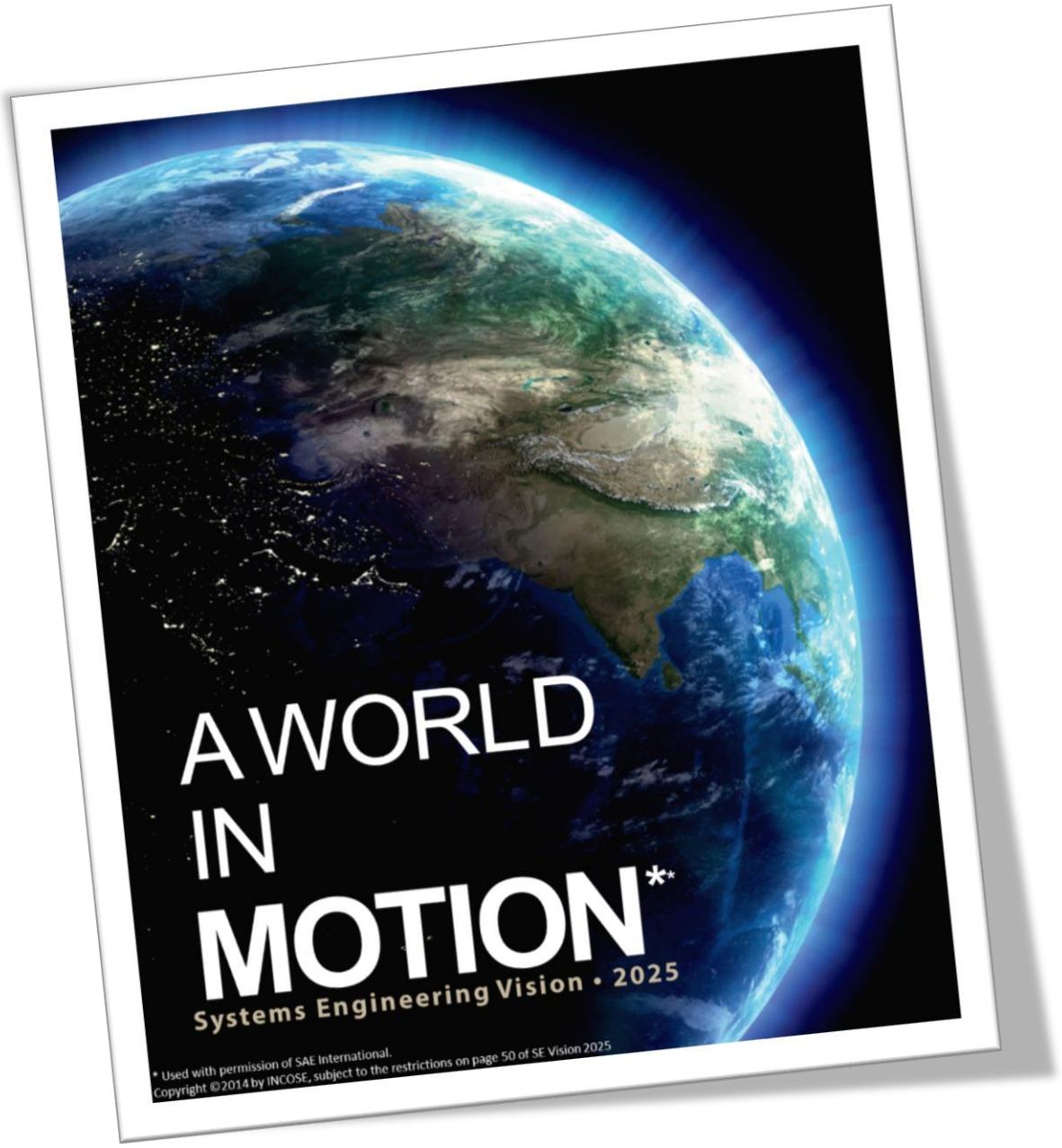


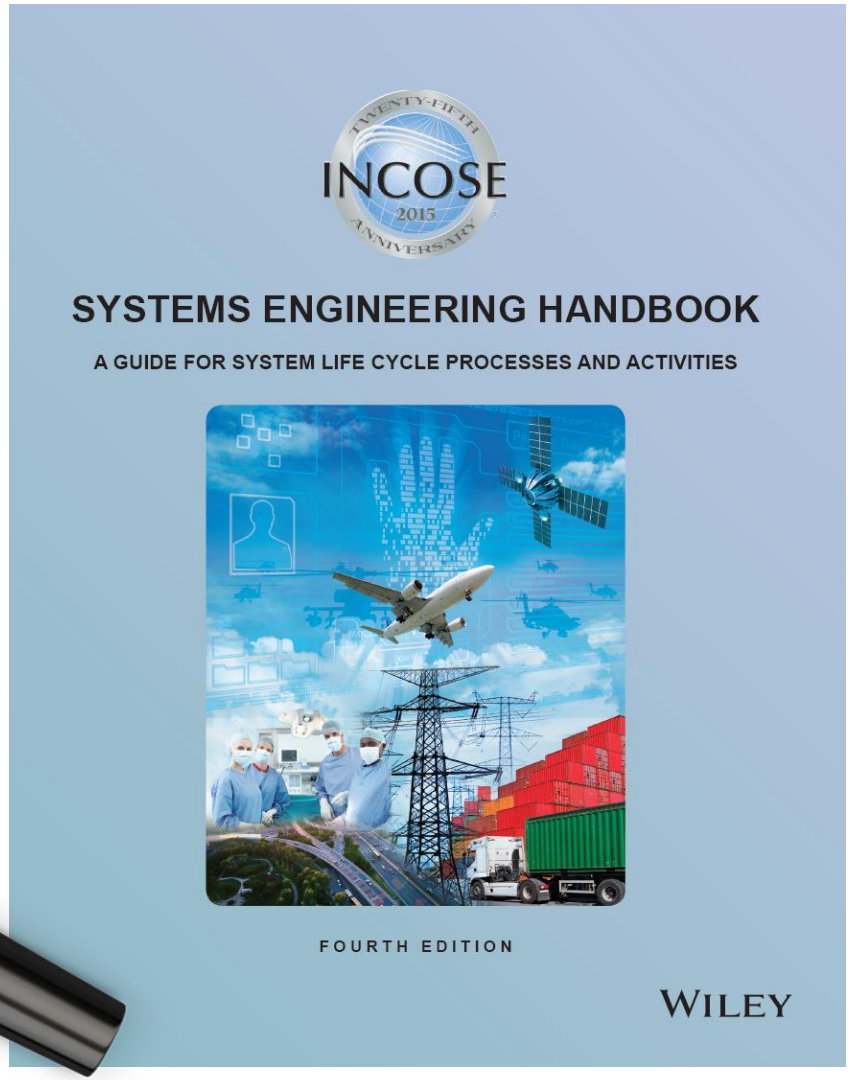
Building for Tomorrow: Towards 21st Century Systems Engineering

David Long
INCOSE President
david.long@incose.org
@thinkse

"The Good Ol' Days"

"The Good Ol' Days"

Recognizing a Solid Foundation

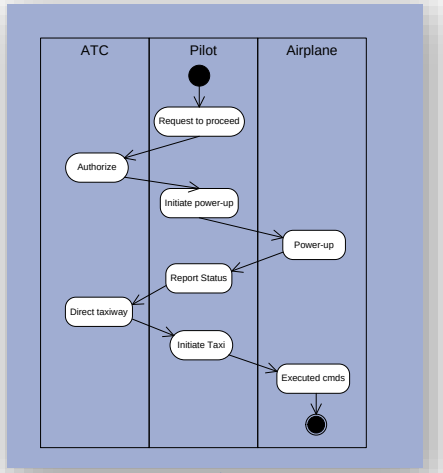


21st Century Systems Engineering: A Practice in Transition

Traditional

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

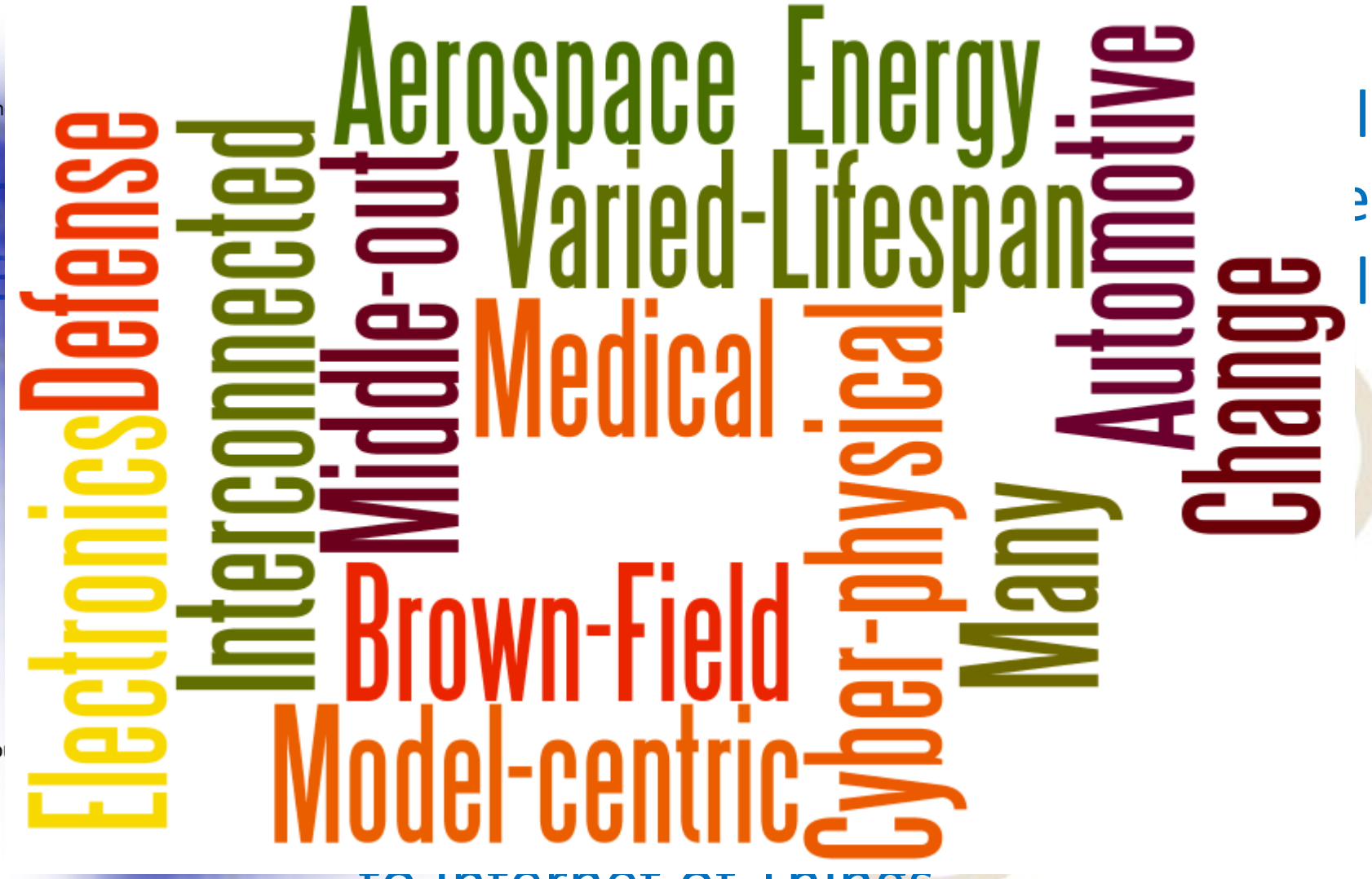
Future



Moving from document-centric to model-centric

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

Aspects of the New Reality



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.

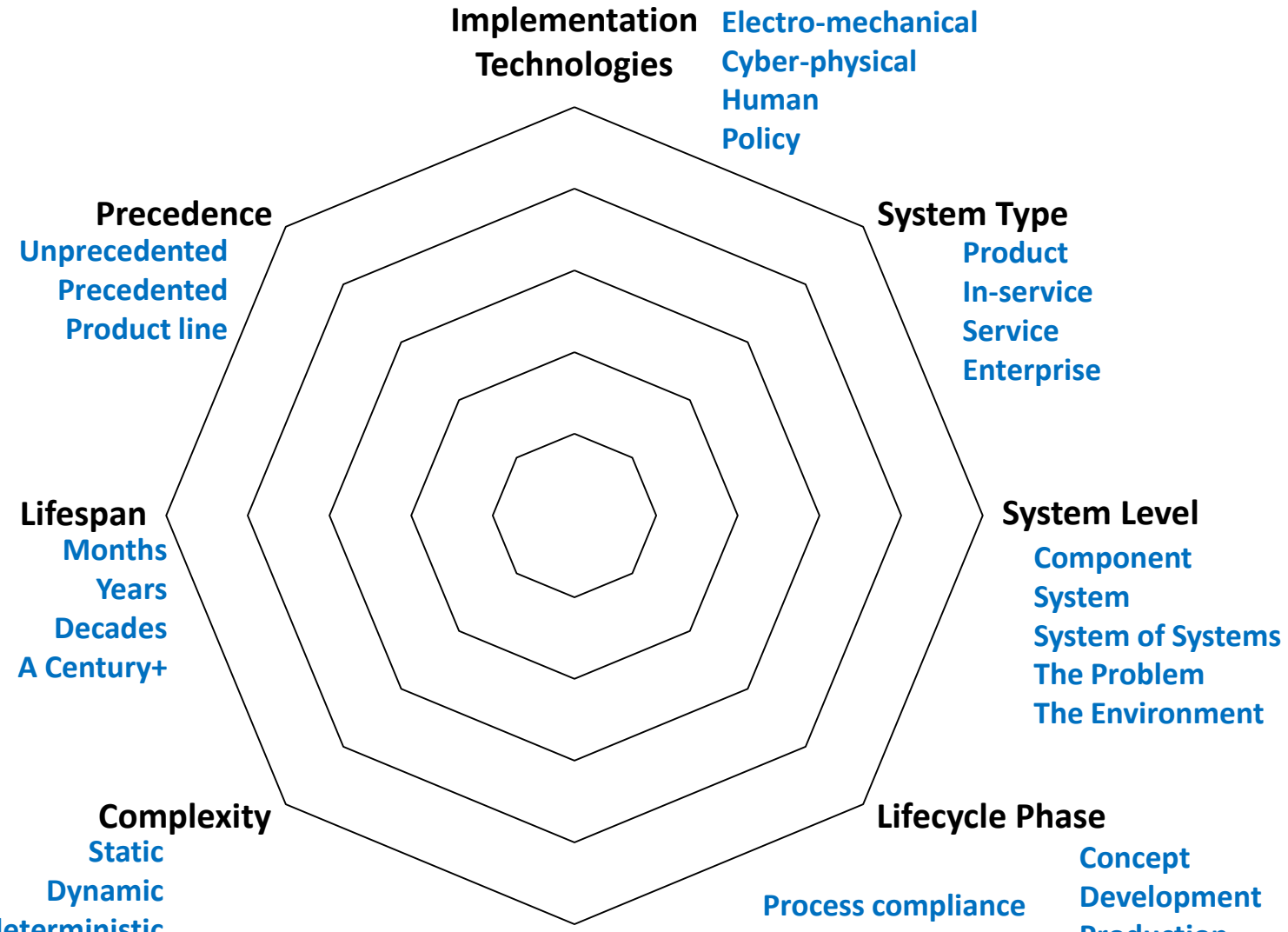
3. Knowledge and investment are lost at project life cycle phase boundaries . . . increasing development cost and risk of late discovery of design problems

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

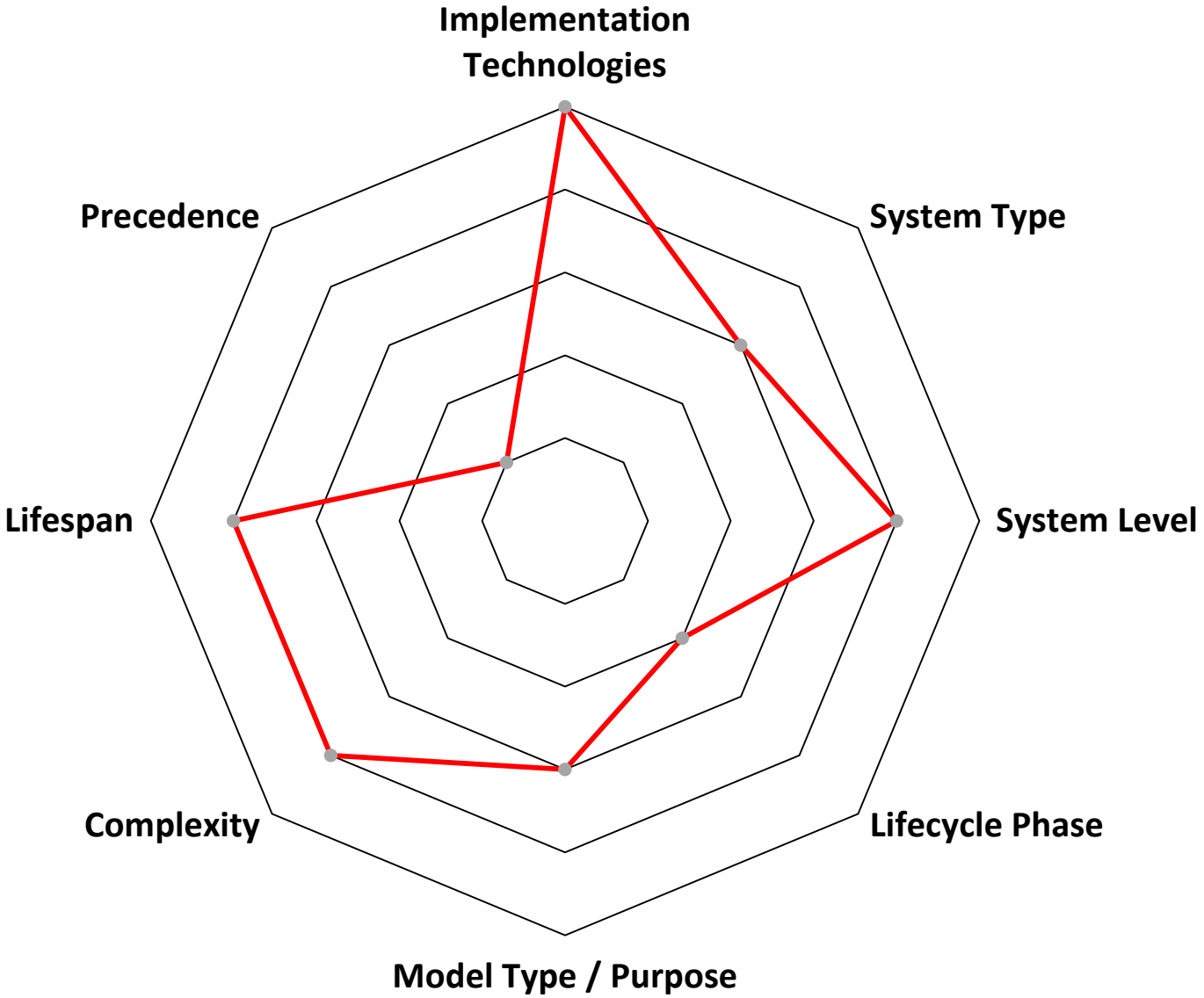
5. Technical and programmatic sides of projects are poorly coupled . . . hampering effective project risk-based decision making.

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".

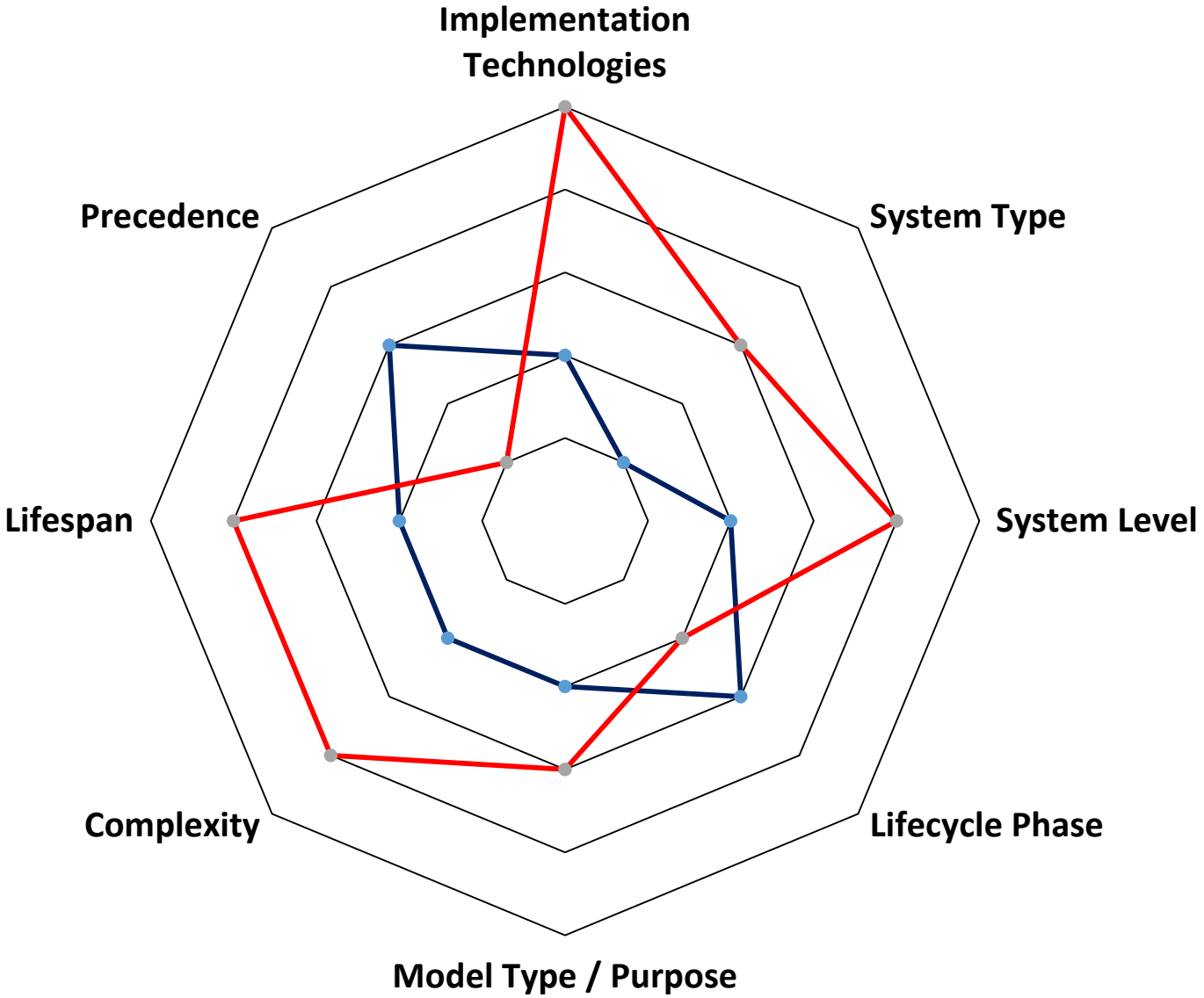
8 Dimensions to Our Challenge



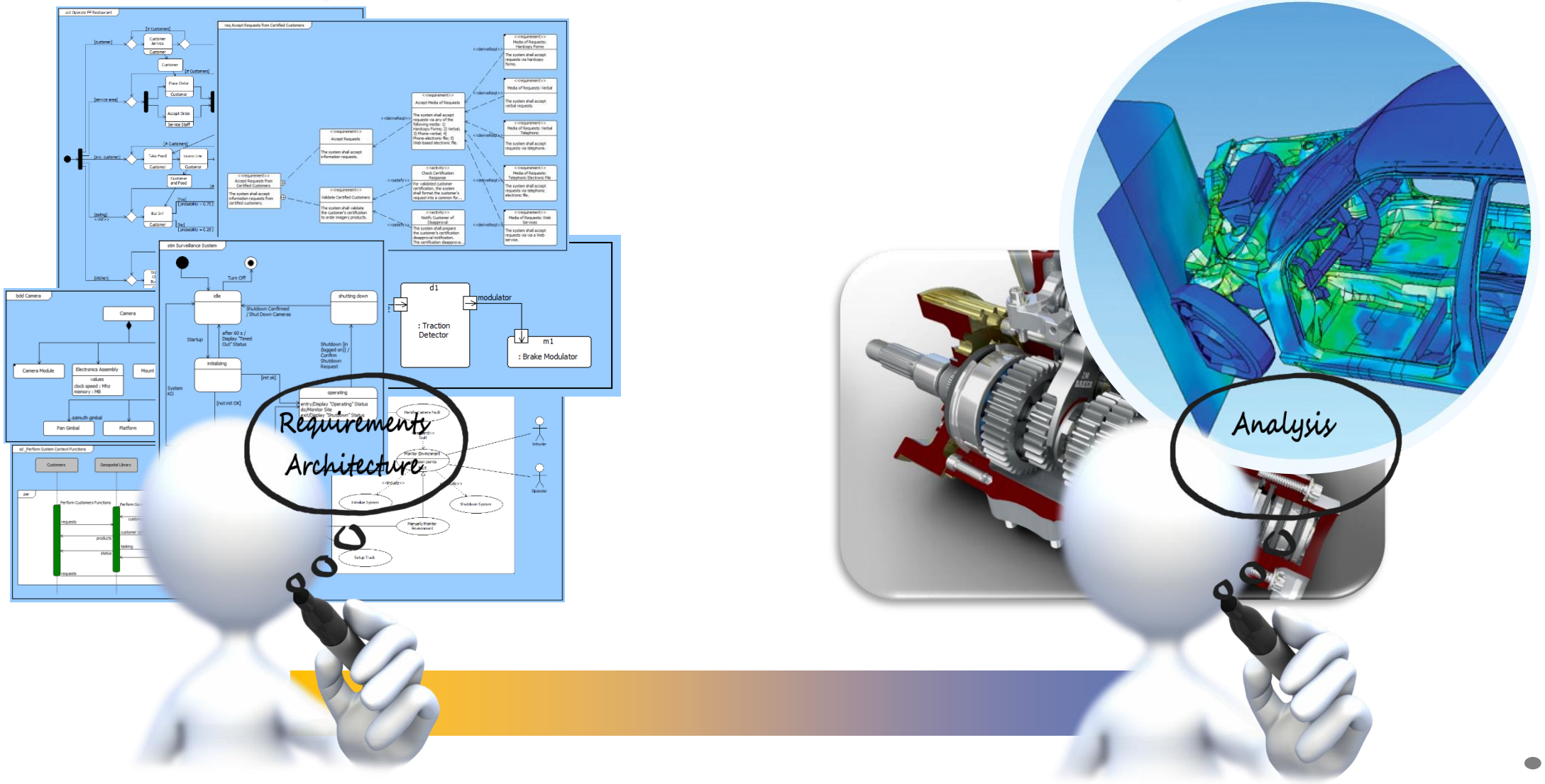
8 Dimensions in Practice



8 Dimensions in Practice



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



Enabling Communication, Analysis, Learning, and More

Technical Processes

"Non-traditional domains"

SE Management

Soft Systems

Model-Based SE

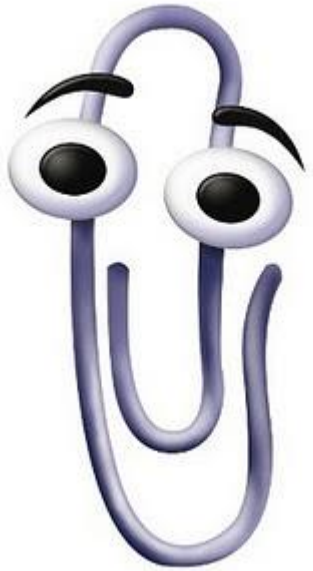
Systems Science

SE Leadership

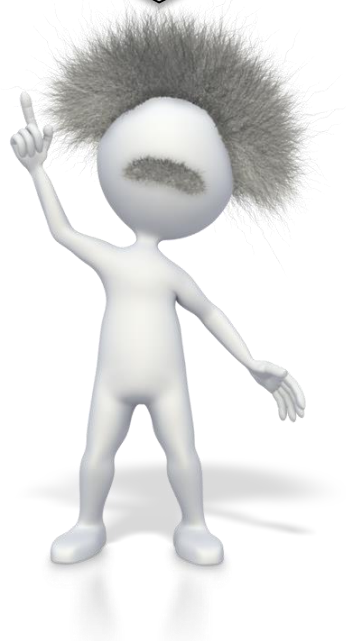
Systems Thinking

Moving from Data Capture to Heuristics and Wizards

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

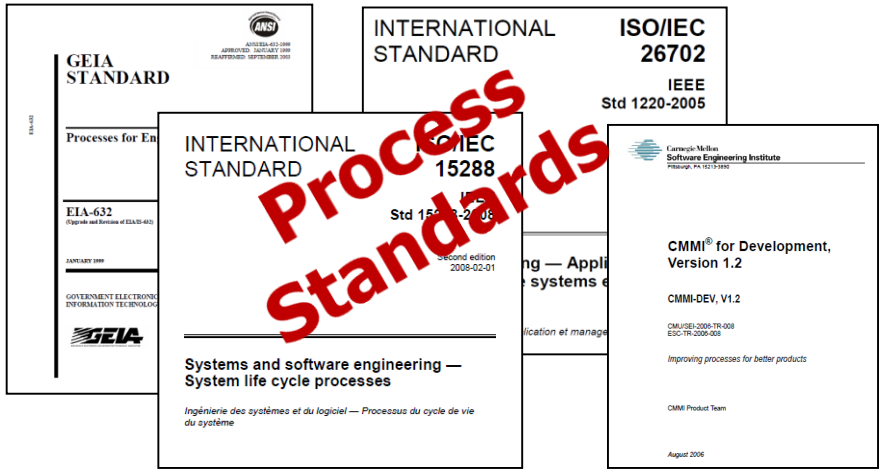


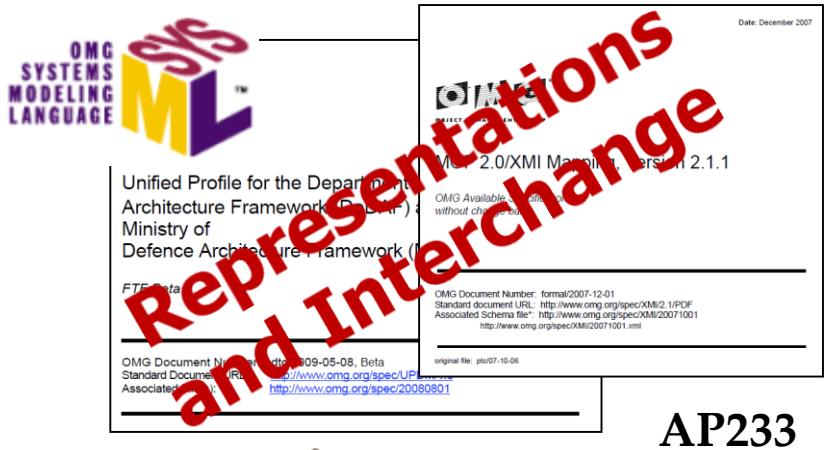
It looks like you are trying to achieve .99999 reliability. Would you like me to help?



Moving from Custom-Built to Composability and Integration

Enabling – not Inhibiting – Progress with Process and Standards





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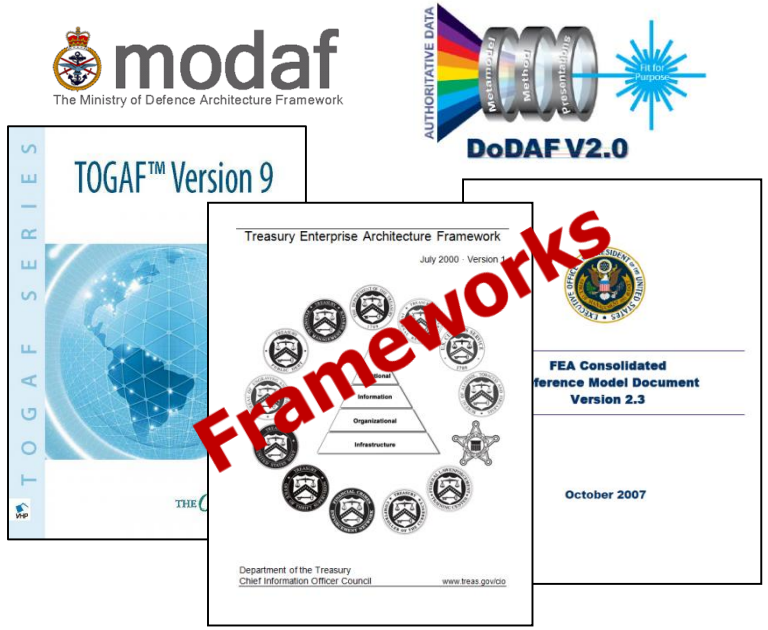
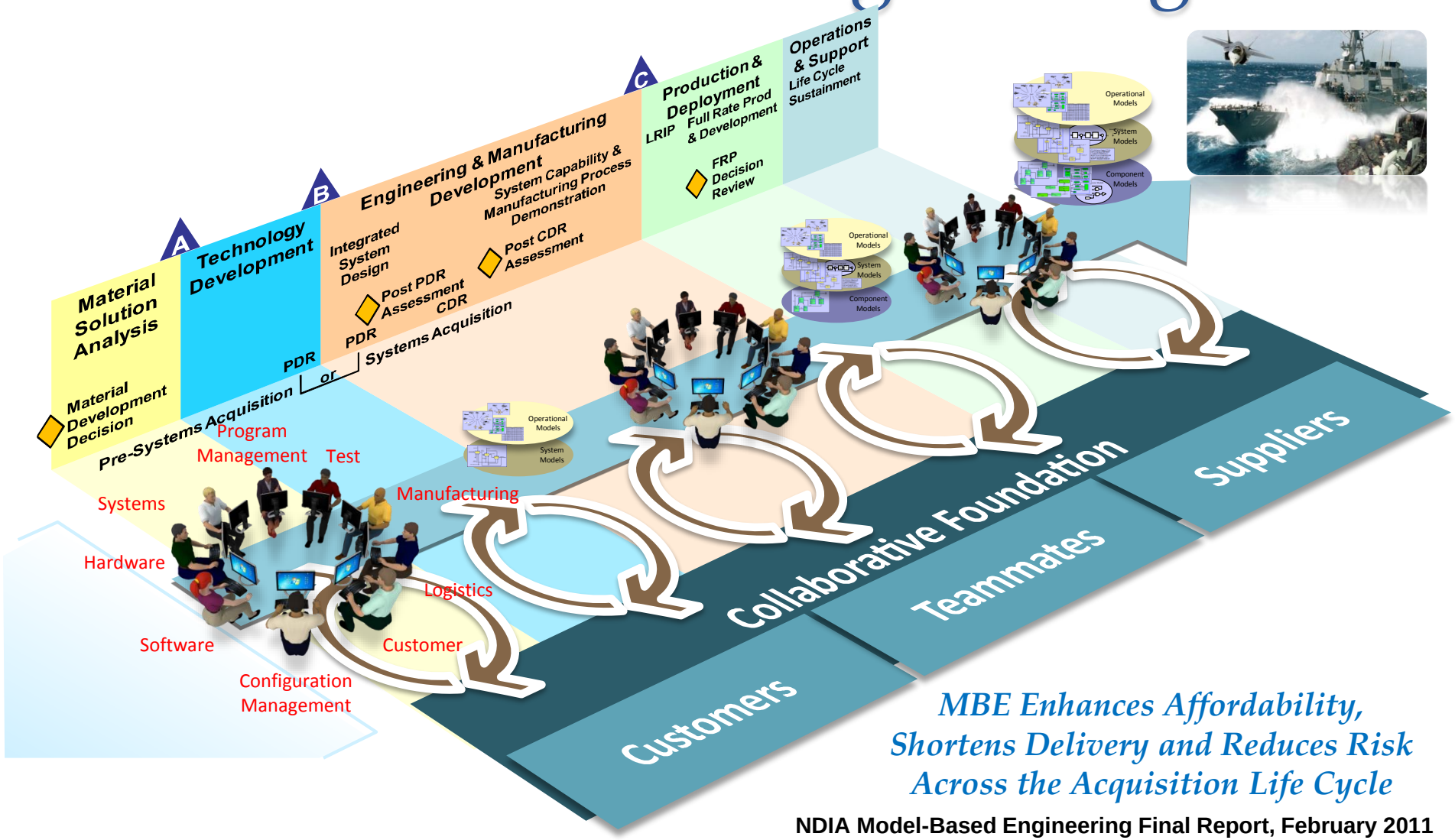


Targeting the To-Be State: Model-Based Engineering



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

NDIA Model-Based Engineering Final Report, February 2011

Practitioners in Transition: Systems Engineers and Systems Engineering

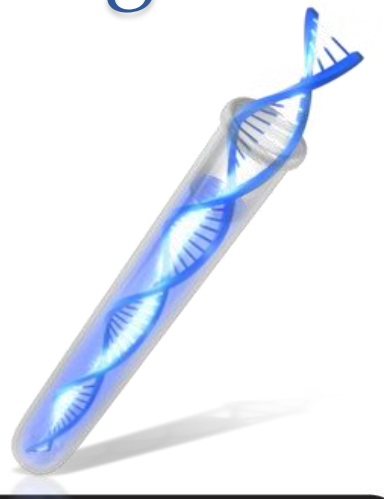
SYSTEMS ENGINEERING Research Center

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

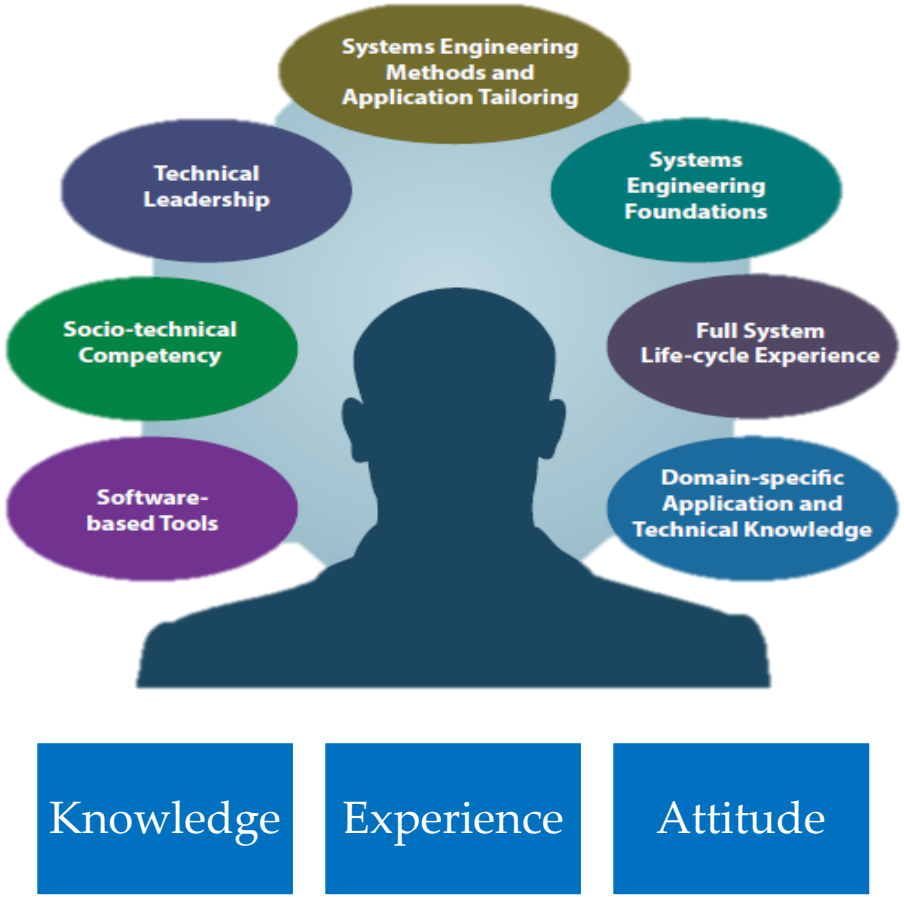
- Systems thinking is used by many.
- Systems engineering is understood and embraced by all engineers.

- Systems engineering is a career for a few.

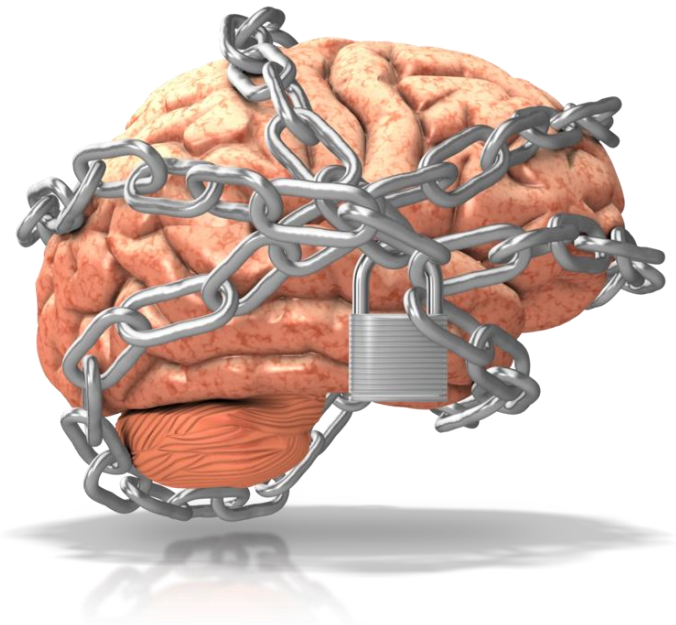
Advancing Our Competency

- 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



Unlocking Our Potential

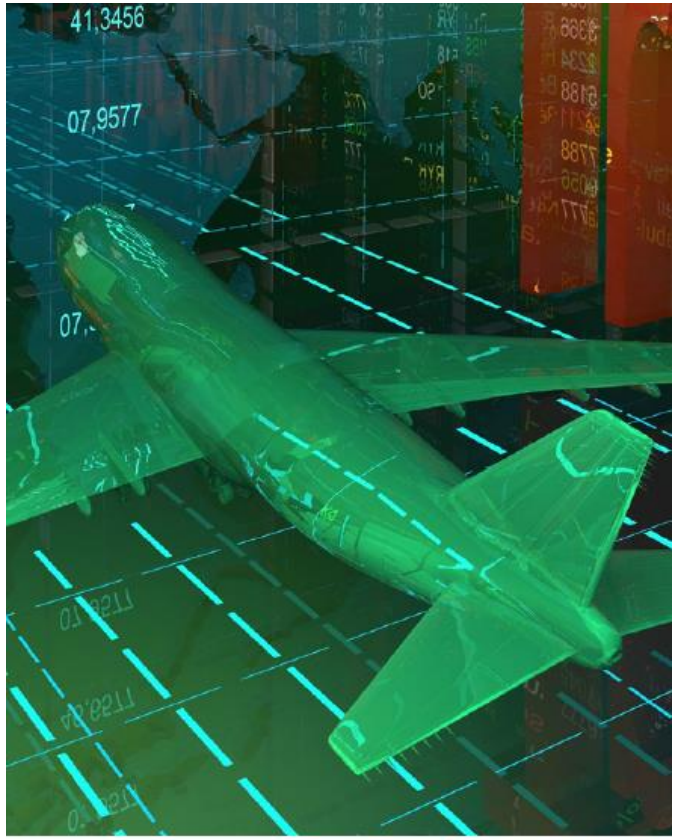


- Achieving SE potential is dependent upon
  - Improving the practice of SE
  - Improving the way we practice SE
  - Improving the opportunity to practice SE
- Our success depends on others
  - The decision to use SE in the first place
  - Understanding of SE logic and application
  - Enabling systems 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



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