



Uncertainty Management in AoAs:

Case Study of an ACAT ID Program's Approach Plan in Using the ACEIT 7.3 Suite of Tools

Tomeka S. Williams

Senior Operations Research Analyst, Team Lead

Ground Combat & Support Vehicles

Tomeka.Williams.Civ@mail.mil

Office 703-697-1576



Overview

ODASA
Cost &
Economics

- ❖ Background
- ❖ Cost Analysis Policy
- ❖ AoA Purpose and Intent
- ❖ Areas for Uncertainty Considerations
- ❖ How to Conduct Uncertainty Analysis
- ❖ Uncertainty Management in ACEIT 7.3
- ❖ Questions



Background

❖ What is an AoA?

- A key element of the Defense acquisition process.
- Analyzes a spectrum of solutions to fill a set of identified capability gaps.
 - Each alternative is analyzed and rated not only based on its military utility but also its cost effectiveness.
- This is conducted in the Milestone-A timeframe before an acquisition program is established and updated at each major milestone.

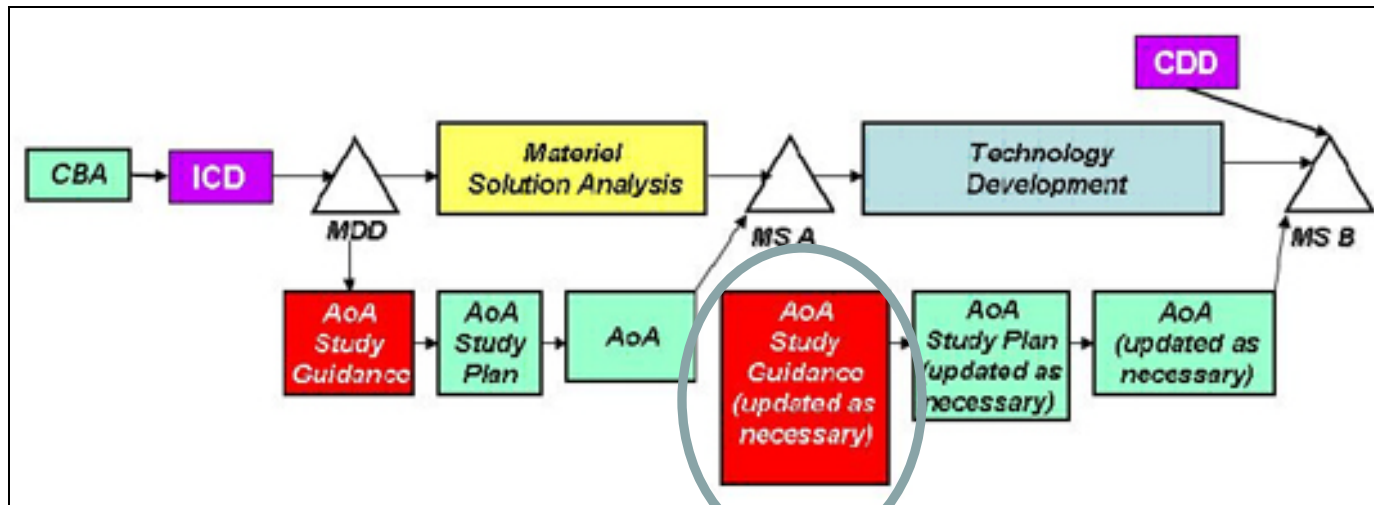


Figure 2: The AoA Within the Defense Acquisition Management System
(Source: Defense Acquisition Guidebook Dated 19 March 10)



Milestone-B Cost Analysis Policy

- ❖ **Weapon Systems Acquisition Reform Act of 2009**
- ❖ **DoDI 5000.02 Revision (8 December 2008)**
 - Mandatory Materiel Development Decision (MDD)
 - Milestone-B Independent Cost Estimates
 - Milestone-B Component Cost Estimates
 - **Milestone-B Analyses of Alternatives (AoA)**

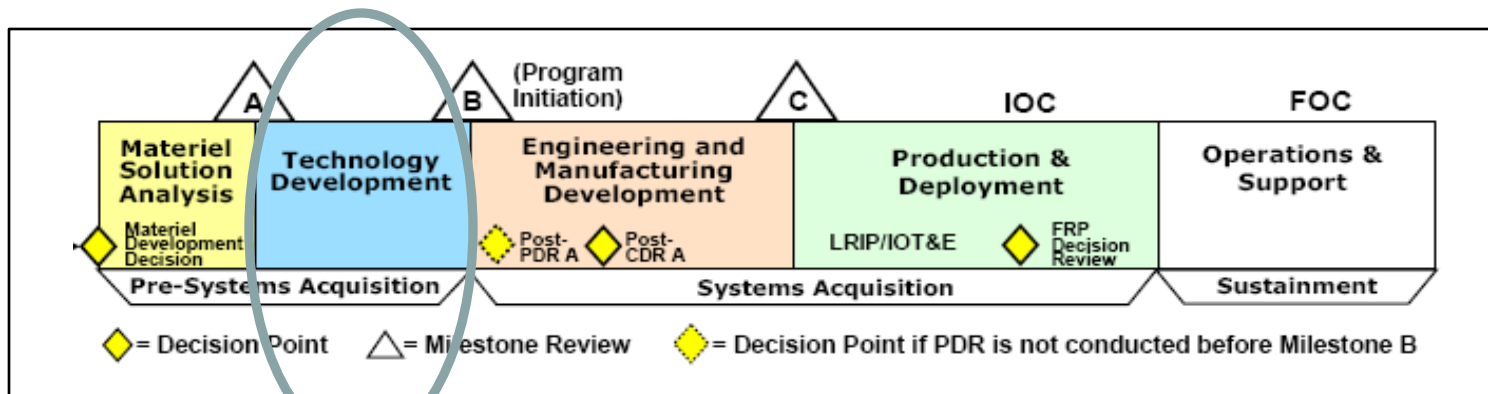


Figure 1: The Defense Acquisition Management System
(Source: DoDI 5000.02 Dated 8 December 08)



AoA Purpose & Intent

- **ACAT ID Program AoA Dynamic Update will:**
 - Inform DA and OSD of the full range of viable options to meet the warfighter's needs
 - Determine affordable and achievable set of requirements that provide significant operational utility to support the goal of opening the requirements gap as wide as possible to facilitate a Engineering and Manufacturing Development Phase full and open competition
 - Illuminate the trade-space inherent in achieving varying degrees of the requirements.
 - Identify technical , schedule, and **cost risk (uncertainty)** that the potential AoA candidates may face as a vehicle replacement.



How to Conduct Uncertainty Analysis?



1. Determine and discuss with technical experts the level of cost, schedule, and technical risk associated with each WBS element;
2. Analyze each risk for its severity and probability;
3. Develop minimum, most likely, and maximum ranges for each risk element;
4. Determine type of risk distributions and reason for their use;
5. Ensure that risks are correlated;
6. Use an acceptable statistical analysis method (e.g., Monte Carlo simulation) to develop a confidence interval around the point estimate;
7. Identify the confidence level of the point estimate;
8. Identify the amount of contingency funding and add this to the point estimate to determine the risk-adjusted cost estimate;
9. Recommend that the project or program office develop a risk management plan to track and mitigate risks



Common Cost Drivers that Impact Areas of Uncertainty & Risk to Cost Growth/Savings

1. Shorter or longer economic life;
2. The volume, mix, or pattern of workload;
3. Potential requirements changes;
4. Configuration changes in hardware, software, or facilities;
5. Alternative assumptions about program operations, fielding strategy, inflation rate, technology
6. Heritage savings, and development time;
7. Higher or lower learning curves;
8. Changes in performance characteristics; testing requirements;
9. Acquisition strategy, whether multiyear procurement, dual sourcing, or the like;
10. Changes in labor rates and material costs
11. Growth in software size or amount of software reuse; and
12. Down-scoping the program;
13. Quantity reduction or increase.

Reference: GAO Cost Estimating and Assessments Guide



Cost Uncertainty Analysis



❖ The Need For:

- Without risk analysis, a cost estimate will usually be a point estimate, which may not account for all of the uncertainties inherent in the effort
- Not accounting for potential uncertainties may lead to underfunding, cost overruns, and the potential for a program to be reduced in scope in the future

❖ Operational Definitions:

- Uncertainty is the indefiniteness about the outcome of a situation. Uncertainty is assessed in cost estimate models for the purpose of estimating the risk's or opportunity's (probability) that a specific funding level will be exceeded
- Risk/ Opportunity is the probability of an unfavorable/ favorable outcome occurring (i.e. the probability of overrunning/ underrunning the estimated cost)
- Cost uncertainty & risk/opportunity analysis identifies the cost, in terms of dollars, time, and materials that should be added to a point estimate to increase the probability of meeting the desired outcome

❖ Analysis Methodology:

1. *Identify Areas of Uncertainty within the Cost Estimate*
2. *Address the Uncertainty within the Cost Estimate*
3. *Quantify the Risk/Opportunity within the Cost Estimate*
4. *Presentation of Results*



Cost Uncertainty Methodology: Step 1



1. Identify Areas of Uncertainty:

❖ Objective is to identify areas where variance may have an impact on future costs, and to establish lower and upper bounds to bound this variability.

➤ Potential areas of uncertainty include:

- Cost Estimating: Variability inherent in cost estimating data and methodologies used
- Technical: Variability in the range of technical options possible to meet requirements
- Schedule: Variability due to potential fluctuations in duration of activities
- Requirements: Variability due to potential changes in system performance
- Programmatic: Variability due to changes in the program's acquisition strategy

➤ Combat and tactical vehicle data sources include:

- Historical data / trends
 - Cost growth reports
- Programmatic documents
 - Initial Capabilities Document (ICD), Capability Development Document (CDD), Capability Production Document (CPD)
- Discussions with Subject Matter Experts (SMEs)
- Analogous system data- **CSDRs and SRDRs, EVM, Contract and Budget Data Reports**



Cost Uncertainty Methodology: Step 1

Specific Areas of Uncertainty Cost Growth/Savings

- Cost Estimating: Variability inherent in cost estimating data and methodologies used
 - Potential Cost Growth –Average Development Cost Growth Factor of 1.45 - 2007 RAND Study- “Is Weapon System Cost Growth Increasing?”
- Technical: Variability in the range of technical options possible to meet requirements
 - Potential Cost Growth associated if technology integration approach could be difficult even though individual technologies are relatively mature
- Requirements: Variability due to potential changes in system performance
 - Potential Cost Growth/Savings associated with partial Protection System induction strategy for IFV
- Programmatic: Variability due to changes in the program’s acquisition strategy
 - Potential Cost Growth associated if current PM Schedule and chosen Contractor’s ability to staff up quickly is not enough to successfully execute the IFV program.
- Schedule: Variability due to potential fluctuations in duration of activities
 - Potential Cost Growth associated with Tech Development (TD) phase to first Production ready vehicle requires more than 7 years

(Past systems trend in schedules for TD to production require more than 7 years on next slide)



Cost Uncertainty Methodology: Step 2



2. Address the Uncertainty within the Cost Estimate:

- ❖ Need to determine which identified uncertainties to model (i.e. which are cost-sensitive/cost drivers)
- ❖ Cost methodology highly dependant, reliant upon data available
- ❖ Application of uncertainty dependant upon cost methodology
 - Uncertainty assessment is best done at the lowest-level variables possible
 - Important to identify uncertainty associated with cost drivers at a minimum
- ❖ Selection of appropriate probability distribution for each risk element is critical

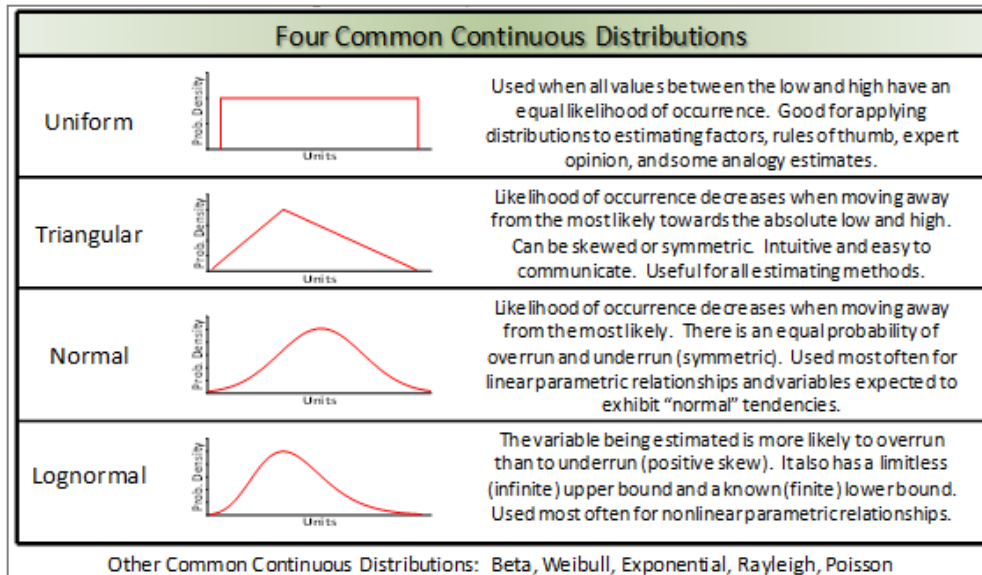


Figure 1: Common Risk Distributions



Cost Uncertainty Methodology: Step 3



3. Quantify the Risk within the Cost Estimate:

- ❖ ODASA-CE utilizes the Automated Cost Estimating Integrated Tools (ACEIT)
 - Integrated within ACEIT is a simulation-based risk analysis capability (RISK) that allows the analyst to perform cost, schedule, and technical risk and uncertainty analysis
 - Provides the capability to calculate risk results for various confidence levels using Latin-Hypercube sampling
 - Input: Specification of risk within ACEIT

WBS/CES Description	Point Estimate	Equation / Throughput	RISK Specification	Distribution Form	PE Position in	Low (% of PE)	High (% of PE)
5.10 SYSTEMS ENGINEERING/MGMT	\$ 40.452 (50%) *						
5.101 Project Mgmt Admin (PM Civil)	\$ 40.452 (50%) *	SEPM_CIV_FACT	Form=Triangula	Triangular	Mode	90	110

Figure 2: Specifying a Risk Distribution within ACEIT

- Output: ACEIT risk statistics report
 - Displays statistical results in Base Year (BY) dollars for each WBS element at the specified confidence level

WBS/CES	Point Estimate	Mean	Std Dev	CV	5.0% Level	10.0% Level	15.0% Level	20.0% Level
5.10 SYSTEMS ENGINEERING/MGMT	\$ 40.452 (50%)	\$ 40.451	\$ 3.657	0.090	\$ 34.343	\$ 35.515	\$ 36.404	\$ 37.166
5.101 Project Mgmt Admin (PM Civil)	\$ 40.452 (50%)	\$ 40.451	\$ 3.657	0.090	\$ 34.343	\$ 35.515	\$ 36.404	\$ 37.166
5.102 Other								

Figure 3: Example Statistics Report within ACEIT



Cost Uncertainty Methodology: Step 4

4. Presentation of Results:

- ❖ ACEIT can also be used to formulate a Cumulative Density Function (CDF) or S-Curve
 - Each point on the S-Curve identifies the cumulative probability that the associated cost on the x-axis will not be exceeded. This is referred to as the level of confidence in a particular estimate.

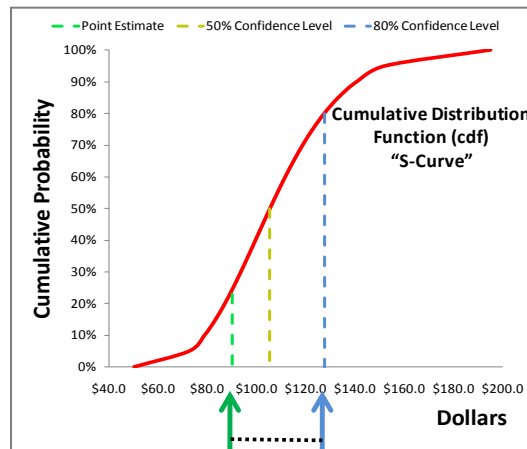


Figure 4: Example S-Curve

- ❖ AoA cost estimates are presented as a point estimate at the 50% confidence level accompanied by a risk-informed cost range ($\pm\sigma$)



Uncertainty Management in AoAs with ACEIT 7.3

- ❖ Collect data to determine what credentials specify that they are a SME (years of experience, categorization, to weight responses of SMEs)
- ❖ Build Survey for SMEs to respond to a Scoring Matrix in Support of Current Inputs used for ACEIT Cost Model
- ❖ Build Correlation Within ACEIT Cost Model in the Ri\$K Basic worksheet
- ❖ Conduct Convergence Testing to Determine Ideal # of Iterations Have Been Simulated Prior to Running Last Risk/Opportunity Adjusted Point Estimate



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Tomeka S. Williams
Senior Operations Research Analyst, Team Lead
Ground Combat & Support Vehicles

Tomeka.Williams.Civ@mail.mil

Office 703-697-1576