National Defense Industrial Association
Systems Engineering Conference 2012

Maximizing Innovation With Systems Engineering

Robert (Bob) Scheurer & Daniel (Dan) Strosnider
Boeing Defense, Space and Security **| Systems Engineering**

Topics for Discussion

- Definition of Innovation
- Characteristics of an Innovation
- Elements of Systems Engineering which Influence Innovation
- Better Systems Engineering and More Innovation

Improving Innovation Outcomes with Systems Engineering

Innovation

"The successful introduction of a new thing or method… Innovation is the embodiment, combination, or synthesis of knowledge in original, relevant, valued new products, processes, or services."

Luecke and Katz (2003)

Innovation = Valued Outcome

Characteristics of an Innovation

- Capability
- Flexibility
- Adaptability
- Complexity
- Affordability
- Supportability
- Modularity
- Interoperability
- Resiliency
- Testability
- Scalability
- …

Characteristics of an Innovation Emerge from Systems Thinking

Some Enablers of Innovation

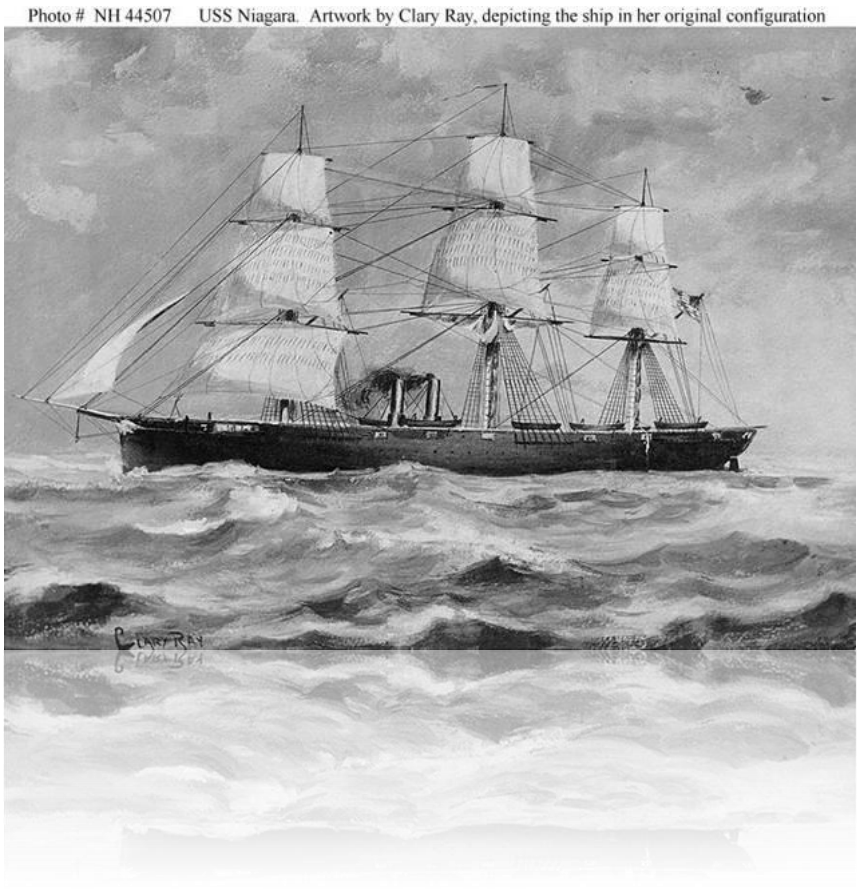
- Systems Thinking (The Fifth Discipline)
- Systems Engineering
- Lean Enablers
- Agile Techniques
- Modeling & Simulation

Creative thinking, bridging chasms, and cross-boundary networks in managing organizations and complex ecosystems worldwide

Some Inhibitors of Innovation

1. Inability to Unlearn Obsolete Mental Models
2. A Successful Dominant Design *or Person*
3. A Risk-Averse Climate
4. Innovation Process Mis-Management
5. Lack of Adequate Follow-Thru Competencies
6. Inability to Develop Appropriate Internal or External Infrastructure
7. Excessive Proprietary Rights, Patents, and Regulation

DOMINANT DESIGN



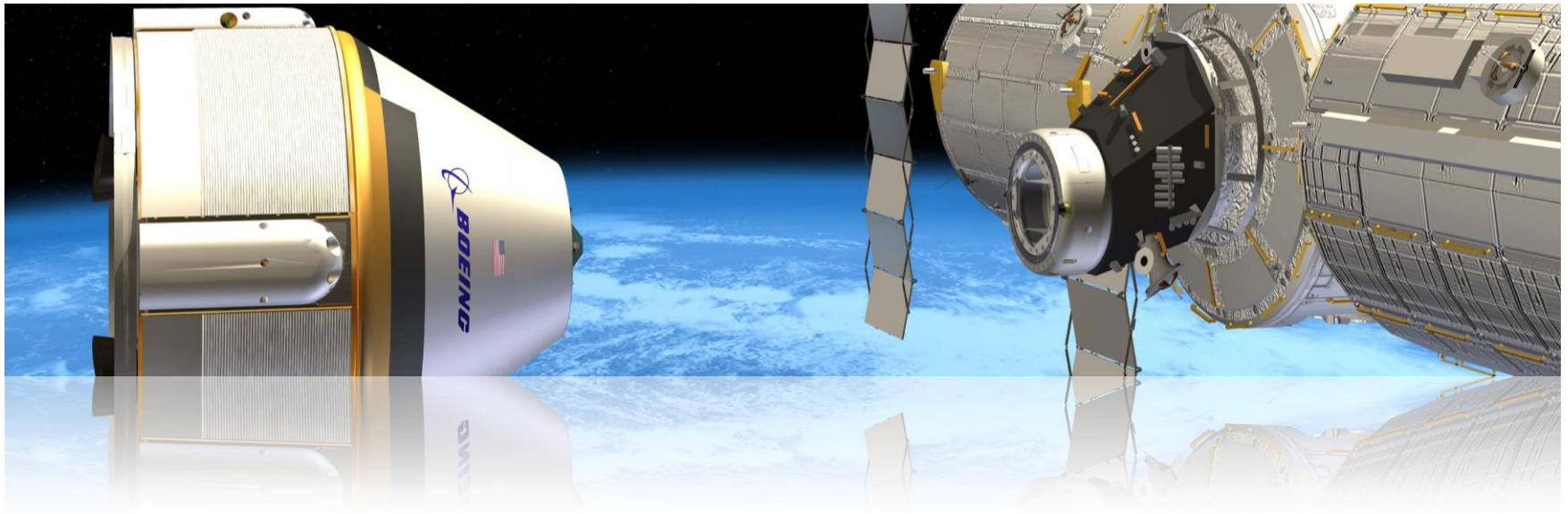
Characteristics of the Systems Engineering *Process*

- **Starts** with the “Big Picture”
- **Transforms** from Ambiguity to Discrete Structure
- **Leads** to Best Decision / Trade Among Alternatives
- **Entails** Process Discipline
- **Features** Process Coordination/Orchestration
- **Involves** Integration of Elements / Right Side of Vee
- **Manages** Technology Maturity / Readiness

Characteristics of Systems Engineering Align with the Characteristics of Innovation

SE Processes that Impact Innovation

DIRECT IMPACT	INDIRECT IMPACT
▪ Analysis (Knowledge)	▪ Configuration Management (Change Control)
▪ Architecture (Refinement / Relationships)	▪ Data Management (Accounting)
▪ Synthesis (Embodiment)	▪ Integration & Test (Uniting)
▪ Trade-Off Studies (Decisions)	▪ Verification & Validation (Assuring)



Beyond Systems Engineering Processes

Relationships

Between system elements, functions, people, etc.

Environment

Context for system, people, etc.

Data

Evolution and learning

Decisions

Having the “right” choices

At Issue: How to Further Enhance these Key SE Elements to Maximize Innovation Outcomes

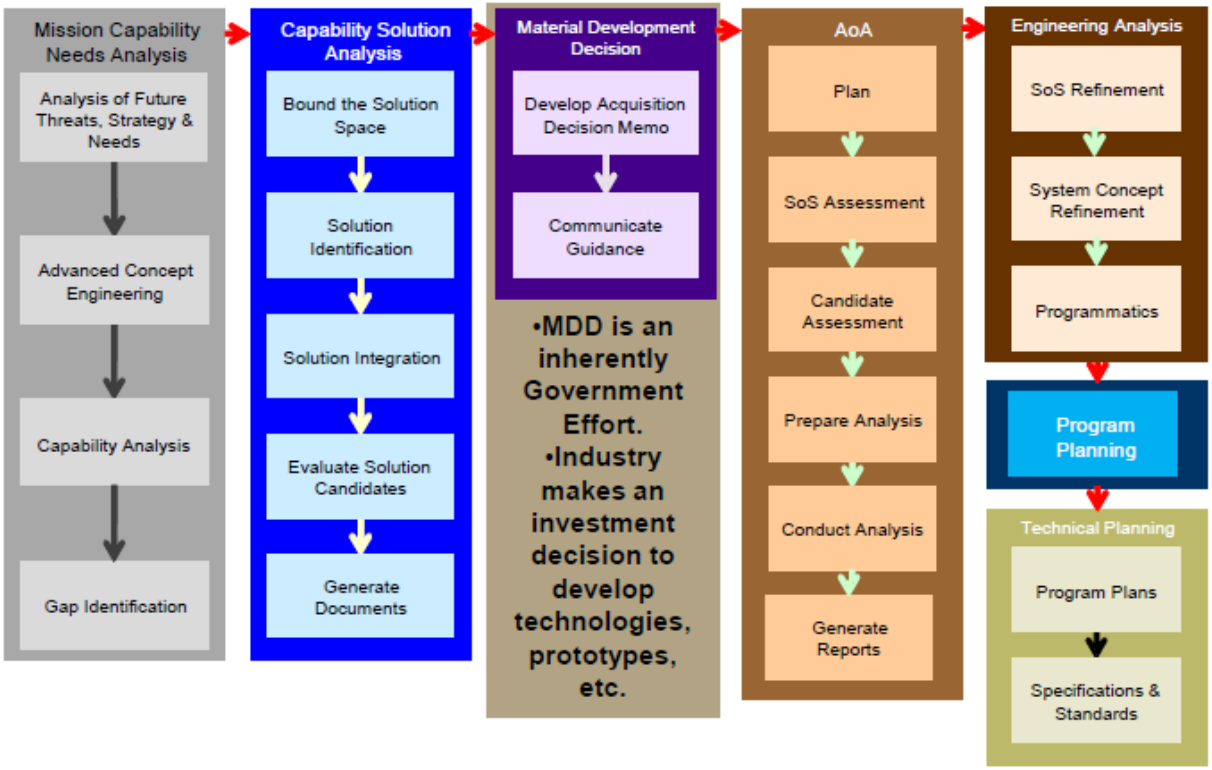
Objective: Better Results and Outcomes

Improving Relationships

- **Better Relationships -> Better Interfaces**
- **Acquirer/Customer Closer to Suppliers (e.g., Co-Creation)**
- **Components Melding Together in Modularized Fashion (e.g., Mash-Ups)**
- **Immersive Collaboration**
- **“Getting the Whole System in the Room” (e.g., Innovation Workshops)**
- **NDIA Development Planning / Early Systems Engineering Working Group**

NDIA Development Planning/Early Systems Engineering Working Group

Industry's Pre-Milestone A Systems Engineering Process



The answer to "What problem are we trying to solve?" enables the tailoring of this process!

Improving Environments

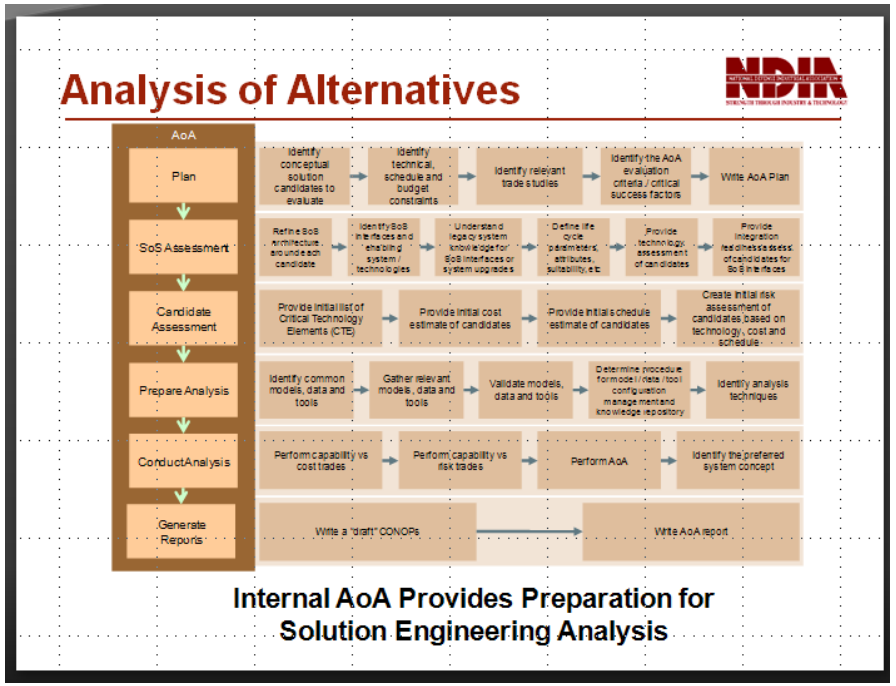
- **Immersive Environments**
- **Inclusive Environment: All Treated as Equals**
- **Tolerance of Risk & Failure**
- **Supportive and Motivating Culture**
- **Secure Base**
  - Someone or something that gives protection or sense of protection, inspires, or brings forth energy from an individual
- **Overcoming Goal to Survive**
  - Secure base allows brain to shut down defensive focus and looks for positives and opportunities
- **Product Lifecycle Focus**

Improving Data and Information

- **Knowledge Management**
- **Crowd Sourcing**
- **Entity Analytics**
- **Data Encapsulation in Modules**
- **Data is the Model is the Requirements Set**

Improving Knowledge and Decisions

- More Choices Aided by Past Results (Knowledge Mgt.)
- Automation to Enable More “What If’s”/Better Choices
- Better Choices from Focus on Results/Outcomes
- Immersive Data Visualization
- Systems Engineers as “Decision Coaches”



Improving Systems: Resilient Systems Concepts

Model Based Engineering

- Virtual designed products
- Product Lifecycle Management
- Immersive Design Centers
- Virtual Manufacturing
- Integrated Global Supply Chain
- Simulated Operational and Design Concepts

Platform Based Engineering

- Open Architecture principles
- Architectural, quality attribute driven patterns
- Reuse of Product Line assets
- Agile Software
- Architected and planned variant assets to support new missions and new products

Capability on Demand

- Autonomous Systems
- Context Aware
- Integrated Health Management
- Self Adaptive Concepts
- Field Adaptive (Modular Payloads)

Trusted Systems Design

- Enterprise Network Security
- Infrastructure Operations Support
- Intrusion and Virus Detection
- System Integration
- Information Assurance
- Cyber Concepts applied from Enterprise IT

Innovative Systems Engineering Approaches

Improving Systems Engineering

- Enabling Environment & Tools (Model-Based SE)
- Model becomes the completed system
- Tailored Processes for Varied Objectives (No One Size Fits All)
- Streamlining of Reviews (Focus on Outputs & Outcomes)
- Questioning Need for All CDRL's/SDRL's (Value?)
- Is the timing appropriate for current processes?
- Would data suffice in place of specifically produced documents?
- Is there such a thing as the "80% Solution"?
- Systems Engineering Research Center (SERC)

Summary

- **Innovation and Systems Engineering Share Similar Characteristics**
  - SE is a process leading to a product or process
  - Innovations take the form of a product or process
- **Systems Engineering Can Drive Innovation**
- **Better Systems Engineering and More Innovation Can Lead to a Better Outcomes**

Innovation is a Journey, Not Always a Destination… But Systems Engineering Can Improve Arrivals!

References

"Innovation Characteristics and Innovation Adoption-Implementation", IEEE Transactions on Engineering Management; Tornatzky and Klein, "February 1982 http://www.management.wharton.upenn.edu/klein/documents/Tornatzky_Klein_1982.pdf

"Inhibitors of Disruptive Innovation Capability: A Conceptual Model", European Journal of Innovation Management

Ramaswamy, Venkat and Gouillart, Francis, "Building the Co-Creation Enterprise", Harvard Business Review, Oct. 2010

"Thinking and Acting Systemically" - http://blog.pegasuscom.com/Leverage-Points-Blog/bid/88579/Thinking-and-Acting-Systemically

"A New Profession is Emerging: The Decision Coach" http://bakerstreetpublishing.com/2012/07/13/a-new-profession-is-emerging-decision-coach-2/?goback=.gde_1218517_member_159024560

"Top Three Characteristics of Innovative Companies"; McFarlin, Kate, Demand Media

"Six Characteristics of Highly Effective Change Leaders"; Clay, Brett

"Where Good Ideas Come From", Steven Johnson

"Why Being a Boss is Like a Hostage Crisis" http://www.cnn.com/2012/08/30/opinion/hostage-secure-leader-kohlrieser/index.html?hpt=hp_c3

"Educating Your Management Team About Innovation"; OVO Innovation 2008

Abstract

Innovation can take on many forms and meanings. Meanwhile, the diversity of the Systems Engineering process lends itself well to various system implementations, some that might be considered innovative, which span the commercial and defense industries. Unfortunately, there are also characteristics of the innovation process, such as speed and agility, which many would argue preclude the use of today's sometimes rigorous and cumbersome Systems Engineering activities. At issue is how to maximize the benefits of proven systems engineering practices to the innovation process and reformulate those activities which are arguably ineffective.

This briefing examines innovation and evaluates the components of the systems engineering process which best drive the innovation process. Disciplined processes, trade studies, risk activities, and others are cross-examined for their value proposition to innovation on programs. The briefing then asks the question as to whether we can do better, including establishing the proper expectations and plans, choosing the right participants, providing the enabling environment, defining the valued outputs, and predicting outcomes. It then presents a vision for tomorrow's systems engineering which involves newer, emerging techniques and technologies that can lead to higher levels of innovation along with perhaps reduced complexity, both in the engineered systems and the systems engineering process itself.