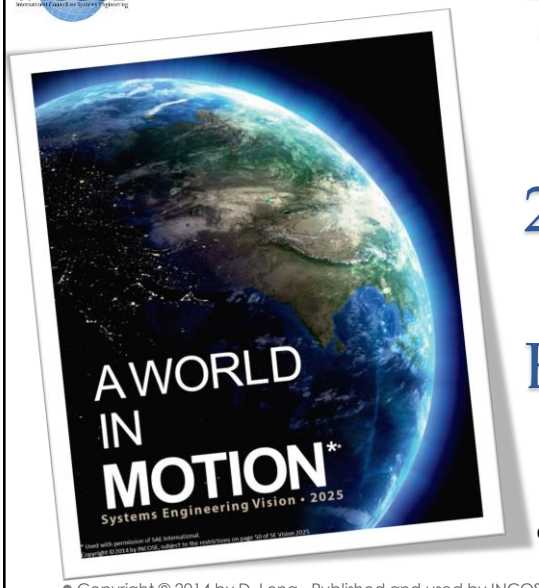
Building for Tomorrow: Towards 21st Century Systems Engineering



David Long
INCOSE President
david.long@incose.org

"The Good Ol' Days"

"The Good Ol' Days"

Document-centric
Top-down
Aerospace
Defense
Long-Lived
Stable
Electromechanical
Green-Field
Stand-alone

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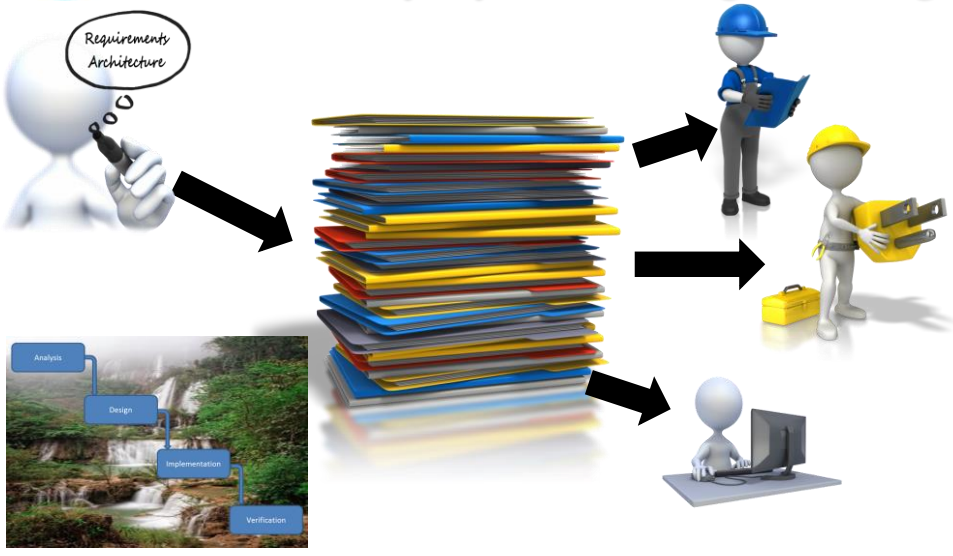
20th Century Systems Engineering



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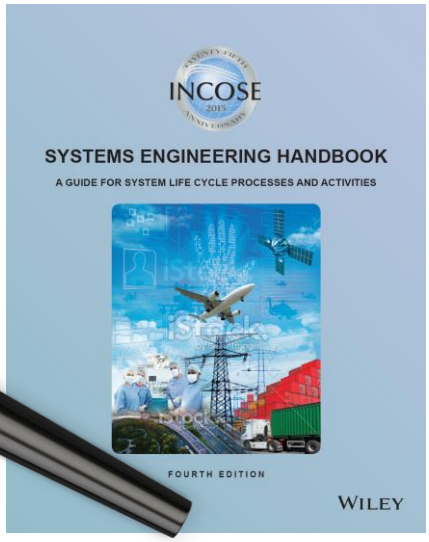
Recognizing a Solid Foundation



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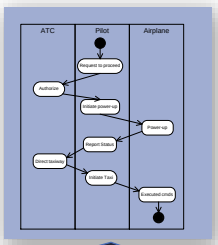
21st Century Systems Engineering: A Practice in Transition

Traditional

- Specifications
- Interface requirements
- System design
- Analysis & Trade-off
- Test plans

Future



Moving from document-centric to model-centric

Reprinted from INCOSE Model-Based Systems Engineering Workshop, February 2010

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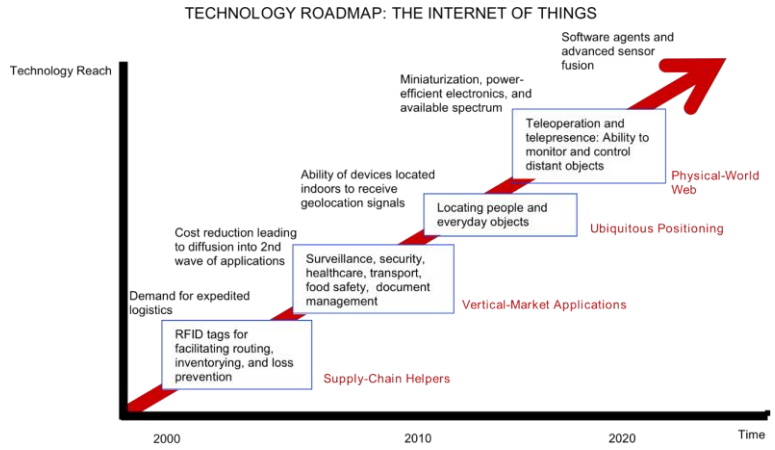
From Aerospace & Defence to Broader Recognition

- From
  - Complex expensive programs
  - Long timescales
- To
  - Variety of systems, including consumer/mass market
  - Disparate scales and lifespans
  - Adaptation
  - Diversification
  - Sharing good practice
  - Increasing product focus
  - Requiring clear value proposition
- But
  - Often practiced under "another name"

From Electromechanical to Software-Intensive to Cyber-Physical

From Stand-Alone to Interconnected to IoT



Source: SRI Consulting Business Intelligence

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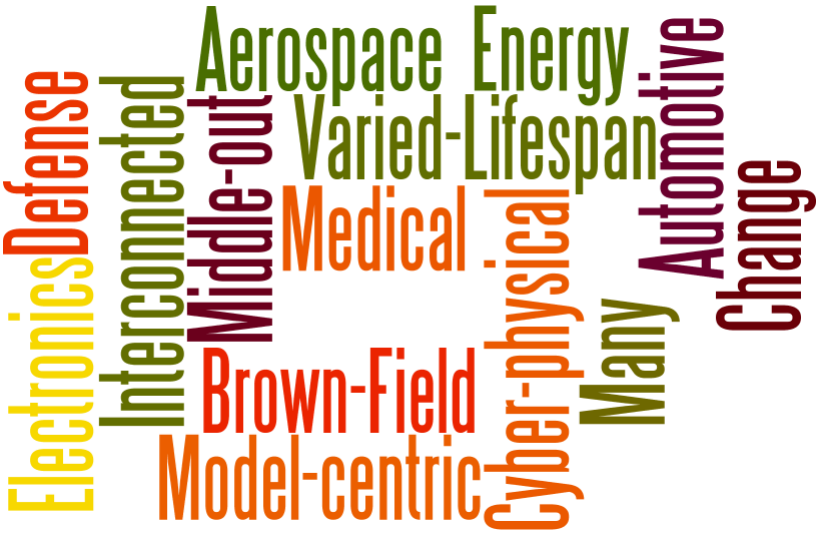
Aspects of the New Reality



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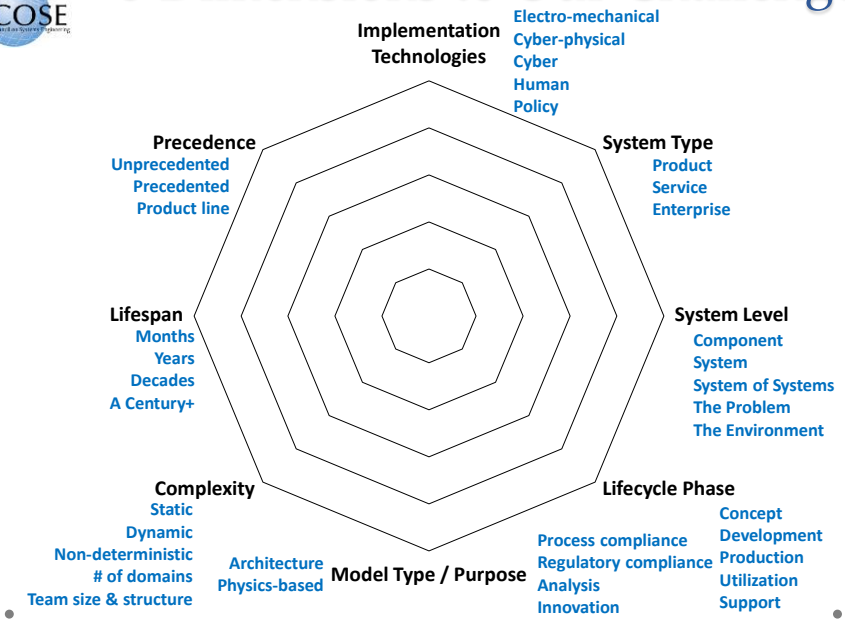
Resetting the Problem: A Systems Practice in Transition

Understanding Current SE Practices and Challenges

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".

8 Dimensions to Our Challenge



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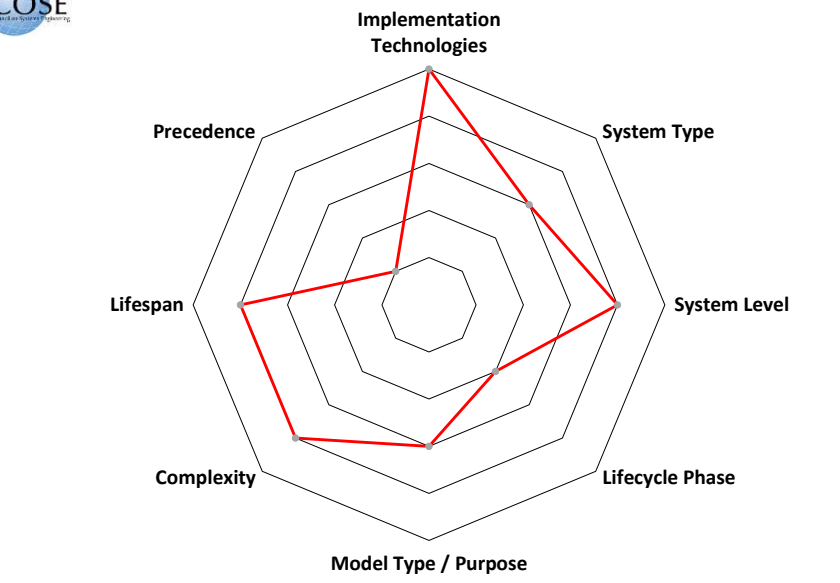
8 Dimensions in Practice



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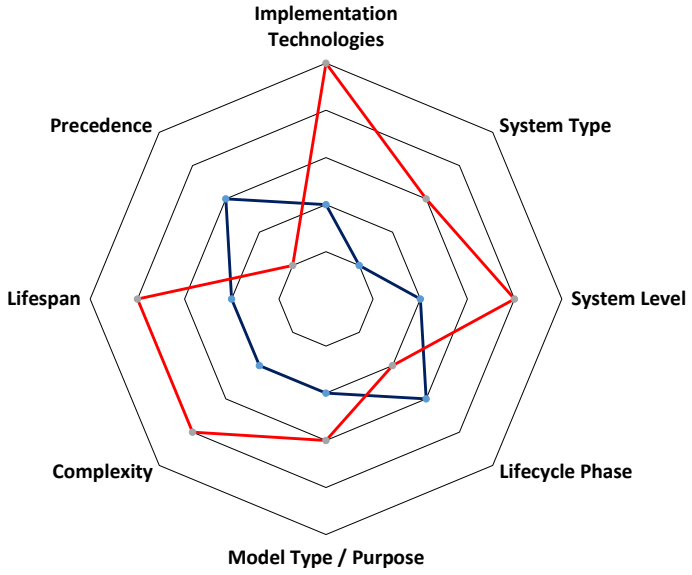
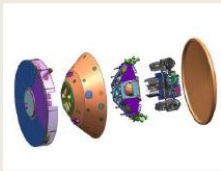
8 Dimensions in Practice



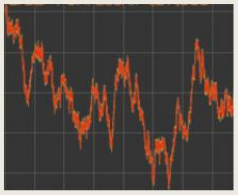
21st Century Problems Demand Adaptable and Scalable Methods

TAILORED TO THE DOMAIN

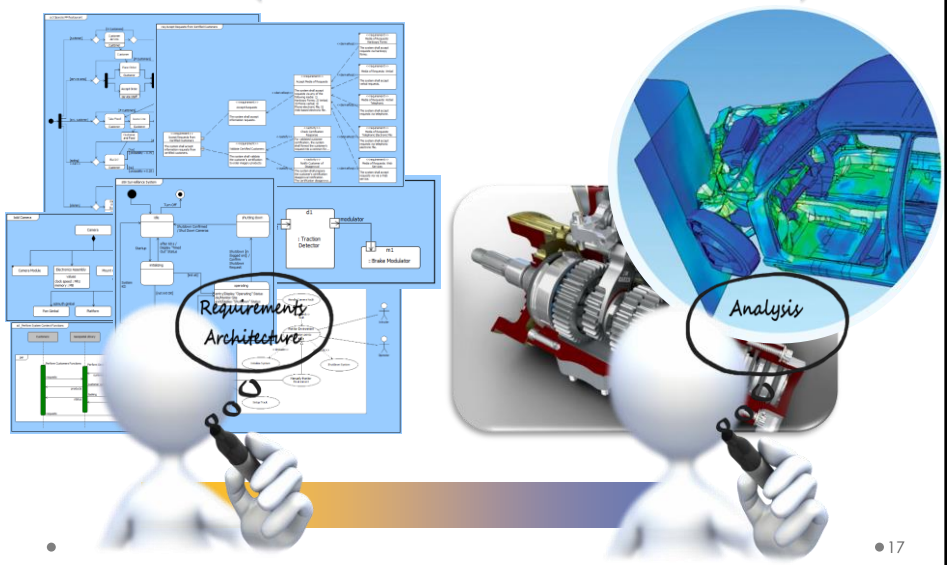


SCALED TO PROJECT SIZE

SCALED TO SYSTEM COMPLEXITY



Leveraging MBSE as a Stepping Stone (but which do we choose?)



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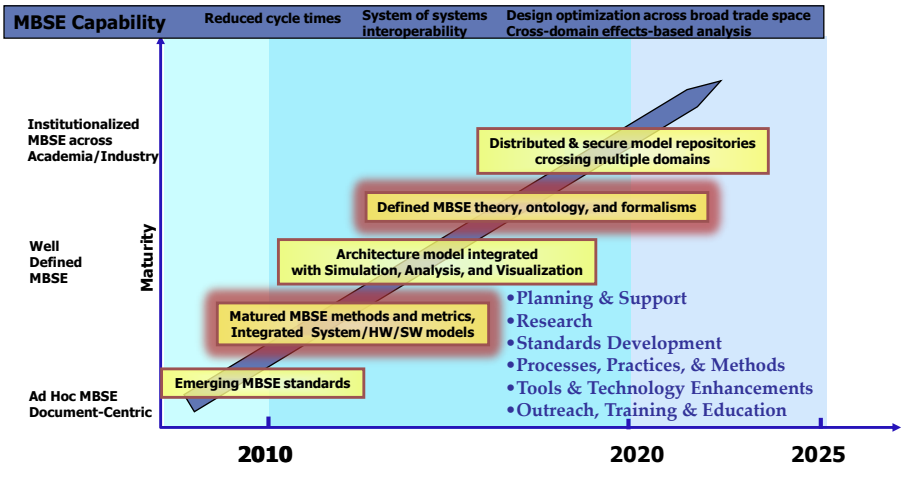
Recognizing and Addressing a Disconnect in Our Roadmap



Reprinted from INCOSE MBSE Workshop, February 2010

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Enabling Communication, Analysis, Learning, and More

Technical Processes

"Non-traditional domains"

SE Management

Soft Systems

Model-Based SE

Systems Science

SE Leadership

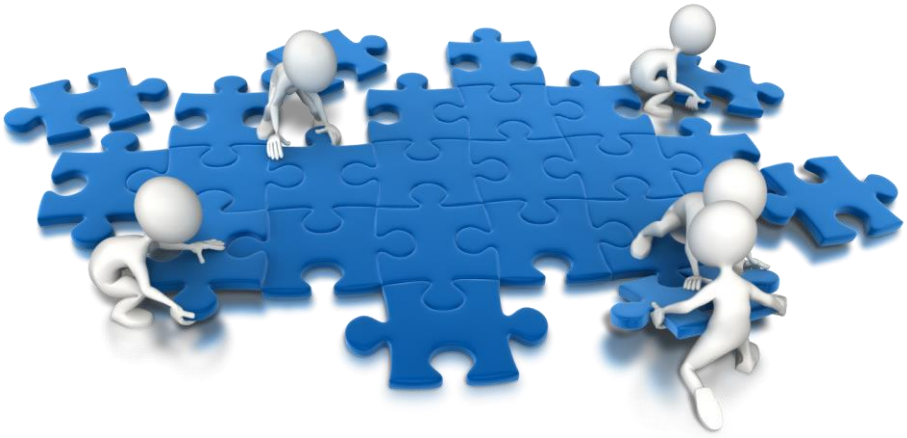
Systems Thinking

Moving from Data Capture to Heuristics and Wizards

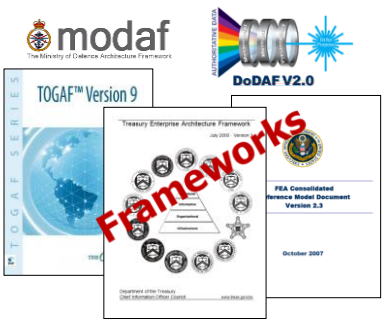
It looks like you are trying to write a requirements specification. Can I help?

It looks like you are trying to achieve .99999 reliability. Would you like me to help?

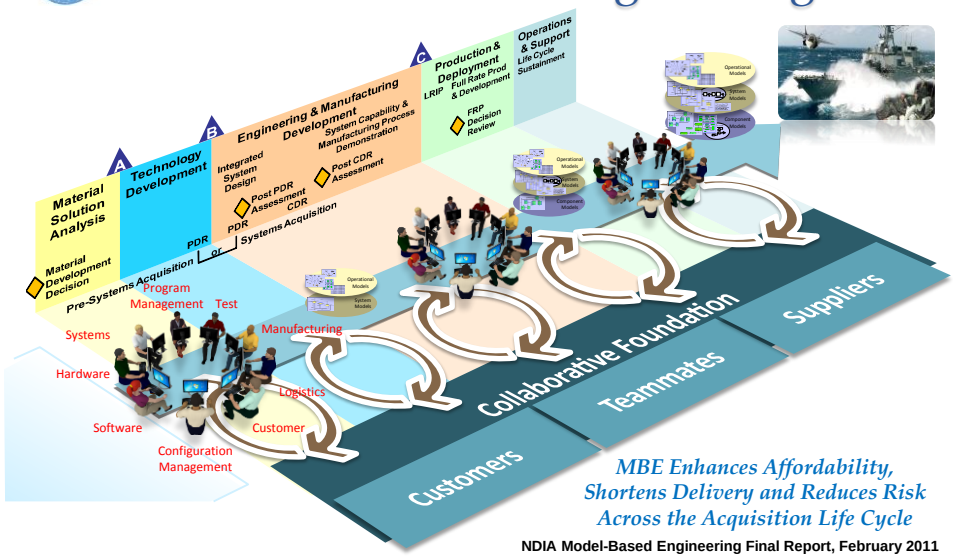
Moving from Custom-Built to Composability and Integration



Enabling – not Inhibiting – Progress with Process and Standards

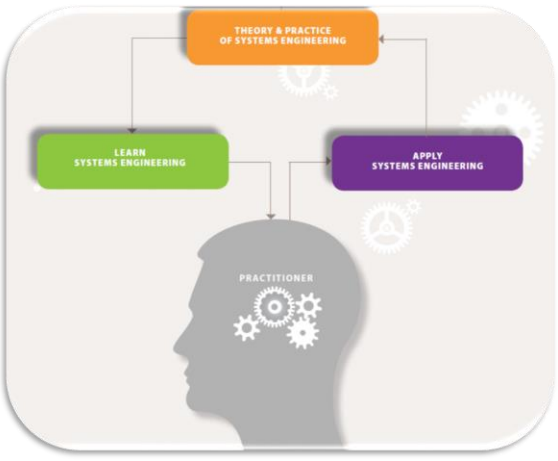


Targeting the To-Be State: Model-Based Engineering



MBE Enhances Affordability, Shortens Delivery and Reduces Risk Across the Acquisition Life Cycle

NDIA Model-Based Engineering Final Report, February 2011



Systems Engineering and Systems Engineers

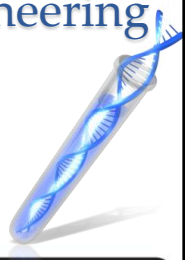
Practitioners in Transition: Systems Engineers and Systems Engineering

SYSTEMS ENGINEERING Research Center | HELIX

Important Characteristics of Effective Systems Engineers

1. **Paradoxical Mindset**
   - Big Picture Thinking *and* Attention to Detail
   - Strategic *and* Tactical
   - Analytic *and* Synthetic
   - Courageous *and* Humble
   - Methodical *and* Creative
2. **Effective Communication**
   - Modes *(oral and written; good speakers and listeners)*
   - Audience *(bridge between problem domain and solution domain)*
   - Content *(social, managerial, technical)*
   - Purpose *(understanding needs, negotiation, information brokering, technical arbitration, driving consensus)*
3. **Flexible Comfort Zone**
   - Open Minded
   - Rational Risk Taking
   - Multidisciplinary
   - Enjoys Challenges
4. **Smart Leadership**
   - Quick Learning and Abstraction
   - Knowing when to stop
   - Focused on 'Vision' for System
   - Ability to Connect the Dots
   - Patience
5. **Self Starter**
   - Curiosity
   - Passionate and Motivated
   - Eager to Learn

Helix Workshop, Washington DC July 23, 2014



SYSTEMS ENGINEERING IS BROADLY APPLICABLE

- Systems thinking is used by many.
- Systems engineering is understood and embraced by all engineers.

- Systems engineering is a career for a few.

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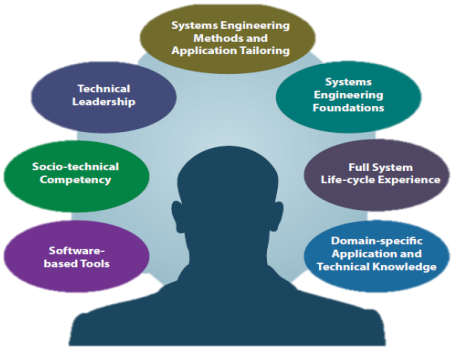
Advancing our Competency and Positioning our Value

- Systems engineer is the linchpin
- Must lead/influence decision-making
- Balance hard & soft skills
- "T-shaped" individual

- Competency is key
  - Specialist SE skills
  - Wider general understanding
  - Leadership and soft skills



Knowledge | Experience | Attitude

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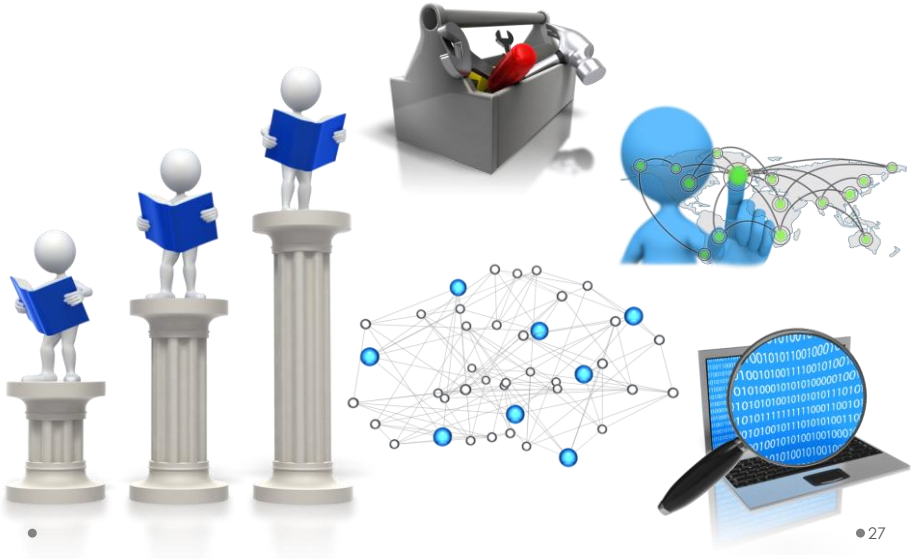
Embracing Life-Long Growth and Learning



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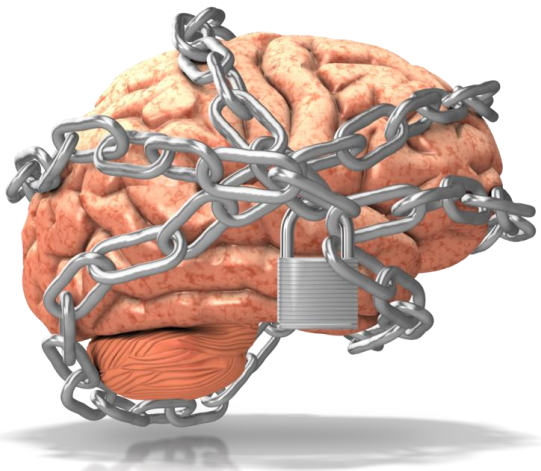
Freeing Systems Engineers to Contribute



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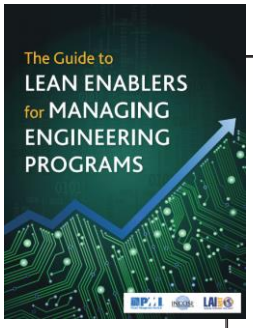
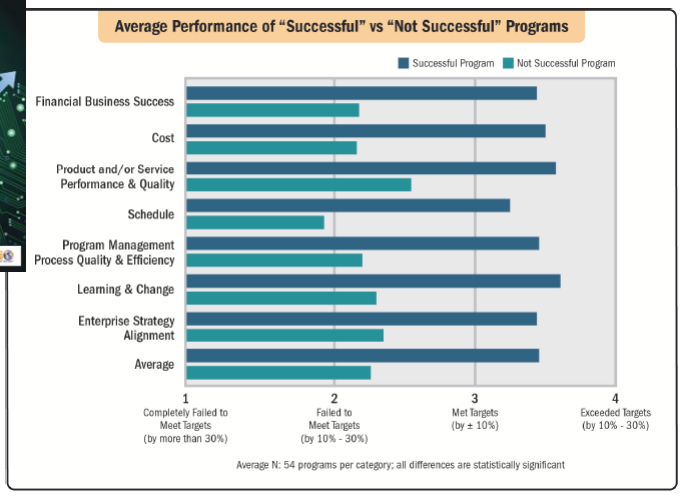
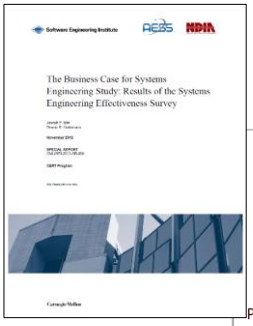
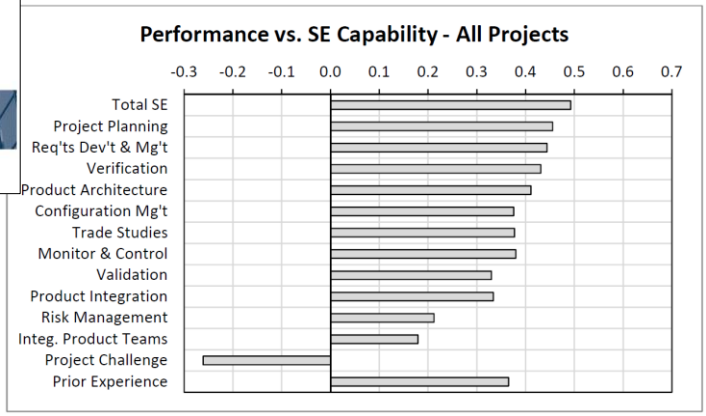
The Greater Motivation to Act





The Greater Motivation to Act





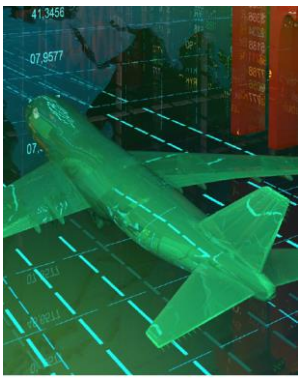
Unlocking Our Potential

- Achieving SE potential is dependent upon
  - Improving the *practice of* SE
  - Improving the *way we practice* SE
  - Improving the *opportunity to practice SE*
- Our success depends on others
  - The decision to use SE in the first place
  - Understanding of SE logic and application
  - Enabling systems and advocacy
  - Adequate schedule and resources
  - Patience in the face of short-term delay
  - Learning from long-term results
- Our success depends on our ability to make the case
  - For systems
  - For the systems perspective
  - For systems engineering and systems engineers

Adapted from Randall C. Iliff, 2014

A Practice in Transition: Transforming SE

- Value-driven practices
- Complex system understanding
- Leveraging technology for SE tools
- Collaborative engineering across all boundaries
- System design in a system of systems context
- Architecting systems to address multiple stakeholder viewpoints
- Architecting and design of resilient systems
- Cyber security – securing the system
- Leveraging information and analysis for effective decision making
- Virtual engineering – part of the digital revolution

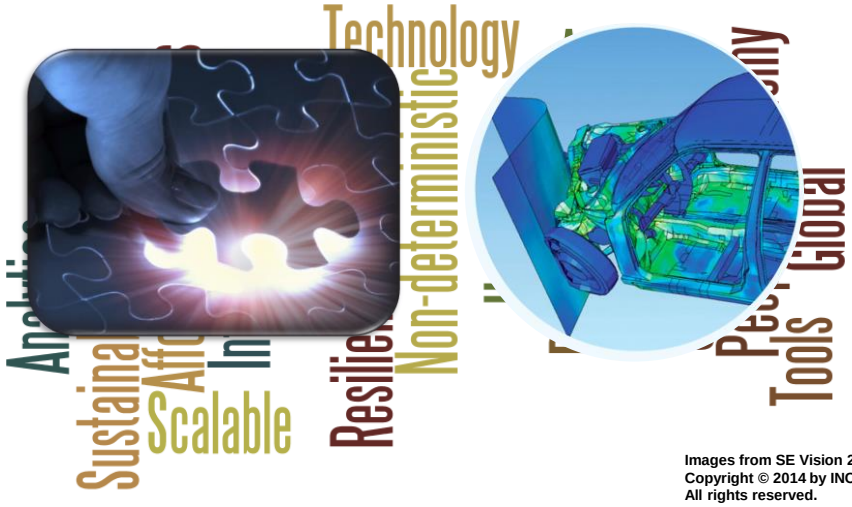


Practice • Practitioners • Opportunity

Enabling the Transformation: INCOSE's Five Year Objectives

Growth: INCOSE doubles its membership and embraces the healthcare, mobility, and energy business sectors
Alliances: INCOSE amplifies its ability to achieve its mission through diverse alliances
Education: INCOSE curricular recommendations are widely adopted around the world, raising the quality of engineering education
Products: INCOSE produces and brokers the most impactful systems engineering information in the world, grounded in effective practice and research
Forums: INCOSE produces and supports the most impactful forums in the world on systems engineering practice, policy, education and research
Competency: INCOSE teams with industry to raise systems engineering competency across their supply chains
Transformation: INCOSE accelerates the transformation of systems engineering to a model-based discipline

Responding to 21st Century Needs with 21st Century Systems Engineering



Questions

David Long
President

www.incose.org
david.long@incose.org