



# Systems Engineering in the S&T Environment

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



**October 2008**



# 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!”**



# 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 processes**
- **The S&T environment is “different”**
  - Variable program size
  - “Soft” requirements (aka “desirements”)
  - Complex (vs hierarchical) relationships
  - Instability in customer base

**These factors drive the tailoring of SE to S&T**



# 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



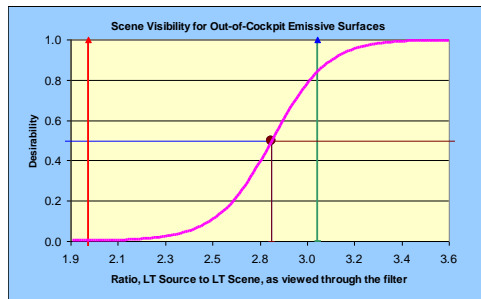
# AFRL Science & Technology Systems Engineering Best Practices



- **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



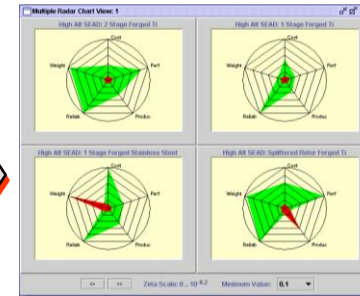
# AFRL S&T SE Best Practice: IPPD Process



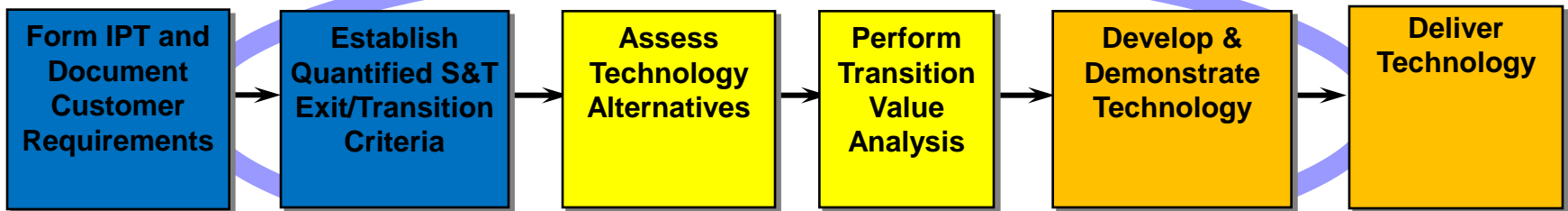
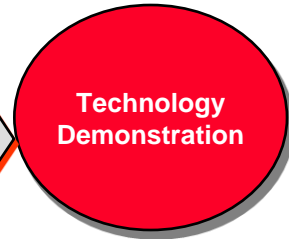
**Customer Requirements**



**Technology Alternatives**



**Value Analysis**



## Transition Focused:

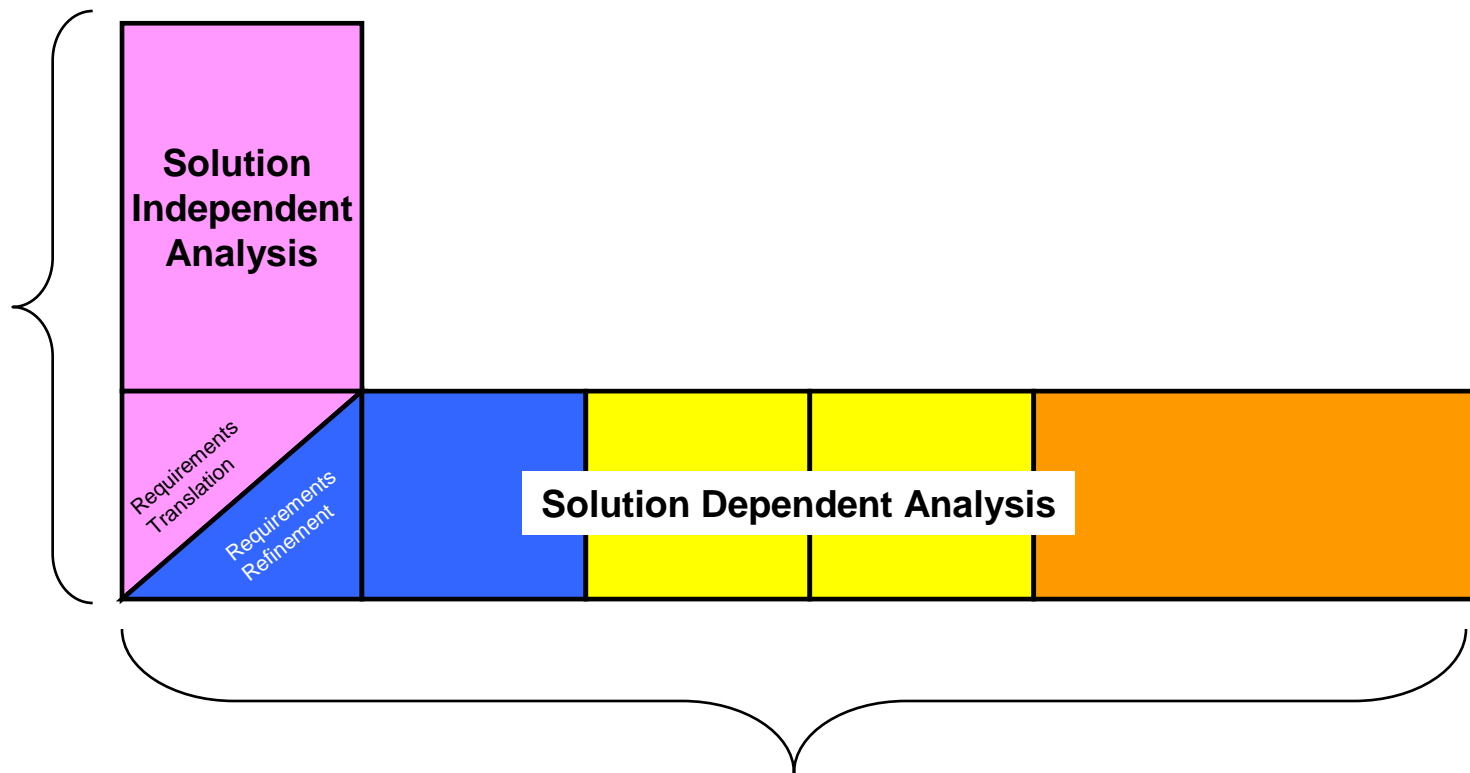
- Measurement-based methods
- Balanced tech trades/options
- Quantify desirability & risk



# IPPD Revisited



Phase 1:  
Expand the  
problem  
space



Phase 2: Expand the solution 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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