SoSECIE Webinar

Welcome to the
2019 System of Systems Engineering Collaborators
Information Exchange (SoSECIE)

National Defense Industrial Association

We will start at 11AM Eastern Time

Skype Meeting +1 (703) 983-2020, 46013573#

You can download today's presentation from the SoSECIE Website:

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NDIA System of Systems SE Committee

- **Mission**
  - To provide a forum where government, industry, and academia can share lessons learned, promote best practices, address issues, and advocate systems engineering for Systems of Systems (SoS)
  - To identify successful strategies for applying systems engineering principles to systems engineering of SoS
- **Operating Practices**
  - Face to face and virtual SoS Committee meetings are held in conjunction with NDIA SE Division meetings that occur in February, April, June, and August
  - SoS Track at NDIA 22nd Annual Systems Engineering Conference, Grand Hilton Tampa Downtown, Tampa, FL, October 21-24, 2019
    - Conference Info: http://www.ndia.org/events/2019/10/21/22nd-annual-systems-and-mission-engineering-conference

NDIA SE Division SoS Committee Industry Chairs:

Mr. Rick Poel, Boeing

Ms. Jennie Horne, Raytheon

OSD Liaison:

Dr. Judith Dahmann, MITRE

Simple Rules of Engagement

- I have muted all participant lines for this introduction and the briefing.
- If you need to contact me during the briefing, send me an e-mail at sosecie@mitre.org.
- Download the presentation so you can follow along on your own
- We will hold all questions until the end:
  - I will start with questions submitted online via the CHAT window in Skype.
  - I will then take questions via telephone; State your name, organization, and question clearly.
- If a question requires more discussion, the speaker(s) contact info is in the brief.

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2019 System of Systems Engineering Collaborators Information Exchange Webinars

Sponsored by MITRE and NDIA SE Division

September 10, 2019
An Analysis of Systems-of-Systems Opportunities and Challenges Related to Mobility
Mr. Jakob Axelsson

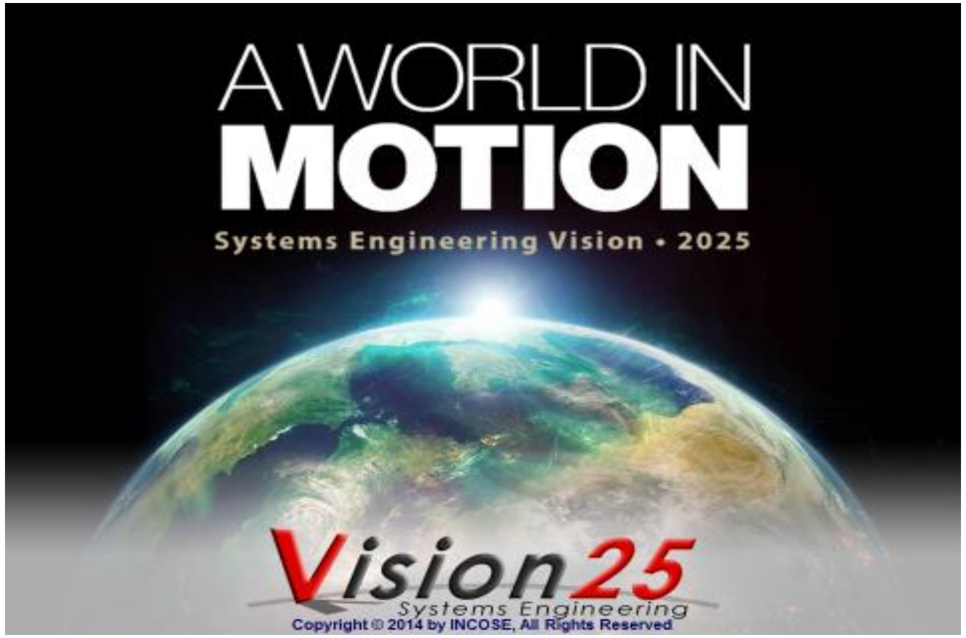
September 24, 2019
Modeling and Simulation for Internet of things as System of Systems
Dr. Paul C. Hershey

October 22, 2019
Modeling Process for the Design of System of Systems Evolution
Dr. Jeremy Buisson, Dr. Isabelle Borne and Mr. Franck Petitdemange

November 5, 2019
Irrational System Behavior in a System of Systems
Mr. Douglas L. Van Bossuyt, Mr. Bryan M. O'Halloran and Mr. Ryan M. Arlitt

November 19, 2019
Multi-Dimensional Classification of System-of-Systems
Dr. Bedir Tekinerdogen

December 3, 2019
Digital Twin Strategies for System of Systems
Mr. Michael Borth



Understanding and Shaping the Future of Systems of Systems Engineering

Garry Roedler, ESEP
INCOSE President,
INCOSE Fellow and Founder Recipient,
IEEE-CS Golden Core,
Lockheed Martin Senior Fellow,
Engineering Outreach Program Manager

SoSECIE Webinar
27 August 2019

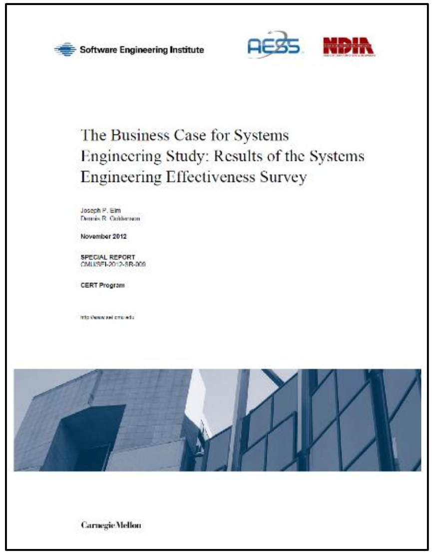
Agenda

- Evolution of Our Systems Environment
- The Challenges for Systems of Systems Engineering
- The Need for Change
- What INCOSE and Others are Doing to Make a Difference

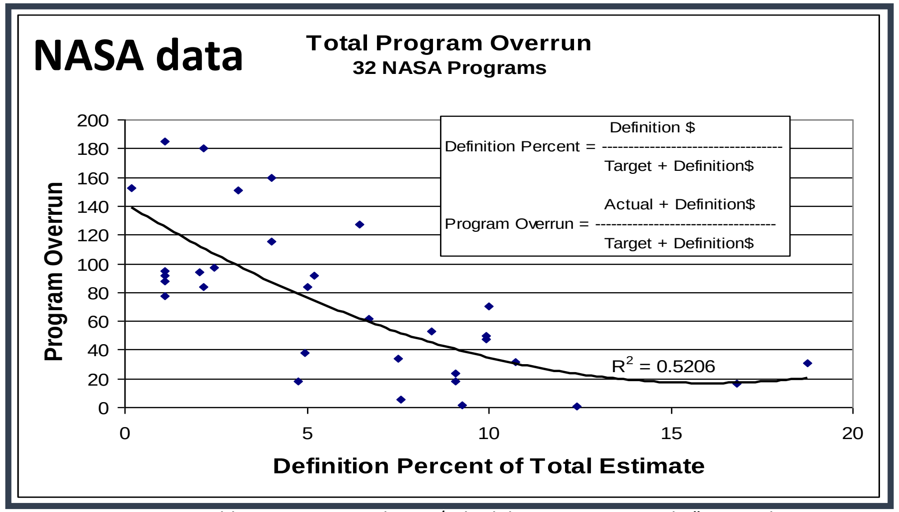
Evolution of Our Systems Environment

Observed Trends

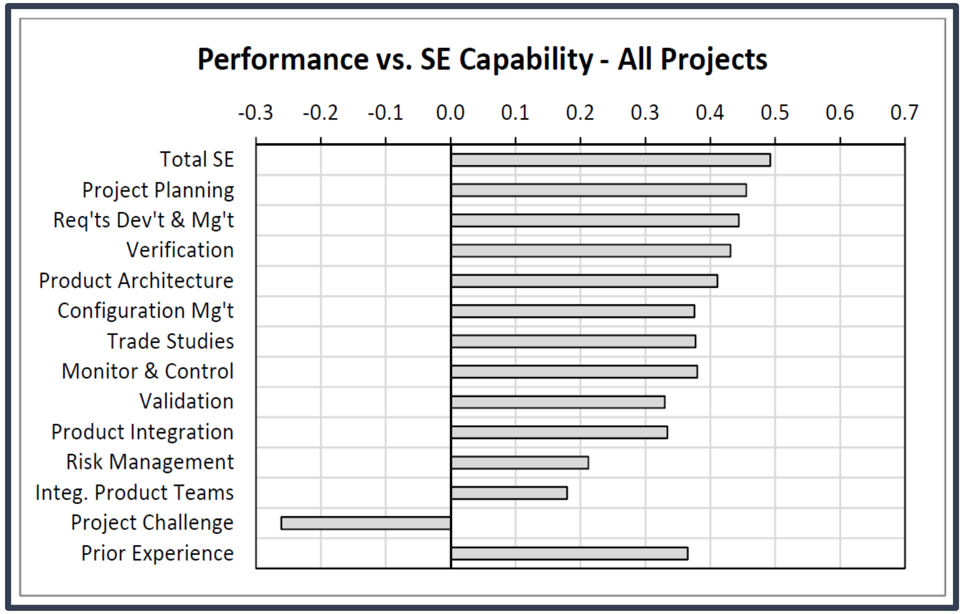
The Value of SE: Relevancy

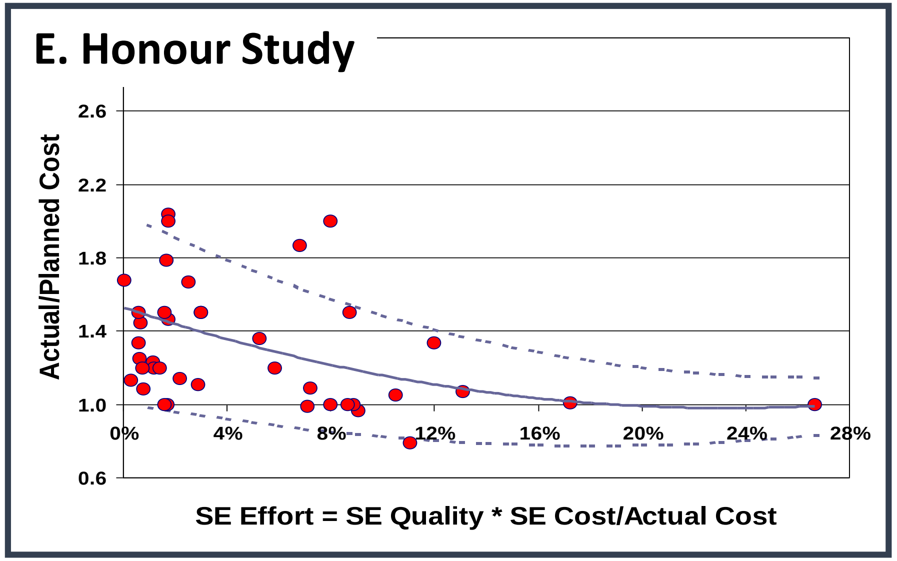


Elm, Joseph, et al "The Business Case for Systems Engineering Study: Results of the Systems Engineering Effectiveness Survey", CMU/SEI-2012-SR-009, November 2012



W. Gruhl, Lessons Learned, Cost/Schedule Assessment Guide," Internal Presentation, NASA Comptroller's Office, 1992





E. Honour, "Understanding the Value of Systems Engineering," INCOSE, 2004

Current Situation: Practices and Challenges

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1 Mission complexity is growing faster than our ability to manage it . . . increasing mission risk from inadequate specifications and incomplete verification.

2 System design emerges from pieces, rather than from architecture . . . resulting in systems that are brittle, difficult to test, and complex and expensive to operate.

3 Knowledge and investment are lost at project life cycle phase boundaries . . . increasing development cost and risk of late discovery of design problems

4 Knowledge and investment are lost between projects . . . increasing cost and risk: dampening the potential for true product lines.

5 Technical and programmatic sides of projects are poorly coupled . . . hampering effective project risk-based decision making.

6 Most major disasters such as Challenger and Columbia have resulted from failure to recognize and deal with risks. The Columbia Accident Investigation Board determined that the preferred approach is an "independent technical authority".

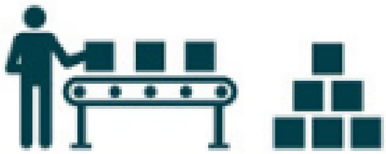
Driving Change in Industry

TODAY & TOMORROW

1784 | 1870 | 1969 | Now

1[st] Industrial Revolution:

- Mechanization, steam power, weaving looms
- Large-scale transportation with steam-powered vessels and railroads
- Replacing human and animal power with machines



2[nd] Industrial Revolution:

- Electricity, assembly line, mass production
- Internal combustion engines, automobiles
- Radio and television

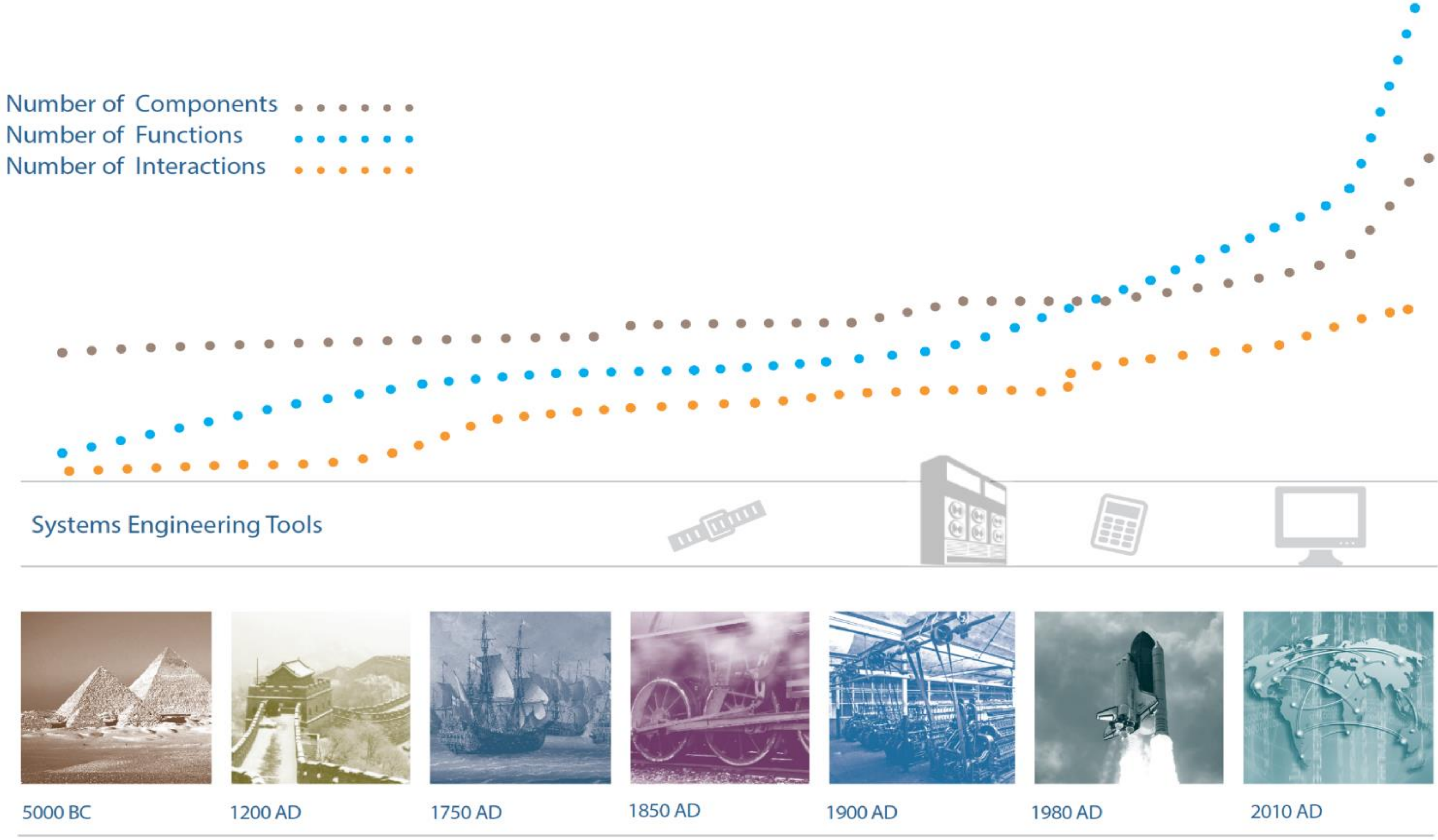
3[rd] Industrial Revolution:

- Electronics, computers
- Automation
- Information technology

4[th] Industrial Revolution:

- Cyber-physical systems
- Internet of Things
- Sensor Networks
- Advanced Robotics
- Big Data
- Machine Learning
- Cloud Computing
- Driverless cars
- 3D/4D printing-based manufacturing
- Blockchain transaction architecture
- Artificial Intelligence
- Autonomy

Trend: Increasing Complexity of Systems



Complexity for Less

iPhone is more than 1000x more powerful than a Cray 1.

What is the cost of an iPhone's computing power in 1976?

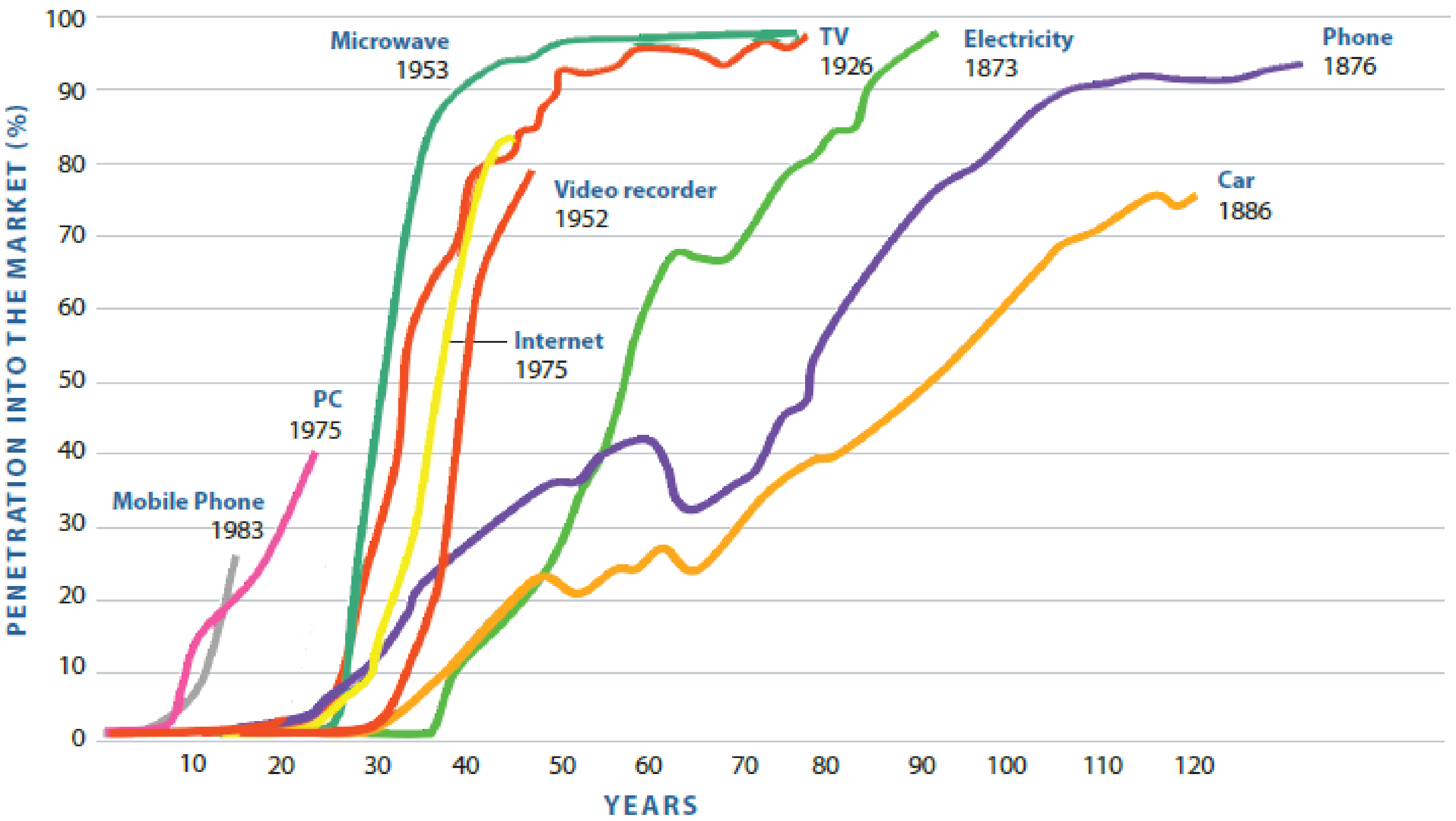
1. $10,000
2. $100,000
3. $1,000,000
4. **$3,200,000,000**

Source: INCOSE IS2018 - Langdon Morris, The Big Shift: Innovation and Systems Engineering, Tuesday Keynote
https://www.youtube.com/watch?v=XpB6wYc0E00

Trend: Increasing Rate of Technology Adoption

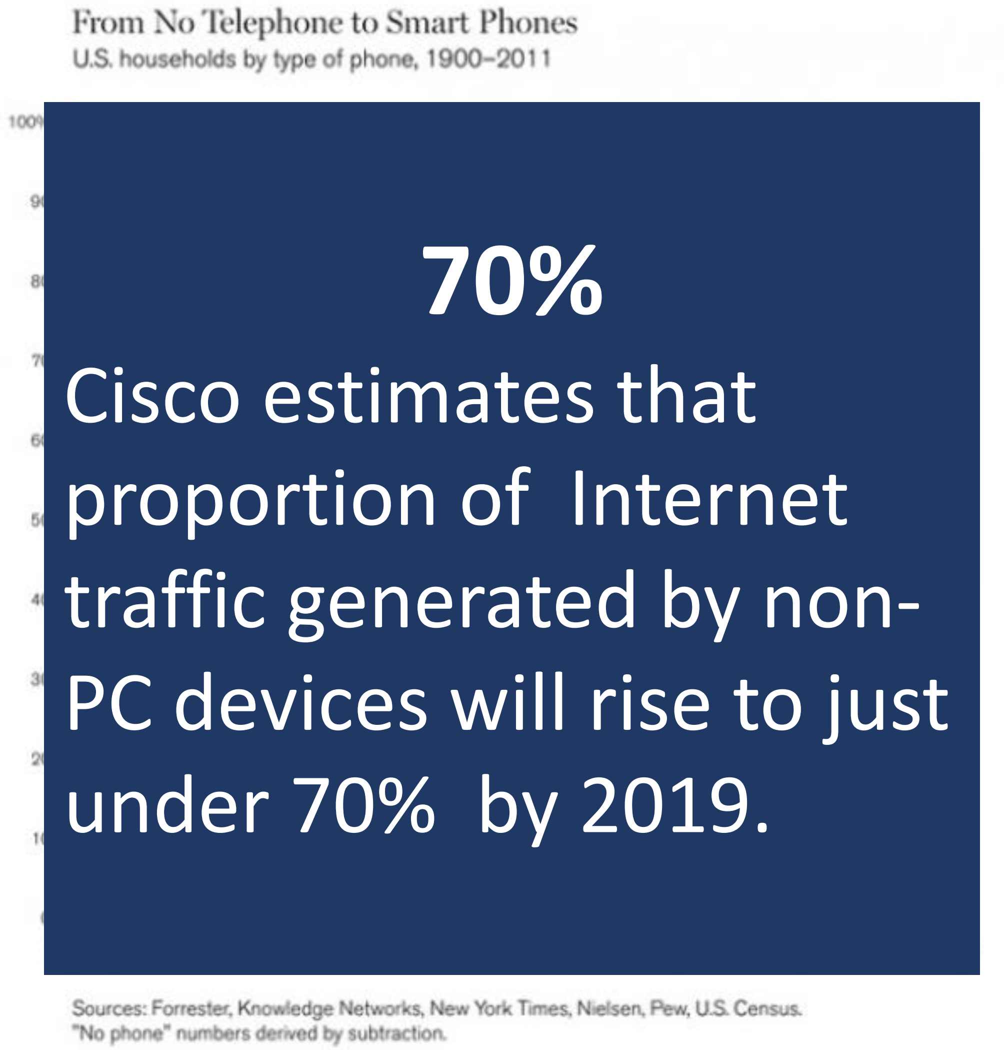
NEW TECHNOLOGIES CHANGE OUR DAILY LIFE AT AN EVER INCREASING RATE

Source: Forbes magazine



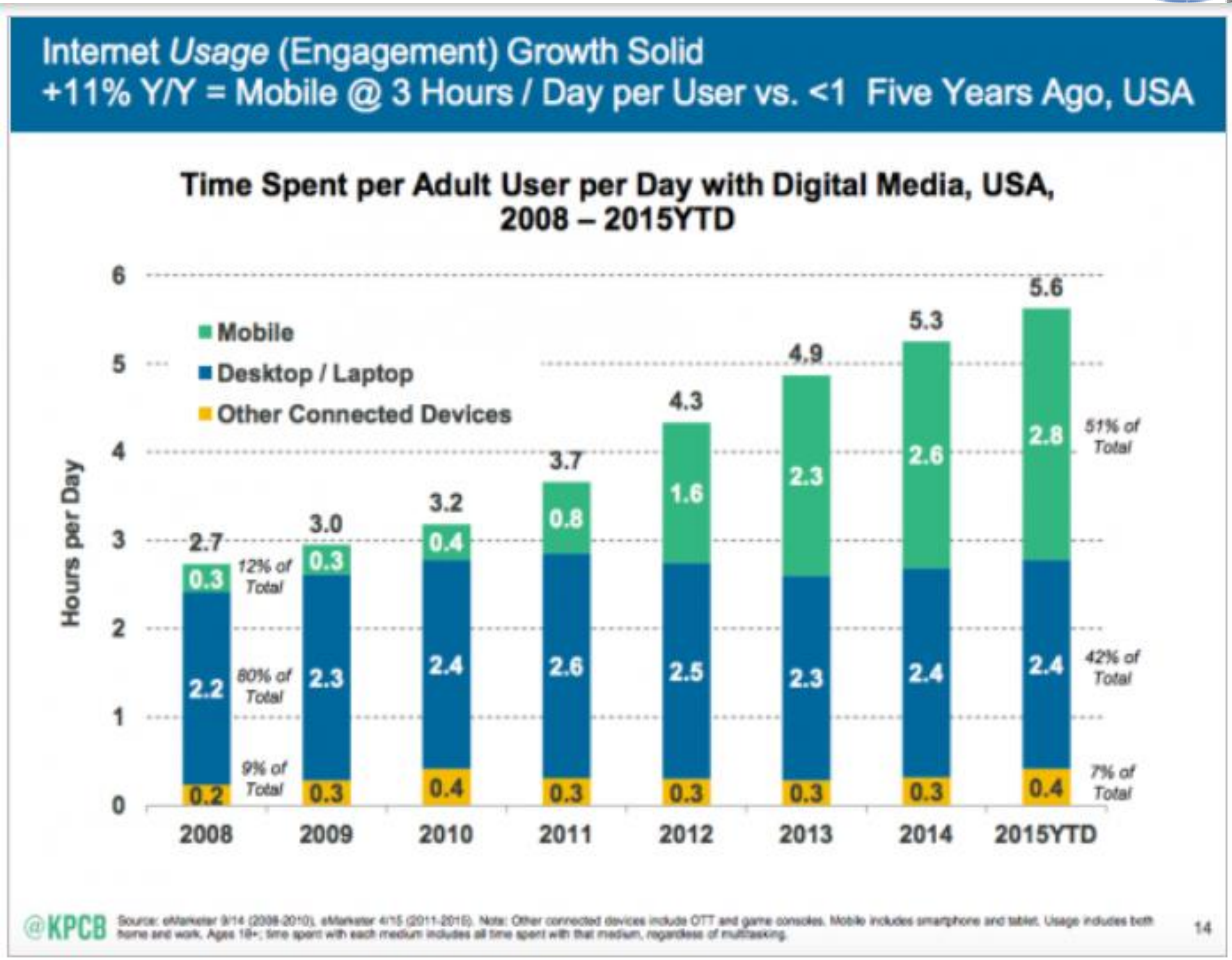
"With technology infusion rates increasing, the pressure of time to market will also increase, yet customers will be expecting improved product functionality, aesthetics, operability, and overall value. "

Example: Smart Phone Adoption



70%

Cisco estimates that proportion of Internet traffic generated by non-PC devices will rise to just under 70% by 2019.



Jun 28, 2017

Source: KPCB mobile technology trends by Mary Meeker

Smart Phone is the most quickly adopted consumer technology in history

Example: Recent technology adoption with increasing complexity

- Autonomy / Artificial Intelligence (AI)
  - Embedding into many of our systems
  - Driverless cars
    - Uber - Pittsburgh
    - Google – Palo Alto
  - Deliveries
    - Amazon
    - Budweiser – Otto - Video
  - Hotels (CNN)
  - Google DeepMind
  - Advanced Robotics (Sophia)
  - AI Creation of AI
  - Evolving Perspectives (Musk vs Zuckerberg)
  - DoD
    - Autonomous Learning Systems
    - Human-machine Collaborative Decision Making
    - Assisted Human Operations
    - Advanced Manned-Unmanned System Operations

Credit: Steve Jurvetson, 2012.

These technologies will impact both Systems and SoS

Need to consider positive results, challenges and unintended consequences

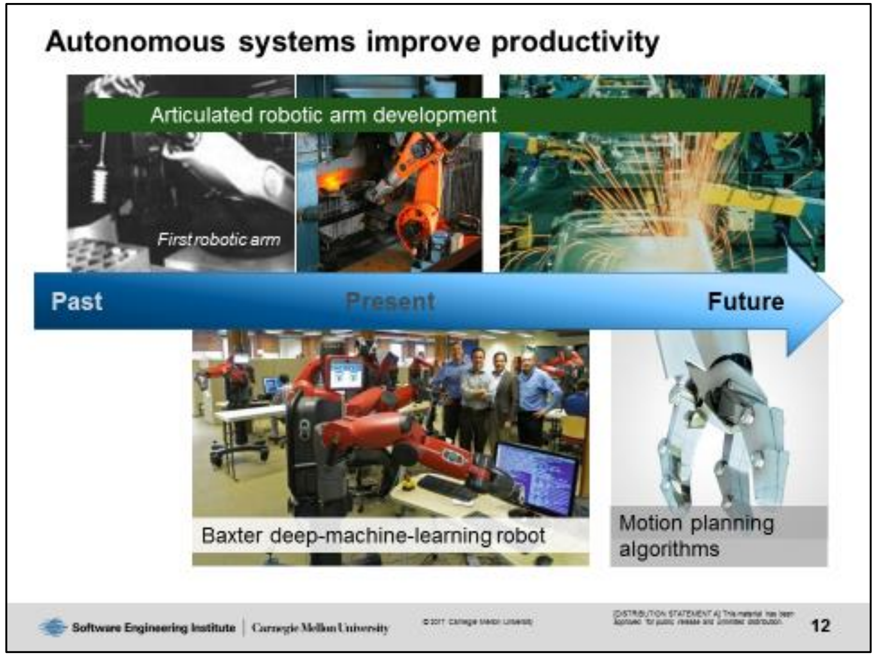
Moving from Technology Research to Production

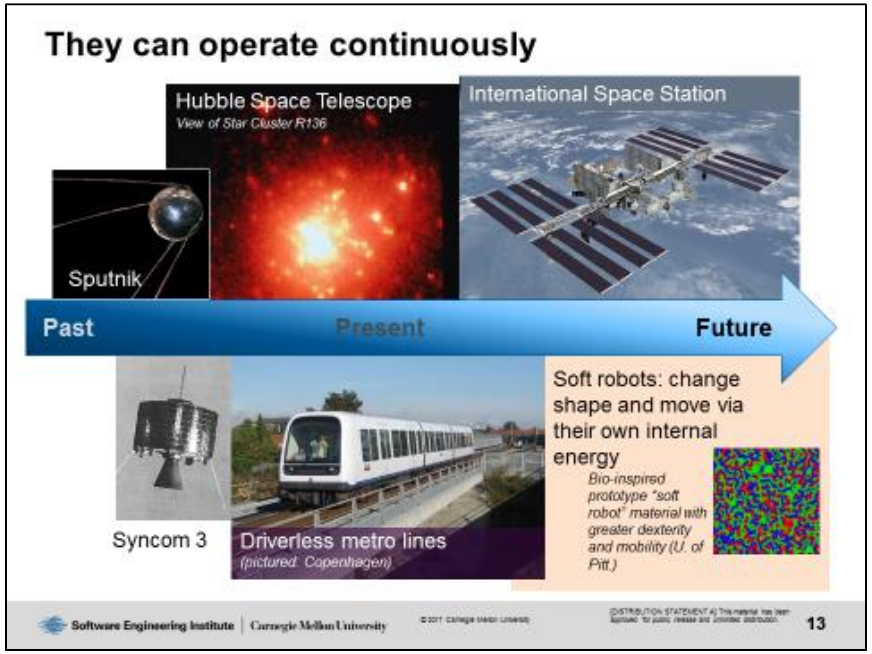
- State of the art has gone well beyond these

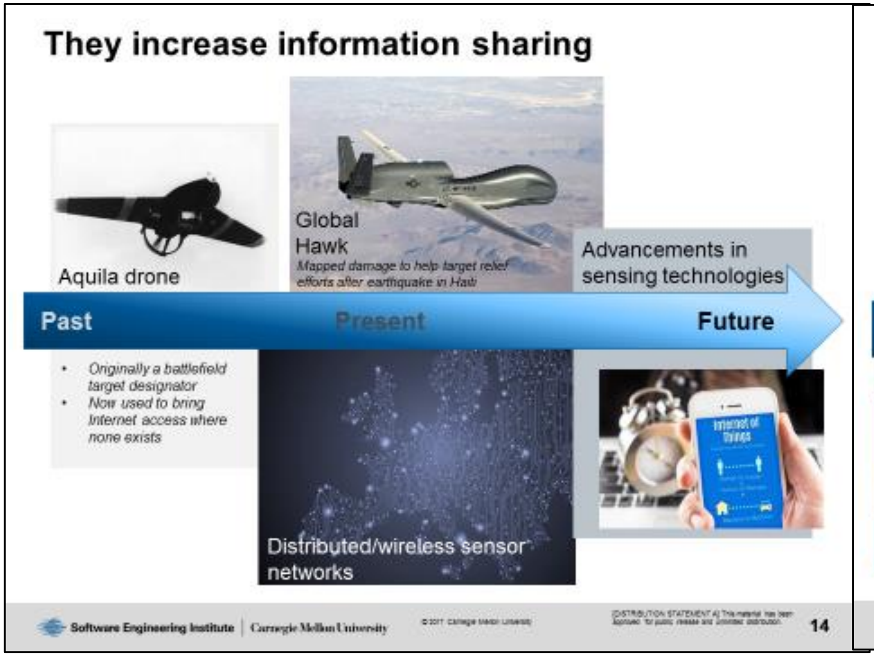
- Tesla example

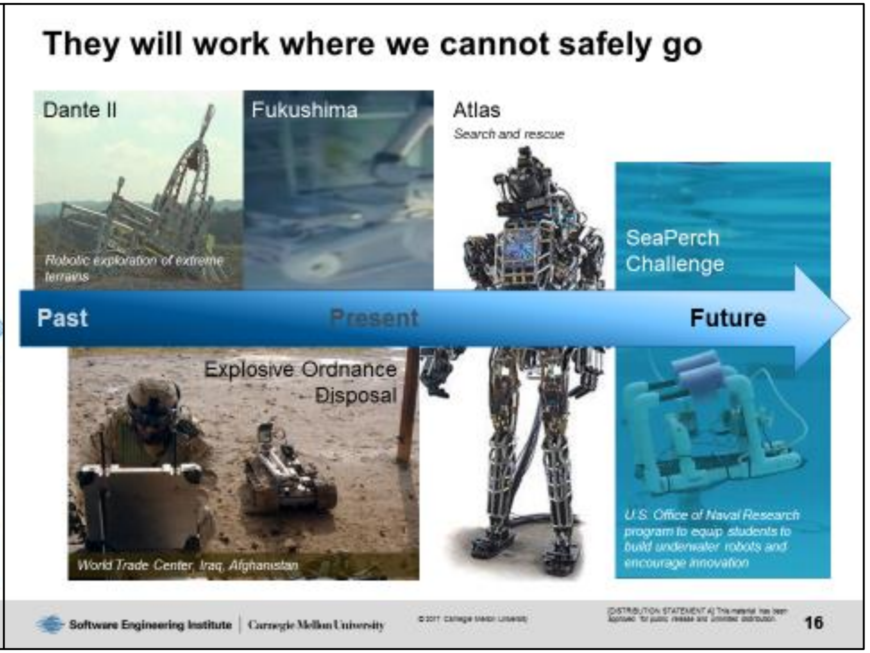
Source: Paul Nielsen, "Systems Engineering and Autonomy: Opportunities and Challenges", Keynote Presentation at INCOSE Symposium, July 2017 – used with permission

Effects of Autonomy









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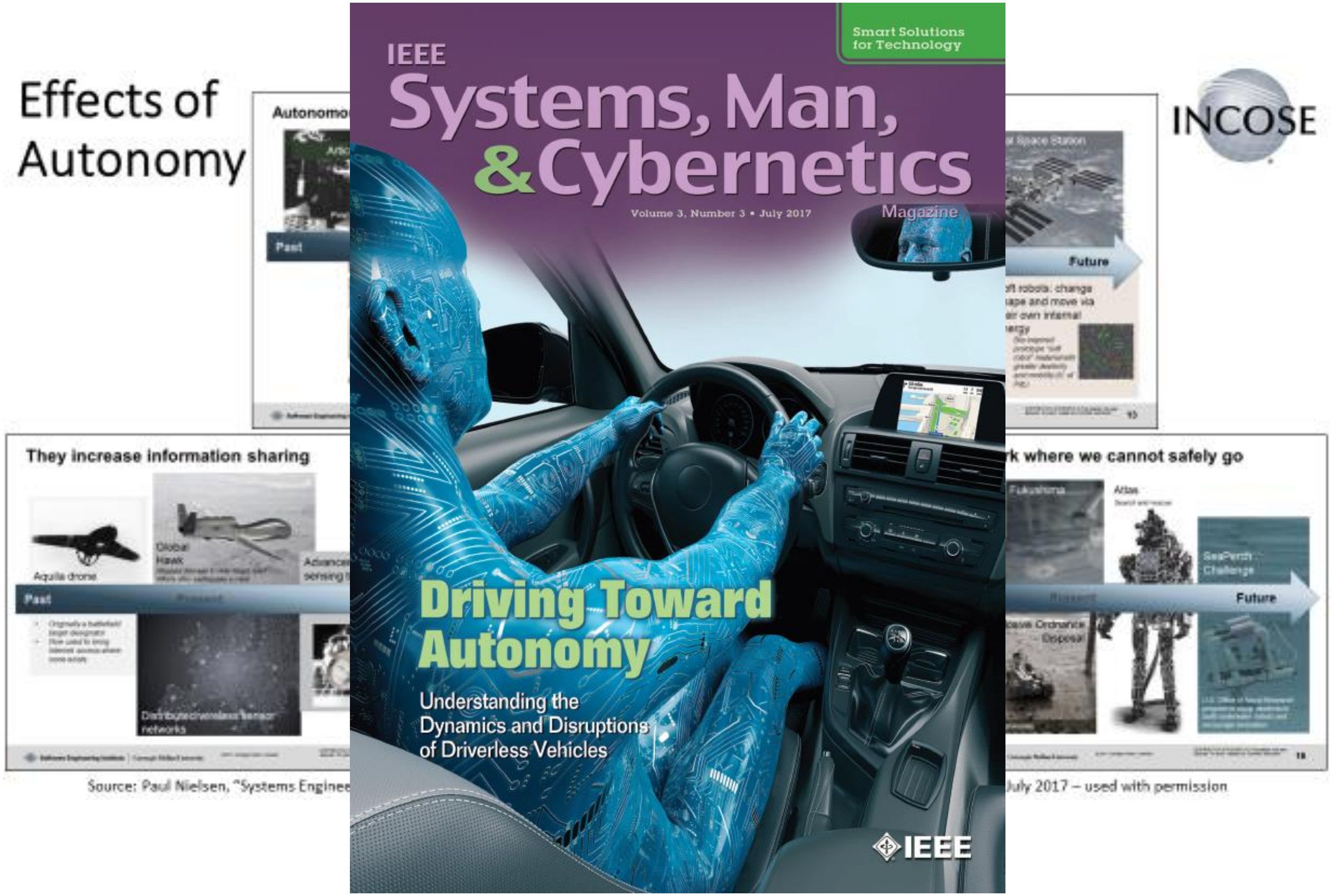
Source: Paul Nielsen, “Systems Engineering and Autonomy: Opportunities and Challenges”, Keynote Presentation at INCOSE Symposium, July 2017 – used with permission

Effects of Autonomy - 2



- However, autonomy creates other issues
  - Emergent behavior
  - Continuous change
  - Human/machine interfaces
  - How to do V&V
  - Trust
  - Attack vulnerabilities
  - Unemployment
  - Unintended changes to other businesses
  - Ethics
  - Issues from new interfaces
  - Information overload

Are we ready to deal with these new issues?

But Do We Know How to Manage AI?

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Disruption certainly. Deep AI is the real risk, though, not automation.

Musk on Automation versus AI

— Elon Musk (@elonmusk) June 9, 2017

Disruption may cause us discomfort, but it's not a threat in and of itself. However, Musk and others do see the potential for deep AI to be world-shattering, at least for humans.

Futurism, June 2017

Computers are going to take over from humans, no question. If we build these devices to take care of everything for us, eventually they'll think faster than us and **they'll get rid of the slow humans to run companies more efficiently**."
(Steve Wozniak)

…perhaps most disturbing, scientists working with Google's DeepMind AI tested whether or not AI are more prone to cooperation or competition — and found that it can go either way …

Futurism, June 2017

The development of full artificial intelligence could **spell the end of the human race**."
(Stephen Hawking)

Another Perspective on AI

- AI building blocks have begun to emerge, but the principles for putting these blocks together have not yet emerged
  - Ad hoc approaches applied
- High-level reasoning and thought remain elusive
  - Not yet "Human-Imitative"
- Major progress in past two decades
  - Complementary aspiration to human-imitative AI => "Intelligence Augmentation" (IA)
  - Computation and data used to create services that augment human intelligence and creativity
- However, we are very far from realizing human-imitative AI
- Other challenges (such as SoS interactions) need to be in the forefront
  - The focus on human-imitative AI may be a distraction

(Michael J. Jordan, Medium, April18, 2018)

Trend: From Stand-Alone to Interconnected to IoT

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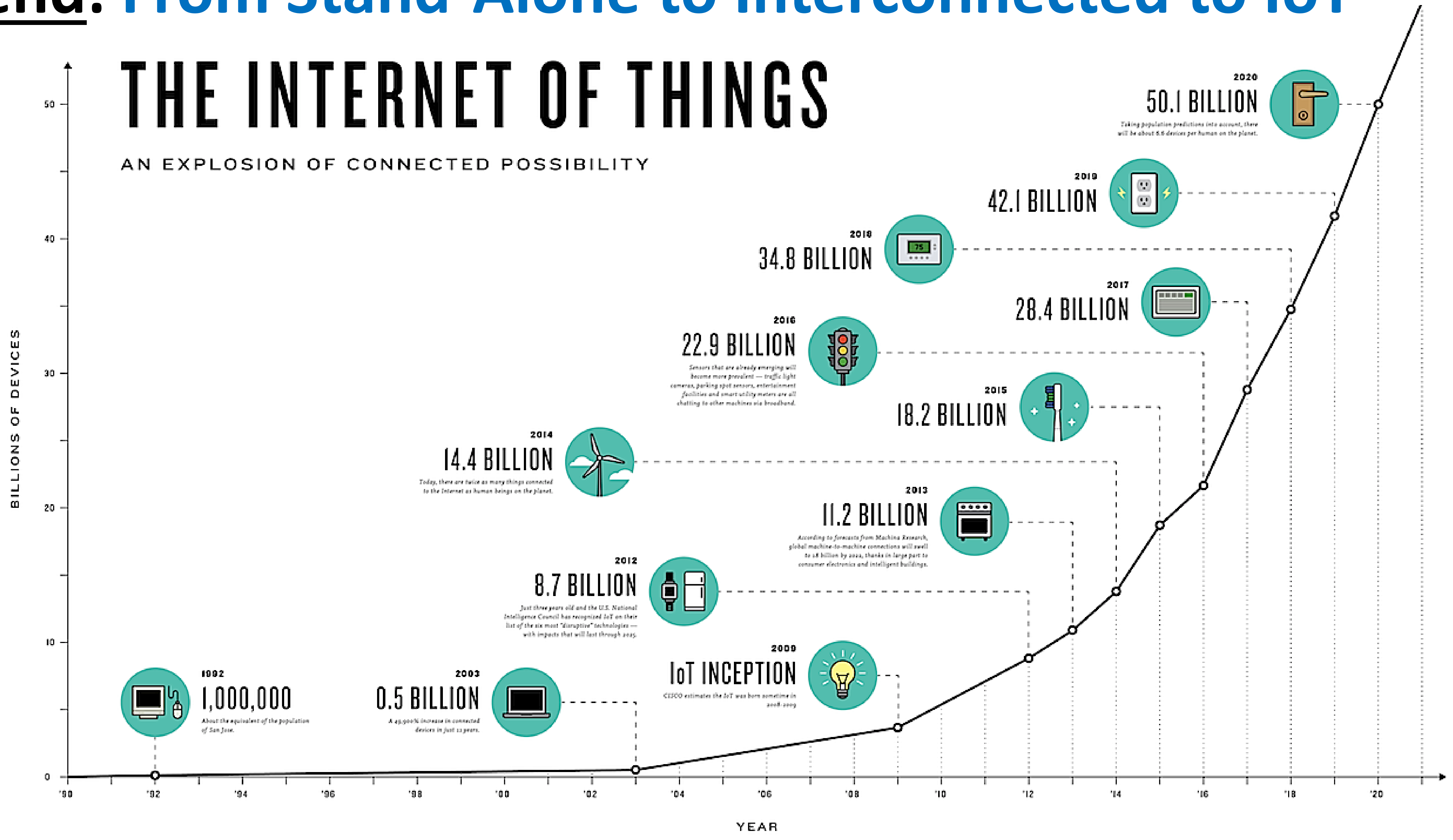

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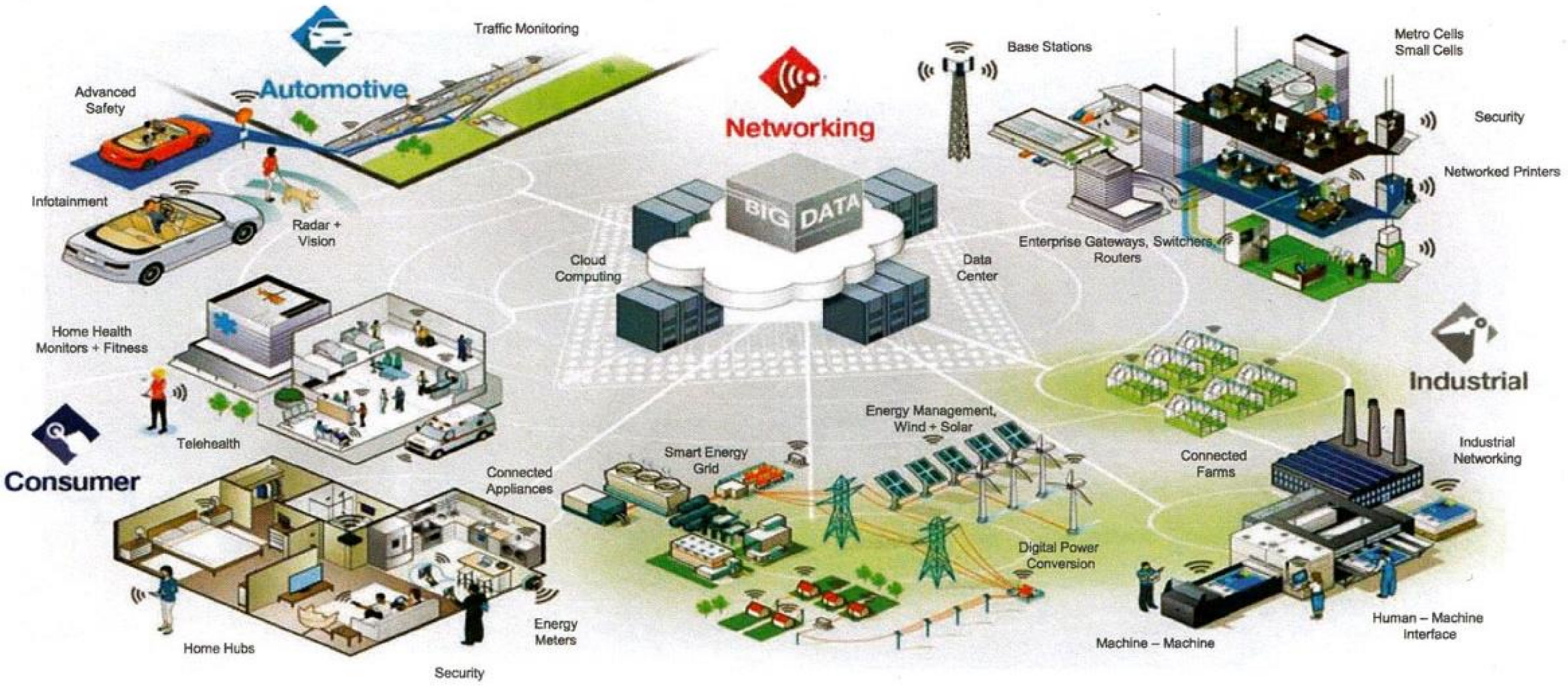
Example: Systems of Systems Connectedness



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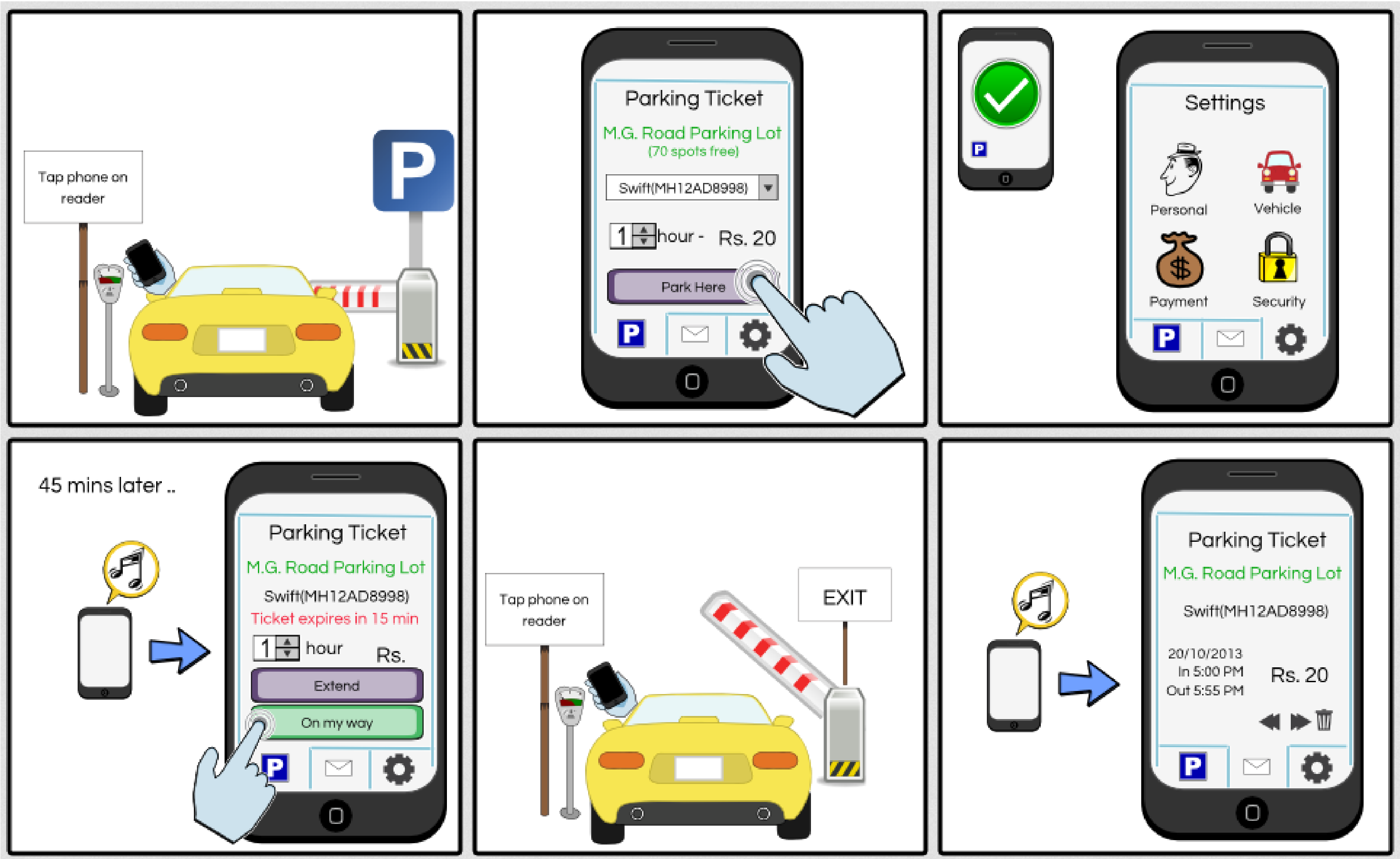
http://www.bing.com/images/search?view=detailV2&ccid=vCGOQ8jR&id=987796C6840D77192F05A43588F4FC57A7C0A123&q=internet+of+things&simid=608039612412199103&selectedIndex=8&ajaxhist=0

Are Parking Meters part of a System of Systems?

Parking Yesterday (System)



Parking Today (System of Systems)

IoT – System of Systems in Our Daily Lives
You Tube Videos on IoT

- Internet of Things: Are Smart Devices Helping or Harming?
  - Rose Barker, Risk Management Consultant and Board President of MERIT
  - 5 April 2018
- How Dangerous are IoT Devices?
  - Yuvol Elovici, Ben Gurion University, Head of the Cyber Security Research Center
  - 9 March 2018

Challenges of Highly Interconnected Systems

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Security

Control of interfaces

Emergent vulnerabilities

Vulnerabilities growing faster than solutions

Data

Privacy – e.g., conflict of surveillance vs civil rights or use of data

Data capture, analysis, and access/exchange issues

Data adequacy and accuracy

Regulations and Standards

Policy lags technology

Who? Spans government jurisdictions – users from any locations

Lack of Standards – enables poor behavior - develop w/o regard to impact

Life Cycle Sustainment

Ability continue to meet evolving expectations and deliver value

V&V for continually evolving set of connected systems – who is responsible?

Who is responsible for sustainment of interconnections and shared functions?

Applies to IoT, Smart Anything, and Other Highly Interconnected Systems

Challenges of SoS

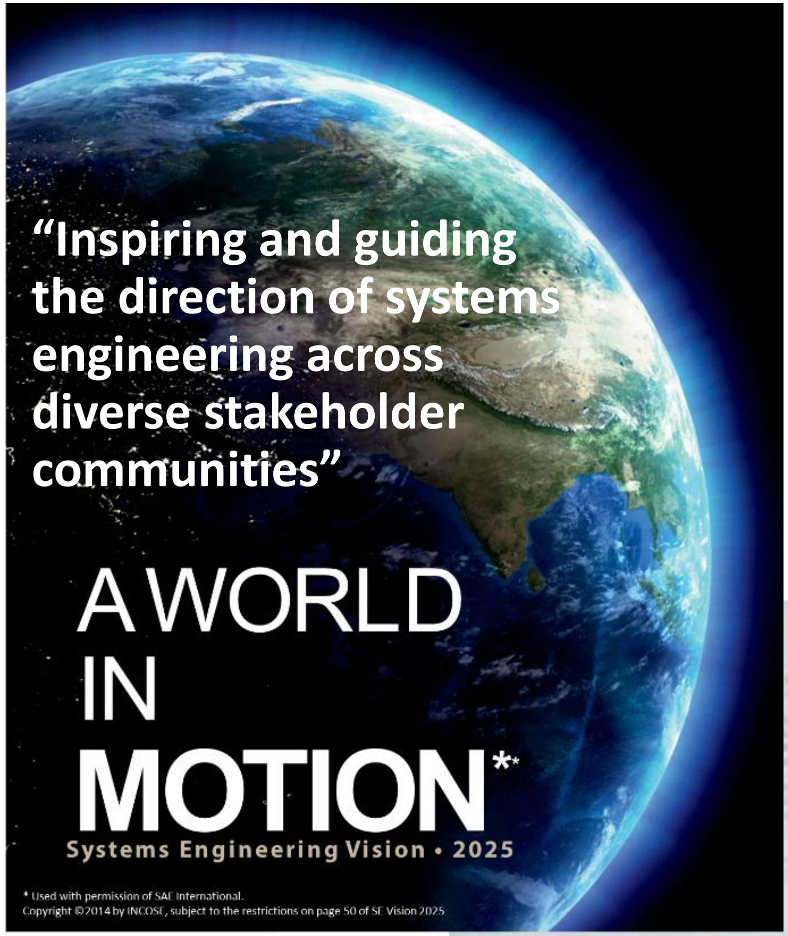
- SoS Governance / Authority
  - Who is in charge? Who makes decisions? Who has financial responsibility?
- Independent versus holistic perspectives
  - Constituent system versus SoS (holistic) trades and decisions
- Impacts from emergence or from other systems
- Security
- SoS requirements
  - Constituent system requirements versus SoS needs – may be a mismatch
  - Impact of new SoS requirements on the Constituent System as a user of the SoS
- Verification and validation of SoS capabilities – who and how?
- Standards are just now evolving

Ambiguity of SoS Design, Dynamics, Sustainability, and Standards/Practices

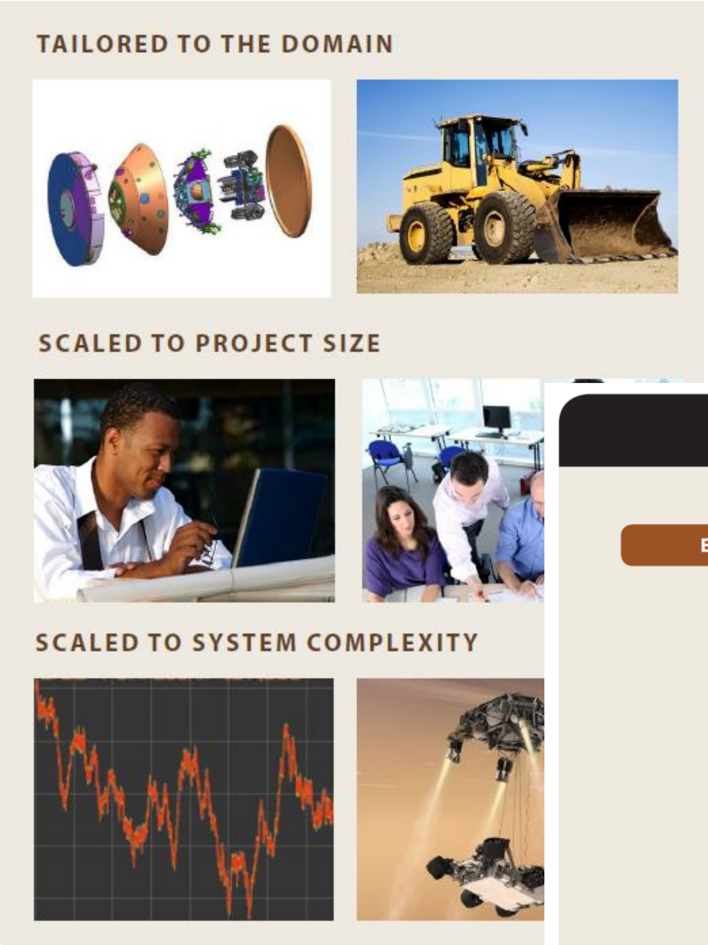
Overview of SE Vision 2025 and the Need for Change

Are we ready for the Future?

SE Vision 2025

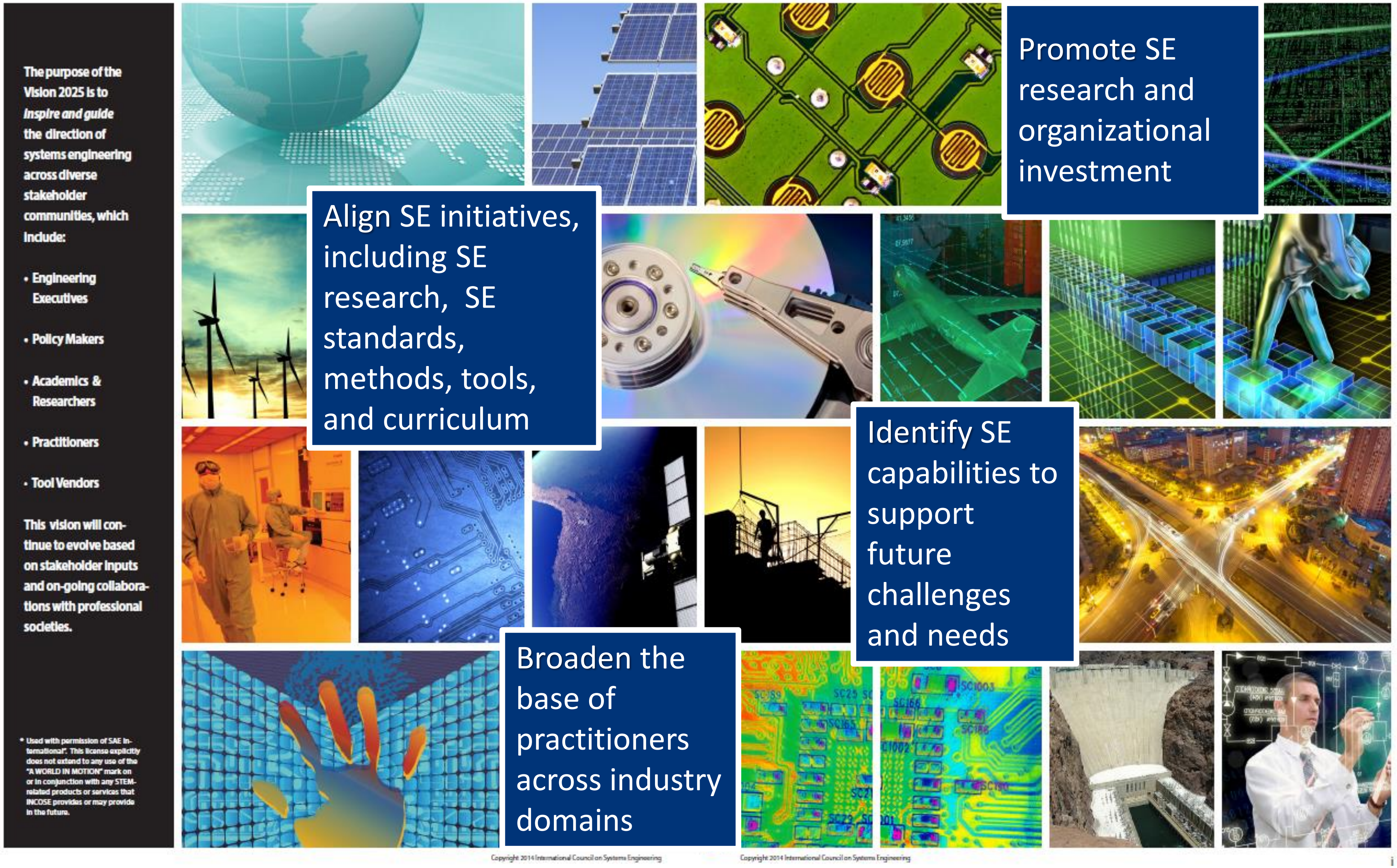


Note: Chapter and Domain versions of the Vision are being developed (e.g., Dutch Chapter and Automotive)



Freely available on INCOSE Store

Vision Objectives



Transforming Systems Engineering (and SoSE)

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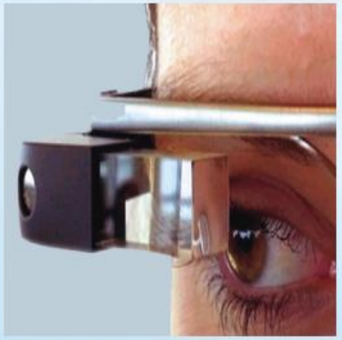
Leveraging Technology for SE Tools

Cloud-based high performance computing supports high fidelity system simulations

Advanced search query, and analytical methods support reasoning about systems

Immersive technologies support data visualization

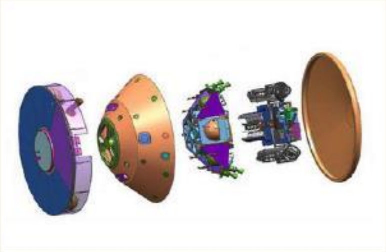


Net-enabled tools support collaboration

Tailoring and Scaling Practices for Best Value

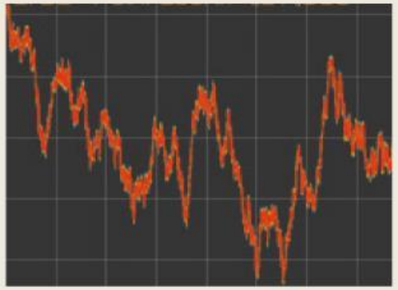
Value Driven Practices for Developing Systems in 2025 and Beyond

TAILORED TO THE DOMAIN



SCALED TO PROJECT SIZE

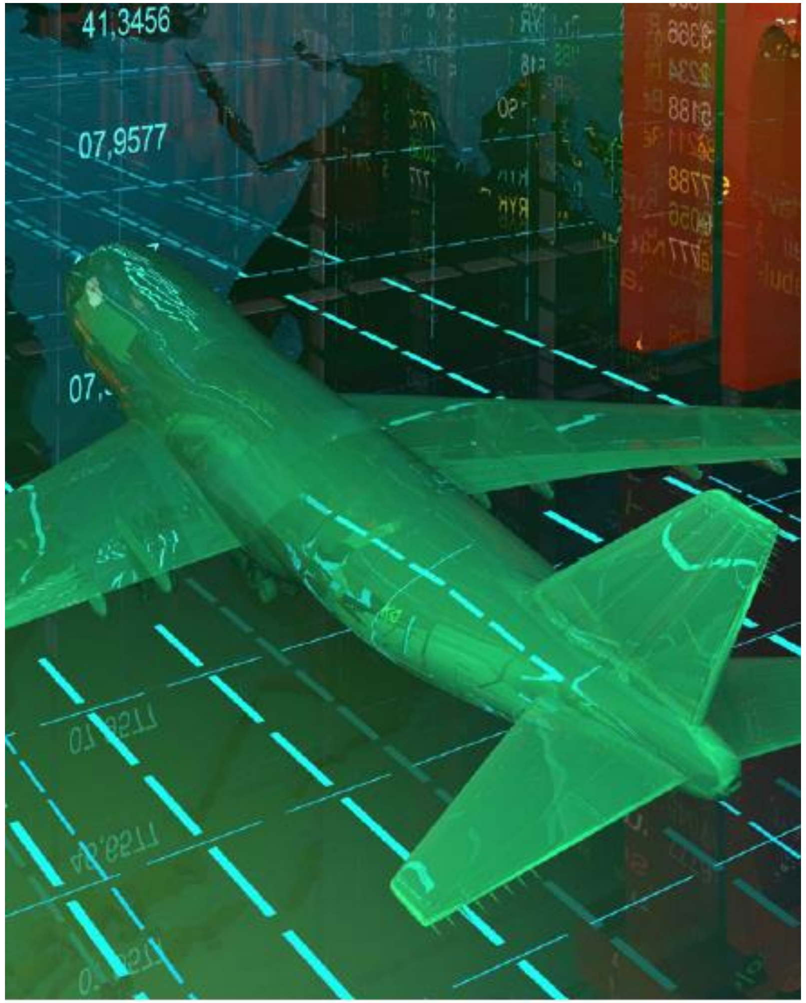
SCALED TO SYSTEM COMPLEXITY



SE Vision 2025. Copyright © 2014 by INCOSE. All rights reserved.

Transforming Practices

- Collaborative Engineering
- *Complex System Understanding*
- *System of Systems Engineering*
- System Architecting for multiple viewpoints
- Composable Design
- Design for Resilience
- Design for Security – system integrity
- Decision Support
- Virtual Engineering and MBSE – part of the digital revolution
- Change of process implementation to address technology & application
- Tailoring and scaling practices for value



What Does SE Look Like in This Environment? (1)

INCOSE

Dynamic, non-deterministic, evolutionary	• Emergent Behavior is common • Capabilities continue to evolve • Learns and adapts to new needs
Cybersecurity and assurance need to be integral, not "bolt-on"	• Integrity, Availability, and Confidentiality (resistance to access)
New approaches to V&V	• Current methods are inadequate for testing systems that learn and adapt • Behavior changes as data and models are changed by system • V&V needed throughout life cycle – especially when state changes

What Does SE Look Like in This Environment? (2)

INCOSE

Ongoing modeling and simulation challenges

- Robust modeling and simulation capabilities are needed, but …
- How is M&S kept current and controlled when system learns and adapts?

Ongoing operational changes

- Less human dependent, changing Rules of Engagement and Concept of Operations
- Changes to training and mission/business parameters

Changes required for a literate workforce

- Much greater man-machine interface, and machine may have the leading role
- Need for skilled personnel at all lifecycle phases
- Adaptable workforce, as roles will change more quickly - get past culture change issues

What Does SE Look Like in This Environment? (3)

INCOSE

Look at all systems as part of an SoS

- SoS considerations are necessary … for all potential SoS interactions
- Most CS will be part of more than one SoS, and it could be many

Technology will continue to influence

- But at potential faster rates …
- "Tech watch" programs are necessary, but not sufficient

Governance may present issues

- Different "ownership" of the interacting systems (System of Systems issue)
- Control of the learning and changing system
- Management of the changing operational areas
- Preventing unintended use or consequences

Challenges of Digital Engineering – An Enabler

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Transform Practice

- Embrace models as primary basis of SE; Culture change
- Meet expectations from traditional approaches
- Implement new or modified standards

Data & Artifacts

- Manage data as an asset; Models rely on valid data
- Provide a consistent set of artifacts that facilitate communication
- Improve tool interoperability and information exchange

Integration

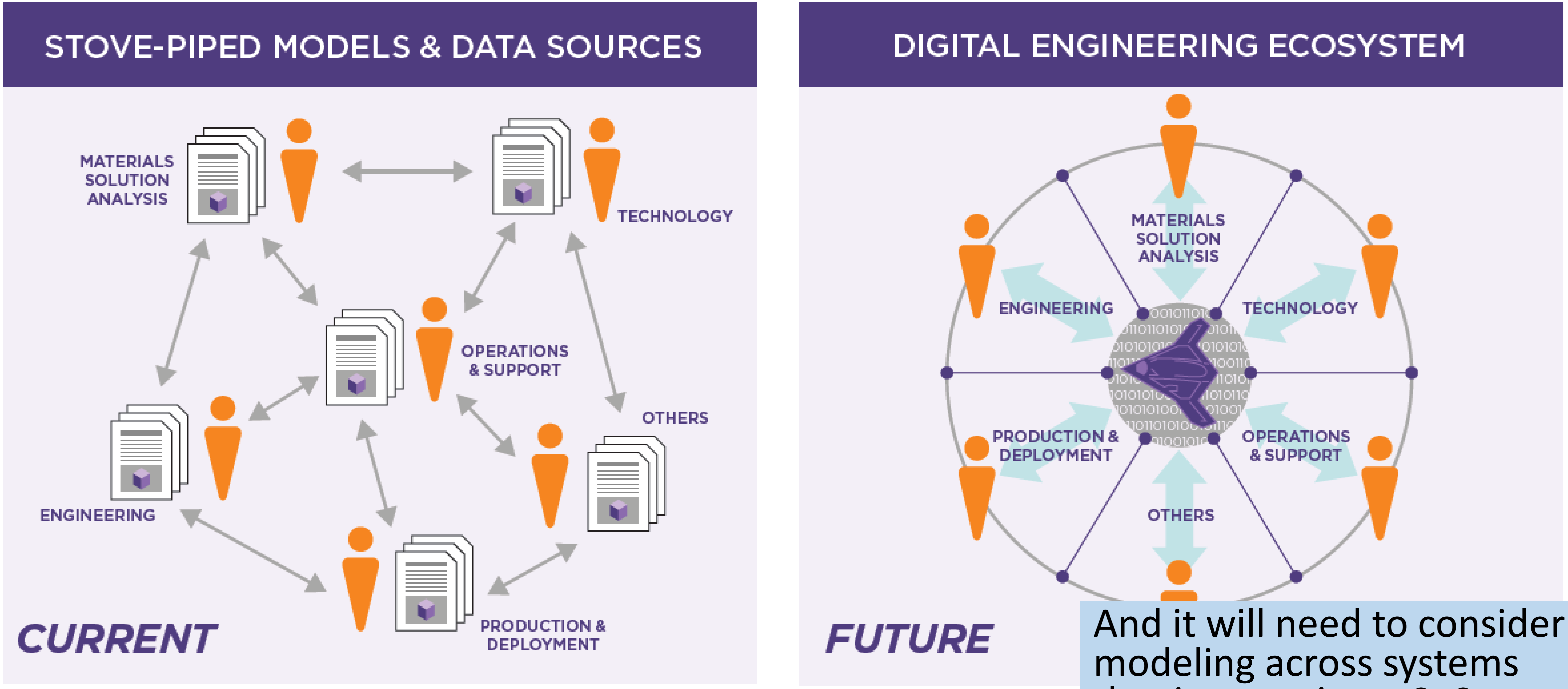
- Integration across models
- Integration across disciplines
- Interactions between systems – application for SoSE

Response to change

- Ability to V&V models as changes are introduced
- Potential changes to stakeholder interactions
- Potential changes to systems from self learning/ adaptation

Trust of models

Evolution of Digital Engineering

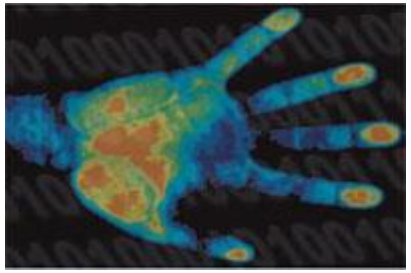


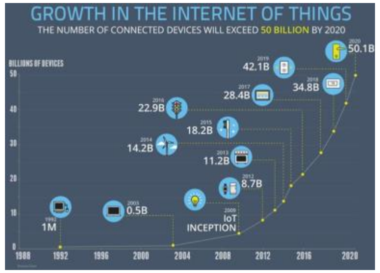
And it will need to consider modeling across systems that interact in an SoS

Source: Evolving Defense Acquisition through Digital Transformation, AIA, 19 September 2018

Evolution is Needed

- Evolve our systems





- Evolve our systems engineering approaches (processes, methods, tools, perspectives, …)

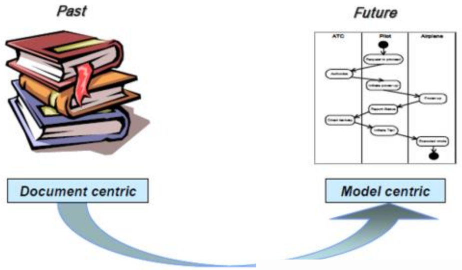
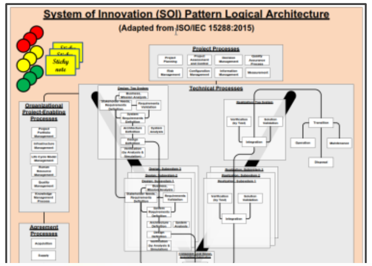
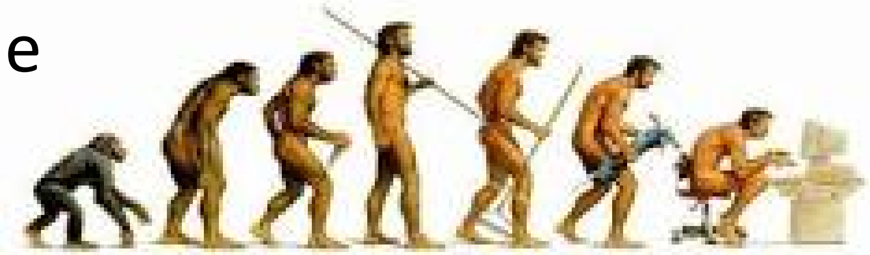


Figure from INCOSE Systems Engineering Vision 202



Deterministic	→	Non-deterministic
Linear		Evolutionary
Predictable		Stochastic

- Evolve our people

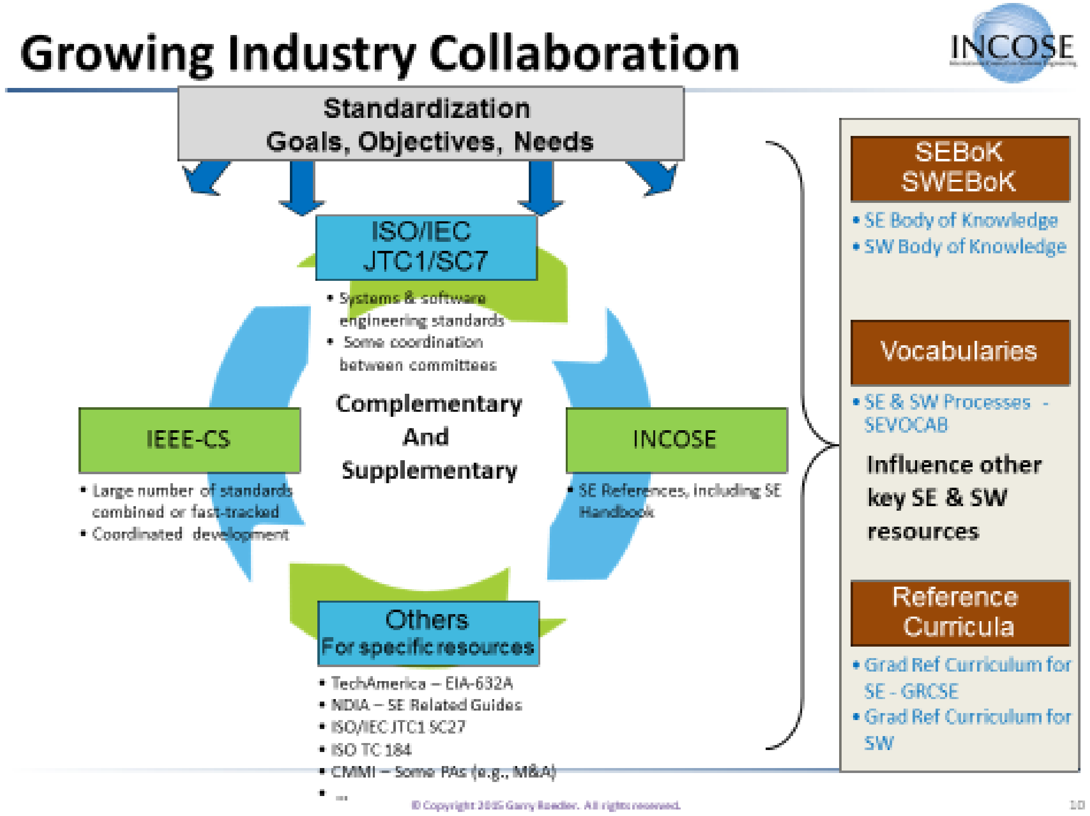

Alphabytesoup.wordpress.com

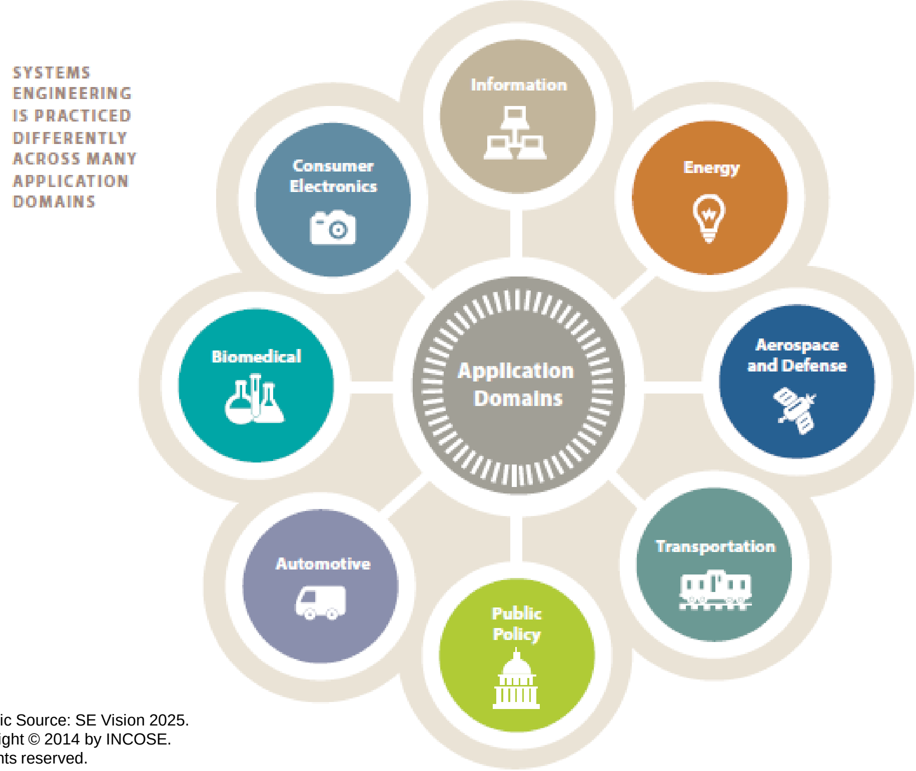
"When the rate of external change exceeds the rate of internal change, the end of your business is in sight." [Jack Welch]

Enabling Action

What INCOSE and Collaborators are doing to make a difference

INCOSE Outreach – Greater Collaboration with industry on targeted objectives



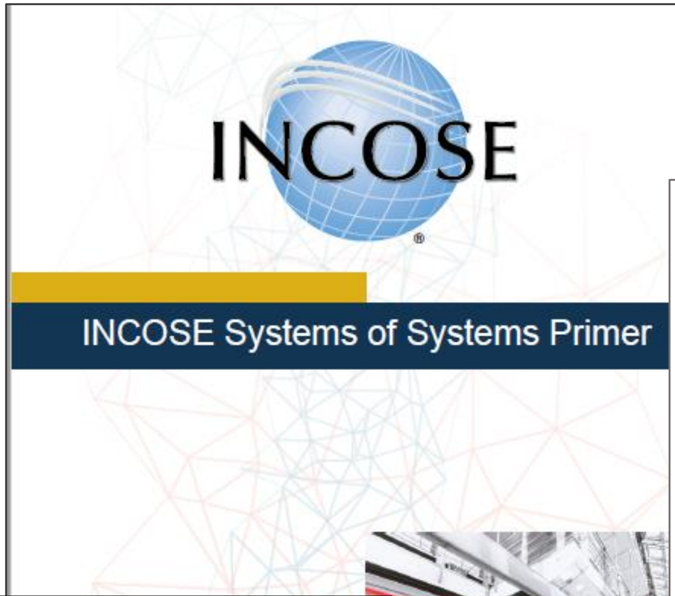


Graphic Source: SE Vision 2025.

- Build/refine an effective outreach strategy and set of alliances
- Focus needs to be on mutual value and clear objectives to be effective

SoS Primer – Launched at IS 2018

- Based on CAB request
- Short – 8 page foldout
- Provide an introduction to systems engineers and others on SoS



Introducing
Systems of Systems

A System of Systems (SoS) is a collection of independent systems, integrated into a larger system that delivers unique capabilities. The independent constituent systems collaborate to produce global behavior that they cannot produce alone. This type of collaboration is powerful, but brings major challenges for systems engineering:

- Because they are independent, constituent systems may make decisions or upgrades without considering the rest of the SoS. Sometimes this unintentionally forces others to make changes too
- Constituent systems may withdraw (possibly without warning) from the SoS if their own goals conflict with SoS goals
- Separate constituent systems are often drawn from different engineering disciplines, and the SoS itself is commonly large-scale and usually highly complex. It's difficult to produce accurate predictive models of all emergent behaviors, and so global SoS performance is difficult to design
- Testing and verifying upgrades to an SoS is difficult and expensive (sometimes prohibitively) due to scale, complexity and constant evolution

Why should I care about SoS?

Many systems engineers (SEs) work in an SoS context at some time during their careers – perhaps without even realizing it. This could be as an SE in a constituent system, or directly working on the SoS functionality itself. SoS contexts are associated with specific challenges, and the existence of the SoS places long-term, evolving requirements on each of the constituents. Without an awareness of the wider SoS context, engineers on separate constituent systems run the risk that their system will struggle to meet operational requirements in the long term, even if it currently meet its immediate requirements.

SoS span socio-technical contexts and enterprises as well as technology. Developing an SoS approach to problem-solving involves taking a step back, identifying critical players and understanding their motivations, looking at how they interact and then considering options in this light. This includes looking at technology challenges as well as organizational or socio-technical challenges across the SoS. Developing this awareness of the SoS context can help SEs working on separate constituent systems to identify potential sources of change earlier and plan more effectively for emerging long-term requirements.

How do I know if I'm in an SoS?

One widely-used definition proposed by Mark Maier in 1998 defines an SoS as follows:

- The constituent parts are operationally and managerially independent (i.e., they can make decisions about their future and are capable of leaving the SoS if they wish)
- The systems in the SoS are distributed
- The SoS evolves continually over time
- The SoS exhibits emergent behaviour. "Emergent behaviour" is the global behaviour produced by interactions of the constituents which cannot be reproduced by constituents acting alone.

Example SoS: emergency response

An emergency response service responds to life-threatening situations. The optimal response to a situation may require any combination of fire crews, ambulances, police, mountain rescue, coast guard, etc. Each of these services is autonomous, with its own budget, structure, leadership, processes and systems, but none can implement the necessary comprehensive response acting alone. For example, paramedics rely on police to secure the area, and on fire crews to open up dangerous buildings or damaged vehicles. In return, police and fire crews rely on paramedics to treat and transport casualties. Together the services establish enablers such as shared protocols to facilitate joint operations without compromising their autonomous decision-making.

INCOSE's Vision 2025

INCOSE has identified system design in an SoS context as one of the key transformations we must achieve to respond to changing global contexts. Transformative technologies such as Internet of Things (IoT) and autonomous systems mean more future systems will be SoS, composed of independent stakeholders, and delivering emergent behavior that is difficult to design and predict. INCOSE's "Vision 2020" argues that SoS engineering techniques must be improved and widely adopted to deliver interoperability, predictable emergent behaviors, high performance and quality of service. This will require continuous verification and methods for managing the integration of systems in a dynamic context with limited control.

INCOSE System of Systems Primer

1:42
INCOSE - Systems of Systems Primer
INCOSE YouTube
YouTube - Jun 20, 2018

- *Introduction*
- *Why should I care?*
- *Relationship to SE Vision*
- *Comparing Systems with SoS*
- *SoS Types*
- *SoS Pain Points*
- *Core Elements of SoSE*
- *Further Reading*
- *Key Points to Remember*
- *SoS Considerations for SE*

SE and SoSE Standards

INCOSE

Number	Title
ISO/IEC/IEEE 15288:2015	*System life cycle processes*
IEEE 15288.1: 2014	*Application of Systems Engineering on Defense Programs*
IEEE 15288.2: 2014	*Technical Reviews and Audits on Defense Programs*
ISO/IEC/IEEE 21839	*System of Systems (SoS) Considerations in Life Cycle Stages of a System (published 7/23/19)*
ISO/IEC/IEEE 21840	*Guidelines for the utilization of ISO/IEC/IEEE 15288 in the context of System of Systems (SoS) Engineering*
ISO/IEC/IEEE 21841	*Taxonomies of Systems of Systems (published 7/23/19)*

Purpose of ISO/IEC/IEEE 21839

System of Systems (SoS) Considerations in Life Cycle Stages of a System

- Provides a set of critical considerations for the SOI to be addressed at key points in the life cycle of systems created by humans.
- Refers to a constituent system that will interact in a system of systems as the system of interest (SOI).
- Considerations are aligned with ISO/IEC/IEEE 15288 and the ISO/IEC/IEEE 24748 framework for system life cycle stages and associated terminology.
- Selected subsets of these considerations may be applied throughout the life of systems.
- Published 7/23/19

- Editor: Dr. Judith Dahmann (US)
- Co-editor: Garry Roedler (US)

Purpose of ISO/IEC/IEEE 21840

Guidelines for the utilization of ISO/IEC/IEEE 15288 in the context of System of Systems (SoS) Engineering

- Addresses systems of systems (SoS) considerations that apply to the set of systems at key stages in the life cycle of systems.
- Describes the systems of systems considerations when developing an SoS.

- It does not
  - Detail the approach to addressing systems of systems considerations in terms of methods or procedures.
  - Detail the described documentation in terms of name, format, explicit content, and recording media of documentation.

- Editor: Dr. Mike Yokell (US)
- Co-editor: Dr. Alejandro Salado (US)

Purpose of ISO/IEC/IEEE 21841

Taxonomies of Systems of Systems

- The purpose of this standard is to define normalized taxonomies for systems of systems (SoS) to facilitate communications among stakeholders.
- It also briefly explains what a taxonomy is and how it applies to the SoS to aid in understanding and communication.
- Published 7/23/19

- Editor: Dr. Mike Yokell (US)
- Co-editor: Dr. François Coallier (Canada)

INCOSE SoS Working Group Research Roundtable

International Workshop 2018

- Bridging the Performance Gap: Model-Based SoS Engineering and the Learning Digital Twin
- Agent-based simulation framework and decentralized planning algorithm for opportunistic coalition formation in Earth observing systems of systems
- Mission Engineering Competencies
- A Cyber-Physical Systems Approach to Optimizing Internet of Vehicles Architecture with Rapidly Evolving Technology
  - Complex System Governance Research: Advancing System of Systems Engineering
- SoS Analytic Workbench – Reflections on a Successful SERC Project and Directions for Future Projects
- SoS Solutions in Driverless Vehicles
- Lessons Learned from Engineering Emergence Research

Research Priorities on SoS

INCOSE

Transatlantic AREA-SOS Research Agenda

Table 1: Priority research themes

Rank	Research Area
1.	Engineering for emergence
2.	Architecture patterns for SoS
3.	Multi-heterogeneous modelling and multi-notation approaches
4.	Enterprise SoS, governance and policy
5.	Trade-off techniques for integration of legacy and managing evolution
6.	Metric identification/validation
7.	How to prototype SoS?
8.	Scenario-based simulation and analysis
9.	Dynamic SoS
10.	Security of SoS implementation
11.	Capabilities, processes and competencies
12.	Techniques for validation of interoperability
13.	Qualification of safety or security critical SoS
14.	Multi-level infrastructure consistency
15.	Technological issues
16.	Economic effects
17.	Political and social user acceptance and legal: mixing criticality – security ar
18.	Need for case studies and identification of commonalities across case studies
19.	Identify and build the constituency and stakeholders in a SoS

My Personal Priorities

- SoS Analysis (including trade-offs)
  - Need to accelerate
  - Current research by SERC and others – SoS Workbench – SoS Modeling and Analysis
- SoS Emergence and Dynamics - highly interconnected systems with dynamic changes
- SoS Architecture
- SoS Governance and Policy
- SoS Cybersecurity, Cyber Resilience, and Security Engineering

Charter

INCOSE FuSE
Future of Systems Engineering

Purpose: Evolve the practice, instruction and perception of SE to:

1) Position SE to leverage new technologies
2) Enhance SE's ability to solve the emerging challenges
3) Promote SE as essential for achieving success and delivering value

Goal: Create a road map that drives the evolution of SE to:

1) be increasingly *adaptable, evolvable and fit for purpose*
2) account for human abilities, needs and their interactions with a system
3) be more responsive in resolving increasingly challenging societal needs
4) *realize and enhance INCOSE SE Vision 2025* and other visionary inputs

Scope: Identify the needs, priorities and means for transforming SE including:

1) underlying foundations, systems theory and principles
2) people, methods, tools, processes, education and training
3) the future social and ethical duties, contributions, and responsibilities of future systems engineers

Collaborating Organizations

INCOSE International Council on Systems Engineering
IEEE Advancing Technology for Humanity
ITEA
APL Johns Hopkins Applied Physics Laboratory
ISSS
NDIA National Defense Industrial Association
SAE International
Software Engineering Institute Carnegie Mellon University
Systems Engineering Research Center
MORS
Department of Defense United States of America

Initiative Lead and Primary POC
Bill Miller
(wdmiller220@gmail.com)

FuSE Way Forward

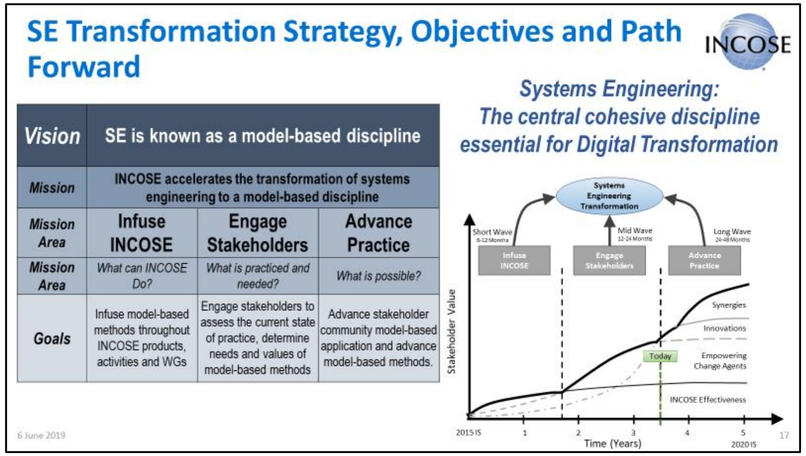
INCOSE FuSE
Future of Systems Engineering

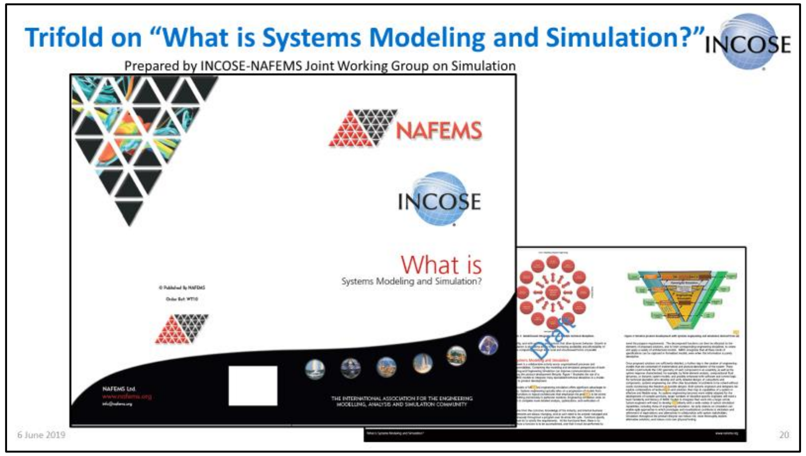
- Get involved!
  - Public facing website
  - Collaboration portal & Wiki
  - Mini-workshops with other events
- Priority projects
  - SE4AI and AI4SE
  - SE Foundations
  - Horizon Scanning
  - Characterizing SE Impact
  - Complexity
  - Agility
  - Cybersecurity
  - Adaptive Systems
- Intended Outcomes
  - Realization of SE Vision 2025 aligned with goals of FuSE
  - Shape the evolution of SE using FuSE Roadmap

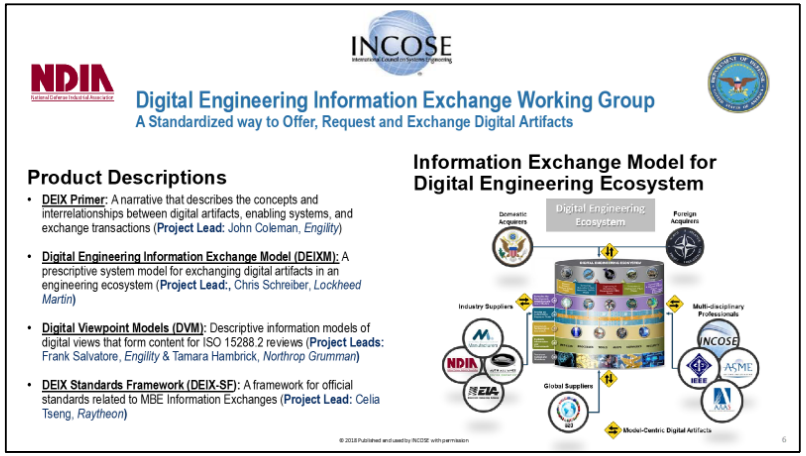
Contact us at:
fuse@incose.org

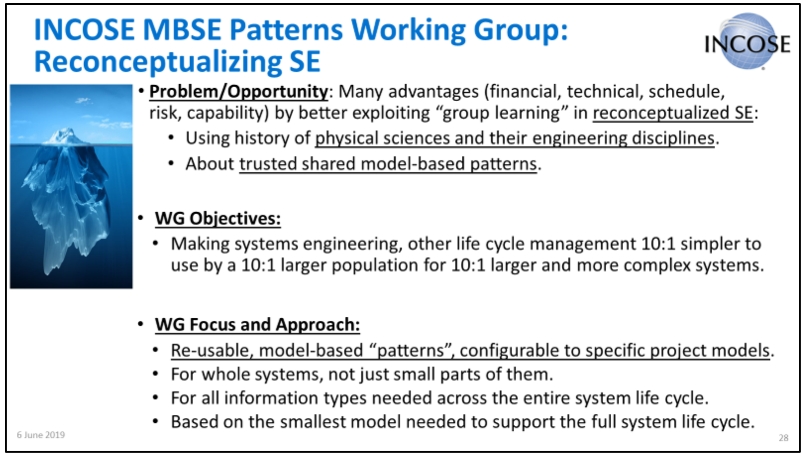
Participate in the collaboration to welcome the future!

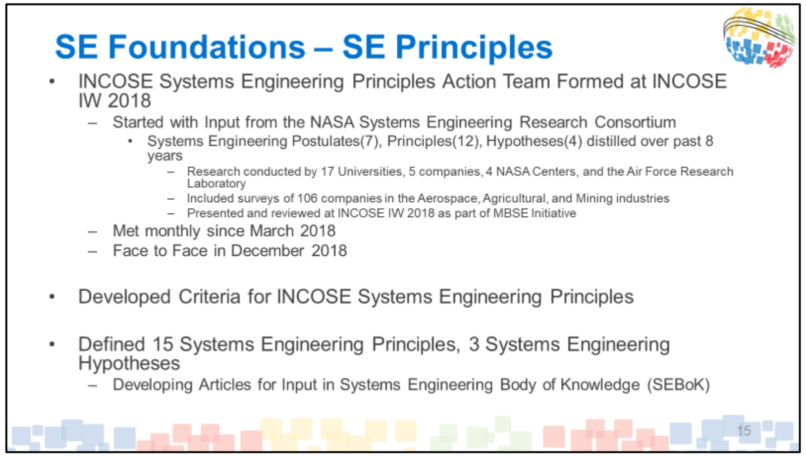
Future Focus in INCOSE

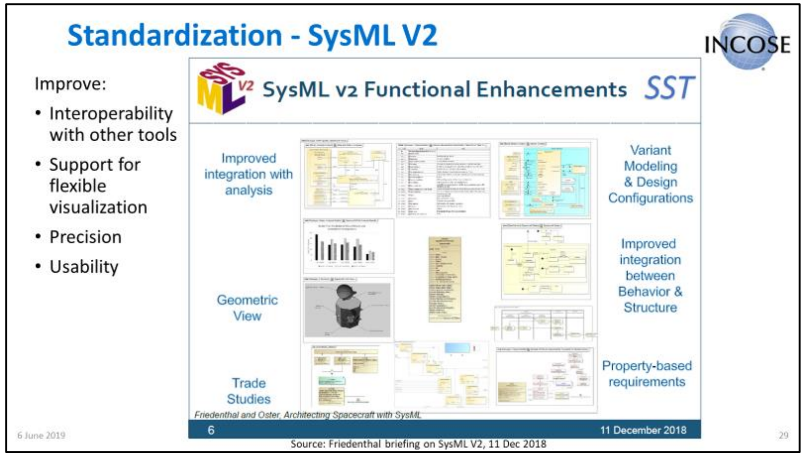


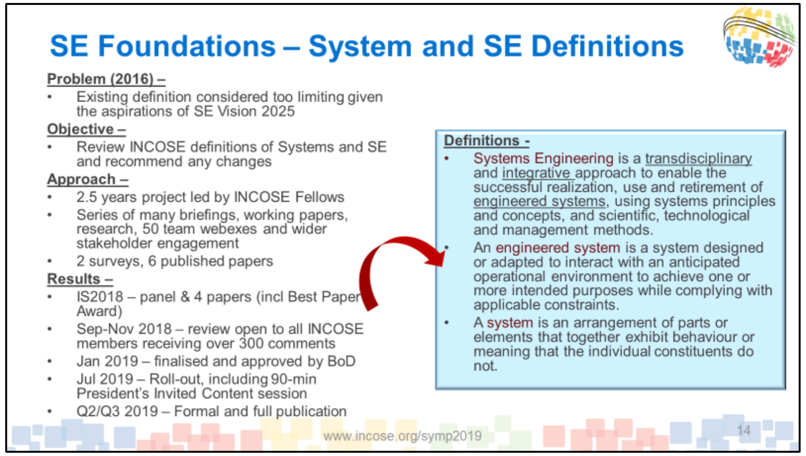






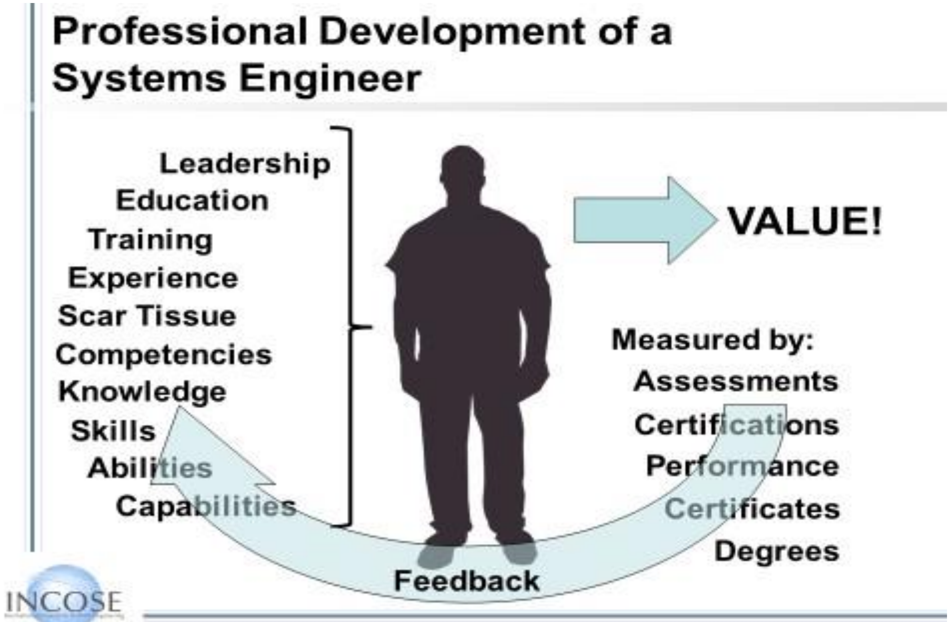






And many others projects and initiatives …

INCOSE Focus on Professional Development and Competency



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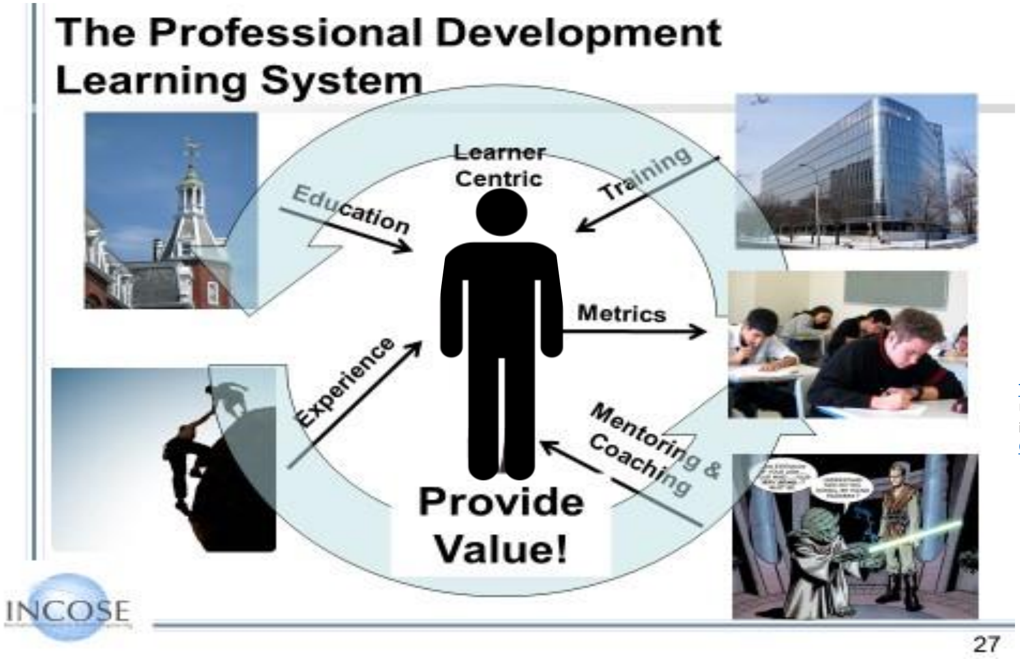


GRCSE® BKCASE

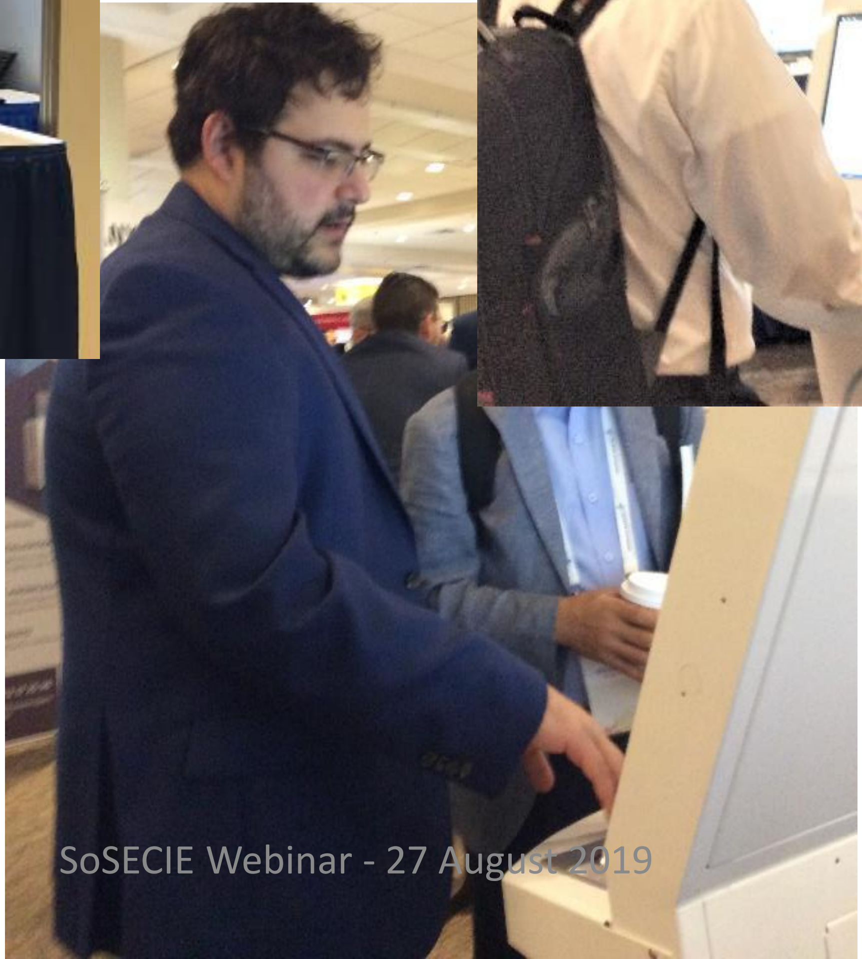
Graduate Reference Curriculum for Systems Engineering

Includes:

- Understand the characteristics of Systems Engineers
- Evolving the existing INCOSE SE Competency Framework
- Ensure the right enablers are in place
- Take a holistic approach to Professional Development
- Work collaboratively with others to get wide community consensus

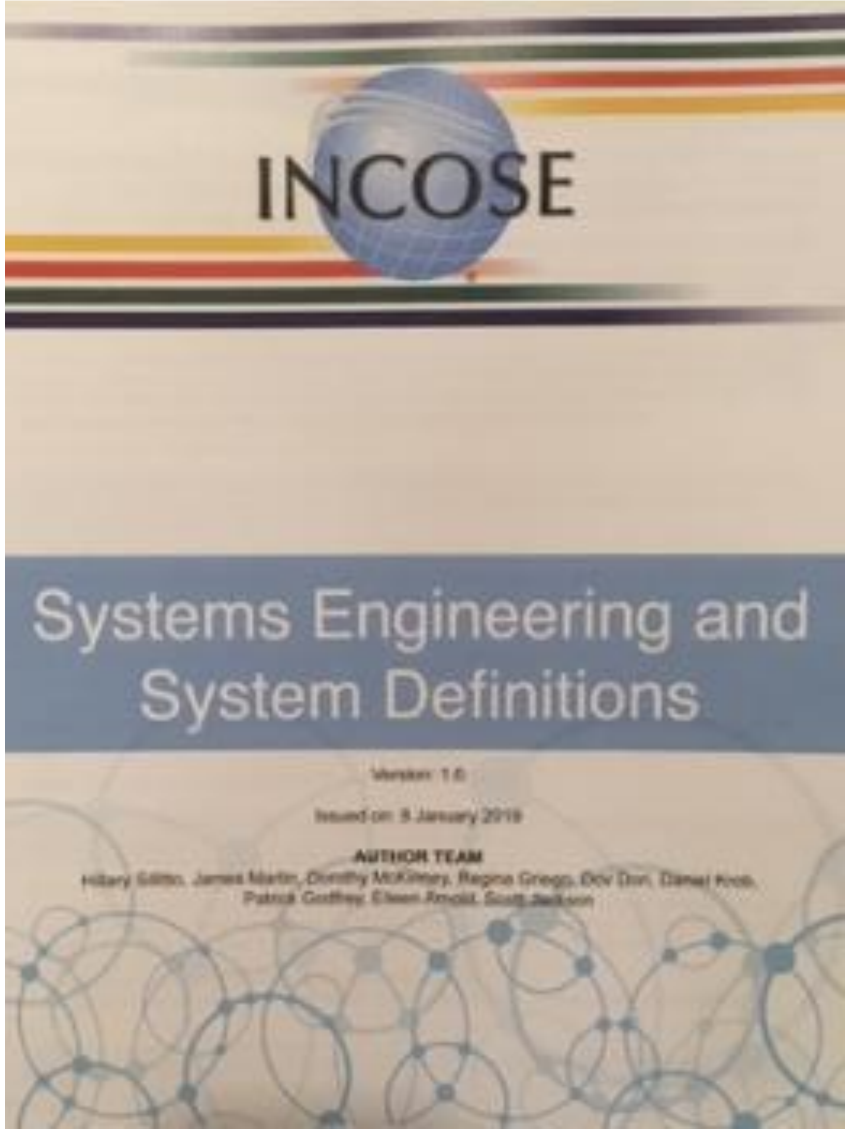
Notional Vision - Professional Development Portal

Professional Development Portal Demo



- 2 kiosks
- 6 Laptops
- 444 Visitor Sessions
- Average Duration > 13 min.

Just Released!



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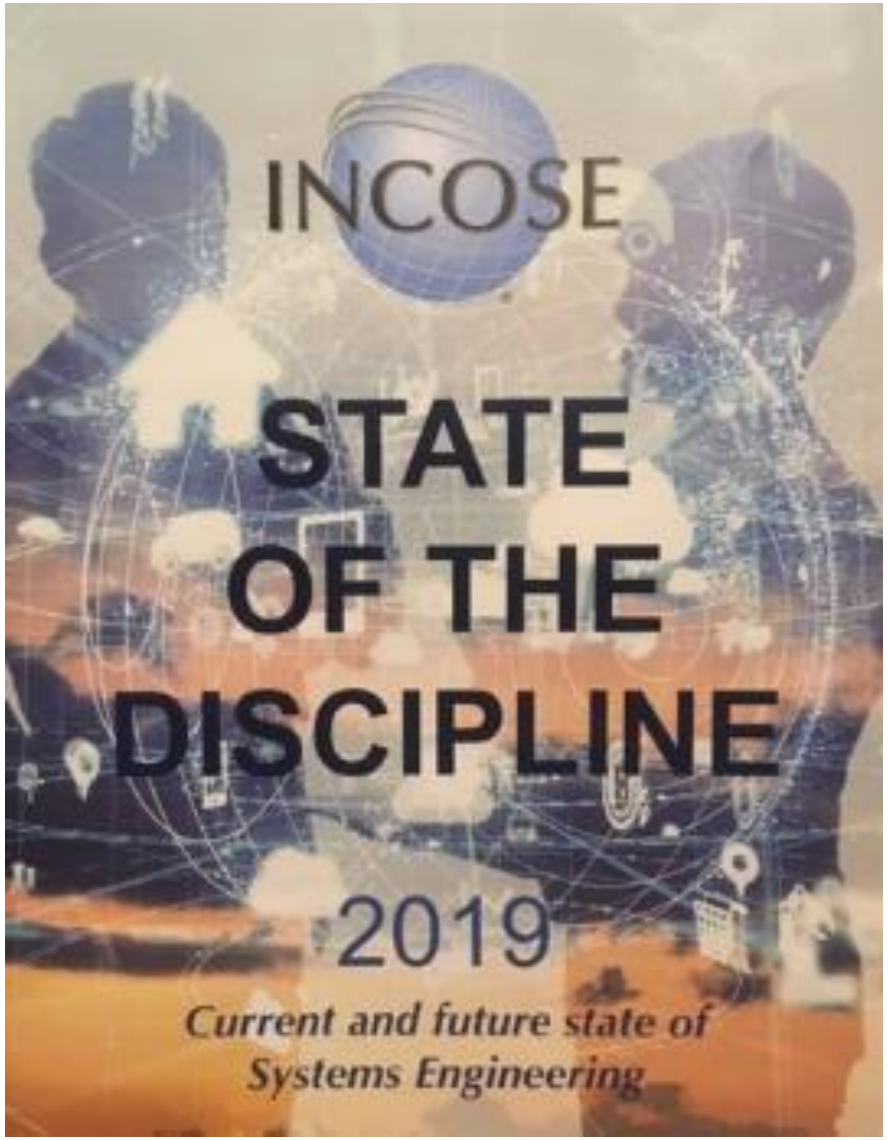

Thank you!

For More Information or To Share Ideas contact:

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Questions?

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INCOSE International Council on Systems Engineering