Introduction
Systems Engineering Application Extensions Stream

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The SE Application Extensions stream integrates social sciences, soft systems, as well as initiatives such as Smart Cities to address grand challenges to meet human and societal needs as stated in the United Nations Sustainable Development Goals.

The IW 2023 goal is to frame the value model to justify systems engineering’s role at the policy table for these grand challenges.
The world is coming to a conclusion that we need to take a systems approach to solve our challenges.

A better world through a systems approach

The world’s recognition of systems engineering and INCOSE is still very limited.
2025
Goal: Expand domain application: Address growing societal challenges. Influence policy across enterprises.

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

2030
Goal: Impactful application across domains underpinned by SE foundations and best practices supported by education and research.

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

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

Goal: SE theoretical foundations taught at multiple institutions.

2035
Goal: SE is the ‘go to’ discipline across domains 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: Evidence of wide reuse with system generative design underpinned by 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.

REALIZE THE VISION 2035
Stream Output

• An overview of initiatives that support the realization of the SE Application Extensions Roadmap.
  • Existing, e.g. Smart Cities Initiative
  • Potential new ones, e.g. Innovation

• Stimula and support to initiatives
  • Typically cross-WG, cross-organization

• Coordination and collaboration
  • products, papers, workshops, lobbying
How?

DEFINING TOPICS THAT CAN SUPPORT EXTENDING THE APPLICATION OF SE

DEFINING TARGET GROUPS AND THE MESSAGE REQUIRED

DEFINE HOW TO APPROACH THE TARGET GROUP

IDENTIFY THE RESOURCES REQUIRED, INTERNAL AND EXTERNAL TO INCOSE

STIMULATE AND SUPPORT JOINT INITIATIVES
Initial Selection of Topics.

- Smart Cities
- Innovation
- Asset Management
- Grand Challenges
Results IW2023
Key Insights SE Application Extensions

Topics

Validating the stream’s **purpose**, content and goals

**Topics for extending SE applications** proposed validated fit for purpose:

- Smart Cities
- Innovation
- SE and Asset Management
- Grand Challenges

Key Insights

SE Application Extensions stream **purpose and topics** have been **validated**. **MoE, risks and activities** have been **proposed** by the participants.

**Smart Cities** – good foundation exists for reaching out to internal & external groups. Next step is the validation by application together with mayors or alike.

**Innovation** – an innovation framework based on systems thinking identified to be a useful means to engage with new target groups. Good potential for collaboration between WGs.

**Asset Management** – Value and interest to cooperate with the Institute of Asset Management in order to align the forces. Identify the respective WGs within INCOSE.

**Grand Challenges** – Quite some Value Propositions identified that INCOSE could provide – Proposed next step set up a cross-WG initiative and to seek collaboration with complementary organizations with a joint message to target groups.
Saturday January 28th
Session

1) Feedback on the stream’s scope

2) Feedback on the stream’s planned activities in order to accomplish our targets & deliverables.
As focused on the Methodologies Stream

- Feedback on the stream’s scope.
  - What questions do you have?
  - What measures of success would you propose?
  - What risks do you see?
  - What mitigations do you propose?

- Feedback on the stream’s planned activities in order to accomplish our targets & deliverables.
  - What other activities should be considered? With whom?
  - What if any priority is there to the activities?
Feedback on the stream’s scope.

*What questions do you have?*

- What would be the minimum Level of success in the stream?
- What is the focus? get a message that is clear!
- Are we answering the right questions in terms of societal needs?
- Are we addressing the right needs of stakeholders → survey stakeholder needs!
- How are the differences between the 3 sectors to approach societal needs?
- What can we as INCOSE produce as a group of volunteers?
- What are the low hanging fruits to approach like SMART CITY?
- When will INCOSE establish lobbyists in national capitals?
- Are there SEs in the UN? If not: measure of success = SE in the UN
- What do we mean by INNOVATION?
Feedback on the stream’s scope.
What measures of success would you propose?

- VISION as a general understandable language - 5 pager
- INCOSE Known as a resource for policy creation in national capitals & U.N.
- Need good representation in all of the different agencies
- Show / Prove that INCOSE can do it
- INCOSE recognized by agencies outside Defences Aerospace
- We want to demonstrate that the SE approach has helped to cope with a certain challenge
Feedback on the stream's scope. 
**What risks do you see?**

- INCOSE is offered funding for projects but can't accept it.
- → **Mitigation:** INCOSE to act as a broker for establishing consortia
- Innovation means novelty for novelty's sake
- Systems Engineering not recognized as a term/ discipline/ profession → System Engineer = Computer Engineer
- INCOSE as a name is not explicit.
- Why are there Systems Engineers that don't know of INCOSE?
Feedback on the stream’s scope.

What other activities should be considered?

• INCOSE needs a sister cooperation that can make profit as a think tank
• Offer free hours sessions --> MENTORSHIP PROGRAM
• Offer SE training in curricula / educational programs in "new" domains   Educating non-graduate students in SE principles
• Review what we have as products that could be used (and what revisions maybe necessary ...)
• Ensure that our / WG products are brought out by ambassadors to the target groups
• Establish SE Primer for the "new" domains, written in the language of the domain .
• We have already good content --> we have to bring these product to the people that could use them !
• SE Ambassadors to UN, WEF, ...
• SE equivalent to US "land-grant" university - SE for sustainable/ resilient agriculture e.g., 1/3 of world's wheat from Ukraine ... but now ?'
• Electrification of Transportation ... - Lithium mining for batteries - SE planning / solution for long-term sustainability environmental reclamation
• Reach out to totally different target groups !
• For the different target groups, we need to adopt to their language
• Transformative Research & Innovation Policy (TRIP)
• Establish an initiative to find the synergy between standards, e.g. 15258 /55000, BiM
• Plain language! Illustrations !
Feedback on the stream’s scope.
What other activities should be considered?

• Offer modelling of system problems / failures.
• For successful Acceptation Provide Proof of success in other Industries. => Extend Scope with Success stories.
• Open a chapter in UN - Establish a kind of network
• Apply SE to Financial Model
• Check if any INCOSE member is affiliated within Policy makers, UN & other influential org.
• Help someone to solve a problem and learn in the process .
• Offer training to other organizations like asset management organizations
• Approach organizations that are dealing with the societal needs -> Explore their needs !
• Student Chapters to engage in SE solving Grand Challenges
• Implement & provide a platform for the "daily Engineer success stories"
• Provide a list of all relationships INCOSE got with other organization .
• Get students involved via student chapters, connect them worldwide and let them work on grand challenges stuff
• Promote job exchanges between domains.
• Provide the Value Proposition for a Systems Engineer practicing SE.
• Ensure that we involve all 3 sectors. --> include cultural aspects.
Sunday January 29th
Session

1) Innovation
2) Smart Cities
Breakout (50 min) - Approach for the 4 Topics

Round table hello

1) Feedback on topic and value SE could bring
2) The target groups to approach
3) The message to use when approaching the target group
4) How – what actions are in place or need to be taken?
5) What internal and external resources (collaborations) to engage
Smart Cities Initiative

Chair: Jennifer Russell EISE, CSEP  Jennifer.Russell@incose.net
Co-Chair: Marcel van de Ven, CSEP  marcel.vandeVen@incose.net
Co-Chair: Rael Kopace  Rael.Kopace@incose.net

INCOSE International Workshop  January 29, 2023
Purpose

• Support communities
  • Concepts
  • Applications
  • Technology
  • Services (CATS)
  by leveraging systems engineering tools and principles

Goal

• Create a model that illustrates the resources
• Enabling
  • interconnectivity
  • reuse
  • consistency
Smart Cities are a moving target.

And lack of success has diminished the concept and term.
Technology focused smart cities are rethinking their approach.

Success in a smart city “has nothing to do with technology and has to do with people. We need to invite the public into co-creating these experiences with high degree of civic engagement. Cities need to be engaged with the public around connecting communities.”

- David Graham, Chief Innovator Officer for the City of Carlsbad, California.
We need a common definition for a smart city

Guiding the evolution of smart cities

By Calli Queiroz June 01, 2021

The idea of the “Smart City” is a fashionable one. However, there is no common definition of what a smart city should look like.

(Image credit: Image source: Shutterstock/Jamesteohart)
Smart Cities Products Plan

complete
✓ Definition of Smart City
✓ Metrics
✓ Reference model

started
• Case Studies
• Stakeholder List + Management Plan
• Architecture template for Smart Cities ~ MBSE model

future
• Input on other Smart Cities publications
People are at the center of the most complex challenges facing today’s municipalities around the world. Economic development, homelessness, healthcare, racial equity, and many other issues are directly related to the humans in the city. Meanwhile, technology continues to provide new resources and opportunities. Smart Cities efforts often attempt to leverage technology to solve the human challenges, however the efforts can fall short. The INCOSE Smart Cities Initiative has developed an approach to focus on the humans in the city and identify solutions to best support their needs.

We propose a human-centric model to help cities make decisions with human needs in focus. This model helps identify and classify technological and other investments with the greatest positive impact for the residents. This document proposes a new framework, a definition of a smart city, and human-centric metrics to consider for evaluating a smart city.
A smart city is capable of identifying its problems and mitigating root causes by generating and processing engineered quality data in a continuous and inclusive manner.
Human Fundamental needs are the basis for a Smart City’s goal.

Economist
Artur Manfred Max Neef /1932-2019/
The INCOSE-TUS Reference Model is a robust, tailorable, and systematic way to view and evaluate a smart city as an integrated complex social system.
SCI Team Focus Areas

Framework & demonstration city
- Human centric perspective
- City goals – top level
- Jennifer Russell + TUSS

IEC – INCOSE Smart City Reference Architecture
- UAF modeling collaboration
- Rael Kopace

Smart City Use Cases
- Solution Architectures
- Matthew Hause
Smart Cities Reference Architecture
SCRA Level 1 Capability Map (example)

7.27.3 Smart Cities example

Figure 31 – Potential SCRA level 1 reference capability map
Autoville Unhoused Person Concept Diagram

- Unhoused people have interactions with multiple organizations and systems in Autoville.
- This helps to understand the positive and negative effects that homeless people have on city elements, and vice versa.
- Understanding this will help to frame solutions.
Questions?

INCOSE:
The global professional association for systems engineers

International Council on Systems Engineering
A better world through a systems approach
**Value Proposition**

- Define the problem space first
- Tools to understand the why first
- Prioritize the resources

**Target Groups**

- Mayor
- Global professionals
- Educational institutions
- Non-profits
- Foundations
- Municipalities

**Messages**

- Support identifying the system problem
- Help/support prioritizing the priorities

**WHO**

- Attend mayors' meetings
- Organizations: national, local

**HOW**

- Out of scope: implementation
- Governance model

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**Smart Cities**

- A framework that gives you a way to understand and measure a city's health.

- Does not set the goals for the city.

- Further research: How a city's status can influence people's lives.

- Municipalities, city planners, council of mayors.

- Leaders of critical verticals: government, public services, transportation, emergency.

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incose.org | 20
Smart Cities. **Feedback on topic and value SE could bring.**

- Define the problem space first
- Prioritization of resources
- Tools to understand the why first
- Framework to define their (city) goal
- Provide a toolset that supports the decision makers / responsibles
- Provide an unbiased framework (volunteer organisation / non-profit)
- Governance model
- A framework that gives you a way to understand & measure a city’s situation.
- Resilience - Justify broader margin to be included in design in the beginning
- How does smart city demonstrate city is being a good steward of taxpayer $??
- **BARRIER / Challenge:** A city can’t serve everyone’s needs. Spending on things people don’t want / need
- **Out of Scope:** Implementation, setting the goals for the city
Smart Cities. The target groups to approach & message

- Mayors
- Global professionals' societies
- Educational Institutions
- Non-profit Foundations
- Municipalities
- City planners
- Council of mayors
- Leaders of critical verticals (power, water, comm, transport, emergency ..)

- Support identifying the system problem
- Help / support prioritize the priorities
- Mayors want to find next step forward to be best at ... "Smartness"
- For mayors + elected officials: Empower to quantity how performing
- For mayors + elected officials: Leverage competition - Need / want headlines
- Demonstrate how the framework can support managing variability (e.g. weather)
- Holistic views beyond verticals. Interactions between disciplines - Interdependencies!!
Smart Cities. How – what actions are in place or need to be taken and who will be involved?

- Attend Mayors' Meetings
- Meetings of associate critical systems verticals, e.g. National Association of City Transportation Officials
- SIMPLE Diagrams + Pictures

- Organizations - regional, national - for mayors, ...
FuSE Implementation

How does Systems Engineering view Innovation?
The ability of Systems Engineering to find adoption in new applications and respond to societal situations is not about reinventing SE, it is about converging all the ways of doing SE (by other names) into a universal framework.
Definitions:

• Innovation is simply “the introduction of something new” (Webster)

• ISO 56000:2020 Innovation management — Fundamentals and vocabulary defines innovation as "a new or changed entity realizing or redistributing value".
Lawson’s Universal Mental Model of Systems

- Situation: problem or issue, event, opportunity
- Assets: available assets to bring to a situation
- Response: temporary system asset formed in response

From: Lawson, Harold, A Journey Through the Systems Landscape, College Publications, 2010
Innovation “Three System Model” (with inspiration from Bud Lawson)

Emergence in Systems-of-Systems

INCOSE IW2023 - Torrance, CA
INCOSE Innovation Ecosystem Pattern
AKA--Agile Systems Engineering Life Cycle Management (ASELCM) Pattern

**System 1**: Engineered System

**System 2**: Life cycle environment of System 1, including its Life Cycle Management--its Engineering, Production, Distribution, Operations, Sustainment). *Learns about System 1 and its environment.*

**System 3**: The environment and life cycle management of System 2 (its design, implementation, deployment, support). *Learns about System 2 and its environment.*
INCOSE Innovation Ecosystem Pattern
AKA--Agile Systems Engineering Life Cycle Management (ASELCM) Pattern

Especially for study of group learning and its effective application
The Three Horizons

Business Life Cycles + Portfolio Regeneration = 3 Horizons

http://www.internationalfuturesforum.com/transformative-innovation
Four Questions

1. (Value) What Innovation Systems Models should INCOSE adopt, then push out to potential target organizations?
   – Frameworks, competencies, case studies?

2. (Targets) Who would we target as potential users of our models/ products?

3. (Messaging) What messages (with regard to INCOSE’s value) should we bring them?

4. (Resources) Who are the resources inside of and outside of INCOSE?
2023 Annual INCOSE International Workshop
HYBRID EVENT
Torrance, CA, USA
January 28 - 31, 2023

www.incose.org/IW2023
Innovation. Feedback on topic and value SE could bring.

- How to measure
- Understand innovation context
- Improve innovation effectiveness
- Select optimal innovation level
- Delivery real beneficent results
- System life-cycle method
- Create something new with SE and it will become normal in society
- Connection to the business systems
- Bringing a possibility to provide a common language for all stakeholders
- Disrupts (breaks) preconceived "boundaries"
- Simplify issues/ solutions using models - diagrams - pictures / matrices / tables
- Overall overview off all systems - SOS view
- Baseline for cost model and resource sharing
Innovation. Feedback on topic and value SE could bring.

- Language for communication and data link between participants
- Bringing (abstract) overview
- Services (overview) - life cycle
- Larger strategy
- Mechanism for "listening" to innovator need prior to deployment
- Scope definition and system boundaries
- Mediator of technologies
- Bring logic into new technology (hypes)
- Making things TANGIBLE
- Identify dilemmas, understand values
- Making things ACCESSIBLE
- Alternate perspective prioritization
- Reveal / understand risk
Innovation. The target groups to approach & message

- Businesses
- Non-Profit Organizations (e.g. INCOSE ourselves)
- Municipalities, Government
- Professional Society
- Policy Makers City / County Board's
- Policy & Decision Makers
- Users / operators
- Non-Profit Organization like UN, Green Peace, WEE

- Maximize ROI - Do more with less
- Balance between innovation and QCD
- Rulemaking regulation
- A Methodical Process for identifying + managing innovation within organization + Product cycle
- Better Economy - For Residents / Constituents - Friendly to Small Business
- Simplified and Lower Cost for Big Business
- Provide large Studies where a new Innovative solution was created by means of SE.
- Innovation is a lifecycle model
- Seeing the big picture
- Solving the RIGHT PROBLEMS right
- SE is a lens to amplify SUSTAINABILITY --> costs, environmental impact, user impact, etc.
Innovation. How – what actions are in place or need to be taken and who will be involved?

- Outreach to other prof. Societies
- Municipal outreach
- Fundraising
- Test system
- Evaluation of standards
- Assess technologies/ innovations from end user perspective
  - 1. Identify the "delta" to chance, (required + achieved); 2. Enable the chance; 3. Support "new state" (sustain)
- Risk and opportunity identification
- Facilitate effective communication!
- What will emerge
- Interface management
- Connecting multiple socio-tech systems for example - mobility systems

- Local chapter
- Local chapter outreach/ to municipality
- Working groups
- Financial institution that can review SE
- Use role of enterprise architect
- Transition management
Monday January 30th
Session

1) Asset Management
2) Grand Challenges
PRESENTATION COVERAGE

What is Asset Management
Where can we connect INCOSE with Asset Management
Aligning SE to AM
Ben Mogridge MSc CEng MIET MINCOSE
Asset Management Domain Lead
Internal Technical Support Systems Engineering Consultant
Engineering Group
Abbey Wood South, BS34 8JH
Tel: +44 (0)7966 146 724

- DE&S ITS SE Asset Management Domain Lead
- Leading the technical implementation of AM in multiple areas of UK MOD
- AMS/1 Deputy Chair
- TC251 Asset Management Leadership Committee
- Developing and supporting SSGs on behalf of the IAM
Asset Management – What is it and Why?

Asset Management - “the coordinated activity of an organization to realise value from assets” (Clause 3.3.1 of ISO 55000).

“Asset management is more than doing things to assets - it is about using assets to deliver value and achieve the organisation’s business objectives. It also brings a different approach and way of thinking and a transformation of organisational alignment and culture. Each organisation has to determine what it considers value to be and choose how to manage its assets to derive best total value.”

(The Institute of Asset Management - An Anatomy of Asset Management Ver.3 (2015, December) - p8)

“What’s going to happen is equally as important as what is happening today...”

“We must balance our duty to commission our Assets as swiftly as reasonably practicable with the need to ensure through-life reliability and availability”
Asset management is a strategic discipline which gives rigour and accountability to the way organisations decide:

- how, where and in what to invest
- what assets are most critical
- what risks need to be managed
- what demands must be served
- what needs to be known
- how this knowledge should be captured and disseminated how organisations should be structured and led
- what types and teams of people they need how activities should be carried out
- how actual performance should be measured
- that improvements are needed.
OVERALL GOALS OF AM

• spending where necessary
• leaving assets in the same state as you would wish to find them
• managing risks not resources
• thinking in whole systems not their parts
• applying a whole-life perspective
• everyone reading from the same page
• stakeholders understanding the choices made.
ISO/TC 251 sees its work contributing specifically to the SDG’s under categories: 6, 7, 9, and 11
### ASSET MANAGEMENT & MANAGING ASSETS — THEY’RE DIFFERENT!

<table>
<thead>
<tr>
<th></th>
<th>Managing Assets</th>
<th>Asset Management</th>
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<tbody>
<tr>
<td><strong>Colleague Focus</strong></td>
<td>Asset data, location and condition assessment</td>
<td>Information supported decision making (i.e. with strategic context and related to customer need)</td>
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<td></td>
<td>Current KPIs</td>
<td>Strategies to select and exploit assets over the lifecycles to support business aims</td>
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<td>Department budgets</td>
<td>Collaboration across departments to optimise resources allocated and activities</td>
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<td><strong>Stakeholder Focus</strong></td>
<td>Current costs</td>
<td>Triple bottom line and value</td>
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<td>Current performance</td>
<td>Clarity of purpose of the organisation</td>
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<td>Response to failure/ maintain function</td>
<td>Focus on impact of activities of an organisation’s objectives</td>
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<td><strong>Senior Focus</strong></td>
<td>Short term gain and loss</td>
<td>Long term value for the organisation</td>
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<td>Departmental/individual performance</td>
<td>Developing competence and capability across workforce</td>
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<td>Savings, especially OPEX</td>
<td>Business risks understood and mitigated</td>
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<tr>
<td><strong>Supplier Focus</strong></td>
<td>Short term contracts and performance</td>
<td>Long term contracts and/or partnering relationships in support of client value and objectives</td>
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<td></td>
<td>Service level agreements focussed on contract specifications</td>
<td>Understanding client strategy and needs in 5-10 years</td>
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Table adapted from ISO/TC 251 - Managing Assets in the context of Asset Management – First Edition dated May 2017
ASSET MANAGEMENT SUBJECT GROUPS
ASSET MANAGEMENT PUBLICATIONS
WHERE CAN WE CONNECT SE TO AM

2 Institutions…

ISO 55000 series

ISO 15288

2 ISO’s

Common interests?
ALIGNMENT

Asset Management

“enable an organization to achieve its objectives through the effective and efficient management of its assets. The application of an asset management system provides assurance that those objectives can be achieved consistently and sustainably over time”

ISO 55000

System Engineering

“a structured and auditable approach to identifying requirements, managing interfaces and controlling risks throughout the project lifecycle”

Z1 - Guide
ALIGNMENT

Asset Management

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ISO 55000

System Engineering

“a structured and auditable approach to identifying requirements, managing interfaces and controlling risks throughout the project lifecycle”

Z1 - Guide
ALIGNMENT

Asset

“An item, thing or entity that has potential or actual value to an organization. The value will vary between different organizations and their stakeholders, and can be tangible or intangible, financial or non-financial.”

System

“Combination of interacting elements organized to achieve one or more stated purposes”

ISO 55000

ISO 15288
Explicitly advises organizations to leverage Systems Engineering practices.

The goal of asset lifecycle management is to achieve an optimal balance between risk, cost and performance.

Where SE practitioners can build bridges with AM:

- Balance lower capital costs with longer operating life costs (trade-offs)
- Strategies for end of life (retire/replace/renew); with technology migration and procurement strategies
- Provide tools to assess trade-offs to optimize systems performance, cost and risk
QUESTIONS?
Asset Management. Feedback on topic and value SE could bring.

- Harmonize SE and Asset Management Processes and Standards
- Asset Management is the what, SE is how!
- Value: integrated (SE/AM) methodology to apply scientific principles to support decision making
- asset = system
- Looker to the bigger picture
- Achieving "Line of Sight" through an org with SE, (People understand their value to the org)
- Thinking forward
- standardization / uniform
- predict failure of assets / systems
- Share methods for analyzing systems/assets for achieving missions in a cost-effective long-term manner
- long term aspects of AM & SE counters "Accountability Fade" in big infrastructure programs
- Define digital thread requirements: - Eng - Conflg. - Sustain - Finance - Procure
Asset Management. The target groups to approach & message

- IAM & 150
- asset owners
- owners/operators of public infrastructures

- Communicate:
  - Value
  - Interest
  - seeking alignment
Asset Management. How – what actions are in place or need to be taken and who will be involved?

- Gain MoU between INCOSE and each AM Group
- Working groups to harmonize languages - Use cases on how SE/AM work together
- Best practices

• INCOSE - Monthly Meetings:
  - IWG
  - TWG
  - CIPR
- Task force to organize INCOSE resources and define products
- Task force also to manage outreach
Michael Watson - SE Application Extensions
Monday 30 Jan 2023, 08:00-10:00 PST

FuSE: Systems Engineering Application Extensions
Topic: Grand Challenges
Systems Engineering Applications – Grand Challenges

• INCOSE Systems Engineering Vision 2035 sets the framework for Grand Challenges in Systems Engineering Applications
  • SYSTEMS ENGINEERING AIMS TO ENSURE THE PIECES WORK TOGETHER TO ACHIEVE THE OBJECTIVES OF THE WHOLE

• As society benefits from advancements in system capabilities, consumers and users continue to expect more from these systems.
  • This includes expectations that systems are more capable, dependable, sustainable, and affordable.
  • They expect systems to be more socially acceptable by considering their impact on society and the environment.
  • Users also expect systems to be more autonomous, enabling them to seamlessly interact, and understand and respond to their requests.
INCOSE Systems Engineering Vision 2035 Challenges

• Applications
  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.
Social Grand Challenges from International Organizations

• The United Nations Sustainable Development Goals (SDG) focus on Social Grand Challenges

• Systems Engineering provides system solutions to support identified social needs
  • Require a system understanding and system engineering approach, in particular:
    SDG 1 - Eliminate Poverty
    SDG 2 - Eliminate Hunger (food supply chain)
    SDG 3 - Good Health and Well-Being (medical systems)
    SDG 6 - Clean Water and Sanitation Systems
    SDG 7 - Affordable and Clean Energy
    SDG 8 - Economic Growth (products and manufacturing)
    SDG 9 - Industry, Innovation, and Infrastructure
    SDG 12 - Responsible Consumption and Production
    SDG 11 - Sustainable Cities and Communities
    SDG 13 - Climate Action
    SDG 14 - Aquatic Systems
    SDG 15 - Agricultural Systems
Grand Engineering Challenges from National Organizations

- **Engineering Grand Challenges** focus on engineering solutions which have a social benefit
- The United States National Academy of Engineering has established a set of **Engineering Grand Challenges**

1. Advance Personalized Learning
2. Make Solar Energy Economical
3. Enhance Virtual Reality
4. Reverse-Engineer the Brain
5. Engineer Better Medicines
6. Advance Health Informatics
7. Restore and Improve Urban Infrastructure
8. Secure Cyber-Space
9. Provide Access to Clean Water
10. Prevent Nuclear Terror
11. Provide Energy from Fusion
12. Manage the Nitrogen Cycle
13. Develop Carbon Sequestration
14. Engineer the Tools of Scientific Discovery
Other Grand Challenges

- **Societal and Engineering Grand Challenges**
  - **Society 5.0**
    - Reinforces the role and the contribution of industry to society
    - It places the wellbeing of the worker at the centre of the production process
    - Uses new technologies to provide prosperity beyond jobs and growth
    - Focus on sustainable, human-centric and resilient European industry
    - System solution needs in the areas of
      - Digital Transformation
      - Integration of Cyber-Space physical life
      - Green Transformation
  - **Biological Economics**
  - Establish sustained human presence on the Moon and Mars
  - Self Driving Automobiles
  - Electric air transportation

*Society 5.0* explicitly looks to a future of socio-cyber-physical systems. That is, a human-centered society that balances economic advancement with the resolution of social problems by a system that highly integrates cyber-space and physical space. In Society 5.0, data from sensors in physical space are accumulated in cyber-space, analyzed by artificial intelligence (AI), and results are fed back to humans in physical space in various forms.

Together these trends respond to the sustainable goals of the UN, the recommendations of the World Economic Forum, and the changing values of the world’s population, especially of younger generations.

**SOCIETY 5.0**

Japan has established Society 5.0 as a national strategic policy that will shape national priorities and investments. Society 5.0 is envisioned as society’s next major transformation beyond the information age.

“Society 5.0 will be an Imagination Society, where digital transformation combines with the creativity of diverse people to bring about “problem solving” and “value creation” that lead us to sustainable development. It is a concept that can contribute to the achievement of the Sustainable Development Goals (SDGs) adopted by the United Nations.”

– Nakamichi, H., World Economic Forum Annual Meeting, 2019
The ultimate aim...to close the gap between water demand and supply by the year 2030.
Clean Water and Sanitation Case Study

• Understood problem
  • Met with Subject Matter Experts (SMEs)
    • Clean Water and Sustainability
    • Socio-Technical Framework
    • Biomimicry

• Defined System Solution
  • Identified layered approach (SOS, Govt, Individuals)
  • Ontology
  • System Definition
  • Functional analysis of system elements
  • etc...

• Planned Next Steps
  • Communicate
    • Deliver work (Connect)
    • Write paper for Insight
  • Collaborate with those working problem
Working Sessions

• Select a Grand Challenge Topic with the group at your table

• Discuss how systems engineering can contribute to solutions to the challenge

• Discuss how INCOSE can foster solutions for the challenge, including:
  • The target group(s) and the message to be delivered
  • Resource within and external to INCOSE that we should engage
Grand Challenges
Grand Challenges. Feedback on topic and value SE could bring.

• Modelling of complex Systems and Interactions
• Strengthen the Systems Thinking & integration of concerns.
• SE could bring methodologies with better rigor to support sustainable solutions
• SE could bring better choice of solutions and ways to select "best" solution
• Design Space exploration and trade-off studies
• INOSE can bring many different engineering domain experts to work on solutions.
• Decision Support tools
• Systems dynamics modeling
Grand Challenges. The target groups to approach & message

- ICC / State / courts local building codes
- IPCC informed group of scientists (present @ EMEA AOSEC)
- European Commission
- Individual Governments
- Insurance Companies

- INSIGHT AT A BROADER SCALE
  - We can help you understand your problems
  - We can help you solve your problems
Grand Challenges. How – what actions are in place or need to be taken and who will be involved?

• Set up an initiative cross - WG
• Identify Who within INCOSE has connections to relevant organizations

• INCOSE WG:
  • Natural Systems WG
  • Social Systems WG
  • infrastructure WG
  • Smart Cities
  • Safety
  • American Planning Association American Urban Planning Association
  • NGOs, charities, Greenpeace ...
  • Carbon Leadership Foundation we can bring systems engineering rigor
  • U. N. organisations
Next Steps
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
Bengaluru, India
11. – 14. OCT 23

Working Sessions
Virtual
Planned for CW 8 – 9

Working Sessions
Virtual
TBD
Let’s connect.

Or find us on www.incose.org/fuse

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FUTURE OF SYSTEMS ENGINEERING (FUSE)

Vision: Inspire the global community to realize the SE Vision

The FuSE Program is organized in 4 streams.

- Vision & Roadmaps
- Foundations
- Methodologies
- Application Extensions