineering into university education and establishing it in academia	https://www.digitalfutures.kth.se/event/archimedes-stoc	Event	Hybrid	06/13/23	06/13/23	06/15/23	☆	Open	External Organization	Tom Strandberg			
12	FuSE Meeting of Swedish Chapter		?	Event	Hybrid	06/24/23	06/24/23	06/24/23	☆	Open	Regions / Chapters	Tom Strandberg			
13	Nordic Systems Engineering Autumn Tour	Empowering the North with Nordic Systems Engineering Experience	https://www.nordic-systems-engineering-tour.com/	Event	In person	09/20/23	09/20/23	09/22/23	☆	Open	Regions / Chapters	Tom Strandberg			Paul
14	Systems Engineering Test & Evaluation (SETE) Conference 2023	Enabling Resilience Through Disruption'	http://www.simulationcongress.com/	Event	Hybrid	08/21/23	08/21/23	08/24/23	★	FuSE content	External Organization	William Miller		Carry	Davi
15	TdSE (Tag des Systems Engineering)	Zukunft braucht Mut! (Future needs Courage)	https://www.tdse.org/	Event	In person	11/15/23	11/15/23	11/17/23	☆	Open	Regions / Chapters	Martina Feichtner, Stephan Finkel			Conf
17	ASEC 2023 INCOSE UK (Annual Systems Engineering Conference)	Embracing the New Opportuni⊘es	http://www.sosengineering.org/2023/	Event	Hybrid	06/14/23	06/14/23	06/16/23	☆	Open	Regions / Chapters	Joshua Sutherland			
19	Royal Society (talk to Bill about contact Kerry Lunney?)			Event					☆			Joshua Sutherland			

- IEEE SMC Conference (Bill)
- SETE Conference in Australia (David)
- *WSRC (open) → initial discussions*
- *UK SEC (Joshua; open) → content submitted*
- *IEEE SC (Chris / Bill; open) → weekly meetings*

Let's connect.

Or find us on
www.incose.org/fuse

Email fuse@incose.net

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Chris Hoffman
Stream Lead "SE Methodologies"

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Tom Strandberg
Stream Lead "SE Application Extensions"

e tom.strandberg@incose.net

INCOSE members are encouraged to join the "FuSE – Future of Systems Engineering" Yammer community for direct engagement.

Find out more by visiting the **FUSE YAMMER** community today!

fuse@incose.net