Linking Cost Estimating with Earned Value Management (EVM)

presented by:

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Outline

- In the Law
- GAO Participation
- The Problem
- A Concept for The Solution
- Earned Value Data
- Linking Cost Estimating and EVM
- Summary
Federal Acquisition Regulation Rule

- Requirement to implement earned value management system (EVMS) policy. Essential to help standardize the use of EVMS across the Government.
- Requires agency heads to approve or define the cost, performance, and schedule goals for major acquisitions and achieve, on average, 90 percent of the cost, performance and schedule goals established.
- Establishes standard EVMS provisions, a standard clause and a set of guidelines for Government-wide use.
- Includes the requirement and timing of an Integrated Baseline Review (IBR), whether prior to or post award.
GAO Participation

GAO Cost Estimating and Assessment Guide

- Employing cost estimating techniques on a variety of audits.
- Reviewing data, such as contractor cost performance reports and program manager's life cycle cost estimates, GAO can determine if a program is on track in terms of its cost, performance and schedule (EVM)
- Cost Estimating and EVM begin to be linked so GAO auditors have ability to understand and recommend to agencies how to strengthen cost estimating which will improve EVM processes, procedures and controls
Example GAO Report: Joint Strike Fighter (F-35)

- Used GAO Cost Estimating and Assessment Handbook in evaluation
- Cost of program increased by $23B in one year
- Ineffective use of Management Reserve
- Risk due to reducing important test requirements
- EVM assessment shows 2/3 of funds expended but only ½ of the work accomplished
- Cost estimates are unrealistic
  - Optimistic ground rules and assumptions
  - Omission of critical items
  - Poor documentation without justification
- EVM data ineffective due to poor baseline development and deficient reporting processes
In the year 2054, the entire defense budget will purchase just one aircraft. This aircraft will have to be shared by the Air Force and Navy 3-1/2 days each per week except for leap year, when it will be made available to the Marines for the extra day.

(Current US Defense Budget - $553B)
(Total Cost for Joint Strike Fighter - $1,000B)
Influences
On Cost Realism

Our focus, credible cost estimating and EVM analysis 2nd order effects on other factors

Leadership, Industry, Politics
Programming, Budgeting
Program Mgmt, Contracting
Realistic Technical Schedule Baseline; Risks Identified
Credible Cost Analysis and EVM Reporting

Cost Community” Influence

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What This Means

- Cost Estimating and EVM (Working Together) need to be linked to:
  - Meet challenge of more accurate estimates and establish realistic baselines
  - Highlight risks
    - Cost
    - Technical/Performance
    - Schedule
  - Tie use of databases/tools to increase accuracy and responsiveness
  - Ensure Independence is critical
- The resulting model improves Program Management and ensures valid cost, schedule, and performance
• **Cost Analysts**
  – Begin work as early as the concept exploration phase of a program
  – Employ a range of methodologies based on the level of definition of the program
  – Base estimates on a wide range of data and not typically the specific programs actuals
  – Drive the identification and quantification of cost and schedule risks early on
  – Produce estimates that can serve as the basis for the program budget
  – Participate in the execution of the program only on an as needed basis
The Problem
The Earned Value Stovepipe

• *Earned Value (EV) Analysts*
  – Enter the picture at contract award which defines the specific scope of the effort just as the Cost Analysts recede
  – Gain access to a growing body of specific program data
  – Use a different set of tools to perform the analyses
  – Set the Performance Measurement Baseline (PMB)
  – Establish detailed work packages that are scheduled
  – Establish resources for each work package
    • Labor (hours) and Material (quantity)
    • Internal, interdivisional or contracted
  – Generate actuals and compare to the baseline
  – Utilize formulas for efficiency indexes and estimates into the future
The Problem - Limited Interaction

• **Cost analysts are often not a core part of the program team**
  – Called back to program after EV baseline is busted!
  – Program in the middle of replan/rephasing

• **Details (basis of the estimate) forgotten after contract award**
  – Estimate range is eclipsed by the Contract Price
  – The drivers of the estimate range (risks) are lost
  – EV Management Reserve (MR) tends to be % reductions

• **EV analysts are part of the program team but are generally not familiar with cost analysis or the estimates**

• **Each analysis is a stovepipe, but there is significant overlap in output!**
• *Each analysis is done in a vacuum*

• *EV analysts work without the Cost Analysts analytical insights*
  – Understand the possible ranges of the PV (the plan) but
  – Lack insight into the risks that drive the range…how might those effect the baseline

• *Cost analysts update estimates without the EV detail plan and performance*

• *Both work from a point-estimate perspective*

• *EV and Cost Analysts don’t understand the cumulative probability distribution around the selected PMB*
A Concept for The Solution: Linking What Each Analyst Does

- Both analysts update estimates during the execution of a program
  - Cost - Post Award or major reviews … for next budget cycle
  - EV - Periodic bottoms up Estimates-to-Complete (ETC)

- Earned Value produces a baseline (PMB) of contract
  - Bottoms up plan (estimate) of the contract (PV)
  - Captures actual costs of worked performed (AC)
  - Captures the value of the work accomplished (EV)
A Concept for The Solution
Data Set Handshakes

• Analysts can utilize the other’s data during updates to
  – Highlight differences between plan and actuals to prior estimate(s)
  – Reconcile between estimating methodologies
  – Identify scope changes, risks, and opportunities
  – Provide insight into Institutional/Management performance
  – Compare performance to historical data on similar programs

• Cost Analysts can
  – Understand the basis of the plan the team is trying to execute
  – Identify the risks that are being mitigated and that have been already realized
  – Calculate cumulative probability distribution around the selected PMB
What Are EVM and Cost Analysts Really Doing?

- **AC** (Actual Cost)
- **EV** (Earned Value)
- **PV** (Planned Value)
- **Time Now**
- **Management Reserve**
- **Schedule Slip**
- **Cost Variance**
- **Schedule Variance**
- **At Complete Variance**
- **Approx. Time Variance**
- **Risk**
EV Data
Various Levels

• Program Level – run with EV Analysis tools
  – Contract Performance Report (CPR)
  – Integrated Master Schedule (IMS)
  – Detail typically to Level III WBS
• Contract Level – run with EV Engine tools
  – Company System Description… explains process
  – Detail to Cost Account Manager (CAM) level, usually the defined level of the WBS
  – Basis for estimating “overhead,” cross cutting tasks
• Major Sub-Contract – same as Contract if reporting
• IPT/Cost Account Manager (CAM) Level
  – Notes on detail below Managed Account (Work Package)
  – Basis of estimate
Assessment of linkage helps identify potential Root Causes

- Provides frame of reference from published guidelines (ANSI/EIA 748B) and Best Practices sources from GAO, DAU, PMI et al)
- **Intensity of Linkage across the Quantitative PM Knowledge Areas**
  - 5 knowledge areas: EVM, risk, schedule, cost, and technical
- **Degrees of Discipline in implementing knowledge areas**
  - 5 degrees of discipline: organization, planning, metrics (accounting), analysis, control
- **Level of Detail in information**
  - 5 levels of detail: program, project, IPT, sub-IPT, control account
- Sets up framework for detailed estimate-to-complete (ETC) analysis and generation of Risk Indexes

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• *Estimators (both Cost and Schedule) develop probability distributions that incorporate risk and opportunities impacts*

• *Simulations tools calculate cumulative effects and determine estimate range in cost and schedule*

• *Estimates (with Cumulative Probability Distributions) should be utilized at IBR and periodically during the program given program execution/changes*
  – Updated at a minimum during grounds up ETC efforts

• *Allows for additional Risk related EV indexes as management tools*
What a Cost Estimate Looks Like

**Percentile** | **Value**
--- | ---
10% | 516.81
20% | 538.98
30% | 557.85
40% | 575.48
50% | 592.72
60% | 609.70
70% | 629.19
80% | 650.97
90% | 683.01

**Statistics** | **Value**
--- | ---
Trials | 10,000
Mean | 596.40
Median | 592.72
Mode | ---
Standard Deviation | 63.18
Range Minimum | 450.19
Range Maximum | 796.68

Forecast: A8

**Cumulative Chart**

- Probability
- Frequency

**Frequency Chart**

- Probability
- Frequency

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• The EAC formulas are not good estimators of the ceiling price.

• Assuming 50th Percentile probability…typical program grows 25%
  – EAC formulas just above Budget at Complete (BAC)
  – Considers only efficiency (index) given scope
  – EV data needs to include SCOPE (BAC) estimate
What an EVM Estimate Looks Like

Cost Range given Risks/Opportunities
20% to 80%

Management Reserve

80% confidence value from Cumulative Probability Distribution (CPD)

PM selected BAC 50% confidence? (Planned Value)

Schedule Range given Risks/Opportunities
20% to 80%

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• *Estimating in early program phases*
• *Understanding of technology requirements*
• *Planning the technical baseline*
• *Understanding the ground rules and assumptions*
• *Identification of total program risk*
• *Planning the schedule*
• *Work Breakdown Structure development*
• *Resource analysis*
• *Historical (Actual) data*
• *Risk registers*
• *Etc.*
Summary

- Historically, the bulk of the Cost Analyst’s work was done before the contract was started.
- Responsibility for the ETC lay with the EV Analyst who utilize basic formulas without update to risk analysis.
- Data Set Handshakes provide the medium for linking Cost and EV Analyses, must get into the details of EV.
- Cost Analyst calculate cumulative probability distribution to figure EV Risk Indexes:
  - Risk Indexes integrates Risk Management into EV Management.
  - Improves understanding of ETC “ceiling” given Risks.
- Program execution improves through integrated analysis.
- Program Management is made simpler due this interaction.