# *RSK05: SAR Data Analysis, CV Benchmarks, and the Updated NCCA S-Curve Tool*

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**Abstract:** To support the development of better probabilistic cost estimates, the Naval Center for Cost Analysis (NCCA) has championed the development of the S-Curve Tool, which was well received at both the 44th Annual Department of Defense Cost Analysis Symposium (ADoDCAS) in February, 2011 (1), and the joint Society of Cost Estimating and Analysis (SCEA) / International Society of Parametric Analysts (ISPA) conference in June, 2011. This paper presents ongoing research to support both continued improvement of the S-Curve Tool and greater understanding of the nature of cost growth for major acquisition programs; its mean value (risk) and variability (uncertainty); and the components thereof. The refinement of historical benchmarks presented in the previous paper on analysis of Selected Acquisition Report (SAR) Summaries for Department of the Navy (DON) programs (2), including cost growth factors (CGFs) and coefficients of variation (CVs), enables more realistic estimates and supports better decision-making.

This paper presents the results of extensive data collection, validation, normalization, and analysis using cost variance data from SARs across all Services DoD components. By shifting from the SAR Summaries to the SARs themselves, the authors were able to decompose the previous data, which were at the level of total Acquisition cost with Quantity and Economic adjustments only, into appropriation types - Research, Development, Test, and Evaluation (RDT&E), Procurement, Military Construction (MILCON), and (Acquisition-phase) Operating and Support (O&S) - and all seven SAR Cost Variance categories. We identified and quantified two additional categories, Baseline Adjustments (identified elsewhere in the SAR) and Inter-Phase growth, which occurs when the initial Baseline Estimate of one phase does not match the final Current Estimate of the previous phase. We identified several distinct validation steps to ensure the soundness of the data, and used those steps to identify and resolve any apparent anomalies. In addition to significantly improving the granularity of the data, we more than tripled the number of data points by incorporating Army, Air Force, and DoD-level SAR programs. The data, comprising more than 400 milestone estimates from more than 300 programs, are stored in a Microsoft Access-based relational database in 3rd normal form. This allows thousands of query types (based on any combination of Service, phase, appropriation type, program year, milestone, etc.) to be run quickly without any manual manipulation of data, and ensures referential integrity by storing all data in only one place.

We re-tested previous hypotheses (2) regarding historical cost growth and variability, including tests for differences in CGFs and CVs by commodity, era, and milestone, and examined more closely the decomposition of CGF and CV by Cost Variance category, beyond just the previous Quantity and Economic (Then Year vs. Base Year) adjustments. We also revisited the comparison of the two primary CV data analysis approaches, the CV of CGFs presented in (1) and the size-effect maximum-likelihood estimation (MLE) regression approach presented in (3). For the latter, we introduce standardized residuals based on the heteroscedastic variance model to enable additional hypothesis testing. The paper includes a brief demonstration of the use of the new expanded benchmarks within the updated S-Curve Tool.

Bibliography

1. The NCCA S-Curve Tool. Richard L. Coleman, Peter J. Braxton, Richard C. Lee. Williamsburg, VA : Department of Defense Cost Analysis Symposium (DoDCAS), February 2011.
2. The Perils of Portability: CGFs and CVs. Peter Braxton, Richard Lee, Kevin Cincotta, Jack Smuck, Megan Guild, Richard Coleman, Brian Flynn. Albuquerque, NM : SCEA/ISPA Conference, June 2011.
3. eSBM Part II: Development and Application of CV Benchmarks. Brian Flynn, Paul Garvey. Williamsburg, VA : Department of Defense Cost Analysis Symposium (DoDCAS), February

# SAR Data Analysis, CV Benchmarks, and the Updated NCCA S-Curve Tool

SCEA/ISPA Conference, June 26-29, 2012

**Benjamin F. Breaux, Naval Center for Cost Analysis (NCCA)**

**Richard C. Lee, Peter J. Braxton, Kevin M. Cincotta, Brian J. Flynn, Technomics, Inc.**

# Abstract

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We re-tested previous hypotheses regarding historical cost growth and variability, including tests for differences in CGFs and CVs by commodity, era, and milestone, and examined more closely the decomposition of CGF and CV by Cost Variance category, beyond just the previous Quantity and Economic (Then Year vs. Base Year) adjustments. We also revisited the comparison of the two primary CV data analysis approaches, the CV of CGFs presented in (1) and the size-effect maximum-likelihood estimation (MLE) regression approach presented in (3). For the latter, we introduce standardized residuals based on the heteroscedastic variance model to enable additional hypothesis testing.

The paper includes a brief demonstration of the use of the new expanded benchmarks within the updated S-Curve Tool.

# Problem Statement

- Growing realization in defense cost community that commonly estimated S-curves are sometimes too narrow and risk analysis is incomplete
  - OSD CAPE, and others, cite cases where actual acquisition costs fall at the 99th+ percentile
    - For MDAPS
    - On S-curves estimated years previously
  - Anecdotal evidence that CV estimates greater than 10% difficult to achieve, in too many cases
  - Experts have seen values of under 10% at MS A, and values of ½ of 1% at roughly half way through production
- Lack of definition of CVs
  - Quantity and inflation as exogenous or random
- Inconsistency in CV estimation between and within organizations
- Guidelines on risk analysis
  - NCCA leading a DON cost-community effort
  - CV Tool and benchmark values will contribute to solution

Inaccurately steep S-curves can lead to an underestimation of the mean, misallocation of scare defense resources, and failure to understand program risk

# Objective

- The objective of the study is to provide historical benchmarks to cost estimates (S-Curves)
- This will be accomplished through the analysis of cost growth factors (CGFs) and coefficients of variation (CVs) through the SARs
- NCCA S-Curve Tool has been built in efforts to easily and efficiently compare cost estimates

# Work In Progress

- At “press time,” data validation and analysis were still underway
- We anticipate significant updates to the presentation prior to the conference

The “historical” icon indicates results published in 2011

The “under construction” icon indicates preliminary results based on the new database

- To request the latest version of the presentation, please email lead author Richard Lee
  - Rlee@technomics.net

# Outline

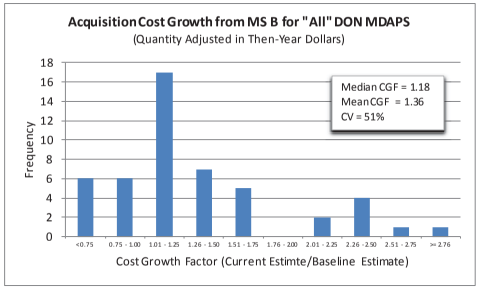
- SAR Growth Papers
- SAR Data Collection
  - SAR Data expansion
  - Added Army, AF, DoD programs
  - Broken out by Appropriation Type and Cost Growth Category
- SAR Data Analysis
  - Analysis of $ Growth, CGFs, CVs, and correlations
  - Hypothesis tests for conjectures
  - Size Effect via Maximum Likelihood Estimator (MLE) Regression
- Update to the NCCA S-Curve Tool
  - S-Curve Tool and Documentation posted to NCCA Tools page

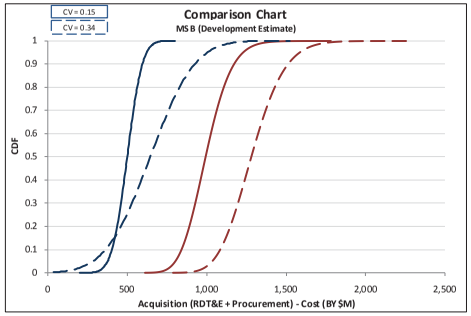
# SAR Growth Papers

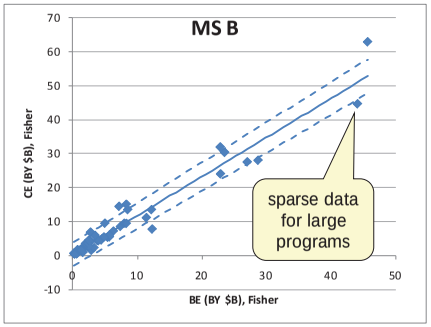
- "Development and Application of CV Benchmarks," Brian Flynn, Paul Garvey, Peter Braxton, Richard Lee, DoDCAS, 2011
- "Testing S-Curves for Reasonableness: The NCCA S-Curve Tool," Coleman, Braxton, Lee, Flynn (Hampton Roads SCEA Chapter, DoDCAS 2011, SCEA/ISPA 2011)
- "The Perils of Portability: CGFs and CVs," Braxton, Lee, Cincotta, Smuck, Guild, Coleman, Flynn (SCEA/ISPA 2011)*

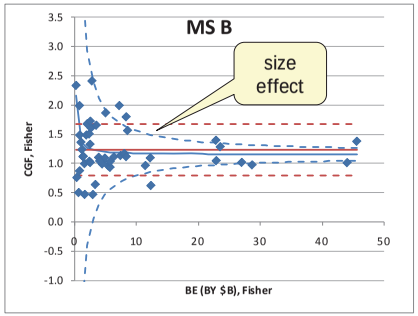
*Pleasant surprises while developing S-Curve Tool

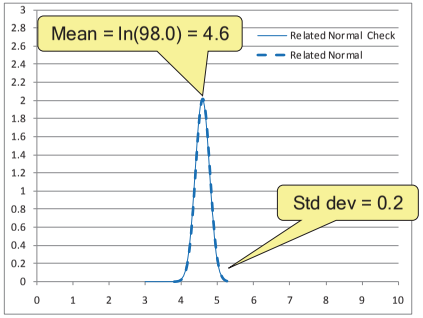
- "Probability Distributions for Risk Analysis," Braxton (SCEA/ISPA 2011)

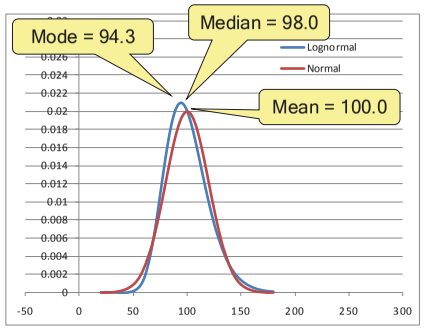


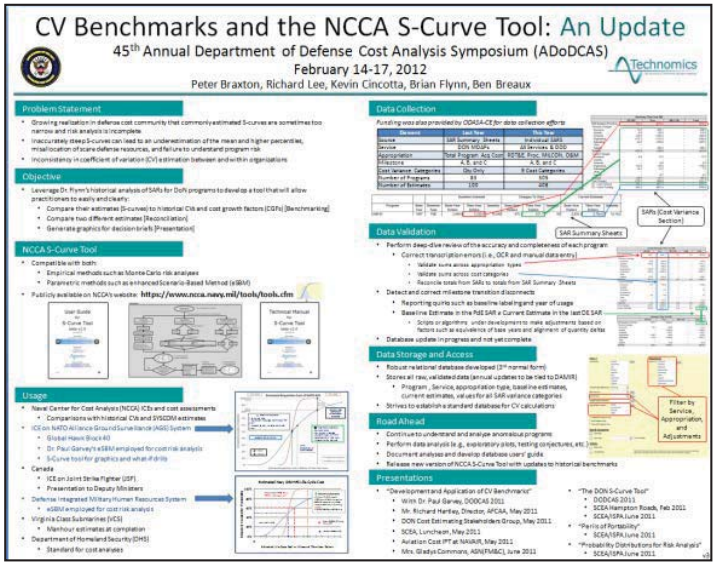



# SAR Growth Papers

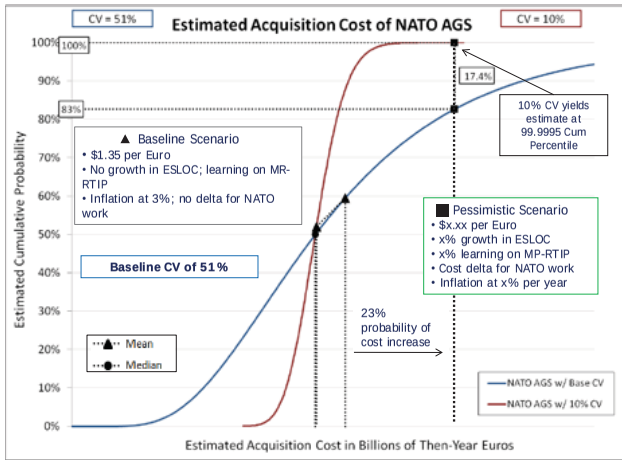
- "CV Benchmarks and the NCCA S-Curve Tool: An Update" Poster Presentation, Braxton, Lee, Cincotta, Flynn, Breaux (DoDCAS 2012)*




- "SAR Data Analysis, CV Benchmarks, and the Updated NCCA S-Curve Tool" Braxton, Lee, Cincotta, Flynn, Breaux (ISPA/SCEA, Brussels, Belgium, 14-16 May 2012)*

*Unpleasant surprises while developing SAR database

- "Enhanced Scenario-Based Method for Cost Risk Analysis: Theory, Application, and Implementation" Braxton, Flynn, Garvey, Lee (SCEA/ISPA 2012)



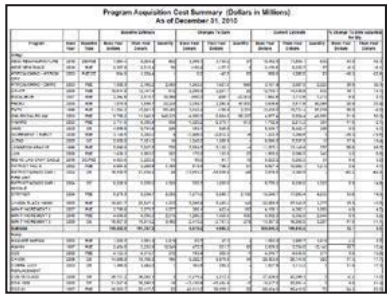
# What is a SAR?

- System Acquisition Reports (SARs) report the status of total program cost, schedule, and performance for major defense acquisition programs (MDAP)
- The SAR for the quarter ending December 31 is the annual SAR and is mandatory for all ACAT I programs
- Quarterly SARs for the quarters ending March 31, June 30, and September 30 are reported on an "exception basis"
  - One of the exceptions is a Milestone B or Milestone C approval within the reportable quarter (will revisit this later in the presentation)

# Data Collection Outline

1

Data was extracted and validated from SAR Summary Sheets to identify last SAR for a given milestone (effort funded by ODASA-CE)




2

Individual SARs were obtained from DAMIR

3

Cost Variance Tables were extracted from individual SARs

| Change Summary Then-Year $M | | | | |
|---|---|---|---|---|
| | RDT&E | Proc | MILCON | Total |
| SAR Production Estimate | 4210.0 | 17421.4 | 107.7 | 21739.1 |
| Previous Changes | | | | |
| Economic | -122.5 | +404.0 | +3.5 | +285.0 |
| Quantity | 0.0 | -15562.8 | 0.0 | -15562.8 |
| Schedule | +25.3 | +6354.0 | 0.0 | +6379.3 |
| Engineering | +161.3 | 0.0 | 0.0 | +161.3 |
| Estimating | +317.3 | +923.3 | -83.9 | +1156.7 |
| Other | 0.0 | 0.0 | 0.0 | 0.0 |
| Support | +54.6 | -804.0 | 0.0 | -749.4 |
| Subtotal | +436.0 | -8685.5 | -80.4 | -8329.9 |
| Current Changes | | | | |
| Economic | -0.9 | -30.5 | -- | -31.4 |
| Quantity | -- | -- | -- | -- |
| Schedule | -- | -- | -- | -- |
| Engineering | -- | -- | -- | -- |
| Estimating | +1.5 | -207.4 | -- | -205.9 |
| Other | -- | -- | -- | -- |
| Support | -- | -15.4 | -- | -15.4 |
| Subtotal | +0.6 | -253.3 | -- | -252.7 |
| Total Changes | +436.6 | -8938.8 | -80.4 | -8582.6 |
| Current Estimate | 4646.6 | 8482.6 | 27.3 | 13156.5 |

4

Several validation steps were taken to understand the raw data and address anomalies

| Summary Then Year $M | | | | |
|---|---|---|---|---|
| | RDT&E | Proc | MILCON | Total |
| SAR Baseline (Dev Est) | 1139.2 | 6954.1 | -- | 8093.9 |
| Previous Changes | | | | |
| Economic | -12.0 | -393.8 | -- | -405.8 |
| Quantity | -- | +395.5 | -- | +395.5 |
| Schedule | -- | +127.6 | -- | +127.6 |
| Engineering | -- | -- | -- | -- |
| Estimating | -20.9 | +80.2 | -- | +59.3 |
| Other | -- | -- | -- | -- |
| Support | -- | +905.1 | -- | +905.1 |
| Subtotal | -32.9 | +1114.6 | -- | +1081.7 |
| Current Changes | | | | |
| Economic | +1.4 | +19.7 | -- | +21.1 |
| Quantity | -- | -- | -- | -- |
| Schedule | -- | +19.9 | -- | +19.9 |
| Engineering | -- | -- | -- | -- |
| Estimating | +541.3 | +1993.3 | -- | +2534.6 |
| Other | -- | -- | -- | -- |
| Support | -- | +141.9 | -- | +141.9 |
| Subtotal | +542.7 | +2174.8 | -- | +2717.5 |
| Total Changes | +509.8 | +3289.4 | -- | +3799.2 |
| CE - Cost Variance | 1649.0 | 10244.1 | -- | 11893.1 |
| CE - Cost & Funding | 1649.0 | 10244.1 | -- | 11893.1 |

5

Prepared data were stored in relational database (MS Access)

# SAR Summary Tables

- SAR Summary Tables can be found through the following link:

  http://www.acq.osd.mil/ara/am/sar

  – Unlike the SARs themselves, SAR Summary Tables are publicly available

- Through funding from ODASA-CE, December SAR Summary Sheets were collected and validated from 1986 to 2010*

  – Program Acquisition Cost Summary
  – Cost Categories ($BY and $TY)
  – Programs are organized by Service
  – Does NOT split cost by appropriation

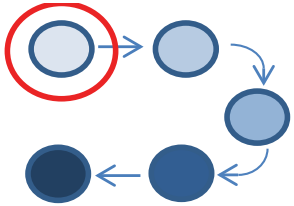
- Examples of the SAR Summary Sheets used for this analysis may be found in Backup

*December 2011 SARs were just released at "press time"

# SAR Summary Tables

- Extracted SAR Summary Sheets from PDF to Excel
- Validated and corrected transcription errors (shown in detail on next slide)
  - Validation A: Sum of Baseline Estimates (BE) and all changes to date are equal to Current Estimates (CE)
    - Applies to $BY, $TY, and Quantity columns
  - Validation B: Sum of Cost Categories are equal to Total Changes
    - Applies to $TY and $BY Cost Categories, and also to changes for "This Qtr" and "To Date" columns
  - Validation C: Total Changes in Program Acquisition Cost Summary table are equal to Total Changes in Cost Category tables
    - Applies to both $TY and $BY
- Improved program metadata
  - Populated data with PNO, since program names often change over time (e.g., DD 21 → DD(X) → DDG 1000)
  - Verified Milestone/Phase in SARs against Baseline Type (e.g., DE/PdE)

# SAR Summary Tables



**Program Acquisition Cost Summary (Dollars in Millions)**
**As of December 31, 2010**

| | | | Baseline Estimate | | | Changes To Date | | | Current Estimate | | | % Change To Date Adjusted for Qty | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Program | Base Year | Baseline Type | Base-Year Dollars | Then-Year Dollars | Quantity | Base-Year Dollars | Then-Year Dollars | Quantity | Base-Year Dollars | Then-Year Dollars | Quantity | Base-Year Dollars | Then-Year Dollars |

Validation A: Baseline Estimate + Changes To Date = Current Estimate

Validation C: Changes To Date = Total Changes

**Distribution of Cost Changes (Base-Year Dollars in Millions)**
**As of December 31, 2010**

| | | Cost Changes Between the Baseline and Current Estimate | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | | Schedule | | Engineering | | Estimating | | Other | | Support | | Total | |
| Program | Base Year | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date |

Validation B: Sum of all Cost Changes = Total Changes

**Distribution of Cost Changes (Then-Year Dollars in Millions)**
**As of December 31, 2010**

| | Cost Changes Between the Baseline and Current Estimate | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Economic | | Quantity | | Schedule | | Engineering | | Estimating | | Other | | Support | | Total | |
| Program | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date |

# SAR Summary Tables

- Used SAR Summary Sheets to identify final SAR for a given milestone estimate
  - Final SAR is sufficient, as it contains Baseline Estimate

| Program Metadata | | | | | | | Baseline Estimate | | | Changes To Date | | | Current Estimate | | | % Change To Date Adjusted for Qty | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Date | Service | Program | BY | Baseline | PNO | Unique ID | BY $ | TY$ | Qty | BY $ | TY$ | Qty | BY $ | TY$ | Qty | BY $ | TY$ |
| 12/31/10 | Army | AB3A REMANUFACTURE | 2010 | DE | 202 | 202 _DE | 7,064.40 | 8,093.90 | 602 | 3,388.10 | 3,799.20 | 37 | 10,452.50 | 11,893.10 | 639 | 43.9 | 40.1 |
| 12/31/10 | Army | AB3B NEW BUILD | 2010 | PdE | 437 | 437 _PdE | 2,307.00 | 2,510.40 | 56 | -150.4 | -157.7 | 1 | 2,156.60 | 2,352.70 | 57 | -8.3 | -8.1 |
| 12/31/10 | Army | ATIRCM-CMWS: QRC | 2003 | PdE | 219A | 219A_PdE | 894.8 | 1,054.40 | 0 | 6 | -47.8 | 83 | 900.8 | 1,006.60 | 83 | -16.3 | -25.9 |
| 12/31/10 | Army | ATIRCM-CMWS | 2003 | PdE | 219B | 219B_PdE | 1,900.90 | 2,186.20 | 2,668 | 1,260.50 | 1,421.60 | -648 | 3,161.40 | 3,607.80 | 2,020 | 38.8 | 30.1 |
| 12/31/10 | Army | ICH (CH-47F) | 2005 | PdE | 278 | 278 _PdE | 10,614.80 | 12,147.40 | 512 | 2,088.30 | 2,291.10 | 20 | 12,703.10 | 14,438.50 | 532 | 15.1 | 14.1 |
| 12/31/10 | Army | EXCALIBUR | 2007 | PdE | 366 | 366 _PdE | 2,264.60 | 2,518.70 | 30,388 | -580 | -808.1 | -22,914 | 1,684.60 | 1,710.60 | 7,474 | 6 | 0.7 |
| 12/31/10 | Army | FBCB2 | 2005 | PdE | 294 | 294 _PdE | 1,579.90 | 1,556.70 | 22,248 | 2,059.70 | 2,260.90 | 67,820 | 3,639.60 | 3,817.60 | 90,068 | 20.9 | 20.9 |
| 12/31/10 | Army | FMTV | 1996 | PdE | 746 | 746 _PdE | 11,594.20 | 18,921.30 | 85,488 | 3,842.40 | -189.9 | 2,351 | 15,436.60 | 18,731.40 | 87,839 | 28 | -2 |
| 12/31/10 | Army | GMLRS | 2003 | PdE | 260 | 260 _PdE | 9,780.20 | 11,848.90 | 140,239 | -4,902.80 | -5,824.50 | -96,357 | 4,877.40 | 6,024.40 | 43,882 | 21.8 | 93.3 |
| 12/31/10 | Army | HIMARS | 2003 | PdE | 367 | 367 _PdE | 3,711.60 | 4,388.40 | 894 | -1,929.20 | -2,375.10 | -513 | 1,782.40 | 2,013.30 | 381 | -11.8 | -2.1 |
| 12/31/10 | Army | IAMD | 2009 | DE | 205 | 205 _DE | 4,856.60 | 5,791.60 | 296 | 483.1 | 528.8 | 0 | 5,339.70 | 6,320.40 | 296 | 9.9 | 9.1 |
| 12/31/10 | Army | INCREMENT 1 E-IBCT | 2010 | PdE | 432 | 432 _PdE | 3,149.50 | 3,284.00 | 9 | -1,906.00 | -2,014.40 | -6 | 1,243.50 | 1,269.60 | 3 | -18.3 | -19.5 |
| 12/31/10 | Army | JLENS | 2005 | DE | 372 | 372 _DE | 5,850.00 | 7,151.00 | 16 | 1,046.00 | 1,386.90 | 0 | 6,896.00 | 8,537.90 | 16 | 17.9 | 19.4 |

PNO and Unique ID were added to the SAR Summary Sheets, and the latter was used to create the Excel Pivot Table shown below

| Row Labels | Dec-86 | Dec-87 | Dec-88 | Dec-89 | Dec-90 | Dec-91 | Dec-92 | Dec-93 | Dec-94 | Dec-95 | Dec-96 | Dec-97 | Dec-98 | Dec-99 | Dec-01 | Dec-02 | Dec-03 | Dec-04 | Dec-05 | Dec-06 | Dec-07 | Dec-09 | Dec-10 | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100_PE | | | | | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | 5 |
| 101_DE | | | | | | | | | | | | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | 10 |
| 101_PdE | | | | | | | | | | | | | | | | | | | | | | 1 | 1 | 2 |
| 106_DE | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | | | | 6 |
| 107_DE | 1 | | | | | | | | | | | | | | | | | | | | | | | 1 |
| 108_DE | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | | 8 |
| 115_DE | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | | | 7 |
| 116_DE | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | | | | | | | 9 |

Final SAR for milestone estimate

# SAR Cost Variance Tables

- Cost Variance tables were extracted in TY$ and BY$ from individual SARs to provide cost growth by both Appropriation Type and Cost Category

| Summary Then Year $M | RDT&E | Proc | MILCON | Total |
|---|---|---|---|---|
| SAR Baseline (Prod Est) | 5574.0 | 36063.3 | -- | 41637.3 |
| Previous Changes | | | | |
| Economic | -23.7 | +37.7 | -- | +14.0 |
| Quantity | -- | +6367.3 | -- | +6367.3 |
| Schedule | -- | +1125.9 | -- | +1125.9 |
| Engineering | -- | +258.3 | -- | +258.3 |
| Estimating | +7.3 | -643.1 | -- | -635.8 |
| Other | -- | -- | -- | -- |
| Support | -- | +2213.2 | -- | +2213.2 |
| Subtotal | -16.4 | +9359.3 | -- | +9342.9 |
| Current Changes | | | | |
| Economic | -- | +132.9 | -- | +132.9 |
| Quantity | -- | +575.3 | -- | +575.3 |
| Schedule | -- | -16.5 | -- | -16.5 |
| Engineering | -- | -- | -- | -- |
| Estimating | -- | -656.3 | -- | -656.3 |
| Other | -- | -- | -- | -- |
| Support | -- | -16.9 | -- | -16.9 |
| Subtotal | -- | +18.5 | -- | +18.5 |
| Total Changes | -16.4 | +9377.8 | -- | +9361.4 |
| CE - Cost Variance | 5557.6 | 45441.1 | -- | 50998.7 |
| CE - Cost & Funding | 5557.6 | 45441.1 | -- | 50998.7 |

| Summary Base Year 2000 $M | RDT&E | Proc | MILCON | Total |
|---|---|---|---|---|
| SAR Baseline (Prod Est) | 5889.4 | 32995.3 | -- | 38884.7 |
| Previous Changes | | | | |
| Economic | -- | -- | -- | -- |
| Quantity | -- | +4990.1 | -- | +4990.1 |
| Schedule | -- | +990.1 | -- | +990.1 |
| Engineering | -- | +227.2 | -- | +227.2 |
| Estimating | +5.8 | -441.6 | -- | -435.8 |
| Other | -- | -- | -- | -- |
| Support | -- | +1980.9 | -- | +1980.9 |
| Subtotal | +5.8 | +7746.7 | -- | +7752.5 |
| Current Changes | | | | |
| Economic | -- | -- | -- | -- |
| Quantity | -- | +431.8 | -- | +431.8 |
| Schedule | -- | +8.0 | -- | +8.0 |
| Engineering | -- | -- | -- | -- |
| Estimating | -- | -512.1 | -- | -512.1 |
| Other | -- | -- | -- | -- |
| Support | -- | -12.0 | -- | -12.0 |
| Subtotal | -- | -84.3 | -- | -84.3 |
| Total Changes | +5.8 | +7662.4 | -- | +7668.2 |
| CE - Cost Variance | 5895.2 | 40657.7 | -- | 46552.9 |
| CE - Cost & Funding | 5895.2 | 40657.7 | -- | 46552.9 |

- Cost Variance Tables occasionally reported data by Subprograms
  - Our fundamental "data points" are Subprograms, not Programs
  - Assignment of PNOs with letter to denote Subprogram

# SAR Cost Variance Tables

| Cost Category | Definition |
|---|---|
| Economic | A change that is solely due to price-level changes in the economy |
| Quantity | A cost variance that is due to a change in the number of units of an end item of equipment |
| Schedule | Costs resulting from a change in a procurement or delivery schedule, completion date, or intermediate milestone for development or production |
| Engineering | Cost increases or decreases that are due to an alteration in the physical or functional characteristics of a system or item delivered |
| Estimating | Changes that are due solely to the correction of previous estimating errors or to refinements of a current estimate |
| Other | Cost variances that are due to unforeseeable events not covered in any other category (e.g., natural disaster, strike) |
| Support | Any change in cost, regardless of reason, associated with support equipment for the major hardware item (defined as any WBS element not included in flyaway, rollaway, or sailaway costs) |
| Baseline Adjustment | Adjustments to the baseline estimate |
| InterPhase | Correction of milestone transition disconnects (will be explained later in the presentation) |

Seven "standard" categories shown in SAR*

*DoD 7000.3-G

Reported occasionally

Calculated value

# Data Collection Approach

- Identified in-house data
  - Leveraged existing SAR holdings
  - Additional SARs requested from DAMIR
- Expanded on last year's data set, both in the number of data points and in the level of detail

| Element | Last Year | This Year |
|---|---|---|
| Source | SAR Summary Sheets | Individual SARs |
| Service | DON MDAPs | All Services & DOD |
| Appropriation | Total Program Acq Cost | RDT&E, Proc, MILCON, O&M |
| Milestone | A, B, and C | A, B, and C |
| Cost Variance Categories | Qty Only | 9 Cost Categories |
| Number of Programs | 83 | 312 |
| Number of Estimates | 100 | 406 |

Numbers may change depending on current V&V efforts.

# Data Verification & Validation

- Correct transcription errors (i.e., OCR and manual data entry)
  - #1: Validate sums across appropriation types (shown in red)*
  - #2: Validate sums across cost categories (shown in blue)**
  - #3: Reconcile totals from SARs to totals from SAR Summary Sheets (shown in green)

*Previous Validations A/C
**Previous Validation B

**Distribution of Cost Changes (Then-Year Dollars in Millions)**
**As of December 31, 2010**

| | Cost Changes Between the Baseline and Current Estimate | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Economic | | Quantity | | Schedule | | Engineering | | Estimating | | Other | | Support | | Total | |
| Program | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date |
| Army Subtotal: | | | | | | | | | | | | | | | | |
| AB3A REMANUFACTURE | 21.1 | -384.7 | - | 395.5 | 19.9 | 147.5 | - | - | 2,534.6 | 2,593.9 | - | - | 1 | | | |
| AB3B NEW BUILD | 4.1 | 4.1 | 49.7 | 49.7 | 2.8 | 2.8 | - | - | -344.6 | -344.6 | - | - | 1 | | | |
| ATIRCM/CMWS - ATIRCM QRC | - | 25.4 | - | 303.3 | - | -866.9 | - | 179.7 | -27.5 | 304.0 | - | - | | | | |

The "To Date" column in the SAR Summary Sheets is equal to the sum of "Previous Changes" and "Current Changes" in the SARs

| Summary Then Year $M | RDT&E | Proc | MILCON | Total |
|---|---|---|---|---|
| SAR Baseline (Dev Est) | 1139.2 | 6954.7 | -- | 8093.9 |
| Previous Changes | | | | |
| Economic | -12.0 | -393.8 | -- | -405.8 |
| Quantity | -- | +395.5 | -- | +395.5 |
| Schedule | -- | +127.6 | -- | +127.6 |
| Engineering | -- | -- | -- | -- |
| Estimating | -20.9 | +80.2 | -- | +59.3 |
| Other | -- | -- | -- | -- |
| Support | -- | +905.1 | -- | +905.1 |
| Subtotal | -32.9 | +1114.6 | -- | +1081.7 |
| Current Changes | | | | |
| Economic | +1.4 | +19.7 | -- | +21.1 |
| Quantity | -- | -- | -- | -- |
| Schedule | -- | +19.9 | -- | +19.9 |
| Engineering | -- | -- | -- | -- |
| Estimating | +541.3 | +1993.3 | -- | +2534.6 |
| Other | -- | -- | -- | -- |
| Support | -- | +141.9 | -- | +141.9 |
| Subtotal | +542.7 | +2174.8 | -- | +2717.5 |
| Total Changes | +509.8 | +3289.4 | -- | +3799.2 |
| CE - Cost Variance | 1649.0 | 10244.1 | -- | 11893.1 |
| CE - Cost & Funding | 1649.0 | 10244.1 | -- | 11893.1 |

# Data Verification & Validation

- <u>#4/#5</u>: Detect and correct milestone transition disconnects
  - Baseline Estimate in the current milestone SAR ≠ Current Estimate in the previous milestone SAR
  - Developed "InterPhase" category to capture changes (split by appropriation)
    - Example shown below, Total InterPhase for DE = 28.7 (11,424.7 – 11,396)

| Change Summary Then-Year $M | | | | | |
|---|---|---|---|---|---|
| | RDT&E | Proc | MILCON | O&M | Total |
| SAR Development Estimate | 548.7 | 5087.7 | 0.0 | 0.0 | 5636.4 |
| Previous Changes | | | | | |
| Economic | -24.6 | -450.8 | -- | -- | -475.4 |
| Quantity | +153.0 | +988.2 | -- | -- | +1141.2 |
| Schedule | -- | +198.0 | -- | -- | +198.0 |
| Engineering | +226.0 | +780.6 | -- | -- | +1006.6 |
| Estimating | +402.4 | +2569.4 | -- | -- | +2971.8 |
| Other | -- | -- | -- | -- | -- |
| Support | +70.2 | +638.9 | -- | -- | +709.1 |
| Subtotal | +827.0 | +4724.3 | 0.0 | 0.0 | +5551.3 |
| Current Changes | | | | | |
| Economic | +3.4 | +144.8 | -- | -- | +148.2 |
| Quantity | -- | -- | -- | -- | -- |
| Schedule | -- | -8.2 | -- | -- | -8.2 |
| Engineering | -- | -- | -- | -- | -- |
| Estimating | -0.3 | -6.9 | -- | -- | -7.2 |
| Other | -- | -- | -- | -- | -- |
| Support | -- | +75.5 | -- | -- | +75.5 |
| Subtotal | +3.1 | +205.2 | 0.0 | 0.0 | +208.3 |
| Total Changes | +830.1 | +4929.5 | 0.0 | 0.0 | +5759.6 |
| Current Estimate | 1378.8 | 10017.2 | 0.0 | 0.0 | 11396.0 |

| Summary Then Year $M | | | | |
|---|---|---|---|---|
| | RDT&E | Proc | MILCON | Total |
| SAR Baseline (Prod Est) | 1375.7 | 10049.0 | -- | 11424.7 |
| Previous Changes | | | | |
| Economic | -10.1 | -164.0 | -- | -174.1 |
| Quantity | -- | +1385.4 | -- | +1385.4 |
| Schedule | -- | +100.7 | -- | +100.7 |
| Engineering | +188.7 | +46.9 | -- | +235.6 |
| Estimating | +113.5 | +1238.6 | -- | +1352.1 |
| Other | -- | -- | -- | -- |
| Support | -- | -83.4 | -- | -83.4 |
| Subtotal | +292.1 | +2524.2 | -- | +2816.3 |
| Current Changes | | | | |
| Economic | +0.2 | -12.2 | -- | -12.0 |
| Quantity | -- | -- | -- | -- |
| Schedule | -- | +9.2 | -- | +9.2 |
| Engineering | +17.0 | +0.3 | -- | +17.3 |
| Estimating | -4.2 | +76.8 | -- | +72.6 |
| Other | -- | -- | -- | -- |
| Support | -- | +71.8 | -- | +71.8 |
| Subtotal | +13.0 | +145.9 | -- | +158.9 |
| Total Changes | +305.1 | +2670.1 | -- | +2975.2 |
| CE - Cost Variance | 1680.8 | 12719.1 | -- | 14399.9 |
| CE - Cost & Funding | 1680.8 | 12719.1 | -- | 14399.9 |

# InterPhase Growth Example

- SSN21 and ANBSY2 (PNO 258)

## 1988 SAR

a. Summary — (Current (Then-Year) Dollars in Millions)

| | RDT&E | PROC | MILCON | TOTAL |
|---|---|---|---|---|
| Development Estimate | 1912.6 | 1962.4 | 0.0 | 3875.0 |
| Previous Changes: | | | | |
| Economic | -44.8 | -253.0 | - | -297.8 |
| Quantity | - | +5080.8 | - | +5080.8 |
| Schedule | - | - | - | - |
| Engineering | - | - | - | - |
| Estimating | +314.3 | +42.7 | - | +357.0 |
| Other | - | - | - | - |
| Support (OF/PD) | - | +237.7 | - | +237.7 |
| Subtotal | 269.5 | 5108.2 | 0.0 | 5377.7 |
| Current Changes: | | | | |
| Economic | +11.1 | +3.8 | - | +14.9 |
| Quantity | - | +8670.0 | - | +8670.0 |
| Schedule | - | - | - | - |
| Engineering | - | - | - | - |
| Estimating | +253.9 | +195.1 | +107.7 | +556.7 |
| Other | - | - | - | - |
| Support (OF/PD) | - | +389.0 | - | +389.0 |
| Subtotal | 265.0 | 9257.9 | 107.7 | 9630.6 |
| Total Changes | 534.5 | 14366.1 | 107.7 | 15008.3 |
| Current/Prod. Estimate | 2447.1 | 16328.5 | 107.7 | 18883.3 |

## 1999 SAR

| Change Summary Then-Year $M | | | | |
|---|---|---|---|---|
| | RDT&E | Proc | MILCON | Total |
| SAR Production Estimate | 4210.0 | 17421.4 | 107.7 | 21739.1 |
| Previous Changes | | | | |
| Economic | -122.5 | +404.0 | +3.5 | +285.0 |
| Quantity | 0.0 | -15562.8 | 0.0 | -15562.8 |
| Schedule | +25.3 | +6354.0 | 0.0 | +6379.3 |
| Engineering | +161.3 | 0.0 | 0.0 | +161.3 |
| Estimating | +317.3 | +923.3 | -83.9 | +1156.7 |
| Other | 0.0 | 0.0 | 0.0 | 0.0 |
| Support | +54.6 | -804.0 | 0.0 | -749.4 |
| Subtotal | +436.0 | -8685.5 | -80.4 | -8329.9 |
| Current Changes | | | | |
| Economic | -0.9 | -30.5 | -- | -31.4 |
| Quantity | -- | -- | -- | -- |
| Schedule | -- | -- | -- | -- |
| Engineering | -- | -- | -- | -- |
| Estimating | +1.5 | -207.4 | -- | -205.9 |
| Other | -- | -- | -- | -- |
| Support | -- | -15.4 | -- | -15.4 |
| Subtotal | +0.6 | -253.3 | -- | -252.7 |
| Total Changes | +436.6 | -8938.8 | -80.4 | -8582.6 |
| Current Estimate | 4646.6 | 8482.6 | 27.3 | 13156.5 |

| DE Only* | | |
|---|---|---|
| BE (DE) | CE (DE) | CGF |
| 3,875.0 | 18,883.3 | 4.87 |

| InterPhase* | | |
|---|---|---|
| CE (DE) | BE (PdE) | CGF |
| 18,883.3 | 21739.1 | 1.15 |

| PdE Only | | |
|---|---|---|
| BE (PdE) | CE (PdE) | CGF |
| 21739.1 | 13156.5 | 0.61 |

BE = Baseline Estimate
CE = Current Estimate
*Calculations aren't shown in current version of database

| DE to end | | |
|---|---|---|
| BE (DE) | CE (PdE) | CGF |
| 3,875.0 | 13,156.5 | 3.40 |

CGF Calculation
(DE Only*) · (InterPhase*) · (PdE Only) = (DE to end)
4.87 · 1.15 · 0.61 = 3.40

# Data Verification & Validation

- Additional verification & validation (V&V) efforts
  - Development of “Scripts” to handle certain cases
  - Contacted SMEs for further understanding of programs
  - Investigation of quarterly SARs in efforts to reduce programs with “InterPhase” growth
- Used SAR Summary Sheets for further V&V
  - Identified programs with different baseline estimates ($TY) in the same milestone
    - Captured additional programs w/ Subprograms and/or Baseline Adjustments

Example: JTUAV (PNO:514)

| Subprogram title in Cost Variance Tables | MS | 1992 | 1993 | 1994 | 1995 |
|---|---|---|---|---|---|
| Close Range | DE | 1017.8 | | | |
| Short Range | DE | 1661.4 | | | |
| Medium Range | DE | 2756.9 | | | |
| Maneuver | DE | | | 1017.8 | |
| JTUAV Hunter/Shipboard | DE | | | 1661.4 | |
| **TOTAL** | | **5436.1** | | **2679.2** | |

# Data Verification & Validation

- Identified programs with the same baseline estimate ($TY) for different milestones
  - Unusual cases since PdE occurred before DE

Example: CG-47 (PNO:159)

| Date | 1986 | 1987 | ~~1988~~ | 1989 | 1990 | 1991 | **1992** |
|---|---|---|---|---|---|---|---|
| MS (Shown in SAR) | PdE | PdE | ~~PdE~~ | DE | DE | DE | **DE** |
| Baseline Estimate ($TY) | 14,083.5 | 14,083.5 | ~~14,083.5~~ | 14,083.5 | 14,083.5 | 14,083.5 | **14,083.5** |
| Current Estimate ($TY) | 24,869.2 | 24,277 | ~~24,070.9~~ | 23,491.1 | 23,315.9 | 23,294.1 | **23,276.9** |
| Base Year of $BY | 1978 | 1978 | ~~1978~~ | 1978 | 1978 | 1978 | **1978** |

  - Was really a Development Estimate (DE) all along
    - Most ship programs do not have a Milestone C

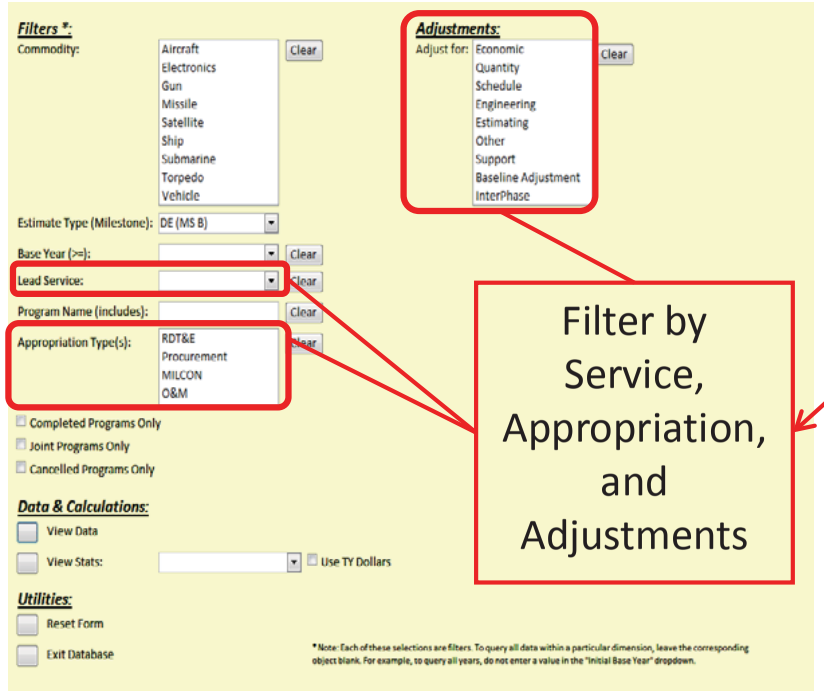
Example: WGS (PNO:326)

| Date | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | ~~2009~~ | **2010** |
|---|---|---|---|---|---|---|---|---|---|
| MS (Shown in SAR) | PdE | PdE | PdE | PdE | PdE | PdE | PdE | ~~PdE~~ | ~~DE~~ **(PdE)** |
| Baseline Estimate ($TY) | 1042.5 | 1042.5 | 1042.5 | 1042.5 | 1042.5 | 1042.5 | 1042.5 | ~~1042.5~~ | **1042.5** |
| Current Estimate ($TY) | 876.9 | 1544.1 | 1555.8 | 1837.4 | 1979.2 | 1943.8 | 1950.5 | ~~3441.7~~ | **3510.7** |
| Base Year of $BY | 2001 | 2001 | 2001 | 2001 | 2001 | 2001 | 2001 | ~~2001~~ | **2010** |

  - Was really a Production Estimate (PdE) all along
    - Program restructure pending

# Data Storage and Access

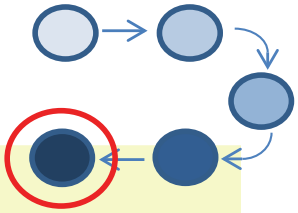
- Robust relational database developed (3rd normal form)
- Stores all raw, validated data (annual updates to be tied to DAMIR)
- Strives to establish a standard database for CV calculations




Filter by Service, Appropriation, and Adjustments

Additional features added to database this year

# Data Storage and Access



***Filters *:***

Commodity: Aircraft, Electronics, Gun, Missile, Satellite, Ship, Submarine, Torpedo, Vehicle [Clear]

Estimate Type (Milestone): DE (MS B)

Base Year (>=): [Clear]

Lead Service: Navy [Clear]

Program Name (includes): [Clear]

Appropriation Type(s): RDT&E, Procurement, MILCON, O&M [Clear]

☐ Completed Programs Only

☐ Joint Programs Only

☐ Cancelled Programs Only

***Adjustments:***

Adjust for: Economic, Quantity, Schedule, Engineering, Estimating, Other, Support, Baseline Adjustment, InterPhase [Clear]

Last Year's Output

| μ | σ | CV | Median | n |
|---|---|---|---|---|
| 1.36 | 0.69 | 0.51 | 1.18 | 50 |

This Year's Output

***Data & Calculations:***

View Data

View Stats: Fisher ☑ Use TY Dollars

| μ | σ | CV | Median | n |
|---|---|---|---|---|
| 1.34 | 0.83 | 0.62 | 1.10 | 65 |

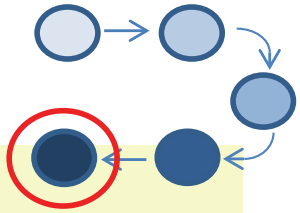
***Utilities:***

Reset Form

Exit Database

* Note: Each of these selections are filters. To query all data within a particular dimension, leave the corresponding object blank. For example, to query all years, do not enter a value in the "Initial Base Year" dropdown.

# Data Storage and Access



***Filters *:***

Commodity: Aircraft Electronics [Clear]

***Adjustments:***

Adjust for: Economic Quantity [Clear]

frmMain | qryProgramSummary

| Program | SumOfBaseYear$Initial | SumOfThenYear$Initial | SumOfBaseYear$Growth | SumOfThenYear$Growth | SumOfBaseYear$Current | SumOfThenYear$Current | SumOfBYAdjustme | SumOfTYAd |
|---|---|---|---|---|---|---|---|---|
| Advanced Amphibious Assault Ve | $8,493.2 | $8,725.2 | ($5,050.6) | ($5,395.6) | $3,442.6 | $3,329.6 | ($6,386.4) | ($7,967. |
| Advanced Deployable System (AD | $1,337.0 | $1,431.7 | ($784.9) | ($902.9) | $552.1 | $528.8 | ($465.3) | ($566. |
| Advanced Seal Delivery System (A | $1,837.9 | $1,969.3 | ($1,094.8) | ($1,231.6) | $743.1 | $737.7 | ($1,115.1) | ($1,298. |
| AGM-88A/B/C High-Speed Anti-Ra | $1,681.8 | $2,409.9 | $1,378.9 | $3,813.3 | $3,060.7 | $6,223.2 | $456.5 | $914. |
| AGM-88E Advanced Anti-Radiatior | $1,339.8 | $1,510.9 | $252.4 | $397.8 | $1,592.2 | $1,908.7 | $44.0 | $59. |
| AIM-9X Air-to-Air Missile Upgrade | $2,464.0 | $3,232.9 | $475.3 | $521.7 | $2,939.3 | $3,754.6 | $25.8 | $39. |
| Airborne Self Protection Jammer ( | $227.7 | $236.4 | $305.0 | $300.0 | $532.7 | $536.4 | $0.0 | $0. |
| AN/BSY-1 Submarine Advanced Co | $2,972.4 | $3,827.6 | ($1,628.4) | ($2,321.1) | $1,344.0 | $1,506.5 | ($57.0) | ($62. |
| AV-8B Harrier II Close-Air-Support | $5,740.6 | $9,125.5 | ($766.8) | ($407.1) | $4,973.8 | $8,718.4 | ($544.2) | ($1,389. |
| CG 47 AEGIS Cruiser (Ticonderoga | $9,013.7 | $14,083.5 | $0.0 | $0.0 | $9,013.7 | $14,083.5 | $5,491.4 | $11,739. |
| CH-53E Super Stallion / MH-53E Se | $464.4 | $578.4 | $1,328.1 | $4,273.3 | $1,792.5 | $4,851.7 | $969.8 | $2,780. |
| CH-53K Heavy Lift Replacement (H | $14,980.9 | $18,766.3 | $5,322.7 | $6,978.5 | $20,303.6 | $25,744.8 | $2,326.4 | $3,108. |
| CH-60S / MH-60S Fleet Combat Su | $2,769.0 | $3,154.0 | $3,874.7 | $4,790.4 | $6,643.7 | $7,944.4 | $1,499.7 | $1,926. |
| COBRA JUDY Replacement (CJR) | $1,365.0 | $1,464.0 | $162.6 | $250.2 | $1,527.6 | $1,714.2 | $0.0 | $0. |
| Cooperative Engagement Capabili | $2,441.6 | $2,573.1 | $1,875.1 | $2,063.5 | $4,316.7 | $4,636.6 | $108.2 | $244. |
| CV Helo (SH-60F) Seahawk Carrier | $2,559.0 | $3,076.2 | ($940.5) | ($1,250.9) | $1,618.5 | $1,825.3 | ($931.4) | ($1,287. |
| CVN 21 / CVN(X) / CVN 78 Nuclear | $28,701.2 | $36,082.1 | ($1,275.2) | $4,213.2 | $27,426.0 | $40,295.3 | $0.0 | $0. |
| CVN 71 Theodore Roosevelt (Nimi | $1,808.3 | $2,420.6 | $86.9 | $120.5 | $1,895.2 | $2,541.1 | $0.0 | $0. |
| CVN 72 Abraham Lincoln / CVN 73 | $5,265.5 | $7,418.9 | ($34.8) | ($1,262.7) | $5,230.7 | $6,156.2 | $0.0 | $0. |
| CVN 74 John C. Stennis / CVN 75 H | $5,911.0 | $6,966.0 | $616.2 | $56.3 | $6,527.2 | $7,022.3 | $0.0 | $0. |
| DD 21 / DD(X) / DDG 1000 Guided M | $31,547.9 | $36,296.3 | ($13,130.9) | ($15,404.9) | $18,417.0 | $20,891.4 | ($14,646.0) | ($19,092. |
| DDG 51 Guided Missile Destroyer ( | $13,595.5 | $18,479.6 | $46,569.4 | $69,937.0 | $60,164.9 | $88,416.6 | $34,827.1 | $54,612. |
| E-2D Advanced Hawkeye | $14,250.5 | $14,982.0 | $2,889.8 | $3,475.9 | $17,140.3 | $18,457.9 | ($0.1) | $0. |
| E-6A TACAMO Airborne Strategic C | $1,584.7 | $2,251.7 | $36.8 | ($88.3) | $1,621.5 | $2,163.4 | $41.1 | $61. |
| EA-18G Growler Airborne Electron | $7,662.6 | $8,421.6 | $2,078.9 | $2,783.4 | $9,741.5 | $11,205.0 | $1,167.6 | $1,384. |
| Extended Range Munition (ERM) | $1,242.7 | $1,478.0 | $44.8 | $43.4 | $1,287.5 | $1,521.4 | $0.0 | $0. |
| F/A-18 A/B/C/D Hornet Naval Atta | $8,016.6 | $12,875.3 | $5,949.8 | $23,908.1 | $13,966.4 | $36,783.4 | $1,116.9 | $333. |
| F/A-18 E/F Super Hornet Naval Str | $66,010.7 | $94,583.0 | ($19,373.5) | ($43,602.8) | $46,637.2 | $50,980.2 | ($13,245.5) | ($25,527. |
| F/A-18E/F AESA / Active Electronic | $1,899.8 | $525.2 | $56.1 | $54.7 | $1,955.9 | $579.9 | $0.0 | $0. |
| F-14D Tomcat All Weather Carrier- | $16,647.0 | $19,219.8 | ($10,539.8) | ($12,721.6) | $6,107.2 | $6,498.2 | ($2,975.3) | ($3,394. |
| FFG 7 (Oliver Hazard Perry Class) | $2,620.4 | $3,244.5 | $1,733.2 | $6,203.4 | $4,353.6 | $9,447.9 | $104.4 | $307. |
| Fixed Distributed System (FDS) Ar | $5,190.5 | $7,847.3 | ($4,094.8) | ($6,583.8) | $1,095.7 | $1,263.5 | ($3,047.3) | ($4,827. |
| H-1 Upgrades (4BW/4BN) United S | $3,449.1 | $3,547.5 | $8,499.1 | $9,171.4 | $11,948.2 | $12,718.9 | $0.0 | $0. |
| Harpoon Anti-Ship Weapon (A/R/ | $795.0 | $1,031.8 | $736.3 | $2,713.2 | $1,531.3 | $3,745.0 | ($35.1) | ($132. |
| High Frequency Anti-Jam (HFAJ) | $3,366.8 | $4,540.3 | ($3,256.6) | ($4,430.5) | $110.2 | $109.8 | ($3,256.6) | ($4,430. |
| Integrated Defensive Electronic C | $660.7 | $746.1 | $121.0 | $117.1 | $781.7 | $863.2 | $59.5 | $69. |
| Joint High-Speed Vessel (JHSV) | $3,460.0 | $3,892.3 | $35.9 | $45.7 | $3,495.9 | $3,938.0 | $0.0 | $0. |
| Joint Precision Approach and Lanc | $963.2 | $1,031.9 | ($27.6) | ($47.6) | $935.6 | $984.3 | $0.9 | $1. |
| Joint Standoff Weapon (JSOW) Ba | $1,885.8 | $2,969.2 | ($388.0) | ($1,069.3) | $1,497.8 | $1,899.9 | ($1,082.0) | ($1,616. |
| Joint Standoff Weapon (JSOW) Ba | $3,360.9 | $6,307.2 | ($1,168.7) | ($2,894.0) | $2,192.2 | $3,413.2 | $901.5 | $1,522. |

Record: 1 of 65 | No Filter | Search

Estimate Type (Milestone):

Base Year (>=):

Lead Service:

Program Name (includes):

Appropriation Type(s):

☐ Completed Programs Only

☐ Joint Programs Only

☐ Cancelled Programs Only

***Data & Calculations:***

☐ View Data

☐ View Stats: Fisher ☑ Use TY Dollars

| μ | σ | CV | Median | n |
|---|---|---|---|---|
| 1.34 | 0.83 | 0.62 | 1.10 | 65 |

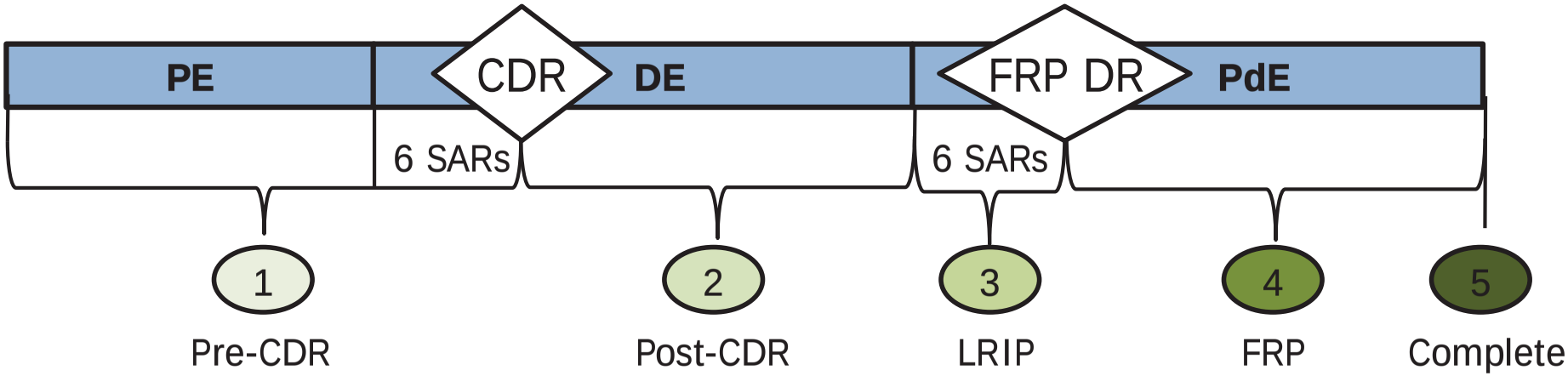
***Utilities:***

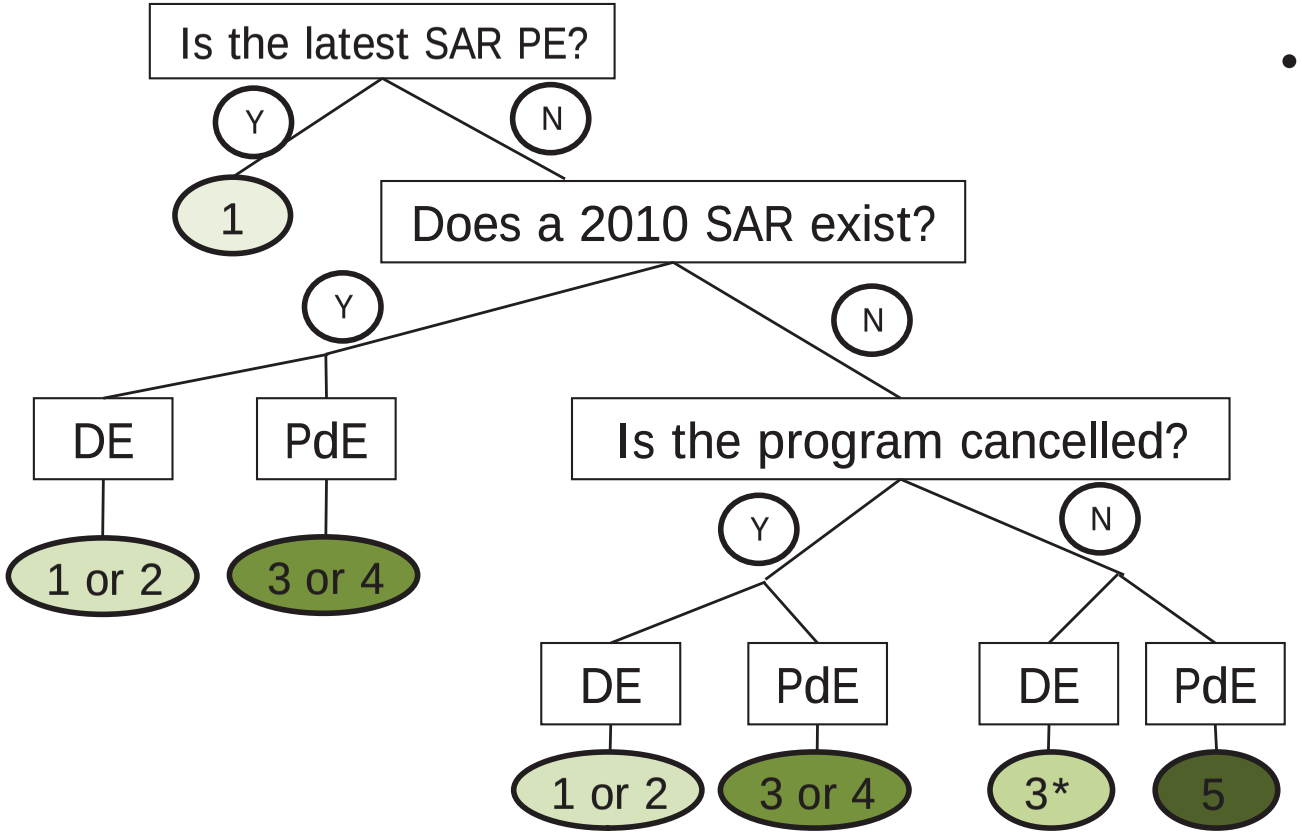
☐ Reset Form

☐ Exit Database

* Note: Each of these selections are filters. To query all data within a particular dimension, leave the corresponding object blank. For example, to query all years, do not enter a value in the "Initial Base Year" dropdown.

# Completeness Degree Index




- Philosophy is to include *all* available SARs in database and use queries to produce desired subsets for analysis

*Exception for completed Production programs without MS C (e.g., Ships)

# Business Rules in Database

- For Procurement or Total Acquisition
  - Include 4s and 5s only
  - Unless “Completed Programs” box checked, in which case 5s only
- For RDT&E
  - Include 2s through 5s, inclusive
  - Unless “Completed Programs” box checked, in which case 3s through 5s only

# CGF is Invariant with Base Year

- CGF is invariant with Base Year
  - Addition of BY12 should not necessitate new CGFs, since the CGFs based on BY12 would be mathematically identical to those based on BY

$$CGF\ (BY) = \frac{CE\ (BY)}{BE\ (BY)} = \frac{CE\ (BY) \cdot i}{BE\ (BY) \cdot i} = \frac{CE\ (BY12)}{BE\ (BY12)} = CGF\ (BY12)$$

where *CE* = Current Estimate, *BE* = Baseline Estimate, *BY* = Base Year, *i* = escalation index from BY to BY12

- Example calculation shown for DDG-51 at MS C for Procurement

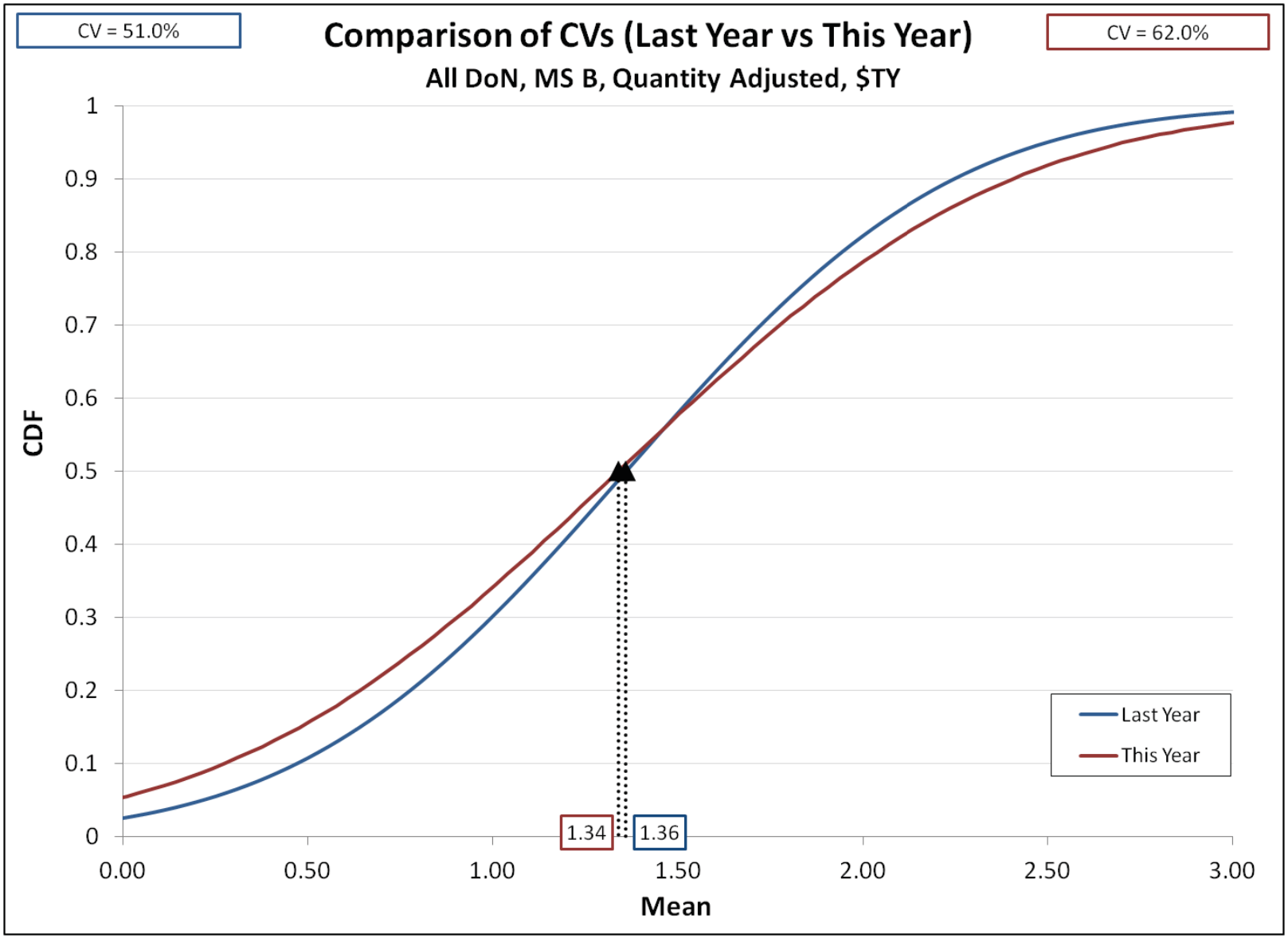
$$CGF\ (BY1987) = \frac{CE\ (BY1987)}{BE\ (BY1987)} = \frac{57{,}095.5}{15{,}948.3} = 3.58$$

$$i = \frac{Raw\ Index\ (2012)^*}{Raw\ Index\ (1987)^*} = \frac{1.0394}{0.6076} = 1.71$$

$$CGF\ (BY12) = \frac{CE\ (BY1987) \cdot i}{BE\ (BY1987) \cdot i} = \frac{57{,}095.5 \cdot 1.71}{15{,}948.3 \cdot 1.71} = \frac{97{,}633.3}{27{,}271.6} = 3.58$$

*Based on BY2010 Shipbuilding & Conversion, Navy (SCN) inflation table

# Self-Benchmark via S-Curve Tool



# Total Number of Estimates

| | Total # of Estimates | PE | DE | PdE |
|---|---|---|---|---|
| | 25 | 25 | | |
| | 38 | 19 | | |
| | 12 | 6 | | 6 |
| | 36 | 12 | | |
| | 130 | | 130 | |
| | 90 | | 45 | |
| | 75 | | | 75 |
| Total # of Estimates | **406** | 62 | 206 | 138 |

Total Number of Programs
(sum of grey cells)

312

# SAR Data Analysis

- Quantity-adjustments:
  - Laspeyres, Paasche, and Fisher $ and indices
- Standard deviations and percentiles
  - Standard deviation vs. CV vs. (median-based) pseudo-CV
  - Empirical percentile of 1.0 CGF vs. implied percentile given CV and CGF
- CGF and CV derivations
  - CV of CGFs
  - Confidence intervals for CV (normal or lognormal assumption)
  - CV of Cost and CE vs. BE graphs
    - White test for heteroskedastic error terms
    - MLE regressions, error functional forms, and the size effect
    - CV of MLE regression vs. CV at x-bar
    - Normalized deviations and correction for size effect

# SAR Data Hypothesis Testing

- Program Maturity
  - CGFs and CVs decline throughout Acquisition process (i.e., MS A to B to C)
- Platform Homogeneity
  - CGFs and CVs equivalent for aircraft, ships, and other platform types
- Service Homogeneity*
  - CGFs and CVs equivalent for three services, DoD
- Adjustment Decline
  - CGFs and CVs decrease when adjusted for changes in quantity and inflation
- Invariance of Secular Trend
  - CVs steady long-term

# Quantity Adjustments

- Quantity viewed as either:
  - Random (no adjustment); or
  - Exogenous (adjustment)
- Three possible quantity adjustments:

| Method | Description | Baseline $ | Current $ | CGF |
|---|---|---|---|---|
| Laspeyres | Adjust current estimate to reflect baseline quantities | $BE$ | $CE - Q\Delta$ | $\frac{CE - Q\Delta}{BE}$ |
| Paasche | Adjust baseline estimate to reflect current quantities | $BE + Q\Delta$ | $CE$ | $\frac{CE}{BE + Q\Delta}$ |
| Fisher | "Split the difference" between baseline and current quantities | $\sqrt{BE \cdot (BE + Q\Delta)}$ | $\sqrt{(CE - Q\Delta) \cdot CE}$ | $\sqrt{\frac{(CE - Q\Delta) \cdot CE}{BE \cdot (BE + Q\Delta)}}$ |

Geometric mean is used for multiplicative comparisons

"Development and Application of CV Benchmarks," Brian Flynn, Paul Garvey, Peter Braxton, Richard Lee, DoDCAS, 2011.

# Cost Growth Calculations

## Example: CG-47 Class (MS B)

- Baseline Estimate (BE) of 1978
  - 16 ships at $9.01B (BY$) and $14.08B (TY$)
- Current Estimate (CE) of 1992
  - 27 ships at $14.11B (BY$) and $23.28B (TY$)
    - Deltas in BY$
      - $5.10B total & $5.49B quantity
    - Deltas in TY$
      - $9.20B total & $11.74B quantity

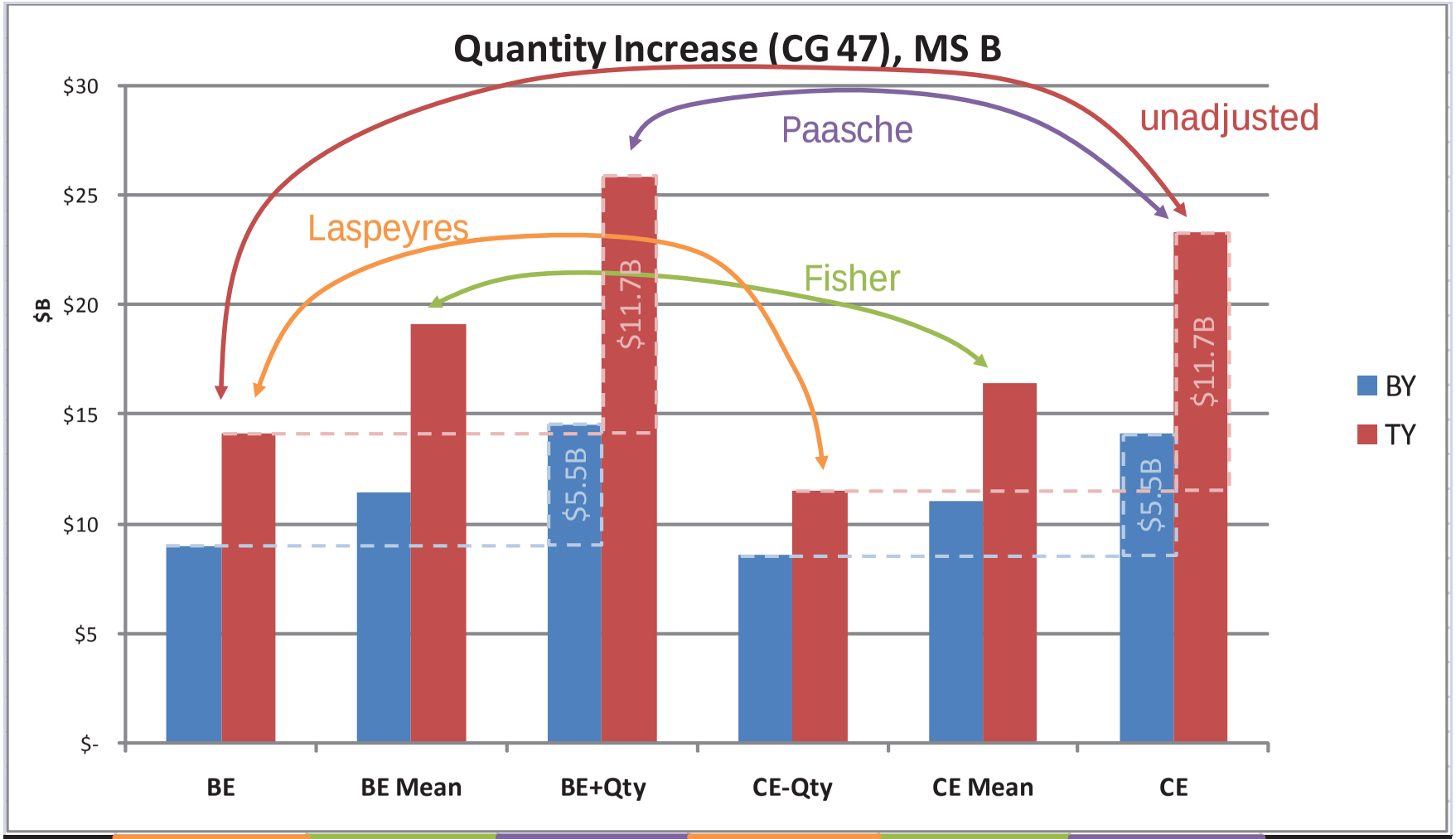
"Development and Application of CV Benchmarks," Brian Flynn, Paul Garvey, Peter Braxton, Richard Lee, DoDCAS, 2011.

## Cost Growth Factors

- Unadjusted for quantity Δ
  - Then-year dollars
    - $23.28B/$14.08B = 1.65
  - Base-year dollars
    - $14.11B/$9.01B = 1.57
- Adjusted for quantity Δ, using OSD methodology
  - Then-year dollars
    - $23.28B/($14.08B + $11.74B) = 0.90
  - Base-year dollars
    - $14,11B /($9.01B + $5.49B) = 0.97

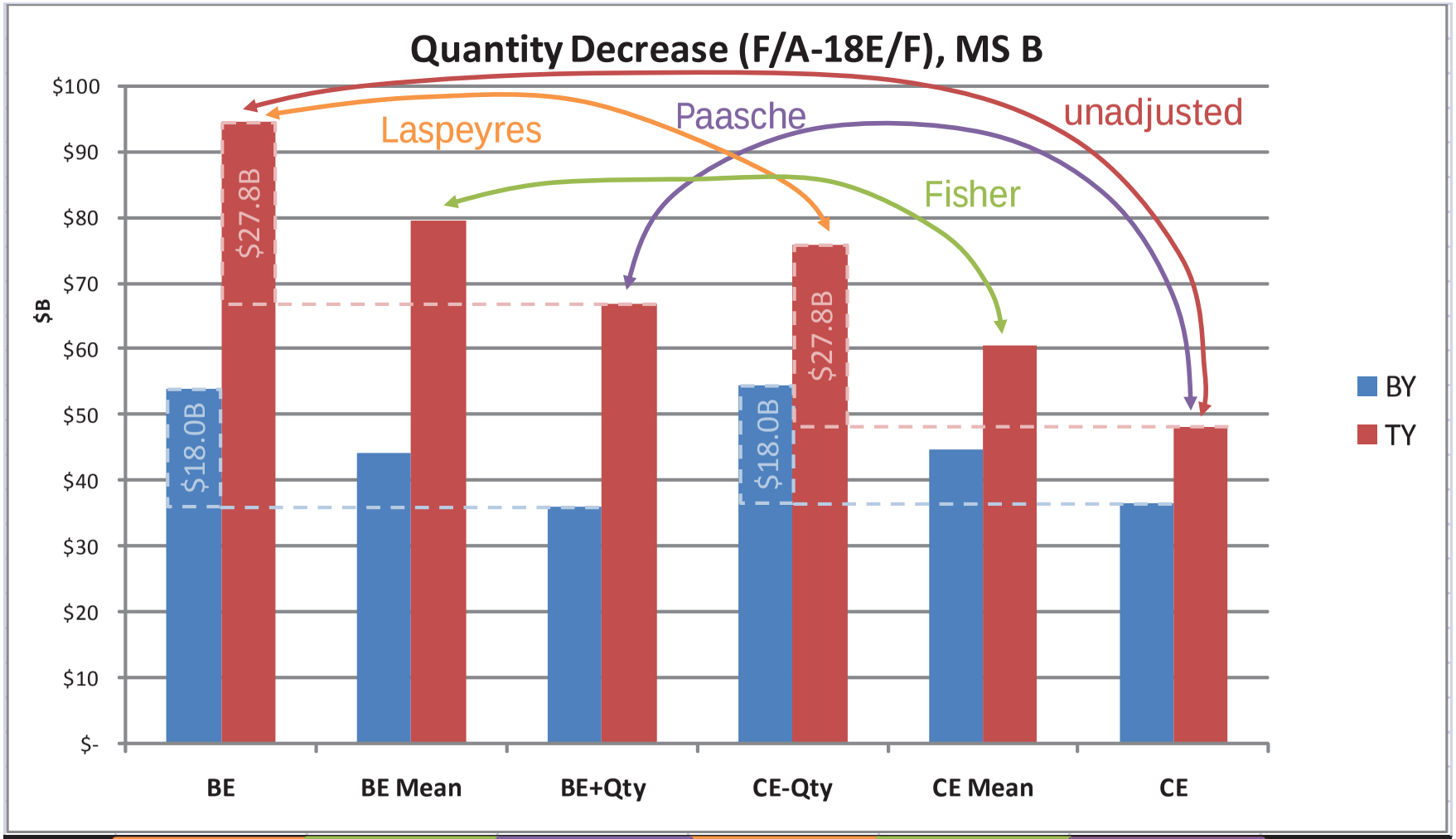
Paasche

# CGF Calculations Illustrated



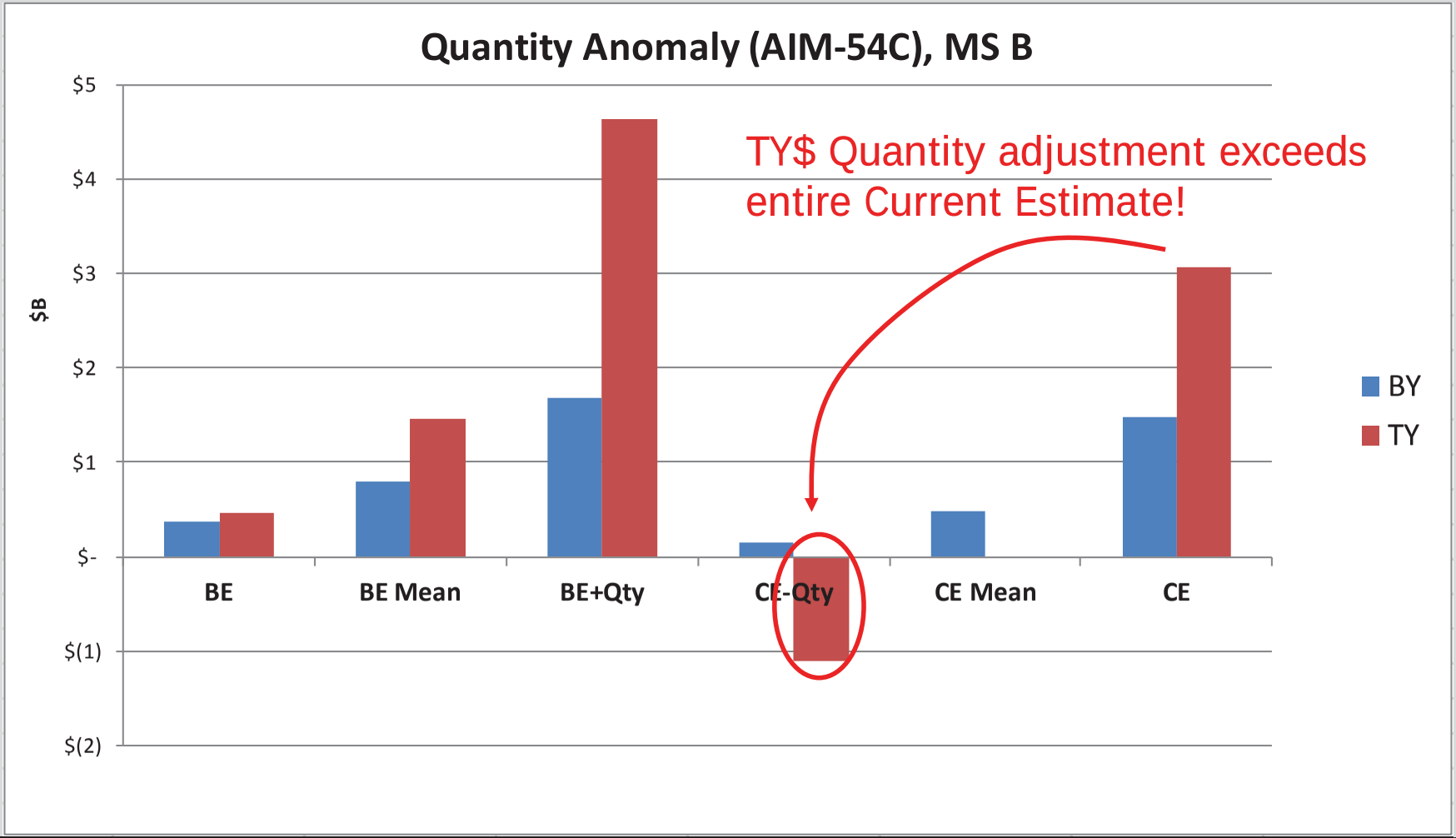

| CG 47 | BE | BE Mean | BE+Qty | CE-Qty | CE Mean | CE | Qty |
|---|---|---|---|---|---|---|---|
| BY | $ 9,013.7 | $ 11,434.4 | $ 14,505.1 | $ 8,620.2 | $ 11,029.3 | $ 14,111.6 | $ 5,491.4 |
| TY | $ 14,083.5 | $ 19,070.2 | $ 25,822.5 | $ 11,537.9 | $ 16,388.0 | $ 23,276.9 | $ 11,739.0 |
| BY | 1.57 | | | 0.96 | 0.96 | 0.97 | |
| TY | 1.65 | | | 0.82 | 0.86 | 0.90 | |
| | unadjusted | | | Laspeyres | Fisher | Paasche | |
| Qty | 16 | | 27 | 16 | | 27 | 11 |

# CGF Calculations Illustrated



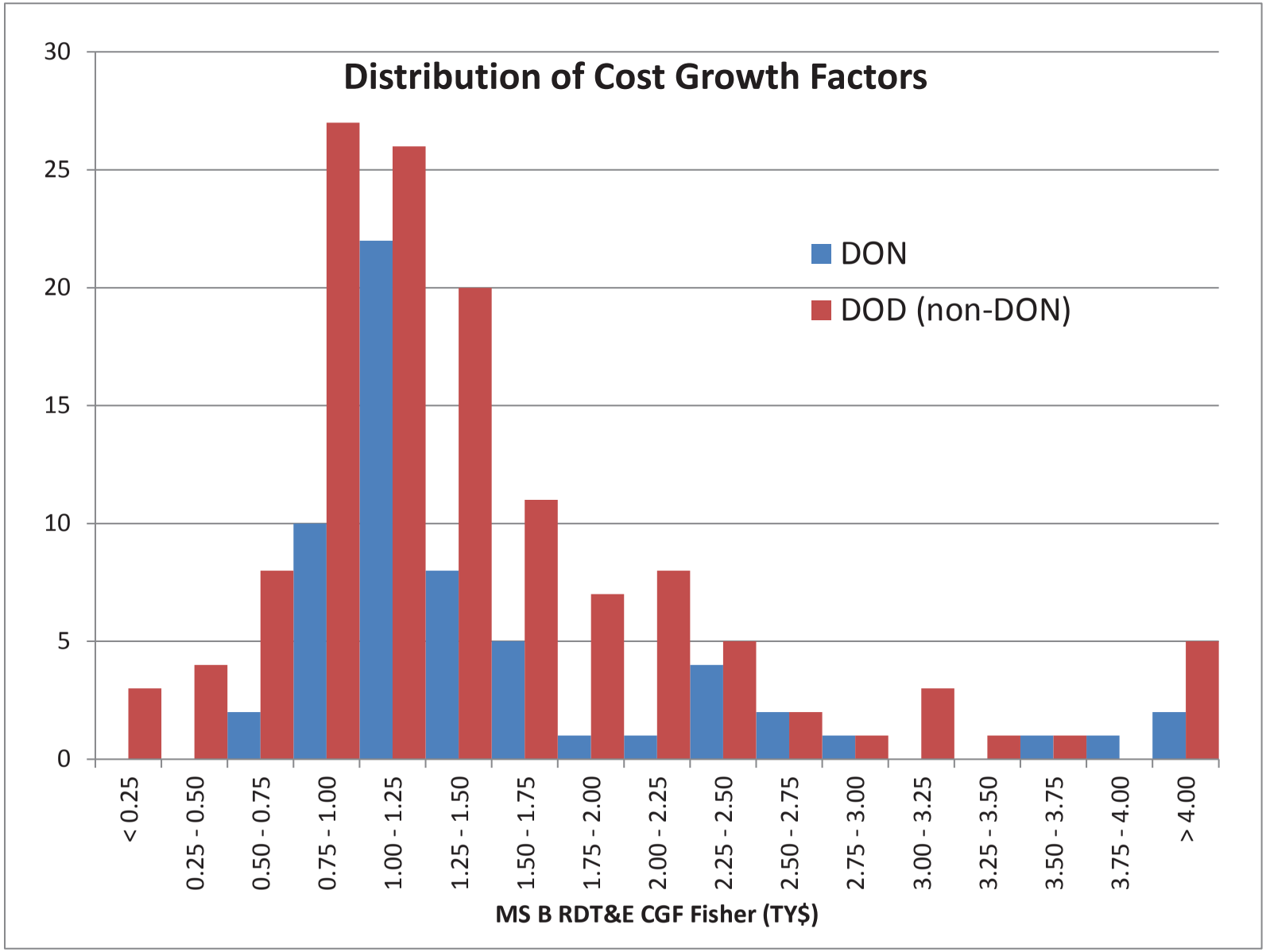

| F/A-18E/F | BE | BE Mean | BE+Qty | CE-Qty | CE Mean | CE | Qty |
|---|---|---|---|---|---|---|---|
| BY | $ 53,959.6 | $ 44,068.9 | $ 35,991.1 | $ 54,538.2 | $ 44,659.2 | $ 36,569.7 | $ (17,968.5) |
| TY | $ 94,583.0 | $ 79,503.6 | $ 66,828.2 | $ 75,846.2 | $ 60,394.9 | $ 48,091.4 | $ (27,754.8) |
| BY | 0.68 | | | 1.01 | 1.01 | 1.02 | |
| TY | 0.51 | | | 0.80 | 0.76 | 0.72 | |
| | unadjusted | | | Laspeyres | Fisher | Paasche | |
| Qty | 1000 | | 515 | 1000 | | 515 | -485 |

# Quantity Anomaly Illustrated

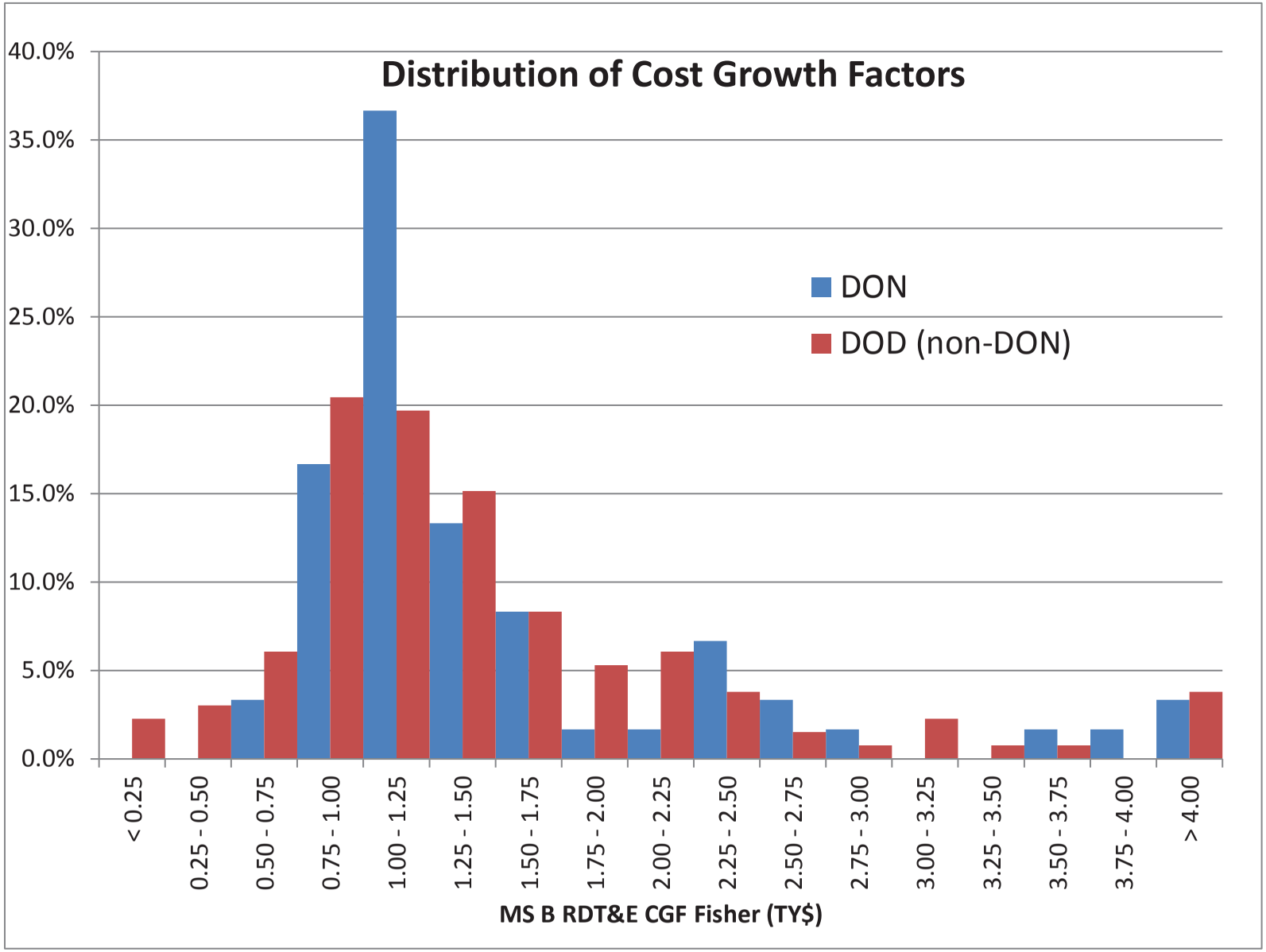



| AIM-54C | BE | BE Mean | BE+Qty | CE-Qty | CE Mean | CE | Qty |
|---|---|---|---|---|---|---|---|
| BY | $ 372.0 | $ 792.9 | $ 1,690.2 | $ 158.1 | $ 483.1 | $ 1,476.3 | $ 1,318.2 |
| TY | $ 464.3 | $ 1,466.8 | $ 4,633.6 | $ (1,096.2) | #NUM! | $ 3,073.1 | $ 4,169.3 |
| BY | 3.97 | | | 0.43 | 0.61 | 0.87 | |
| TY | 6.62 | | | -2.36 | #NUM! | 0.66 | |
| | unadjusted | | | Laspeyres | Fisher | Paasche | |
| Qty | 735 | | 2528 | 735 | | 2528 | 1793 |

# Data Analysis Example



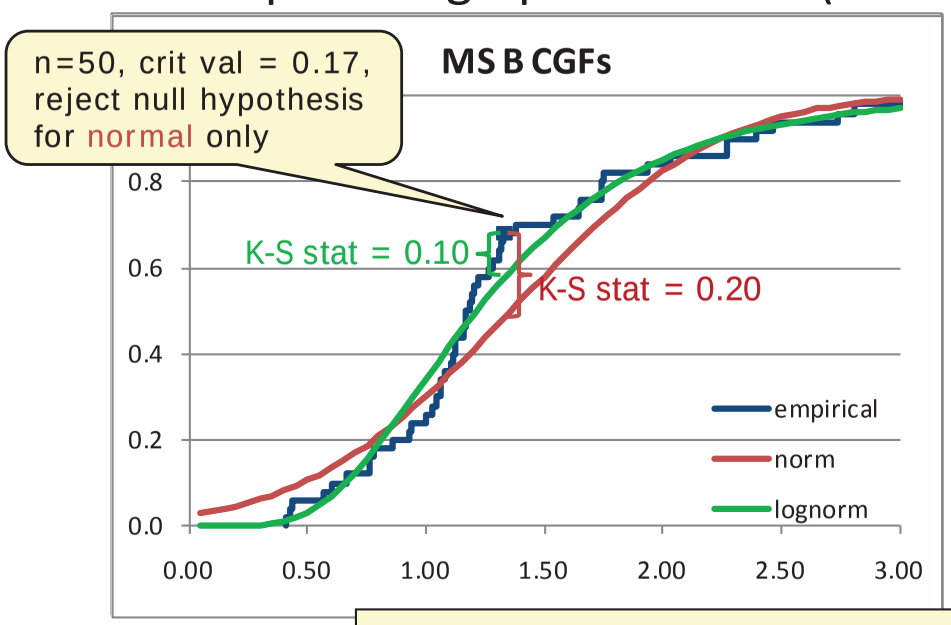
# Data Analysis Example

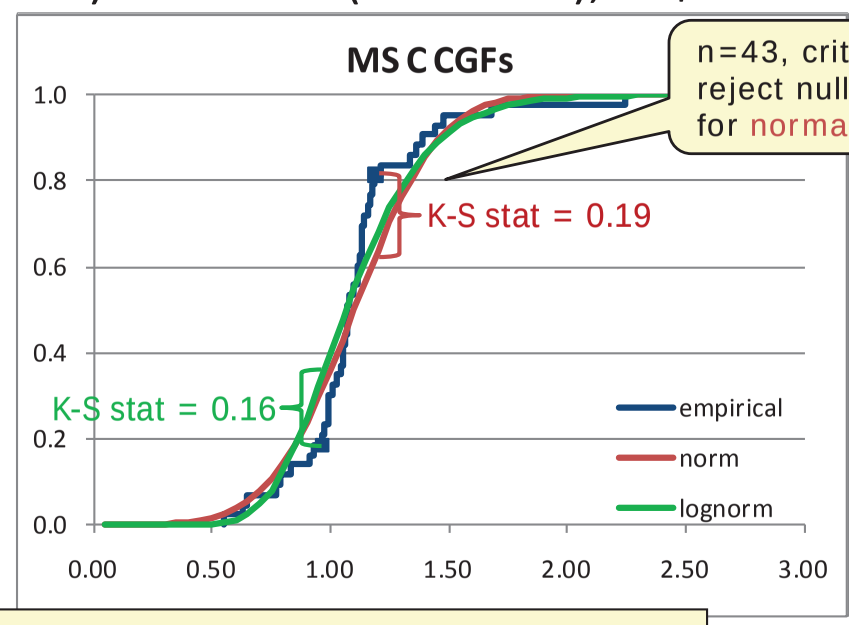


# S-Curve vs. Stair Step

- The aforementioned methods preserve the "shape" of the baseline distribution and ignore the "shape" of historical (cross-program) risk
- Parametric approach
  - Normal or lognormal distribution with historical CV
  - Distributions diverge as CV increases
- Non-parametric approach
  - Empirical distribution of CGFs (non-parametric)
  - Does not circumvent that distribution of CGFs may not be the right thing to look at in the first place
- Comparison graphs for MS B (CV = 51%) and MS C (CV = 26%), TY$ Fisher

For α=0.10, n>40, K-S critical value is approx.[8] $\frac{1.22}{\sqrt{n+\sqrt{n/10}}}$



8. *Practical Nonparametric Statistics* (3rd ed.), W.J. Conover, John Wiley and Sons, Inc., 1999. Table A13 Quantiles of the Kolmogorov Test Statistic.

# CV of Cost – Theoretical Framework

- Some mental models are not very satisfying, as they fly in the face of historical data
  - Variation in cost cannot be a fixed percent, because the well-established "size effect" says that **larger programs** have a **smaller *percent* variation**
  - Variation in cost cannot be a fixed dollar value, because clearly **larger programs** have a **larger *dollar-value* variation**
- Thus we need a model that will accommodate both these observations, which bring us to… [drum roll]
  - Current Estimate is a linear function of Baseline Estimate with a heteroskedastic error term
    - Variance increases linearly with program size (BE$)
- We explore this model using the DON SAR data themselves

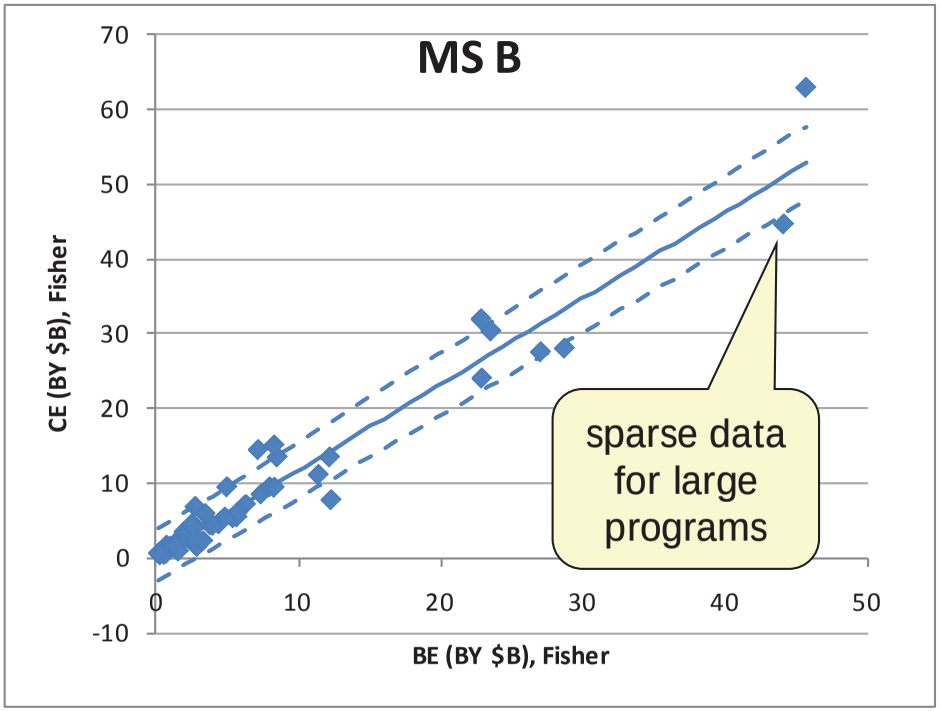
# CV of Cost – SAR Data

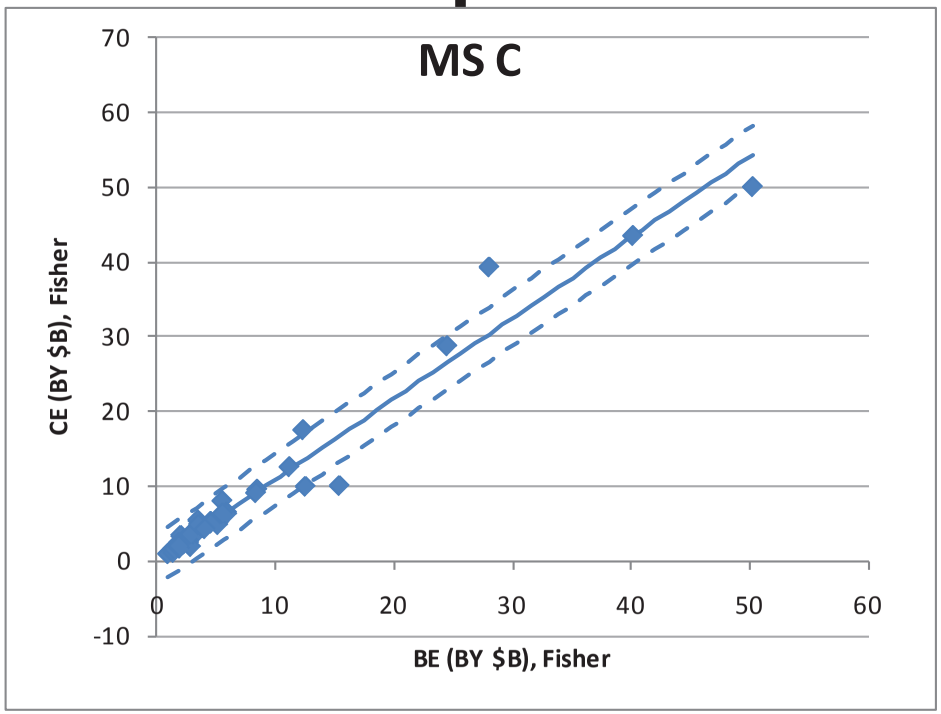
- White test conducted
  - Reject null hypothesis of homoskedastic error terms at $\alpha = 0.10$
- Maximum Likelihood Estimation (MLE) regressions
  - Error functional forms tried:

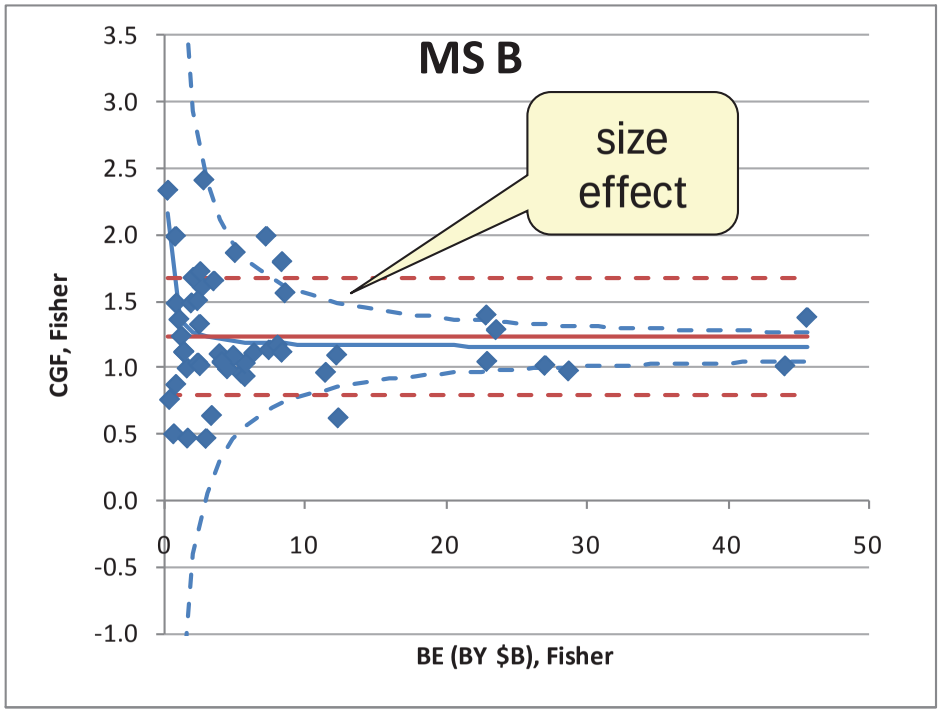
1. $\sigma^2 = kx$, error bands tight for small programs (shrink to zero)
2. $\sigma^2 = kx^2$, error bands are linear, too wide for large programs, constant CV regardless of program size
3. $\sigma^2 = k_0+k_1x$, error bands "just right," models prevalent size effect reasonably, greater $ errors but smaller % errors for larger programs

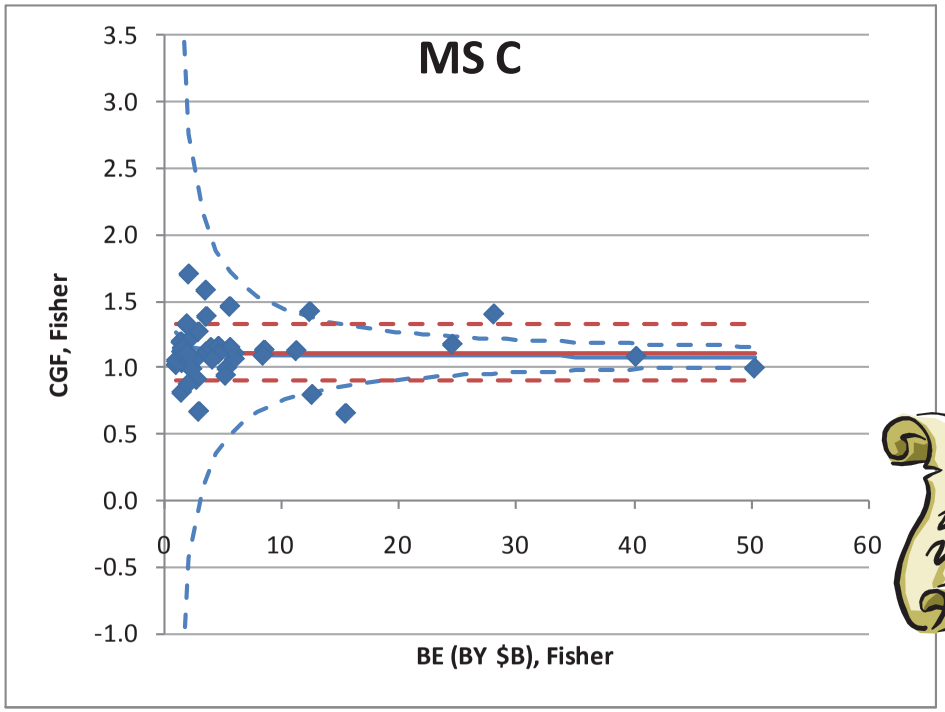
  - Currently prefer #1 for the extra degree of freedom and fact that regression is highly insensitive to constant term in #3
- Because this method uses dollars and not (unitless) quotients, it is somewhat problematic with TY$
  - Even BY$ need to be normalized to a common BY!

# CV of Cost – Scatterplots

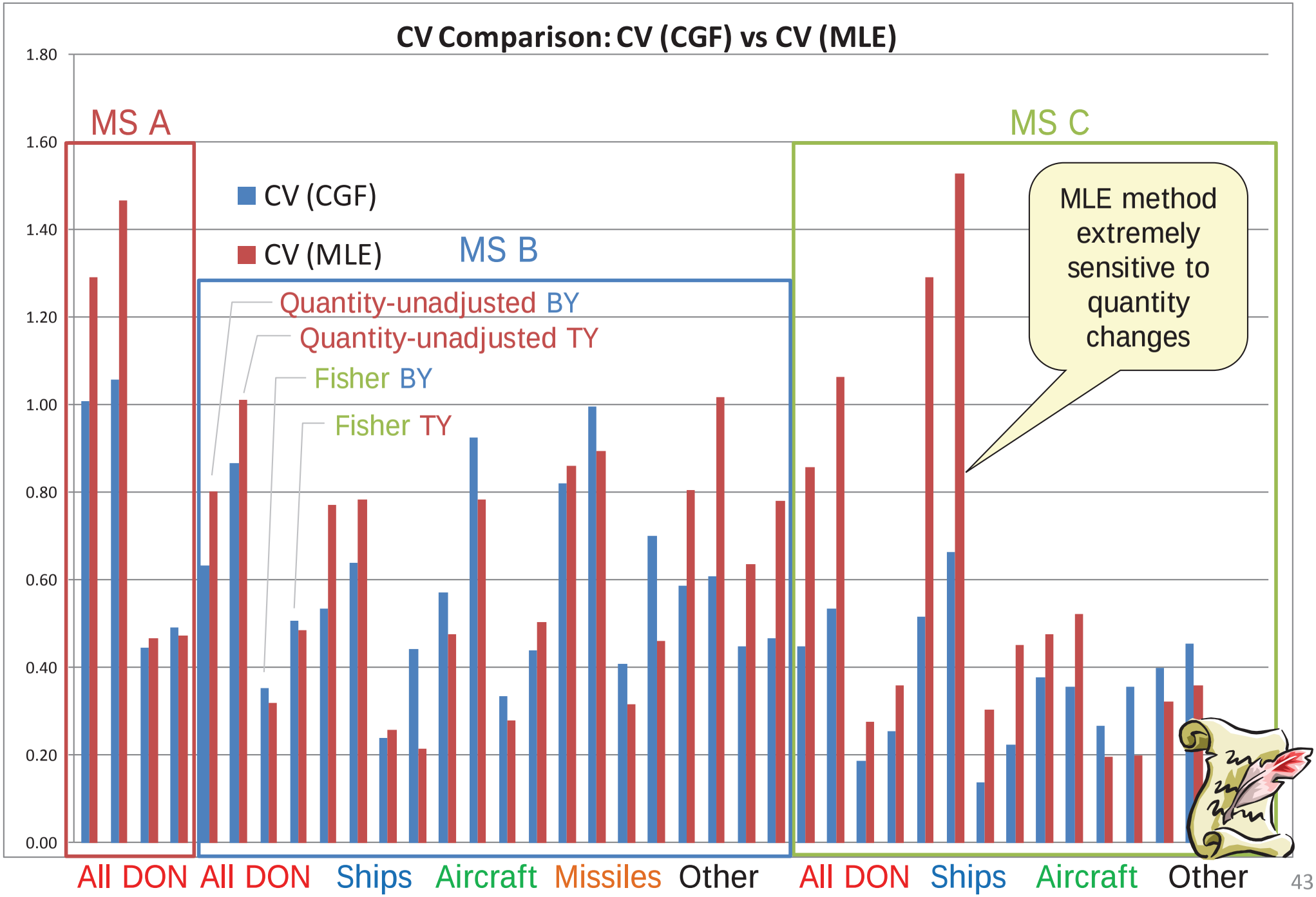


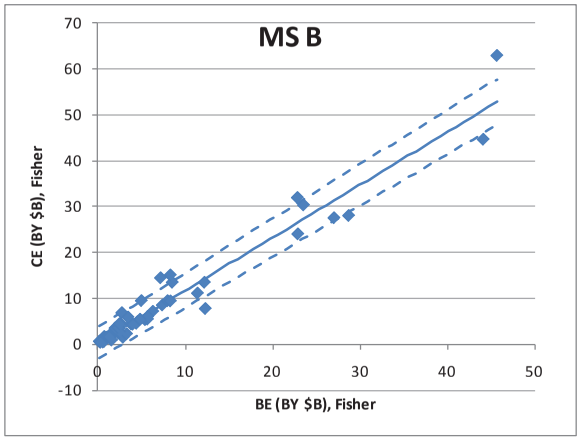
# CV Comparison – CGF vs. MLE

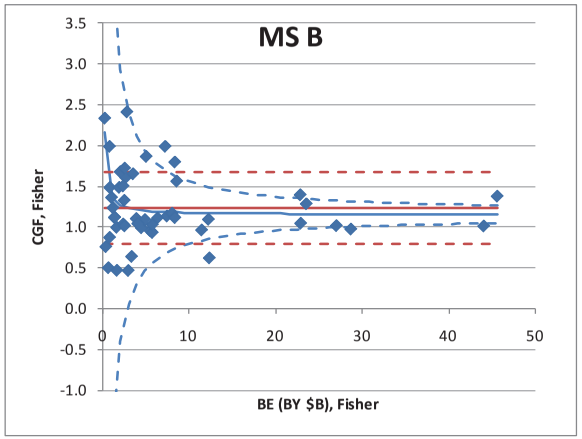


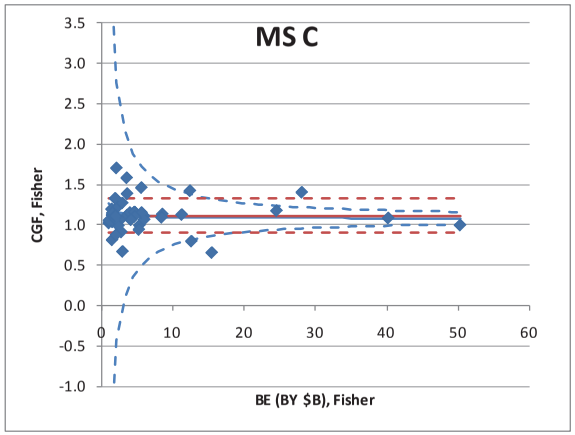
# CV Methods Summary

| | | | CGFs | | | MLE | | |
|---|---|---|---|---|---|---|---|---|
| | | | small (MIDS-LVT) | medium (EA-18G) | large (DDG 51) | small (MIDS-LVT) | medium (EA-18G) | large (DDG 51) |
| MS B | BY | CGF | 1.23 | 1.23 | 1.23 | 1.35 | 1.18 | 1.16 |
| | | CV | 35.4% | 35.4% | 35.4% | 290.8% | 44.8% | 18.3% |
| | TY | CGF | 1.36 | 1.36 | 1.36 | 1.80 | 1.21 | 1.13 |
| | | CV | 50.6% | 50.6% | 50.6% | 255.8% | 56.6% | 26.5% |
| MS C | BY | CGF | 1.11 | 1.11 | 1.11 | 1.17 | 1.10 | 1.09 |
| | | CV | 18.8% | 18.8% | 18.8% | 182.4% | 41.5% | 13.1% |
| | TY | CGF | 1.10 | 1.10 | 1.10 | 1.05 | 1.11 | 1.12 |
| | | CV | 25.5% | 25.5% | 25.5% | 170.6% | 43.6% | 14.0% |

Need to examine extremes of size effect



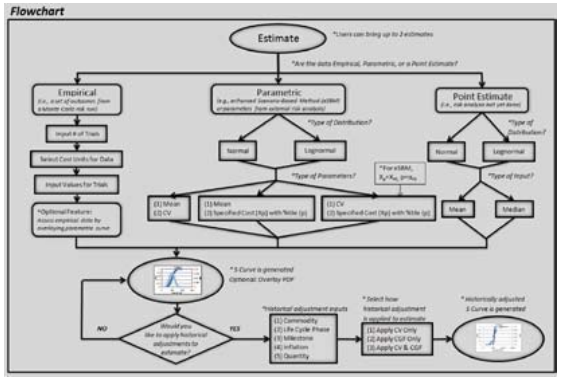



# NCCA S-Curve Tool

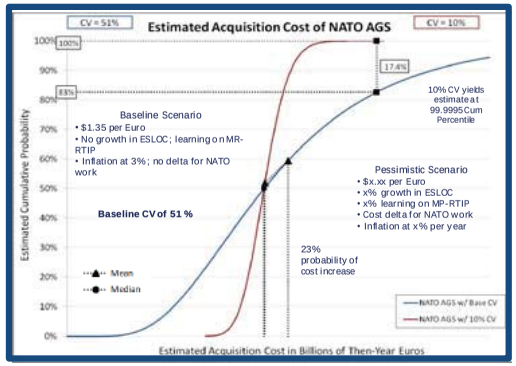
- With the help of the NCCA S-Curve Tool, practitioners can easily and clearly:
  - Compare their estimate (S-curve!) to history in coefficient of variation (CV) and cost growth factor (CGF) [Benchmarking]
  - Compare two different estimates [Reconciliation]
  - Generate graphics for decision briefs
- Compatible with both:
  - Empirical methods such as Monte Carlo risk analyses
  - Parametric methods such as enhanced Scenario-Based Method (eSBM)
- For more information, visit the following link

http://www.ncca.navy.mil/tools/tools.cfm

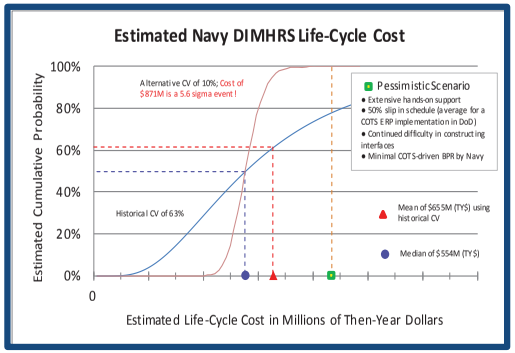


# S-Curve Tool Users

- Naval Center for Cost Analysis (NCCA) ICEs and cost assessments
  - Comparisons with historical CVs and SYSCOM estimates
- ICE on NATO Alliance Ground Surveillance (AGS) System
  - Global Hawk Block 40
  - Dr. Paul Garvey's eSBM employed for cost risk analysis
  - S-Curve tool for graphics and what-if drills




- Canada
  - ICE on Joint Strike Fighter (JSF)
  - Presentation to Deputy Ministers
- Defense Integrated Military Human Resources System
  - eSBM employed for cost risk analysis




- Virginia Class Submarines (VCS)
  - Manhour estimates at completion
- Department of Homeland Security (DHS)
  - Standard for cost analyses

# S-Curve Tool Updates

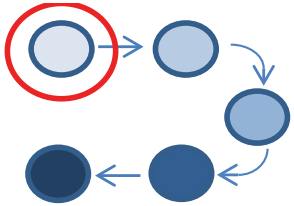
- NCCA S-Curve Tool Beta v3.0 is publicly available tool on NCCA's website
- Listed below are the updates from Beta v2.0 to Beta v3.0
  - Benchmarks now available for RDT&E and Procurement (vice Total Acquisition)
  - Benchmarks now available for all DoD (vice DON)
  - Broader range of commodity-specific benchmarks now available
  - Indicators for number of data points and unusual values in data set for each benchmark

# Future Research

- Update database for December 2011 SARs
- Investigate correlation amongst Cost Growth Category and relate decomposition to Root Cause Analysis (RCA)
- Investigate applicability of MOEs and MARs for development of CV benchmarks for MAIS programs

# BACKUP

# SAR Summary Sheets

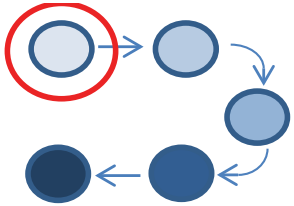


**Program Acquisition Cost Summary (Dollars in Millions)**
**As of December 31, 2010**

| | | | Baseline Estimate | | | Changes To Date | | | Current Estimate | | | % Change To Date Adjusted for Qty | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Program | Base Year | Baseline Type | Base-Year Dollars | Then-Year Dollars | Quantity | Base-Year Dollars | Then-Year Dollars | Quantity | Base-Year Dollars | Then-Year Dollars | Quantity | Base-Year Dollars | Then-Year Dollars |
| **Army:** | | | | | | | | | | | | | |
| AB3A REMANUFACTURE | 2010 | DE/PdE | 7,064.4 | 8,093.9 | 602 | 3,388.1 | 3,799.2 | 37 | 10,452.5 | 11,893.1 | 639 | 43.9 | 40.1 |
| AB3B NEW BUILD | 2010 | PdE | 2,307.0 | 2,510.4 | 56 | -150.4 | -157.7 | 1 | 2,156.6 | 2,352.7 | 57 | -8.3 | -8.1 |
| ATIRCM/CMWS - ATIRCM QRC | 2003 | PdE/DE | 894.8 | 1,054.4 | - | 6.0 | -47.8 | 83 | 900.8 | 1,006.6 | | | |
| ATIRCM/CMWS - CMWS | 2003 | PdE | 1,900.9 | 2,186.2 | 2,668 | 1,260.5 | 1,421.6 | -648 | 3,161.4 | 3,607.8 | | | |
| CH-47F | 2005 | PdE | 10,614.8 | 12,147.4 | 512 | 2,088.3 | 2,291.1 | 20 | 12,703.1 | 14,438.5 | | | |
| EXCALIBUR | 2007 | PdE | 2,264.6 | 2,518.7 | 30,388 | -580.0 | -808.1 | -22,914 | 1,684.6 | 1,710.6 | | | |
| FBCB2 | 2005 | PdE | 1,579.9 | 1,556.7 | 22,248 | 2,059.7 | 2,260.9 | 67,820 | 3,639.6 | 3,817.6 | 9 | | |
| FMTV | 1996 | PdE | 11,594.2 | 18,921.3 | 85,488 | 3,842.4 | -189.9 | 2,351 | 15,436.6 | 18,731.4 | 8 | | |
| GMLRS/GMLRS AW | 2003 | PdE | 9,780.2 | 11,848.9 | 140,239 | -4,902.8 | -5,824.5 | -96,357 | 4,877.4 | 6,024.4 | 4 | | |
| HIMARS | 2003 | PdE | 3,711.6 | 4,388.4 | 894 | -1,929.2 | -2,375.1 | -513 | 1,782.4 | 2,013.3 | | | |
| IAMD | 2009 | DE | 4,856.6 | 5,791.6 | 296 | 483.1 | 528.8 | - | 5,339.7 | 6,320.4 | 296 | 9.9 | 9.1 |
| INCREMENT 1 E-IBCT | 2010 | PdE | 3,149.5 | 3,284.0 | 9 | -1,906.0 | -2,014.4 | -6 | 1,243.5 | 1,269.6 | 3 | -18.3 | -19.5 |
| JLENS | 2005 | DE | 5,850.0 | 7,151.0 | 16 | 1,046.0 | 1,386.9 | - | 6,896.0 | 8,537.9 | 16 | 17.9 | 19.4 |
| LONGBOW APACHE | 1996 | PdE | 5,690.6 | 7,027.8 | 758 | 5,684.5 | 6,122.1 | -1 | 11,375.1 | 13,149.9 | 757 | 80.6 | 69.7 |
| LUH | 2006 | PdE | 1,638.3 | 1,883.0 | 322 | 170.9 | 123.5 | 23 | 1,809.2 | 2,006.5 | 345 | 3.5 | -0.8 |
| MQ-1C UAS GRAY EAGLE | 2010 | DE/PdE | 4,923.6 | 5,220.8 | 13 | 98.6 | 41.7 | 18 | 5,022.2 | 5,262.5 | 31 | 8.4 | 5.6 |
| PATRIOT PAC-3 | 2002 | PdE | 9,084.0 | 9,205.8 | 1,159 | 513.4 | 796.3 | 51 | 9,597.4 | 10,002.1 | 1,210 | 2.0 | 4.1 |
| PATRIOT/MEADS CAP - FIRE UNIT | 2004 | DE | 16,530.5 | 21,839.4 | 48 | -13,651.0 | -18,535.9 | -48 | 2,879.5 | 3,303.5 | - | -62.4 | -64.4 |
| PATRIOT/MEADS CAP - MISSILE | 2004 | DE | 6,220.9 | 8,056.0 | 1,528 | 555.3 | 1,203.8 | - | 6,776.2 | 9,259.8 | 1,528 | 8.9 | 14.9 |
| STRYKER | 2004 | PdE | 8,276.9 | 8,534.7 | 2,096 | 7,271.8 | 8,548.7 | 2,139 | 15,548.7 | 17,083.4 | 4,235 | 13.0 | 14.3 |
| UH-60M BLACK HAWK | 2005 | PdE | 16,801.7 | 20,847.1 | 1,235 | 5,286.9 | 6,493.4 | 140 | 22,088.6 | 27,340.5 | 1,375 | 15.5 | 13.3 |
| WIN-T INCREMENT 1 | 2007 | PdE | 3,798.0 | 3,879.7 | 1,677 | 388.1 | 423.4 | 183 | 4,186.1 | 4,303.1 | 1,860 | 4.0 | 4.5 |
| WIN-T INCREMENT 2 | 2010 | PdE | 4,686.0 | 4,996.9 | 2,216 | 1,206.3 | 1,355.6 | 630 | 5,892.3 | 6,352.5 | 2,846 | 5.9 | 6.2 |
| WIN-T INCREMENT 3 | 2009 | DE | 15,807.9 | 18,813.2 | 3,482 | -2,410.9 | -2,757.3 | -275 | 13,397.0 | 16,055.9 | 3,207 | -11.9 | -11.1 |
| **Subtotal** | | | **159,026.9** | **191,757.3** | | **9,819.6** | **4,086.3** | | **168,846.5** | **195,843.6** | | 10.7 | 8.5 |
| **Navy:** | | | | | | | | | | | | | |
| AGM-88E AARGM | 2003 | PdE | 1,528.5 | 1,861.4 | 1,919 | 63.7 | 47.3 | - | 1,592.2 | 1,908.7 | 1,919 | 4.2 | 2.5 |
| AIM-9X | 1997 | PdE | 2,464.0 | 3,232.9 | 10,049 | 475.3 | 521.7 | 93 | 2,939.3 | 3,754.6 | 10,142 | 18.7 | 15.4 |
| CEC | 2002 | PdE | 4,123.3 | 4,310.7 | 272 | 193.4 | 325.9 | -1 | 4,316.7 | 4,636.6 | 271 | 9.5 | 13.8 |
| CH-53K | 2006 | DE | 14,980.9 | 18,766.3 | 156 | 5,322.7 | 6,978.5 | 44 | 20,303.6 | 25,744.8 | 200 | 17.3 | 17.7 |
| COBRA JUDY REPLACEMENT | 2003 | DE | 1,365.0 | 1,464.0 | 1 | 162.6 | 250.2 | - | 1,527.6 | 1,714.2 | 1 | 11.9 | 17.1 |
| CVN 78 CLASS | 2000 | DE | 28,701.2 | 36,082.1 | 3 | -1,275.2 | 4,213.2 | - | 27,426.0 | 40,295.3 | 3 | -4.4 | 11.7 |
| DDG 1000 | 2005 | DE | 31,547.9 | 36,296.3 | 10 | -13,130.9 | -15,404.9 | -7 | 18,417.0 | 20,891.4 | 3 | 9.0 | 21.4 |
| DDG 51 | 1987 | PdE | 16,953.7 | 20,117.5 | 23 | 43,211.2 | 68,299.1 | 52 | 60,164.9 | 88,416.6 | 75 | 24.3 | 25.2 |

Program Acquisition Cost Summary

# SAR Summary Sheets

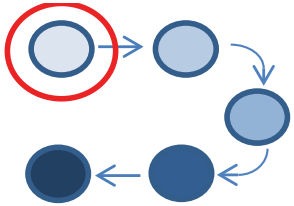


**Distribution of Cost Changes (Base-Year Dollars in Millions)**
**As of December 31, 2010**

| | | Cost Changes Between the Baseline and Current Estimate | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Quantity | | Schedule | | Engineering | | Estimating | | Other | | Support | | Total | |
| Program | Base Year | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date |
| Army: | | | | | | | | | | | | | | | |
| AB3A REMANUFACTURE | 2010 | - | 201.6 | - | 0.9 | - | - | 2,161.7 | 2,222.3 | - | - | 127.8 | 963.3 | 2,289.5 | 3,388.1 |
| AB3B NEW BUILD | 2010 | 44.0 | 44.0 | - | - | - | - | -312.2 | -312.2 | - | - | 117.8 | 117.8 | -150.4 | -150.4 |
| ATIRCM/CMWS - ATIRCM QRC | 2003 | - | 180.9 | - | -593.7 | - | 138.9 | -22.9 | 289.5 | - | - | - | | | |
| ATIRCM/CMWS - CMWS | 2003 | - | 376.7 | - | -99.2 | - | 635.0 | 91.1 | 295.9 | - | - | 0.5 | | | |
| CH-47F | 2005 | 121.0 | 417.0 | -4.1 | -8.3 | 176.9 | 177.4 | 340.2 | 1,463.6 | - | - | 16.8 | | | |
| EXCALIBUR | 2007 | 37.2 | -674.7 | -2.6 | 48.9 | - | - | 73.9 | 47.2 | - | - | 0.1 | | | |
| FBCB2 | 2005 | - | 1,431.3 | - | -44.7 | - | 185.4 | -10.3 | 186.9 | - | - | -14.6 | | | |
| FMTV | 1996 | 559.2 | 462.0 | -134.4 | -91.6 | 241.9 | 2,471.1 | -1,756.0 | 1,204.4 | - | - | -120.9 | -203.5 | -1,210.2 | 3,842.4 |
| GMLRS/GMLRS AW | 2003 | - | -5,775.3 | - | 224.1 | - | 8.5 | -21.6 | 632.6 | - | - | 0.1 | 7.3 | -21.5 | -4,902.8 |
| HIMARS | 2003 | - | -1,689.8 | - | -16.6 | - | 35.5 | -25.5 | -169.3 | - | - | 1.8 | -89.0 | -23.7 | -1,929.2 |
| IAMD | 2009 | - | - | - | - | - | - | 481.3 | 481.3 | - | - | 1.8 | 1.8 | 483.1 | 483.1 |
| INCREMENT 1 E-IBCT | 2010 | -786.1 | -786.1 | - | - | - | - | -680.8 | -839.2 | - | - | -332.6 | -280.7 | -1,799.5 | -1,906.0 |
| JLENS | 2005 | - | - | 90.7 | 278.2 | 77.9 | 77.9 | -104.5 | 316.1 | - | - | 259.4 | 643.8 | 323.5 | 1,046.0 |
| LONGBOW APACHE | 1996 | 4.9 | 606.7 | 0.1 | 5.6 | 8.5 | 2,915.5 | 22.9 | 1,703.8 | - | - | -0.1 | 452.9 | 36.3 | 5,684.5 |
| LUH | 2006 | - | 110.5 | 1.5 | 31.5 | - | 74.4 | -1.5 | -77.9 | - | - | 0.9 | 32.4 | 0.9 | 170.9 |
| MQ-1C UAS GRAY EAGLE | 2010 | -238.9 | -238.9 | -210.4 | -210.4 | 401.4 | 401.4 | 214.3 | 214.3 | - | - | -67.8 | -67.8 | 98.6 | 98.6 |
| PATRIOT PAC-3 | 2002 | 322.2 | 325.5 | 36.4 | 83.2 | - | - | 182.0 | 104.7 | - | - | - | - | 540.6 | 513.4 |
| PATRIOT/MEADS CAP - FIRE UNIT | 2004 | -8,875.5 | -8,875.5 | -148.0 | -148.0 | - | - | -1,795.6 | -2,447.3 | - | - | -2,343.2 | -2,180.2 | -13,162.3 | -13,651.0 |
| PATRIOT/MEADS CAP - MISSILE | 2004 | - | - | - | - | - | - | 121.7 | 546.4 | - | - | 2.7 | 8.9 | 124.4 | 555.3 |
| STRYKER | 2004 | 588.7 | 5,484.2 | -16.4 | -81.8 | 10.7 | 2,292.0 | 990.4 | -1,513.3 | - | - | -21.5 | 1,090.7 | 1,551.9 | 7,271.8 |
| UH-60M BLACK HAWK | 2005 | 2,330.0 | 2,330.0 | 10.4 | 146.6 | -74.2 | 538.8 | 103.2 | 1,722.6 | - | - | 178.8 | 548.9 | 2,548.2 | 5,286.9 |
| WIN-T INCREMENT 1 | 2007 | 114.3 | 227.8 | - | - | - | - | -124.7 | -185.4 | - | - | 418.0 | 345.7 | 407.6 | 388.1 |
| WIN-T INCREMENT 2 | 2010 | 879.1 | 879.1 | - | - | - | - | -78.7 | -75.0 | - | - | 405.1 | 402.2 | 1,205.5 | 1,206.3 |
| WIN-T INCREMENT 3 | 2009 | - | -596.5 | -0.5 | -0.5 | - | -1,741.2 | 92.6 | -127.0 | - | - | 20.1 | 54.3 | 112.2 | -2,410.9 |
| Subtotal | | -4,899.9 | -5,559.5 | -377.3 | -475.8 | 843.1 | 8,210.6 | -59.0 | 5,685.0 | - | - | -1,349.0 | 2,229.4 | -5,842.1 | 9,819.6 |
| Navy: | | | | | | | | | | | | | | | |
| AGM-88E AARGM | 2003 | - | - | - | - | 19.3 | 19.3 | 7.2 | 44.1 | - | - | 15.6 | 0.3 | 42.1 | 63.7 |
| AIM-9X | 1997 | - | 12.9 | - | 64.3 | 84.9 | 297.5 | -1.2 | 307.5 | - | - | -0.6 | -206.9 | 83.1 | 475.3 |
| CEC | 2002 | -71.3 | -181.1 | -3.1 | -36.9 | 16.4 | 261.0 | 139.5 | 237.9 | - | - | -23.5 | -87.5 | 58.0 | 193.4 |
| CH-53K | 2006 | - | 2,326.4 | 48.8 | 848.0 | - | - | 116.9 | 1,333.0 | - | - | 22.2 | 815.3 | 187.9 | 5,322.7 |
| COBRA JUDY REPLACEMENT | 2003 | - | - | - | 30.0 | - | - | 1.3 | 132.6 | - | - | - | - | 1.3 | 162.6 |
| CVN 78 CLASS | 2000 | - | - | - | 120.2 | - | -688.9 | -568.7 | -706.5 | - | - | - | - | -568.7 | -1,275.2 |
| DDG 1000 | 2005 | - | -14,646.0 | - | 63.8 | - | 15.9 | 769.5 | 1,435.4 | - | - | - | - | 769.5 | -13,130.9 |
| DDG 51 | 1987 | 2,060.0 | 31,444.9 | 86.4 | 363.8 | 1,326.5 | 3,342.9 | 100.3 | 8,059.6 | - | - | - | - | 3,573.2 | 43,211.2 |

Cost Categories ($BY)

# SAR Summary Sheets



**Distribution of Cost Changes (Then-Year Dollars in Millions)**
**As of December 31, 2010**

| | Cost Changes Between the Baseline and Current Estimate | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Economic | | Quantity | | Schedule | | Engineering | | Estimating | | Other | | Support | | Total | |
| Program | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date | This Qtr | To Date |
| **Army Subtotal:** | | | | | | | | | | | | | | | | |
| AB3A REMANUFACTURE | 21.1 | -384.7 | - | 395.5 | 19.9 | 147.5 | - | - | 2,534.6 | 2,593.9 | - | - | 141.9 | 1,047.0 | 2,717.5 | 3,799.2 |
| AB3B NEW BUILD | 4.1 | 4.1 | 49.7 | 49.7 | 2.8 | 2.8 | - | - | -344.6 | -344.6 | - | - | 130.3 | 130.3 | -157.7 | -157.7 |
| ATIRCM/CMWS - ATIRCM QRC | - | 25.4 | - | 303.3 | - | -866.9 | - | 179.7 | -27.5 | 304.0 | - | - | | | | |
| ATIRCM/CMWS - CMWS | -0.1 | 124.5 | - | 587.1 | - | -424.3 | - | 704.0 | 128.1 | 386.6 | - | - | | | | |
| CH-47F | 1.0 | -147.8 | 154.4 | 502.9 | -18.5 | -285.6 | 217.5 | 218.0 | 425.8 | 1,969.3 | - | - | | | | |
| EXCALIBUR | -0.9 | -80.3 | 38.5 | -819.2 | -3.4 | 47.9 | - | - | 73.9 | 44.9 | - | - | | | | |
| FBCB2 | -0.3 | 14.7 | - | 1,600.7 | - | -120.2 | - | 198.4 | -12.1 | 226.7 | - | - | | | | |
| FMTV | -13.2 | -2,797.1 | 786.5 | 188.7 | -518.0 | -2,203.8 | 340.4 | 3,388.0 | -2,332.4 | 1,623.1 | - | - | | | | |
| GMLRS/GMLRS AW | -8.1 | 494.7 | - | -8,732.6 | 0.4 | 1,279.5 | - | 10.8 | -26.7 | 1,115.1 | - | - | -0.1 | 8.0 | -34.5 | -5,824.5 |
| HIMARS | -0.6 | 229.3 | - | -2,332.3 | - | -17.3 | - | 39.6 | -32.1 | -150.6 | - | - | 2.2 | -143.8 | -30.5 | -2,375.1 |
| IAMD | -10.0 | -10.0 | - | - | - | - | - | - | 537.3 | 537.3 | - | - | 1.5 | 1.5 | 528.8 | 528.8 |
| INCREMENT 1 E-IBCT | 4.3 | -8.7 | -829.8 | -829.8 | - | - | - | - | -713.3 | -875.9 | - | - | -358.3 | -300.0 | -1,897.1 | -2,014.4 |
| JLENS | -11.5 | -138.9 | - | - | 184.9 | 507.0 | 99.7 | 99.7 | -144.6 | 398.4 | - | - | 345.6 | 520.7 | 474.1 | 1,386.9 |
| LONGBOW APACHE | -1.5 | -270.2 | 6.4 | 721.4 | -0.3 | 24.1 | 11.1 | 3,601.4 | 29.7 | 1,558.8 | - | - | - | 486.6 | 45.4 | 6,122.1 |
| LUH | -0.1 | -50.3 | - | 139.3 | 3.8 | -2.8 | - | 84.9 | -2.0 | -82.7 | - | - | 1.2 | 35.1 | 2.9 | 123.5 |
| MQ-1C UAS GRAY EAGLE | 2.9 | 2.9 | -289.8 | -289.8 | -242.2 | -242.2 | 433.0 | 433.0 | 215.5 | 215.5 | - | - | -77.7 | -77.7 | 41.7 | 41.7 |
| PATRIOT PAC-3 | 5.6 | 165.4 | 398.4 | 405.3 | 42.8 | 86.2 | - | - | 229.2 | 139.4 | - | - | - | - | 676.0 | 796.3 |
| PATRIOT/MEADS CAP - FIRE UNIT | -38.7 | -91.9 | -12,555.5 | -12,555.5 | -491.3 | -86.5 | - | - | -2,226.4 | -2,759.9 | - | - | -3,349.9 | -3,042.1 | -18,661.8 | -18,535.9 |
| PATRIOT/MEADS CAP - MISSILE | -16.5 | -21.9 | - | - | 271.5 | 538.9 | - | - | 117.8 | 630.7 | - | - | 25.0 | 56.1 | 397.8 | 1,203.8 |
| STRYKER | -2.2 | 124.8 | 707.8 | 6,413.9 | -30.8 | -310.4 | 20.9 | 2,669.7 | 1,201.5 | -1,413.4 | - | - | -9.8 | 1,064.1 | 1,887.4 | 8,548.7 |
| UH-60M BLACK HAWK | 7.1 | -706.0 | 3,291.3 | 3,291.3 | 67.2 | 400.3 | -83.7 | 655.1 | 140.5 | 2,147.1 | - | - | 236.4 | 705.6 | 3,658.8 | 6,493.4 |
| WIN-T INCREMENT 1 | -0.4 | -26.3 | 119.5 | 238.0 | -0.2 | -0.7 | - | - | -129.9 | -193.0 | - | - | 479.1 | 405.4 | 468.1 | 423.4 |
| WIN-T INCREMENT 2 | -3.1 | -3.1 | 983.4 | 983.4 | -13.2 | -13.2 | - | - | -78.8 | -75.0 | - | - | 466.5 | 463.5 | 1,354.8 | 1,355.6 |
| WIN-T INCREMENT 3 | -27.7 | -247.1 | - | -761.0 | -4.0 | 334.1 | - | -2,056.7 | 113.3 | -156.5 | - | - | 10.6 | 129.9 | 92.2 | -2,757.3 |
| **Subtotal** | -88.8 | -3,798.5 | -7,139.2 | -10,499.7 | -728.6 | -1,205.6 | 1,038.9 | 10,225.6 | -323.2 | 7,839.2 | - | - | -2,107.8 | 1,525.3 | -9,348.7 | 4,086.3 |
| **Navy Subtotal:** | | | | | | | | | | | | | | | | |
| AGM-88E AARGM | -1.9 | -42.8 | - | - | 5.3 | 5.3 | 22.8 | 22.8 | 10.5 | 63.6 | - | - | 20.3 | -1.6 | 57.0 | 47.3 |
| AIM-9X | -12.7 | -293.3 | - | 19.5 | -0.8 | 306.2 | 109.3 | 375.9 | -7.3 | 400.3 | - | - | -0.7 | -286.9 | 87.8 | 521.7 |
| CEC | 0.3 | 53.7 | -77.6 | -234.7 | -7.3 | 27.6 | 19.8 | 274.3 | 177.8 | 177.3 | - | - | -21.5 | 27.7 | 91.5 | 325.9 |
| CH-53K | -38.6 | -738.5 | - | 3,108.9 | 71.8 | 1,889.8 | - | - | 155.9 | 1,456.1 | - | - | 29.6 | 1,262.2 | 218.7 | 6,978.5 |
| COBRA JUDY REPLACEMENT | -0.2 | 51.2 | - | - | - | 36.3 | - | - | 1.7 | 162.7 | - | - | - | - | 1.5 | 250.2 |
| CVN 78 CLASS | 599.0 | 4,782.2 | - | - | - | 839.5 | - | -963.6 | -849.2 | -444.9 | - | - | - | - | -250.2 | 4,213.2 |
| DDG 1000 | 132.1 | 1,500.2 | - | -19,092.9 | - | 57.7 | - | 66.2 | 987.9 | 2,063.9 | - | - | - | - | 1,120.0 | -15,404.9 |
| DDG 51 | 363.9 | -4,999.8 | 4,376.1 | 50,515.6 | 155.2 | 1,510.3 | 2,697.0 | 5,981.2 | 416.7 | 15,291.8 | - | - | - | - | 8,008.9 | 68,299.1 |

Cost Categories ($TY)

# V&V Due Diligence

- Twin goals:
  - Get the data "as good as we can"
  - Go in "eyes wide open" as to the limitations of the data as "the best we have"
- Leverage in-house expertise
  - Primarily Dr. Brian Flynn, DON programs
- Provide data transparency…
  - …to the appropriate audience

Pee Wee Herman's Law of Visibility

- Acknowledge inherent noise in the data ("measurement error") without being nonchalant
  - Prego = "It's in there"

Coleman's Law of Avoidable Errors

- "Draw the line" and proceed with data analysis at the appropriate time

# Variation in Risk Analysis

- Example of different results with essentially the same data

## Historical Cost Growth

v1.1

| Source | Raw Average Tot | Raw Average R&D | Raw Average Prod | $ Wtd Average Tot | $ Wtd Average R&D Prod | | N | During Prod Prod |
|---|---|---|---|---|---|---|---|---|
| RAND 93: | 1.30 | | | 1.20 | 1.25 | 1.18 | 100+ | 1.02 |
| CAIG 91: | 1.33 | 1.40 | 1.25 | 1.21 | 1.24 | 1.19 | 27 | |
| TASC 94: | | 1.49 | 1.54 | | | | 20+ | |
| TASC 96: | | 1.43 | 1.55 | | 1.21 | 1.35 | 14 | 0.99 |
| Christensen 99: | | | | 1.09 | 1.14 | | | 1.06 |

MSIII

This chart presents data from different eras and different database subsets
The message it conveys is a general similarity, not precise equality

1. All data are from DoD SARs, under generally the same rules and procedures, except for Christensen
2. Christensen data is EVM Data, which includes re-baselining, and is contract only, vice program
3. This cost growth data includes growth due to "Cost Estimating Errors"
4. RAND Data and CAIG Data are from MS I, TASC data is from MSII

SCEA CEBoK Unit III - Module 9 NEW! 97

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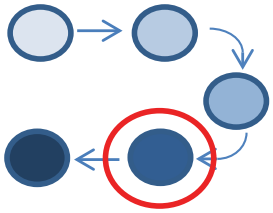
*CEBoK Module 9 - Risk

- Benefits of an "open-source" data approach?
  - A la Mike Popp's SRDR eRoom postings

# WGS Example



- Identified data anomaly
- Identified coordinating SME
- Inputs from those with direct knowledge of program
- Interpretation of inputs

Peter,

See below.

Greg Hogan
(202)210-5693 or (703)609-9134
Gregory.Hogan@pentagon.af.mil

-----Original Message-----
From: PRATER, MICHAEL D GS-15 USAF AFSPC AFSPC/FMS
[mailto:michael.prater.9@us.af.mil]
Sent: Thursday, March 15, 2012 1:14 PM
To: HOGAN, GREGORY A EE-00 USAF U S AIR FORCE HQ/1500 W. Perimeter Road, Suite 3500, Joint Base Andrews, MD 20762
Cc: CIPRESSI, RONALD P GS-13 USAF AF COST ANALYSIS AGENCY/1500 W. Perimeter Road, Suite 3500, Joint Base Andrews, MD 20762
Subject: FW: EXTERNAL: SAR satellite oddities

Greg,

See response below. Please forward to Peter and/or Richard as appropriate.
Let us know if you have any questions.

Thanks,
Mike

-----Original Message-----
From: Cipressi, Ronald P CIV USAF AFCAA/FM
[mailto:ronald.cipressi@pentagon.af.mil]
Sent: Thursday, March 15, 2012 10:55 AM
To: PRATER, MICHAEL D GS-15 USAF AFSPC AFSPC/FMS
Cc: Rutledge, Gabriel CIV USAF AFCAA/FMR
Subject: RE: EXTERNAL: SAR satellite oddities

Mike,

I did some research on the v-drive and spoke to Gabe about this. Here is what Gabe and I came up with.

Yes, three Block I satellites, SV 1-3, were produced and launched in the timeframe cited.

Gabe pulled the 12/31/10 SAR and we compared it to the 12/31/09 version. Due to the Nunn-McCurdy (NM) certification Acquisition Decision Memorandum (ADM) for WGS dated June 01, 2010, the program was restructured to account for the

# Historical Factors Table

| | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | commodity | milestone | phase | quantity | inflation | CGF | CVact | CVest | percentile | Median |
| 82 | DoN Acquisition | MS B (Development Estimate) | Acquisition | adj | BY$ | 1.21 | 0.46 | 55.6% | | 1.06 |
| 83 | DoN Acquisition | MS B (Development Estimate) | Acquisition | adj | TY$ | 1.34 | 0.63 | 83.9% | | 1.09 |
| 84 | DoN Acquisition | MS B (Development Estimate) | Acquisition | not adj | BY$ | 1.38 | 0.70 | 96.6% | | 1.05 |
| 85 | DoN Acquisition | MS B (Development Estimate) | Acquisition | not adj | TY$ | 1.65 | 0.93 | 153.6% | | 1.10 |
| 86 | DoN Acquisition | MS B (Development Estimate) | RDT&E | adj | BY$ | 1.48 | 0.78 | 115.0% | | 1.13 |
| 87 | DoN Acquisition | MS B (Development Estimate) | RDT&E | adj | TY$ | 1.60 | 0.85 | 136.0% | | 1.17 |
| 88 | DoN Acquisition | MS B (Development Estimate) | RDT&E | not adj | BY$ | 1.47 | 0.79 | 116.9% | | 1.13 |
| 89 | DoN Acquisition | MS B (Development Estimate) | RDT&E | not adj | TY$ | 1.60 | 0.86 | 138.0% | | 1.16 |
| 90 | DoN Acquisition | MS B (Development Estimate) | Procurement | adj | BY$ | 1.16 | 0.61 | 70.9% | | 1.03 |
| 91 | DoN Acquisition | MS B (Development Estimate) | Procurement | adj | TY$ | 1.52 | 1.49 | 226.4% | | 1.08 |
| 92 | DoN Acquisition | MS B (Development Estimate) | Procurement | not adj | BY$ | 1.40 | 0.83 | 116.5% | | 1.05 |
| 93 | DoN Acquisition | MS B (Development Estimate) | Procurement | not adj | TY$ | 1.72 | 1.06 | 181.7% | | 1.11 |
| 94 | DoN Acquisition | MS B (Development Estimate) | O&S | adj | BY$ | | | | | |
| 95 | DoN Acquisition | MS B (Development Estimate) | O&S | adj | TY$ | | | | | |
| 96 | DoN Acquisition | MS B (Development Estimate) | O&S | not adj | BY$ | | | | | |
| 97 | DoN Acquisition | MS B (Development Estimate) | O&S | not adj | TY$ | | | | | |
| 98 | DoN Acquisition | MS C (Production Estimate) | Acquisition | adj | BY$ | 1.09 | 0.21 | 22.3% | | 1.06 |
| 99 | DoN Acquisition | MS C (Production Estimate) | Acquisition | adj | TY$ | 1.07 | 0.27 | 28.6% | | 1.05 |
| 100 | DoN Acquisition | MS C (Production Estimate) | Acquisition | not adj | BY$ | 1.11 | 0.46 | 50.9% | | 1.04 |
| 101 | DoN Acquisition | MS C (Production Estimate) | Acquisition | not adj | TY$ | 1.09 | 0.53 | 57.7% | | 1.03 |
| 102 | DoN Acquisition | MS C (Production Estimate) | RDT&E | adj | BY$ | 1.25 | 0.52 | 65.0% | | 1.07 |
| 103 | DoN Acquisition | MS C (Production Estimate) | RDT&E | adj | TY$ | 1.26 | 0.57 | 72.3% | | 1.07 |
| 104 | DoN Acquisition | MS C (Production Estimate) | RDT&E | not adj | BY$ | 1.27 | 0.54 | 68.1% | | 1.07 |
| 105 | DoN Acquisition | MS C (Production Estimate) | RDT&E | not adj | TY$ | 1.29 | 0.59 | 75.5% | | 1.07 |
| 106 | DoN Acquisition | MS C (Production Estimate) | Procurement | adj | BY$ | 1.10 | 0.28 | 31.0% | | 1.07 |
| 107 | DoN Acquisition | MS C (Production Estimate) | Procurement | adj | TY$ | 1.11 | 0.46 | 50.8% | | 1.04 |
| 108 | DoN Acquisition | MS C (Production Estimate) | Procurement | not adj | BY$ | 1.09 | 0.50 | 54.2% | | 1.04 |
| 109 | DoN Acquisition | MS C (Production Estimate) | Procurement | not adj | TY$ | 1.07 | 0.57 | 60.4% | | 1.02 |
| 110 | DoN Acquisition | MS C (Production Estimate) | O&S | adj | BY$ | | | | | |
| 111 | DoN Acquisition | MS C (Production Estimate) | O&S | adj | TY$ | | | | | |
| 112 | DoN Acquisition | MS C (Production Estimate) | O&S | not adj | BY$ | | | | | |
| 113 | DoN Acquisition | MS C (Production Estimate) | O&S | not adj | TY$ | | | | | |

UNDER CONSTRUCTION

# List of Programs

| List of Cancelled Programs | |
|---|---|
| PNO | ProgramShortName |
| 225 | Peacekeeper |
| 239 | NPOESS |
| 254 | Comanche |
| 263A | SRAM II |
| 263B | SRAM T |
| 267 | Small ICBM |
| 370 | Joint Common Missile |
| 371 | ACS |
| 381 | ASDS |
| 382 | TSAT (Legacy) |
| 392 | VH-71 |
| 511 | SLAT |
| 700 | ACM |
| 708 | ATM |
| 715 | ADATS (FAADS LOS-F-H) |
| 743A | ASM – Block III |
| 743B | ASM – CMV |
| 743C | ASM – FIFV |
| 743D | ASM – AFAS |
| 743E | ASM – FARV-A |
| 743F | ASM – LOSAT |
| 752 | NATO AAWS |
| 760 | AAAM |

| List of Programs with 2010 SAR | |
|---|---|
| PNO | ProgramShortName |
| 101 | H-1 Upgrades |
| 178 | Trident II Missile |
| 180 | DDG 51 |
| 191 | MH-60R |
| 197 | DDG 1000 |
| 212 | V-22 |
| 223 | CVN 78 |
| 282 | MH-60S |
| 289 | Tactical Tomahawk |
| 333a | LHA 6 |
| 334 | P-8A |
| 345 | MUOS |
| 364 | E-2D AHE |
| 365 | CJR |
| 368 | AGM-88E AARGM |
| 374 | LCS |
| 378 | EA-18G |
| 391 | SM-6 |
| 515 | EFV |
| 516 | SSN 774 |
| 542 | LPD 17 |
| 549 | F/A-18 E/F |
| 582 | CEC |
| 592 | T-AKE |
| 766A | JSOW Baseline |
| 766B | JSOW Unitary |
| 202 | AB3 |
| 437 | AB3B New Build |
| 261 | AEHF |
| 581 | AIM-9X |
| 185 | AMRAAM |
| 375 | ASIP |
| 224 | B-2 EHF Increment 1 |
| 376 | B-2 RMP |

| List of Programs with 2010 SAR | |
|---|---|
| PNO | ProgramShortName |
| 373 | BAMS |
| 362 | BMDS |
| 298 | C-130 AMP |
| 220 | C-130J |
| 273 | C-5 AMP |
| 327 | C-5 RERP |
| 278 | CH-47F |
| 390 | CH-53K |
| 243 | Chem Demil-ACWA |
| 285 | Chem Demil-CMA |
| 219B | CMWS |
| 432 | E-IBCT Incr 1 |
| 366 | Excalibur |
| 265 | F-22 |
| 198 | F-35 |
| 199 | FAB-T |
| 294 | FBCB2 |
| 746 | FMTV |
| 237 | GBS |
| 252 | Global Hawk |
| 260C | GMLRS |
| 292 | GPS IIIA |
| 420 | Gray Eagle |
| 257 | HC/MC-130 Recap |
| 367 | HIMARS |
| 205 | IAMD |
| 418A | IDECM BLK 2/3 |
| 418B | IDECM BLK 4 |
| 555B | JASSM Baseline |
| 555C | JASSM ER |
| 183 | JCA |
| 503 | JDAM |
| 247 | JHSV |

| List of Programs with 2010 SAR | |
|---|---|
| PNO | ProgramShortName |
| 372 | JLENS |
| 238 | JPALS |
| 560 | JPATS |
| 421 | JTRS AMF |
| 360 | JTRS GMR |
| 385 | JTRS HMS |
| 284 | JTRS NED |
| 357 | LAIRCM |
| 831 | Longbow Apache |
| 182 | LUH |
| 293 | MP-RTIP |
| 353 | MRAP |
| 537 | NAS |
| 166C | NAVSTAR Mod Space & OCS |
| 166D | NAVSTAR Mod User Equip |
| 219C | NG ATIRCM |
| 290 | NMT |
| 239 | NPOESS |
| 531A | Patriot MEADS CAP (Fire Unit) |
| 531B | Patriot MEADS CAP (Missile Seg) |
| 148B | Patriot PAC-3 (Missile Seg) |
| 424 | Reaper |
| 286 | RMS |
| 210A | SBIRS High |
| 328 | SBSS B10 |
| 439 | SDB II |
| 299 | Stryker |
| 341 | UH-60M |
| 253 | VTUAV |
| 326 | WGS |
| 346 | WIN-T Increment 1 |
| 349 | WIN-T Increment 2 |
| 350 | WIN-T Increment 3 |

# Changes Since DoDCAS

| | DoDCAS (February 14-17, 2012) | Current Progress (March 31, 2012) |
|---|---|---|
| # of Programs | 305 | 312 |
| # of Estimates | 408 | 406 |

7 additional programs

| Programs | PNO | Identified Subprograms | Additional Programs | Additional Estimates |
|---|---|---|---|---|
| ANSQQ-89 | 153 | 2 (Basic; Improved) | 1 | 1 |
| Tomahawk | 154 | 2 (Tomahawk; TBIP) | 1 | 1 |
| UH-60 A/L Blackhawk | 156 | 2 (UH-60A; UH-60L) | 1 | 2 |
| MCS | 724 | 3 (Blocks I, II, III; Block IV; Block IV Software) | 2 | 2 |
| SADARM | 735 | 3 (SADARM; 155mm Projectile; MLRS Rocket) | 2 | 2 |

*Further explanations provided on slide 21

| Name of Program | PNO | Discarded Estimate |
|---|---|---|
| CG-47* | 159 | PdE |
| C-130J | 220 | DE |
| VTUAV | 253 | DE |
| WGS* | 326 | PdE |
| SDB I | 354 | DE |
| CVN 72/73 | 161E | DE |
| CVN 74/75 | 161F | DE |
| NAVSTAR GPS Satellite | 166A | DE |
| NAVSTAR GPS User Equipment | 166B | DE |
| SM-2 | 234 | DE |

Deleted a total of 2 estimates (added 8 and discarded 10)