Systems Engineering in the S&T Environment

Best Practices and Other Lessons Learned from the Air Force Research Laboratory

October 2008

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Overview

- AFRL's SE Problem
- The TASE Study
- TASE Assessment Results – Best Practices
- TASE Recommendations
- Conclusions

AFRL's SE Problem

- **Technology development and maturation are a contributing element to the acquisition process**
- **Recent acquisition "failures" have resulted in an increased DoD focus on systems engineering**
- **AFRL is also being asked to do more with fewer resources**

So – why shouldn't AFRL apply systems engineering in its activities?

AFRL's SE Problem - Continued

- **Because…**
  - **"SE is acquisition oriented, and we do research"**
  - **"AFRL programs are small with limited budgets, and SE adds a resource burden"**
  - **"SE focuses on customers and requirements satisfaction, and research programs don't have either"**
  - **"Structured approaches like systems engineering will stifle creativity in research"**

"We don't need no stinking SE!"

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The TASE Study

- AFRL commissioned the Transformational Activities in Systems Engineering (TASE) study in 2006
- 3 Phases
  - Assess AFRL's current SE state of practice: determine DoD/AF requirements; assess current SE policy, practices, and tools (2006)
  - Recommend improvements to AFRL's SE policy and practices (2007)
  - Implement and sustain an approved AFRL SE process (2008+)

TASE Assessment Process

- **Assessment based on:**
  - **Review of DoD and AF SE guidance**
  - **Interviews with AFRL Advanced Technology Demonstration (ATD) and other high-priority program personnel (52 programs assessed)**
- **Facilitated by GD-AIS contractor team**
  - **5 senior systems engineers**
  - **Former Director of the AF Center for Systems Engineering**

TASE Assessment Results

- ***Intent* of DoD guidance *encourages* use of SE in research activities**
- **SE was not foreign to AFRL personnel, but few programs used a full set of SE processes**
- **The S&T environment is "different"**
  - **Variable program size**
  - **"Soft" requirements (aka "desirements")**
  - **Collegial (vs hierarchical) relationships**
  - **Instability in customer base**

These factors drive the tailoring of SE to S&T

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AFRL S&T Systems Engineering Example: Requirements Development and Roadmapping

- **AFRL use of the Integrated Product and Process Development (IPPD) process**
  - **High Energy Laser on a Large Tactical Platform (HELLTP)**
  - **Next Generation Unmanned Aerial System**
  - **Multiple small programs**
- **SE Successes**
  - **Increased understanding of "customer" needs**
  - **Better focus on which technology areas to pursue**
  - **Increased potential for successful transition**

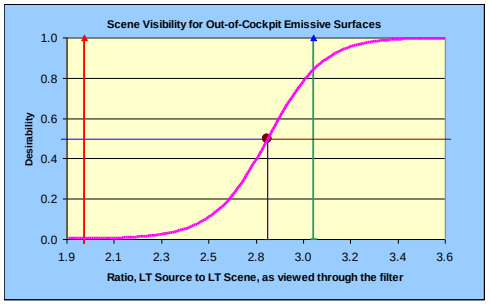
AFRL Systems Engineering Example: Full Systems Engineering Implementation

- **The Advanced Tactical Directed Energy System (ATADS) ATD used SE processes to successfully meet its program objectives**
  - **Result was up to an order of magnitude reduction in weight and cost from the existing airborne infrared countermeasures system with increased performance**
- **SE Successes:**
  - **Lab-led requirements development and management including IPT with user, PO, and contractor resulted in responsive but controlled requirements that balanced user needs with technical realities**
  - **Continuous risk management successfully responded to technology and program issues**
  - **Model-based decision analysis improved both requirements and design choices**
  - **Strong contractor SE processes, monitored by Lab managers, ensured matured technologies and integration met Lab needs**

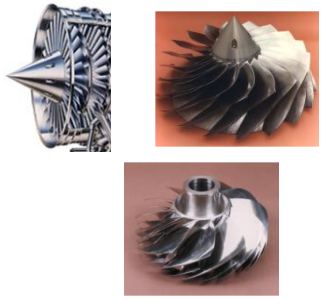
AFRL Science & Technology
Systems Engineering Best Practices

- **Requirements Development and Decision Analysis**
  - Formal IPPD process tailored to AFRL's environment and "Standardized" between Directorates
  - Strong Integrated Product Teams (IPTs)
- **Risk Management**
  - Continuous process involving AFRL and contractor
- **AFRL/Contractor Relationship**
  - Strong contractor SE with AFRL understanding and oversight
- **Senior Leadership Support**
  - Designated Chief Engineers and SE Branches

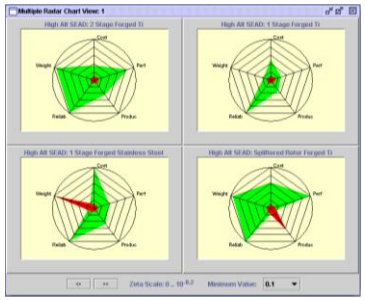
AFRL S&T SE Best Practice: IPPD Process



Customer Requirements



Technology Alternatives



Value Analysis

Technology Demonstration

Form IPT and Document Customer Requirements → **Establish Quantified S&T Exit/Transition Criteria** → **Assess Technology Alternatives** → **Perform Transition Value Analysis** → **Develop & Demonstrate Technology** → **Deliver Technology**

Transition Focused:

- Measurement-based methods
- Balanced tech trades/options
- Quantify desirability & risk

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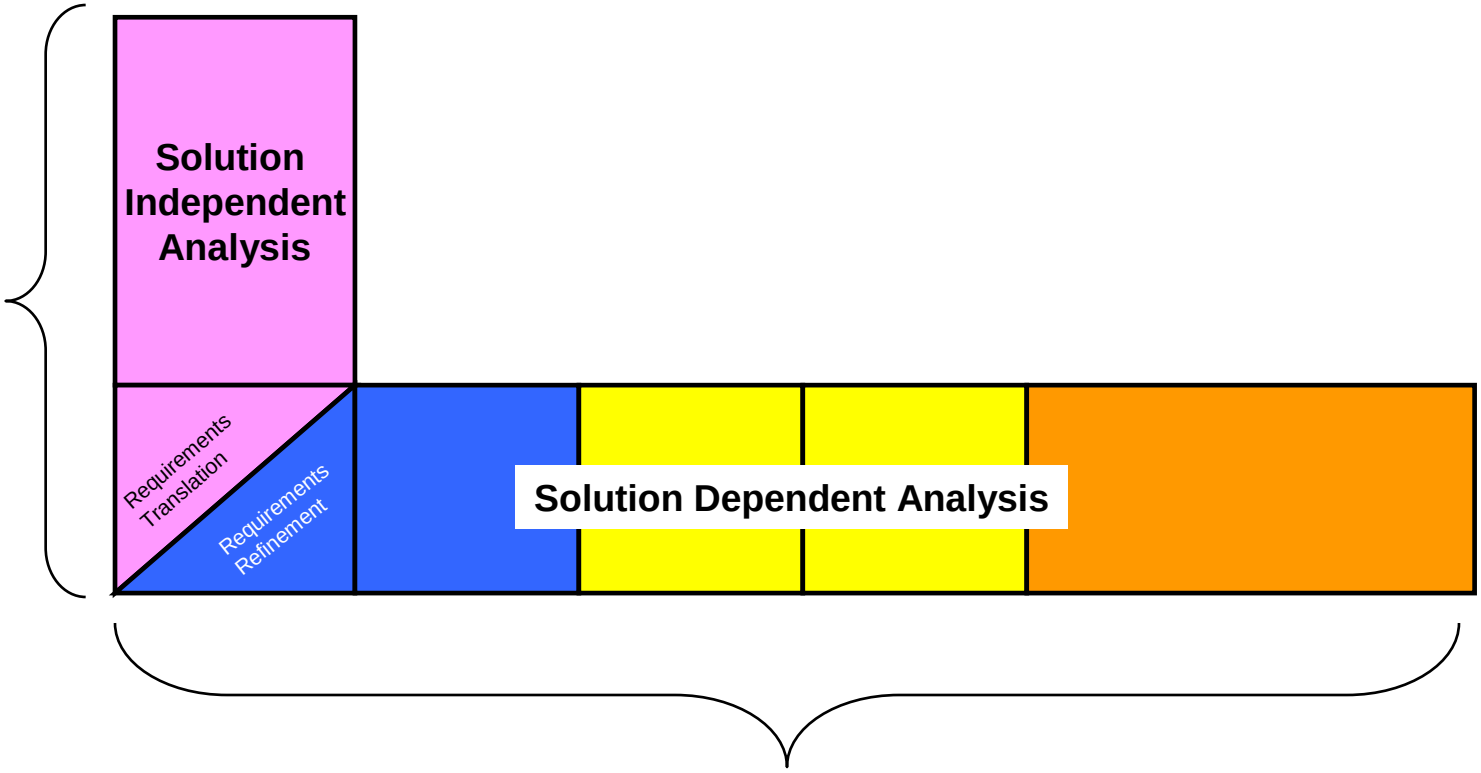
IPPD Revisited

Phase 1: Expand the problem space



TASE Recommendation: Attack the Problem on 2 Fronts

- **Cultural Change:**
  - **Build upon current SE Best Practices in AFRL**
  - **Implement a tailored, consistent, and complete SE framework that is a part of everyday operations (not a "burden")**
  - **Provide training on fundamental SE practices tailored to the research environment**
  - **Champion the S&T SE framework and supporting organization at the highest level of leadership**

TASE Recommendation: Attack the Problem on 2 Fronts

- **Cultural Change and**
- **Process Improvement:**
  - **Institute strong requirements development and decision analysis processes**
  - **Employ continuous technical management processes**
  - **Ensure AFRL technology program managers understand and have visibility into contract SE**
  - **Reduce program risk:**
    - **Foster customer intimacy, recognizing customer changes as a key factor in transition risk**
    - **Investigate technology alternatives early in the program**

Conclusions

- **AFRL has discovered that Systems Engineering is a good idea for S&T work**
- **AFRL has learned that implementing SE processes must be attacked on 2 fronts: cultural change and process improvement**
- **AFRL is implementing process and culture improvement efforts base on Best Practices**

Questions?

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