INCOSE – Today & Tomorrow

Building a Future

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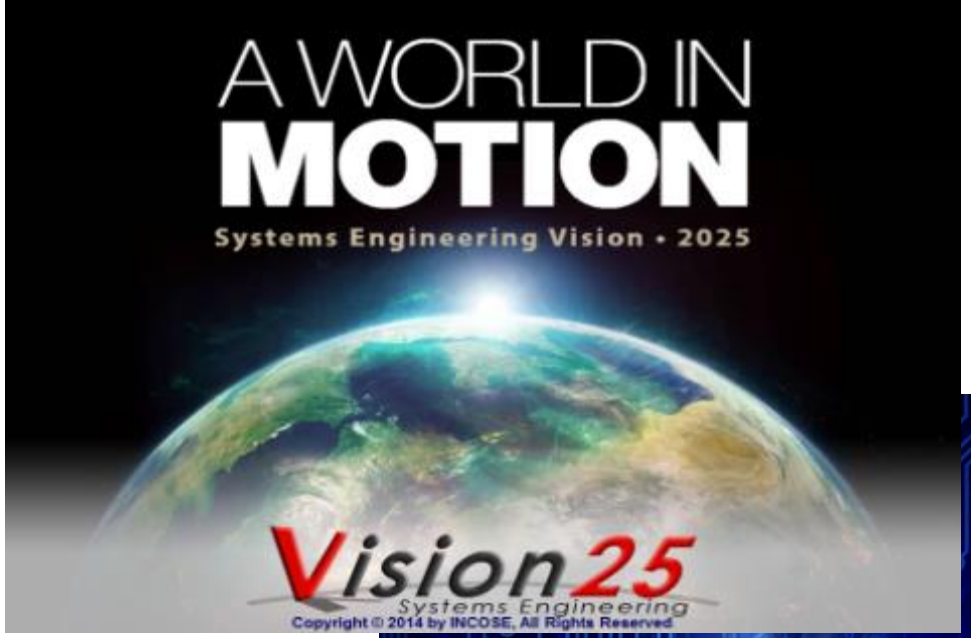


International Council on Systems Engineering

ATIS SE Workshop, Oct 2020

About INCOSE

INCOSE Vision

A better world through a systems approach

INCOSE Mission

To address complex societal & technical challenges by enabling, promoting, & advancing Systems Engineering & systems approaches

Values

- *Systems Thinking*
- *Pioneering & Innovation*
- *Learning & Development*
- *Respect, Diversity, Collaboration*
- *Individuals*
- *Volunteerism*

Principles

- *Impact*
- *Partnership*
- *Holism*
- *Differentiation*
- *Volunteers*

Learn more at: www.incose.org

A Global Organization

Over 18,100 Members Worldwide

65 Chartered Chapters, 8 Emerging Chapters

71 Countries Represented, 25 with Chapters

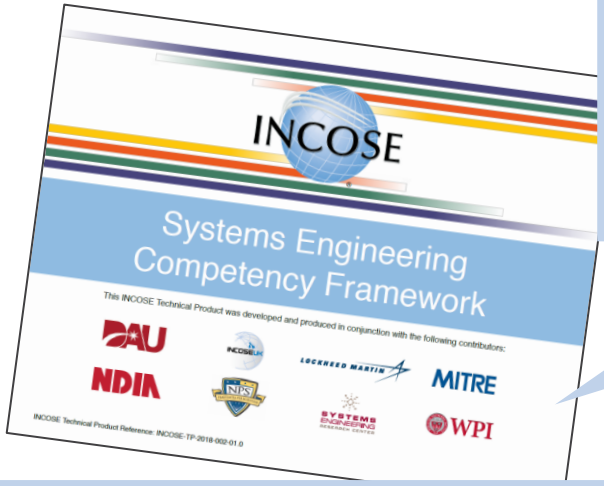
120 Corporate + Academic Members

Honeywell, Boeing, Airbus, FAA, BAE, GE, JPL, Lockheed Martin, Medtronic, NASA, Thales, Siemens, United Technologies, Shell, Rockwell Collins, Rolls Royce, MIT, CMU-SIE, General Motors, IBM…

Many Alliances Across the Globe

Our Value Streams

portfolio of books, papers, videos, standards, tools, & other tangible high-value outputs created & distributed by INCOSE &/or its alliances



portfolio of offerings by INCOSE &/or its alliances of both in-person & on-line courses to enhance a professional's specific knowledge, skills, & abilities in a topic relevant to systems engineers

Products/

portfolio of conferences, workshops, seminars, & other physical & virtual gatherings offered by INCOSE alone or with its alliances

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Men

s

portfolio of offerings through which INCOSE confirms a member's competency in systems engineering

Certification

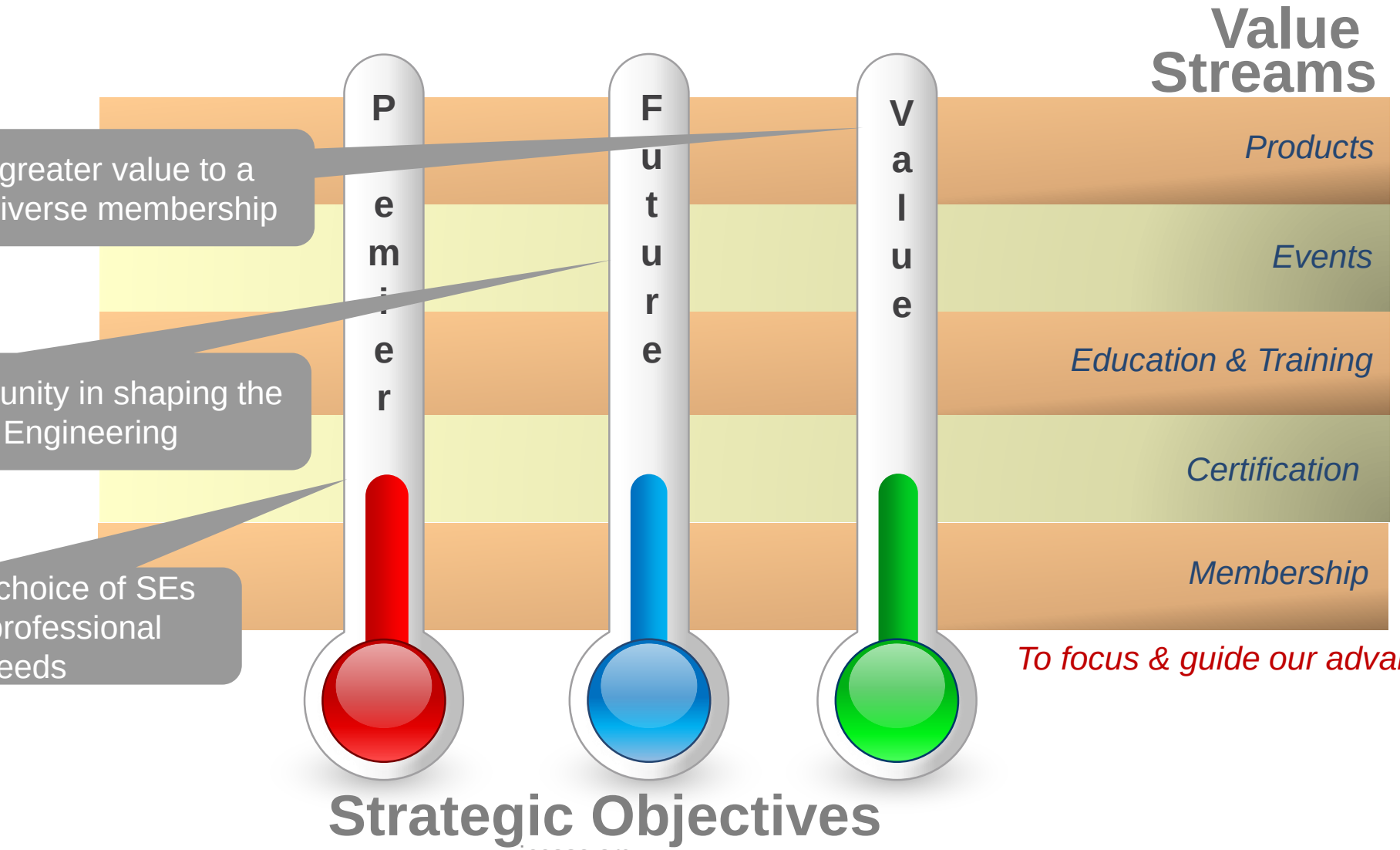
portfolio of the aggregated intellectual capital provided by INCOSE members of all types (full, student, associate, corporate, …) & the services through which INCOSE recruits, engages, influences, & retains members

Our Strategic Objectives

INCOSE delivers ever greater value to a growing & increasingly diverse membership

INCOSE leads the community in shaping the future of Systems Engineering

INCOSE is the premier choice of SEs everywhere for their professional development needs



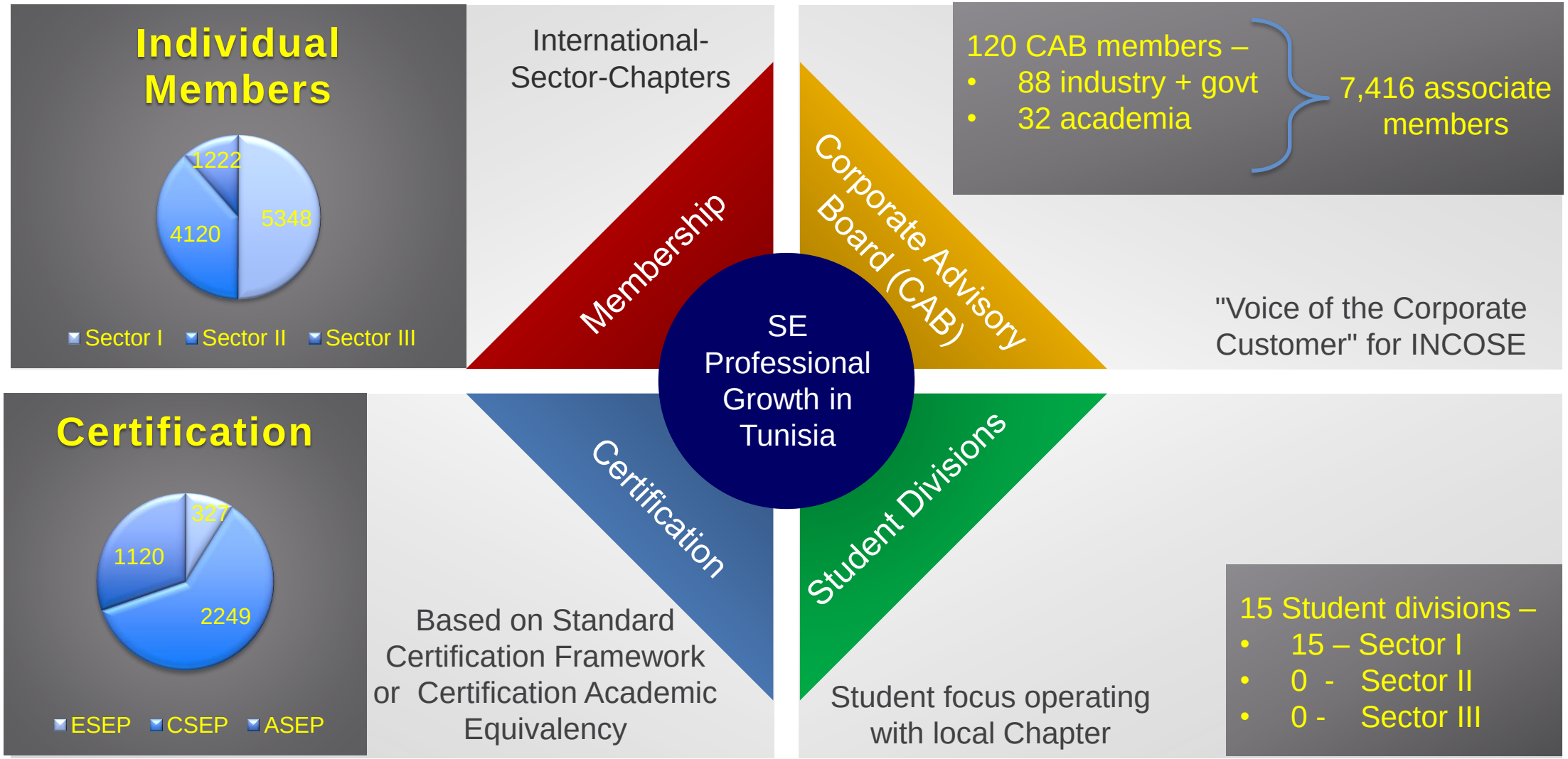
To focus & guide our advancement

Our Reach –
National > International > Global

1990

1995

Membership Facts



Opportunities for SE in Tunisia

- "Technical "Heart of INCOSE"
- Over 50 WGs worldwide
- Solving problems
- Creating technical products
- Influential Standards group & MBSE initiative

- Annual IW (Jan) & IS (Jul)
- Webinars & Tutorials
- New Events eg SoSE Mini Event, Nov 2020
- Community Offerings – Webinar Showcase + Systems Exchange Cafes
- Engagement with events from other professional societies
- INCOSE Events "Toolkit"

- Webinars & tutorials
- Events
- SE Certification
- TLI
- Competency Framework
- Aligned with key SE references (15288, SEH, SEBoK)
- Professional Development Portal
- Offerings from alliances

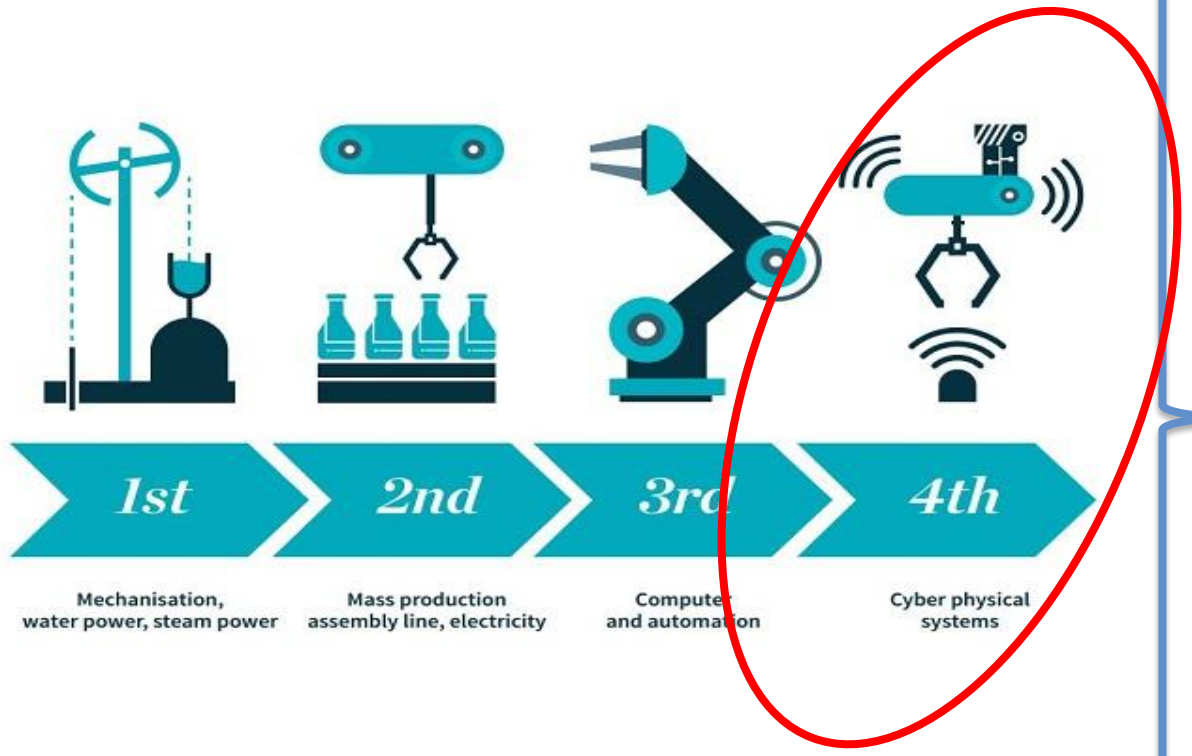
- "To accelerate the development of SE leaders"
- Two-year program; new cohort formed annually
- A blend of synchronous online learning & asynchronous team collaboration to deliver all content & learn together

What Next…25 Year Horizon

Source: Calvin & Hobbes, Twitter, @cavlinandhobbes

- Drivers for Change
  - Examples - Artificial Intelligence (AI), Autonomous Unmanned Systems (AUS), Digital Engineering (DE)
- The Immediate Future
  - Current INCOSE initiatives
    - SE Vision 2035
    - Transformation Activities Examples
    - Future of Systems Engineering (FuSE)
  - Your involvement
- In 25 Years' Time – 2045!
  - Don't miss the increasing SE opportunities

Driving Change - 4th Industrial Revolution



- Today & Tomorrow –
  - Ubiquitous digitisation
  - Technologies blending biological & physical – man vs machine
  - Continuous reinvention
  - Sustainable eco-systems
  - Cyber-physical systems
  - Artificial Intelligence (AI)
  - Autonomous Systems (AS/AUS)
  - Internet of Things (IoT)
  - Sensor networks
  - Genetic editing
  - Mobile supercomputing
  - Digital Engineering (DE)
  - Machine Learning
  - Robotics
  - Block chain architecture
  - Cloud Computing

Source: Graphic from Understanding the Fourth Industrial Revolution, Jackie Randles

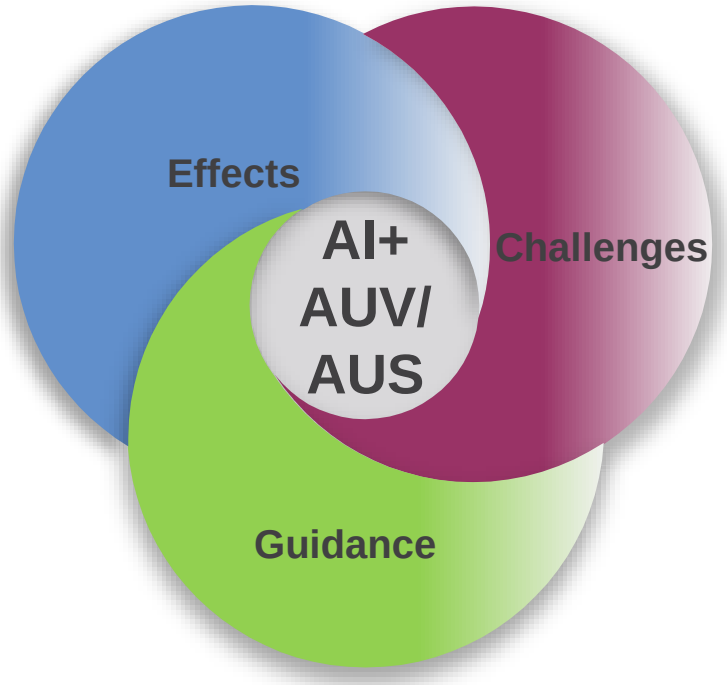
Consider System Focus + AI + AUS

Effects

- Operate continuously
- Improve productivity
- Work where we cannot safely go
- Increase information sharing
- Increase data volume
- Reduction in people & platforms

Guidance

- Think holistically, react speedily
- Create, protect, exchange data
- Focus on situational awareness
- Focus on boundary conditions
- Consider patterns & anti-patterns
- Use data models / digital twin
- Thwart “attack vulnerabilities
- Provide training in information skills
- Increase data analytics
- Utilise simulations / virtual realities
- Focus on validation & pilot programs



Challenges

- Security/Attack Vulnerability
- Resilience
- Control
- Safety
- HSI
- New Interfaces
- Interoperability
- Trust
- Scalability
- V&V
- Patterns & Architecture
- Emergent Behaviour
- MBSE & Digital Twin
- Technology Rate of Change
- Deployment
- Remoteness

Source: Image from article
“Redefining Trust for the Digital Era”

Consider Systems Transformation through DE

Source: Penn State News, Sep 2020
Image: Pixabay

DE

DE mirroring SE (similarities)

Holistic approach / Strong stakeholder engagement / CONOPS / Multi-disciplinary field / Architect before design / Linkages through mission & operational threads / Models & simulation usage / Continuous integration

What is needed to engineer a system

Holistic approach / Strong stakeholder engagement / CONOPS / Multi-disciplinary field / Architect before design / Linkages through mission & operational threads / Models & simulation usage / Continuous integration

SE

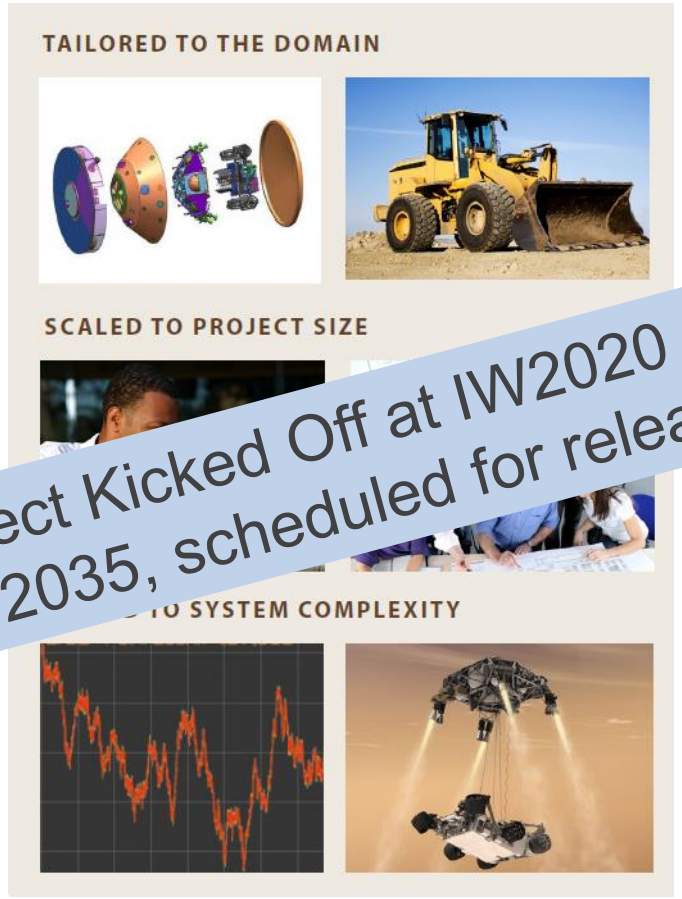
Digitising SE

- Focus on the data
- Develop a core ontology for the practice
- Follow the digital thread, a data-driven architecture
- Develop & use the single source of truth (SST) for the data, ie authorised data
- Trust the authoritative data –
  - Eliminate large scale design reviews
  - Minimise project documentation set
- Trade off requirements to enhance key performance parameters
- Increase usage of data analytics, visual analytics, models, & patterns
- Embrace digital technologies eg IoT, AI, AUS, virtual / augmented reality, additive manufacturing
- Conduct event-driven reviews
- Perform system verification & validation via DE environment – early & often

Source: www.incose.org

Sources: Derived from 1) DE, Digitisation & he MBSE Disconnect, Article by D Long, Sep 2017;
2) Transforming SE through DE, Paper by Bone, Blackburn, Rhodes, Cohen & Guerrero, The Journal of Defence Modelling and Simulation, 2018

Immediate Future - Our SE Vision 2025



New Project Kicked Off at IW2020 to Update - SE Vision 2035, scheduled for release at IW2022

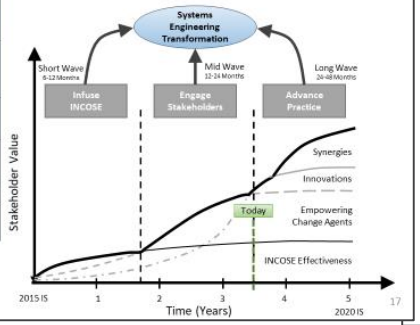
- Published in June 2014
- Freely available on the INCOSE website
- Chapter & Domain versions of the Vision are being developed (e.g., Dutch Chapter & Automotive)
- Will be refined & updated to "2035 vision" in the next 2 years

Transformation Activities – Digital Engineering Examples

SE Transformation Strategy, Objectives and Path Forward

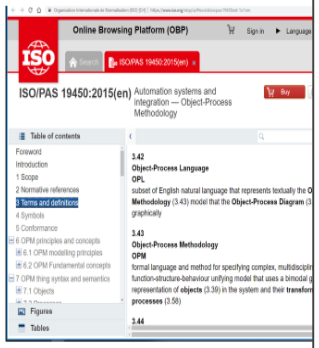
Vision	SE is known as a model-based discipline		
Mission	INCOSE accelerates the transformation of systems engineering to a model-based discipline		
Mission Area	Infuse INCOSE	Engage Stakeholders	Advance Practice
Mission Area	*What can INCOSE Do?*	*What is practiced and needed?*	*What is possible?*
Goals	Infuse model-based methods throughout INCOSE products, activities and WGs	Engage stakeholders to assess the current state of practice, determine needs and values of model-based methods	Advance stakeholder community model-based application and advance model-based methods.

Systems Engineering: The central cohesive discipline essential for Digital Transformation



Standardization - OPM - Object-Process Methodology

- Language and methodology for modeling complex systems of any kind
- Useful for Industry 4.0 and agile MBSE
- Based on minimal universal ontology
  - stateful objects
  - processes that transform them (create, consume, change state)
- Objects and processes can be refined to any desired level of detail
- Executable, can be simulated by animation
- Bi-modal visual-textual presentation:
  - OPD – Object-Process Diagram
  - OPL – Object-Process Language



Dov Dori dori@mit.edu © 2019

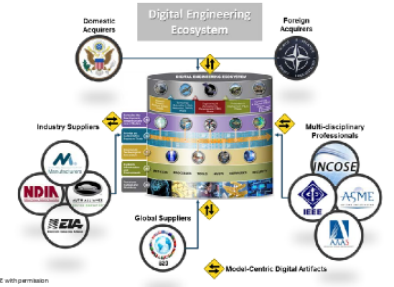
Digital Engineering Information Exchange Working Group

A Standardized way to Offer, Request and Exchange Digital Artifacts

Product Descriptions

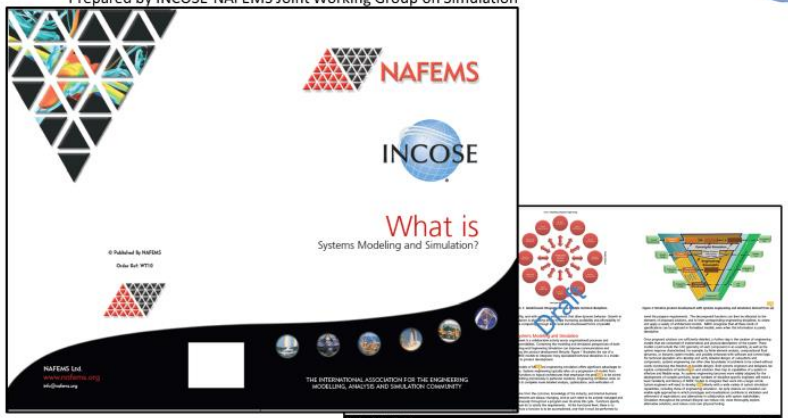
- **DEIX Primer**: A narrative that describes the concepts and interrelationships between digital artifacts, enabling systems, and exchange transactions (**Project Lead:** John Coleman, *Engility*)
- **Digital Engineering Information Exchange Model (DEIXM)**: A prescriptive system model for exchanging digital artifacts in an engineering ecosystem (**Project Lead:**, Chris Schreiber, *Lockheed Martin*)
- **Digital Viewpoint Models (DVM)**: Descriptive information models of digital views that form content for ISO 15288.2 reviews (**Project Leads:** Frank Salvatore, *Engility* & Tamara Hambrick, *Northrop Grumman*)
- **DEIX Standards Framework (DEIX-SF)**: A framework for official standards related to MBE Information Exchanges (**Project Lead:** Celia Tseng, *Raytheon*)

Information Exchange Model for Digital Engineering Ecosystem



Trifold on "What is Systems Modeling and Simulation?"

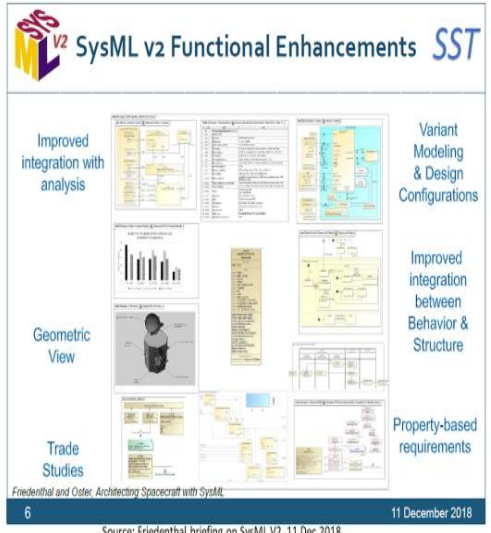
Prepared by INCOSE-NAFEMS Joint Working Group on Simulation



Standardization - SysML V2

Improve:

- Interoperability with other tools
- Support for flexible visualization
- Precision
- Usability

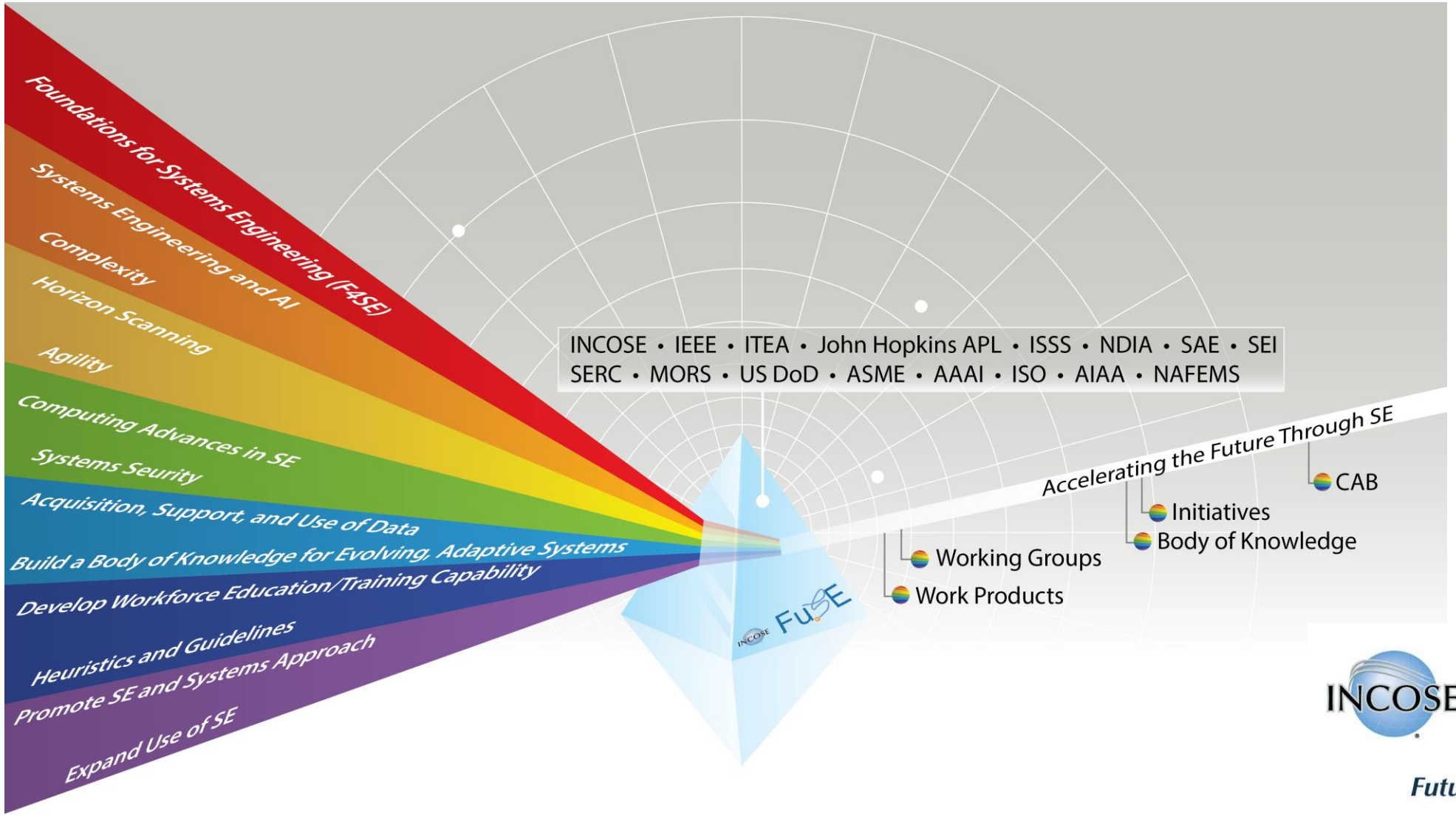


Source: Friedenthal briefing on SysML V2, 11 Dec 2018

INCOSE MBSE Patterns Working Group: Reconceptualizing SE

- **Problem/Opportunity**: Many advantages (financial, technical, schedule, risk, capability) by better exploiting "group learning" in reconceptualized SE:
  - Using history of physical sciences and their engineering disciplines.
  - About trusted shared model-based patterns.
- **WG Objectives:**
  - Making systems engineering, other life cycle management 10:1 simpler to use by a 10:1 larger population for 10:1 larger and more complex systems.
- **WG Focus and Approach:**
  - Re-usable, model-based "patterns", configurable to specific project models.
  - For whole systems, not just small parts of them.
  - For all information types needed across the entire system life cycle.
  - Based on the smallest model needed to support the full system life cycle.

Future of SE - FuSE



FuSE Charter -

- Purpose: Evolve the practice, instruction & perception of SE
- Goal: Create a road map that drives the evolution of SE
- Scope: Identify the needs, priorities & means for transforming SE

INCOSE FuSE

Future of Systems Engineering

FuSE Intra INCOSE Engagements

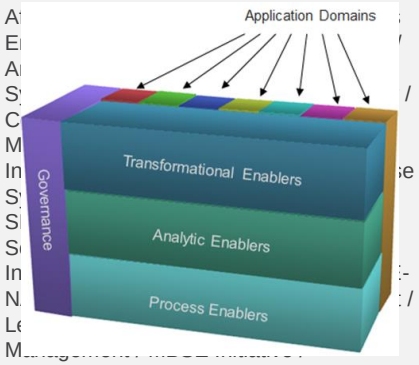
FuSE Engagement with INCOSE Working Groups, Initiatives, and Periodicals

Where You Can Get Involved (1 of 2)

Chapters

- Get active!

Working Groups



Measurement / Model-Based Conceptual Design / Natural Systems / Object Oriented SE Method / Oil & Gas / Ontologies / Patterns / PM-SE Integration / Power & Energy Systems / Process Improvement / Product Lines / Quality Management / Reliability Engineering / Requirements / Resilient Systems / Risk Management / SE in VSE / SE Management / Software – Incremental Dev / Space Systems / Standards Initiative / Systems of Systems / Systems Science / System-Software

- Discover like-minds
- Interact across diverse groups
- Be part of the future

Volunteering

- Volunteer Opportunity Board

https://www.incose.org/about-incose/volunteer-opportunities/vo-request

Events

International Workshop

International Symposium

International Sector/Regional Chapter/Local

ASIA-OCEANIA SYSTEMS ENGINEERING CONFERENCE

SETE

ASEW AUSTRALIAN SYSTEMS ENGINEERING WORKSHOP

- Present
- Exhibit
- Sponsor
- Attend
- Discuss-Q&A

Training & Education

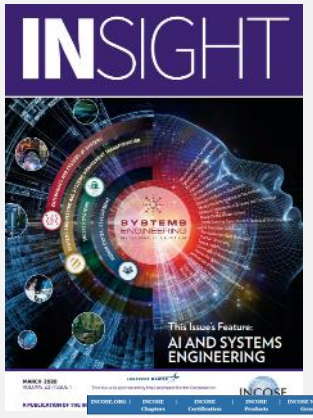
- Professional development path
- SE Competency Framework
- Webinars & tutorials

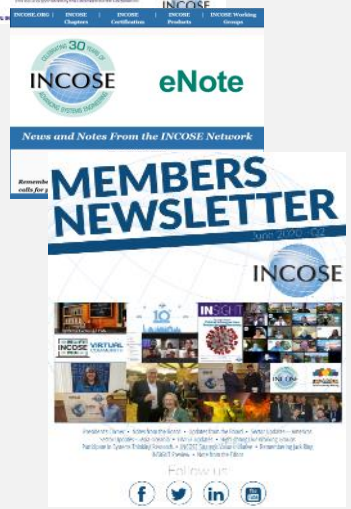
Where You Can Get Involved (2 of 2)

Special Projects/ Grand Challenges

- "A better world through a systems approach"

SUSTAINABLE DEVELOPMENT GOALS





- Contribute!

News Articles

Community Offerings

- Participate &/or host

INCOSE VIRTUAL COMMUNITY

- Get you qualification
- Join the Certification Advisory Group (CAG)
- Help develop material

Certification

Corporate Advisory Board (CAB) Member

- Get your organisation to join the CAB
- Advise & influence the direction of INCOSE
- Work with diverse resources

Looking Further - 2045 Horizon

- "**Purchase** high-quality **emotions** online" – Alex Ayad
- "**Cities** made from living, dynamic materials that **respond to the environment**" – Alex Ayad
- "Driverless cars will **just be**… cars" – Tamar Kasriel
- "**Hyperloop** will be another means of transport" – Ian Pearson
- "**No more smartphones** – replaced with augmented reality" – Ian Pearson
- "**3D printed houses** readily available" – Ian Pearson
- "Simply just **talk** or even press a button **to interact** with a **machine**" – Pam Melroy


Source: Image courtesy of Forward Thinking Farming


Source: Image courtesy of metamorworks


Source: Volvo Concept 26 – The Future of Not Driving

- "Robot intelligence could **match** human intelligence" – Murray Shanahan
- "The personal network will be a "**hyperlocal grid**"" – James Kendrick
- "**Transportation as a Service** (TaaS) will replace private car ownership" – Alfred Poor
- "The notion of "**big data**" will seem **quaint**" – Andrew Brust
- "**Brain prints** join fingerprints"
- - Sarah Lazlo & Zhanpeng Jin
- "I have set the date **2045** for the "**Singularity**"" – Ray Kurzweil
- "The **division between "haves" & "have nots**" to begin with will increase" – Greg Nicholas

What will INCOSE be?
What will be the evolution of Systems Engineering?

Consider Practicing SE

New &/or Greater Importance

- Situational awareness will be critical
- Reliant on intelligence augmentation (AI – General)
- Utilization of knowledge-based expert libraries – via subscriptions
- Primary interaction with models & tools will be voice
- Quick generation & adaptation of models & prototypes
- Resilience, safety, security, environmental sustainability expected, not asked
- Information & data paramount

But Still Relevant

- Lifecycle models – new & existing
- Stakeholder engagement
- Risk mitigation activities
- Sound architectures
- etc

Source: Image courtesy of Miguel Medina

Consider Research Related to Systems

Coming out of the 4th Industrial Revolution, ie

"… this period ~~is~~ was characterised by a range of new technologies that ~~are fusing~~ fused the physical, digital & biological worlds, impacting all disciplines, economies & industries, & even ~~challenging~~ challenged ideas about what it means to be human."

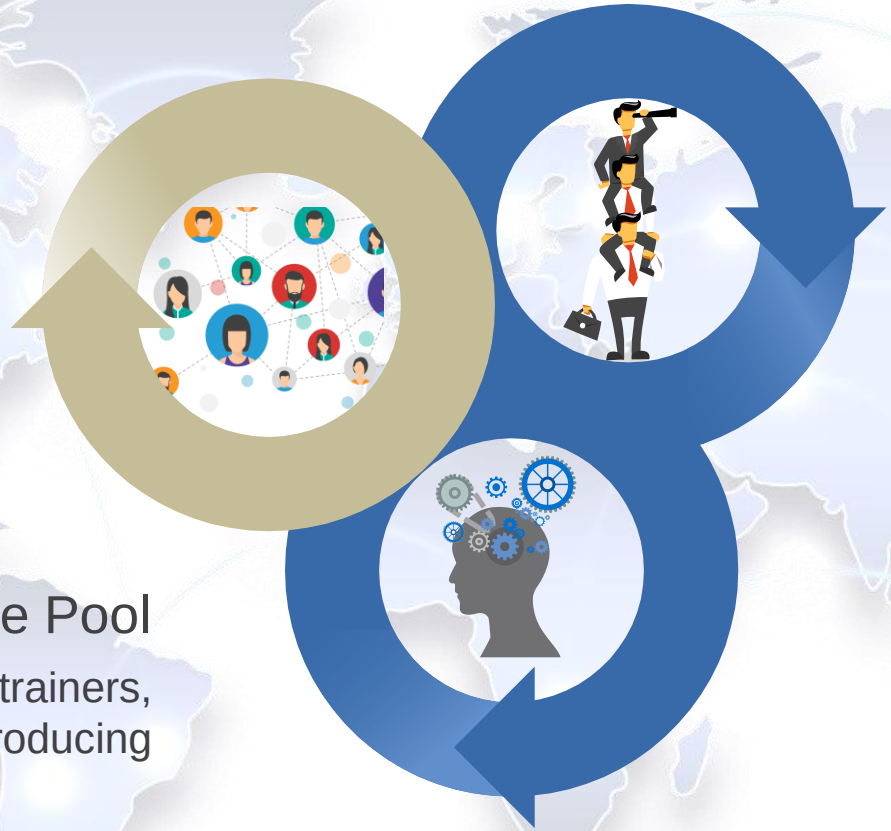
- Klaus Schwab & his book "The 4th Industrial Revolution"

- Impact of Singularity
- Human adaptation research in closed, artificial environments
- Group think & AI
- Societal acceptance in cyber-genetics
- Human- Robot Interactions
- Predictive models of smart nations
- Continuing evolution of life cycle models
- Inter-relationships between sustainability challenges
- …

Consider INCOSE Reach - Inward

Members

Individuals collaborating



Corporate Advisory Board (CAB)

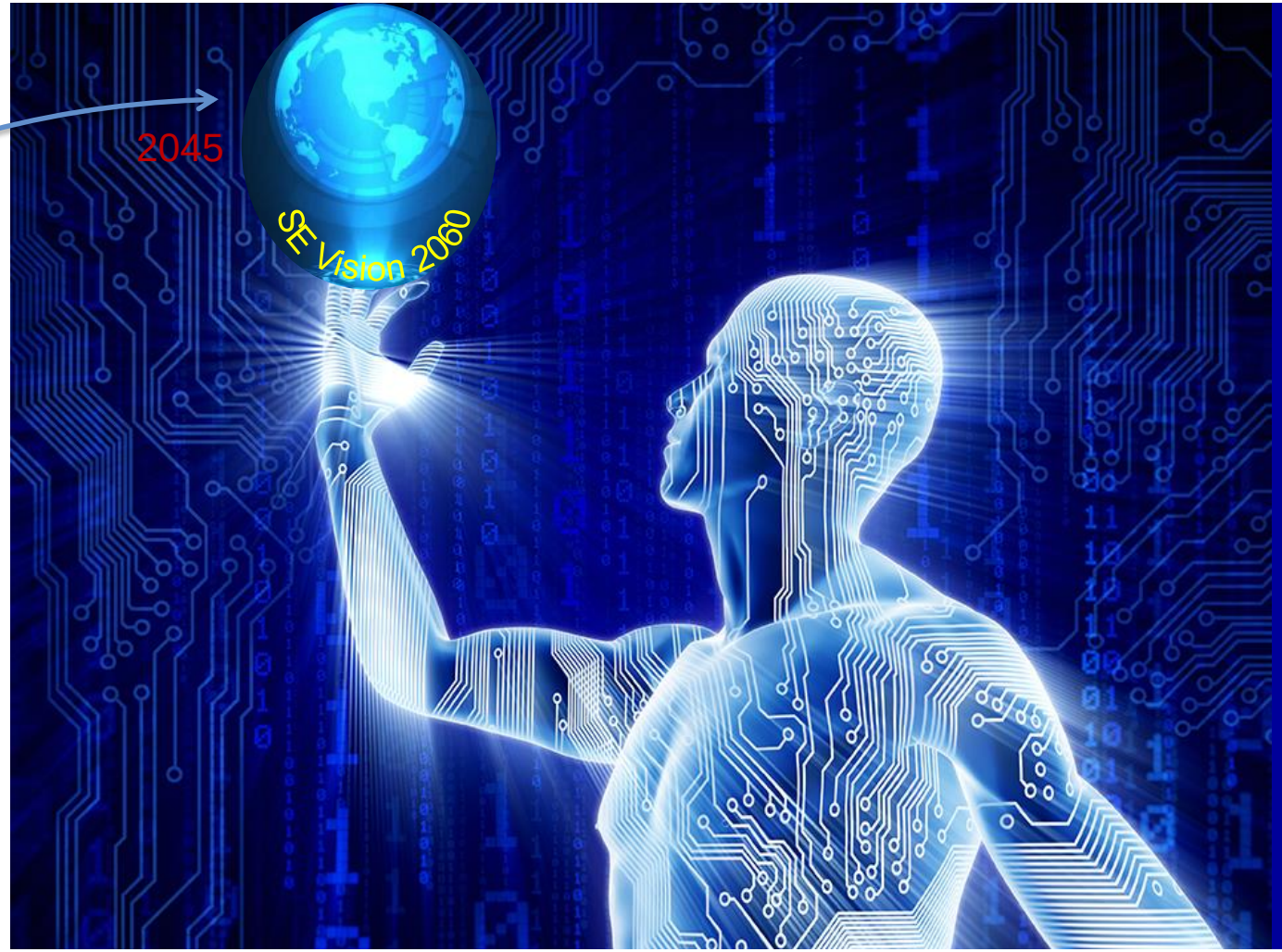
Organisations seeking & guiding

Knowledge Pool

Volunteers, experts, trainers, mentors & working groups producing

And on a stronger, connected worldwide front

Consider INCOSE Reach - Outward



- *Shaping the impact of change*
- *Strengthening collaboration*
- *Harmonising people & technology*
- *Advancing technology & innovation*
- *Sustaining our world as we would like*

And 2045 is a Stepping Stone…

Government + Commercial Space Industry


Source; Space Station Podcast, “A Star Trek-inspired space station”

Naval Fleet – Colonisation, Transport, Exploration, …


Source: Lunar base made with 3D printing, ESA Engineer T Ghidini, Mar 2018


Source: Moon Base, pinterest.com

INCOSE - Coverage in 2045…

INCOSE

Get On Board –
You Don’t Want to Miss Out on this SE Journey

But For Now – Join Us

INCOSE International Workshop – IW2021

A fully virtual event with
plenary, town halls &
working groups “market place”

INCOSE International Symposium – IS2021

Currently a hybrid event -
physical + remote participation

Thank You

For more information or to share ideas, contact:

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