A Perspective on System Engineering – Delivering Capabilities

Briefing to Air Force Studies Board
9 Jan 2007
Dr. David Jacques
Chair, SE Programs

AF CSE Focus

- Process Improvement
  - Tools Development
  - Research and Application
- Rotational program
- Academic programs
  - Graduate programs – MS, PhD & certificate
  - Intermediate Developmental Education (IDE) Program
  - Professional Continuing Education (PCE)
  - Seminars, workshops, short courses
  - Outreach—provide accessibility at key locations
- Case studies
# A Perspective on System Engineering - Delivering Capabilities

**Author:**

Air Force Institute of Technology

2950 Hobson Way

WPAFB, OH 45433-7765

**Abstract**

The original document contains color images.

**Subject Terms**

Report

Abstract

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Systems Engineering Case Studies*

C-5 Galaxy
F-111 Aardvark

Currently available case studies provide good and bad examples of pre-acquisition activity
- New cases underway

Hubble Space Telescope
TBMCS (Theater Battle Management Core Systems)
JASSM (FOUO)

* Available at:
www.afit.edu/cse/

The Challenges

- **Policy**
  - Policy alone will not solve current problems
  - Valid measures of success needed
- **Tools**
  - Exist, but not always used and understood
- **People**
  - Insufficient expertise for pre-acquisition activities in both requirements and acquisition communities
Related Policy Initiatives

- **Joint Capability Integration & Development System**
  - Responsible for developing, approving capability documents
  - Implementation still troublesome after 3+ years

- **DoD Architecture Framework**
  - A tool, not a method or solution by itself
  - Many building architecture products, few using integrated architectures

- **OSD Concept Decision/Evaluation of Alternatives Initiative**
  - Attempting to address problems with transition from JCIDS to Acquisition
  - Combining Analysis of Material Approaches (AMA) with Analysis of Alternatives (AoA) prior to Concept Decision

DoD Capability Development

Current

- FSA – Functional Solutions Analysis
- EOA – Evaluation of Alternatives
- JCD – Joint Capabilities Document
- ICD – Initial Capabilities Document
- CD – Concept Decision
Cautionary Notes:
- Combined FSA & AoA still needs solid foundation from JCIDS FAA & FNA
- Not clear who is responsible for “doing” the EOA
- Combined FSA & AoA must address full range of joint concepts to achieve mission capability

Capability Development – Tools

- System Architecture
  - Most “architectures” are sets of disjoint “products”
  - Must be integrated with other analytic tools
- Modeling and Simulation
  - Fidelity must be tied to analysis questions
  - Discrete event simulation useful for architecture analysis and evaluation
- Other analytic methods
  - Utility theory – often used, underlying assumptions rarely stated or understood
  - Queuing theory – useful for evaluating architectures
  - Optimization – extremely valuable for exploring trade space
- Cost estimation
  - Insufficient parametric and analogy based cost estimation expertise
Capability Development – People

SE process implemented by distinct communities:

- Acquisition Personnel – Typical Focus
  - Ongoing challenges associated with aging acq. workforce
  - Need continued focus on growing personnel with relevant technical backgrounds
    - Concerns for Engineering Technology vs. Engineering degree
  - Need more incentives/opportunities for pursuing technical MS

- Requirements Personnel – Often Overlooked
  - Lack sufficient personnel with relevant technical backgrounds
  - Accession system does not identify needs for technical operators
  - Few incentives/opportunities for pursuing advanced technical education
  - Especially problematic within space community

The communities responsible for capability development do not have the requisite numbers, background and toolset!

SE Education Opportunities

- AFIT has significantly expanded offerings and accessibility of SE programs
  - 12 month resident MS program for AF IDE selects
  - New PhD program
  - Traditional thesis based MS program is now available for part-time students via Distance Learning (DL)
  - Graduate certificate program available for part-time students via DL
  - Continued expansion of DL sites planned, but depends on tuition funding by AF organizations

- Collaborative agreements with civilian universities in place at several locations and possible at others
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Air University: The Intellectual and Leadership Center of the Air Force
Integrity - Service - Excellence

AFIT SE Programs

Systems Engineering Program

1. Core courses cover process, method, and tools applicable throughout the life cycle, with emphasis on Pre-A/B activities.
2. Individuals with non-technical BS degrees may be admitted, but generally require math and other preparatory courses in addition to MS program requirements.

Pre-A SE Research and Application
Relevant Research and Engineering Applied to AF/DoD Problems

Sponsored Projects by:
- Air Force Research Laboratory
- Air Combat Command
- Air Force Special Operations Command
- Air Force Space Command
- National Reconnaissance Office
- Joint Forces Command
- Aeronautical Systems Center
- Air Force C2ISR Center
- 56th/705th Training Squadrons
- Air Armament Center
- Air Staff and others

Student Thesis – Mar 05
Sponsor – AFRL/VS
- TACSAT operational utility
- Logistics impact

Can Provide Systems Analysis, Trade Studies, Design, Operations Concept and Requirement Analysis in 3-9 months!
AIR FORCE CENTER FOR SYSTEMS ENGINEERING  
ANALYSIS OF NEAR SPACE VEHICLES (NSV) FOR THE MISSION OF PERSISTENT ISR  
Research Sponsor: National Reconnaissance Office  
Maj Jack Allen, Maj Steve Buzon, Maj Brian Miller, Maj Scott Wierzbanowski  

Methodology  
- Derived applicable threads via Future Concept Documents  
- Determined appropriate MOP’s/MOE’s for derived threads  
- Analyzed Capabilities, DOTMLPF, Risk/Feasibility  
- Developed application to compare NSV alternatives  

Results  
- Global Hawk ➔ HALE  
- HALE UAV  
  - Low cost  
  - Maturing technology  

AFIT SE Graduate Assignments  
IDE Graduates ideally suited for Joint Staff, MAJCOM and Unified Command jobs  
- Requirements (J8, AF/XOR, ACC/DR, AFSPC/DR, J3 Ops/Plans)  
- Warfighter Integration (J6, AF/XC)  
- Program Element Monitor (SAF/AQ)  
- Advanced Planning and Program Offices  

Feedback from graduates and supervisors indicate direct application of SE in follow-on assignments  
- “I’m working on a new information operations capability for USSTRATCOM; building a new Capability Development Document (CDD)—just thought you would like know I’m one more example demonstrating the SE Program IS preparing IDE students for their next job as tasked by SECAF”  
- Graduate at AF/XOX – “I find myself producing, maintaining and reading architecture products to support AF CRRA process … I’m using utility theory to weight systems, capabilities, activities and tasks for overall assessment … all things I studied at AFIT!”  
- AFMC SES having difficulty hiring architects with DoD perspective; “sounded like a perfect match for AFIT IDE people to me”  

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Professional Continuing Education (PCE)

- Excellent way to reach large numbers of both broad and targeted audiences
  - Provides familiarity, not expertise
- 17 Systems Engineering Courses Currently Available
- 5 Courses in Development
  - AFIT
    - HSI 161 – HSI Requirements Generation
    - HSI 260 – HSI Implementation in the Acq Process
    - Critical Safety Items
  - AFMC/EN
    - Systems of Systems Engineering
    - Systems Engineering Plan Writing
- 20+ Additional Courses have some SE content
- Course Management
  - AFIT is the PCE Course Administrator
  - AF Center for Systems Engineering evolving to single focal point for SE

SE Education Concerns

- Accession system not addressing technical needs
- AF has cut back significantly on resident graduate opportunities
  - AFIT IDE program now at 43 students (FY07) from high of 220 (FY05)
    - Fewer opportunities for operators to get relevant technical degree
  - Overall AFIT quotas now down to pre-2002 levels
  - Example: Turkish AF now sends as many students to AFIT for graduate space education as the USAF!
- Policy alone will not solve the problem
  - AF needs technical operators as well as skilled acquisition and sustainment personnel
Summary

- SE policy without addressing personnel needs will not solve problems
  - Workforce initiatives associated with Pre-Milestone A activities must include both the requirements and the acquisition community
- SE toolset exists, but needs wider dissemination and understanding
- Expanded SE education – to include more requirements personnel – could be the biggest payoff
  - Large draw-downs in AFIT IDE students are hurting efforts
  - AF organizations struggling to resource part-time students in local, DL programs

Questions?