Modeling Hardware Development Cost in a Low TRL / Pre-Acquisition Environment

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Advanced Technology in the News....

US Air Force names new stealth bomber as B-21 "Raider"

Super laser weapons are coming to Navy ships

Laser comms from space gets another test

U.S. Military Successfully Demonstrates Microdrone Swarm
Agenda

- Background
- Challenge
- Case Study
- Potential Solutions
- Future Research
Background

- Some technology must be matured prior to acquisition
- Research lab objective: Discover, Develop and Integrate
- Comparison to traditional acquisition programs
  - Similarities
    - Cost estimation, Sys Eng, Prog Mgmt still occur
    - Proposal eval, contracting functions required
    - Development activities similar to acquisition program
  - Differences
    - “End State” is not necessarily a fielded system
    - Production not a consideration; affordability may be
    - Iterative development may take longer
    - Testing, scaled prototyping, demonstration is key
    - New norm: lack of analogies, schedules, requirements
Challenge

- Apply cost estimation “tool kit” to novel programs
- TRL cost drivers
- Forecast effort for acquisition transition
- Identify affordability early
- Define requirements
- Budget constrained, vice requirement driven
AFRL Unique Challenges

- Identity
  - Science & Technology vs. Integration & Demonstration
- Unique “never been done before” mentality
- Requirements not always shared within program
- Lack of DoD 5000.02 rigor
- Potentially substantial follow-on EMD program to deliver
- Engineer & program management estimates
- Internally funded
Pre-Acquisition Environment

Problem Statement

Research Lab Reality

Scaled / Demo Testing

Science & Technology

Validation & Verification

Requirements Definition

System Design

Traditional Acq Reality

Development Engineering

Development Mfg.

Test and Evaluation

Modeling & Simulation
Case Study – Novel EO/IR Device

- Demonstrate novel concept
- SME initial ROM
- Devil is in the details
- iROM excluded
  - Inflation
  - Lab overheads
  - Uncertainty
  - Applicable wrap rates

![Chart showing Novel EO/IR Estimate Growth Over Time/Iteration]
Novel EO/IR Device Analogy

- **Possible Analogies**
  - EO/IR sensors
  - FLIR

- **Data Sources**
  - CSDR / 1921s
  - EVM and SAR data
  - Tribal knowledge
Novel EO/IR Device Parametric Cross Check

- Commercially available cost estimating framework

- Cost drivers
  - Hardware functionality
  - Operating environment
  - Weight

- Calibrate for low TRL environment
  - Requirements instability
  - Iterative development
  - Partial prototyping
  - Less rugged end item
  - Less stringent operating environment, i.e. brass boarding
Case Study – Novel Ordnance

- Discover & develop new warhead technologies
- SME initial ROM: Y
- iROM BOE: 140%·Y
- Parametric crosscheck: 130%·Y
- iROM excluded
  - Inflation
  - Lab overheads
  - Uncertainty
  - Applicable wrap rates
Novel Ordnance Technology Discovery

Problem Statement

- Unique effort
- Rigorous design of experiments
- Continual model validation & test/verification
- No finite end

Science & Technology Validation & Verification

Modeling & Simulation
Novel Ordnance Analogy

- Analogous Programs
  - SDB
  - FLM
  - SEM

- Skepticism comparing old programs to “novel” programs

- Normalize content & complexity
Novel Ordnance Parametric Cross Check

- Commercially available cost estimating framework

- Cost drivers
  - Hardware functionality
  - Operating environment
  - Weight

- Calibrate tools for low TRL environment
  - Requirements instability
  - Iterative development
  - Partial prototyping
  - Less rugged end item
  - Less stringent operating environment
Challenges of Case Studies

- Normalizing between SDD and pre-EMD
- Analogous small programs “fly under radar”
- Mix resources between programs
- Classified or proprietary programs
- Developing S&T cost data bases
Cone of Uncertainty

As program and technology mature, uncertainty tolerance will likely be reduced.
Potential Solutions

- **Piecing together analogies**
  - Development testing from Program A
  - Integration estimating from Program B
  - Scaled prototyping from Program C

- **Parametric modeling**
  - Cost drivers for immature technology
  - Differences in development time frames
  - Extrapolating affordability from lab / demo programs
    - *Production*
    - *Sustainment*
Future Research

- Can TRL transition be accurately modeled TRL 1 to 4?
- How do typical S&T programs mature over time?
- Identify unique S&T characteristics for modeling?
- At what stage can we accurately estimate affordability be established?
- Analyzing AFLCMC EMD following AFRL tech maturation
Questions?
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Mr. Jack Snyder works for the Air Force Research Labs (AFRL), supporting pre-acquisition research and development programs. Prior to joining AFRL, Jack was the lead development estimator for the MQ-9 Reaper program office. He supported annual program office estimates, budget submissions, and decision support. Jack entered civil service in 2013 and earned an MBA while supporting the HC/MC 130-J and F-22 program office where he developed cost estimating relationships and supported various business case analyses.

Mr. Joe Bauer joined PRICE Systems after twenty years of service in the US Air Force. Joe is the primary Solutions Consultant for US Air Force and Canadian government customers, providing training, mentoring, and consulting. Prior to joining PRICE Systems, Joe was the lead hardware estimator for the F-22 Raptor program office. Joe earned a Master of Science degree in Cost Analysis from the Air Force Institute of Technology in 2009. He earned an MBA from the University of Phoenix in 2005. Joe is also a Certified Cost Estimator / Analyst (CCEA) with the International Cost Estimating and Analysis Association (ICEAA). He can be contacted at Joe.Bauer2@pricesystems.com