INCOSE International Symposium

Need for Robust Systems Engineering in a Time of Budget Austerity

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Agenda

- Goals
- Systems Engineering Need
- Adapting Systems Engineering
- Global 21st Century SE Challenges
- Complexity Science and Systems Engineering
- Evolving Considerations
- Conclusion

Goals

- Show systems engineering is still needed despite budget cuts
- Describe how Systems Engineering is adapting to the challenges of 21^{st} century acquisition
- Recognize international nature of Systems Engineering organizations

Systems Engineering Need, 1

- Acquisition is more challenging in 21st Century.
  - More capable, complex, interoperable systems
  - Need to be built more quickly at less cost
- Aerospace, defense, and energy sectors
- Complex systems *must work:* Failures are societal events and national tragedies
  - Three-Mile Island
  - *Challenger*
  - *Columbia*
  - Power blackouts of 1965 and 2003 in the northeast United States
  - Gulf of Mexico oil spill
- Systems engineering protects the mission and the nation, and minimizes the effect of budget cuts

Systems Engineering Need, 2

- SE objective:
  Ensure system is designed, built, and operated to accomplish its purpose, cost-effectively
  - Performance, cost, schedule, and risk

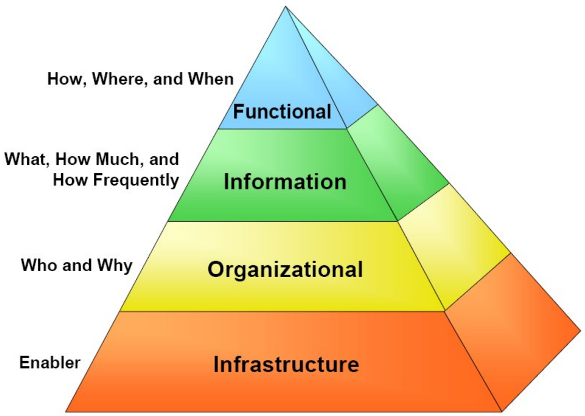
- SE role re cost cuts
  - Before: SE ensures system (or SoS) design is as modular as possible in order to be robust to programmatic changes
  - During: SE identifies which cuts will have the minimum effect
  - After: SE establishes the appropriate tradeoffs to ensure the remaining system is optimized for performance, given the remaining funds

Adapting Systems Engineering, 1

- Support incremental commitment acquisition
  - Dealing with uncertainty and changes
- Use tools to deal with complexity and uncertainty
  - Hierarchical design, architectural patterns, trade studies
  - Designing systems to provide best value, managing complexity, decision making with best practice + new analysis
- Improve decision-making under uncertain conditions
  - Statistical analysis, economics analysis, operations research, management science
- Improve integration with collaboration tools
  - Coordinate multiple disciplines, ensure system integration
- Apply orchestrated integrative review
  - Multiple disciplines and organizations

Adapting Systems Engineering, 2

- Define and implement enterprise architecture roadmaps
  - Capability roadmaps
  - Define and maintain the critical dependencies among system components



- Identify Emerging Technologies
  - Web services, grid computing, virtualization, autonomic computing, and migration to on-demand adaptive environments.
  - Assess each technology’s potential benefits and costs, variable and fixed
- Create useful and enduring models: Model Based Systems Engineering (MBSE)

Global 21st Century SE Challenges

- Broad Base
  - Government and commercial organizations
  - All over the world

- E-collaboration with multi-national teams: challenges of communications, culture and globally dispersed locations

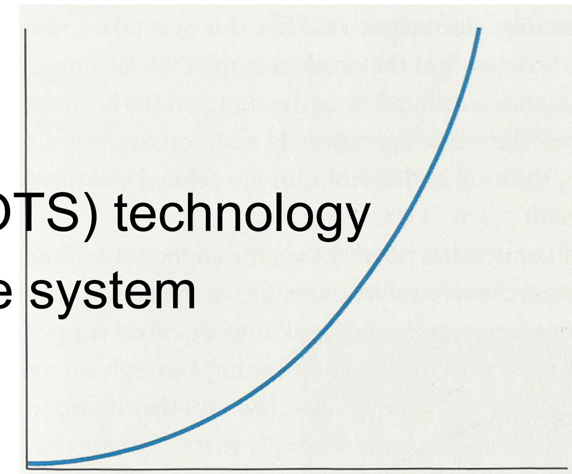
Complexity Science and Systems Engineering

- Insights from the science of complexity now being applied to the engineering of large-scale complex systems
  - Chaos, Complexity and Order
  - Hierarchy and modularity
  - Linearity, nonlinearity, and fractals
  - Design creation and evolution
  - Analysis and risk management

- Example: Identifying and reusing or adapting technologies that have performed a specific function well in the past, systems engineers minimize program risk.

Evolving Considerations, 1

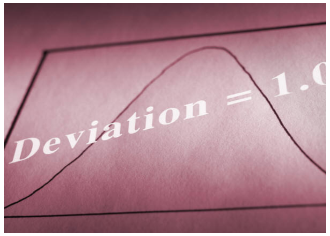
- System failure is unacceptable
  - SE needs well-controlled and high-assurance processes that provide system synchronization, balance, assurance, and agility
- Rapid pace of change will accelerate. Focus on:
  - Mission priorities
  - Adaptation of technology
  - Modular use of Commercial Off-the-Shelf (COTS) technology
  - Tailor system to evolving understanding of the system environment. and tailoring system to it
  - Incremental development
  - Model-based engineering will provide both prescience and rapid adaptability



Evolving Considerations, 2

- Integration is riskier
  - Tendency to underestimate integration difficulty and simultaneously overestimate the maturity of items that require integration
  - Massive amounts of interacting software will be important
  - Role of humans within complex systems
  - Legacy elements

- New roles for SEs
  - Learn about more new discipline and more models and tool
  - Identify appropriate tools and provide skilled tool users
- SEs provide math for management of complexity
  - Stochastic statistics
  - Chaos and complexity
  - Combinatorial computation
  - More typical engineering math such as Fourier and Laplace transforms



Conclusion

- Historically SE has been vulnerable to budget reductions
- Today's larger, more complex systems are riskier than before, with major consequences if they fail
- Systems engineering is needed now more than in the past, and it would be a mistake to reduce funding for systems engineering at the same time that government or commercial programs in general are being reduced
- The challenges of 21st century acquisition for systems engineering are global in nature

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