NATIONAL RECONNAISSANCE OFFICE

NRO Experiences with the Implementation of *Will Cost/ Should Cost* Management

Presented to
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SUPRA ET ULTRA

About the NRO

- The National Reconnaissance Office (NRO) is the national program to meet the U.S. Government's intelligence needs through spaceborne reconnaissance
- A Department of Defense (DoD) agency and an element of the Intelligence Community
- Funded through the National Intelligence Program and the Military Intelligence Program portions of the federal budget
- The NRO's existence was declassified by the Deputy Secretary of Defense on September 18, 1992

NRO and DoD acquisition processes are closely aligned

Agenda

- DoD's Will Cost / Should Cost
- NRO Implementation of Will Cost / Should Cost
- GEAC Policy & Structure
- Trends Over Time
- Will Cost Methods
  - EAC Maturity Model
  - WAM Model
- Summary

DoD's Will Cost / Should Cost

- **Premise is…**
  - To deliver programs below budget baselines that are set using independent will-cost estimates
- **Will Cost is….**
  - Is the "official position of the DoD for use in budgeting, programming, setting acquisition program baselines and other program reporting external to the DoD"
  - All ACAT I, II and III programs are required to have an independent estimate performed outside of the program office
- **Should Cost is…**
  - Presented at Milestone Decision forums and is updated and tracked as the program progresses
  - Responsibility of the Program Office to develop the "Program Office Estimate (POE)," known as the "should cost" estimate with identified efficiencies

NRO Implementation of Will Cost/Should Cost

The NRO premise is similar to DoD's Will Cost/Should Cost and known as the Government Estimate at Complete (GEAC)

- **Will Cost is…**
  - The DNI's and NRO's independent cost estimating organizations develop the ICE, which forms the basis for budget programming, establishing a baseline
- **Should Cost is…**
  - Prior to the start of a contract, all programs prepare a "should cost" estimate to be briefed at the Acquisition Strategy Council (ASC), including:
    - Government 'will cost' and 'should cost' estimates across the FYDP with identified efficiencies, acquisition risk assessment, and funding sources. (Instruction 30-2-1). This information sets cost and efficiency expectations and assists the Government in developing realistic negotiation objectives.
  - Upon approval of the acquisition strategy, and then throughout execution of the program, the Program Office provides a "should cost" estimate, and tracks progress toward achieving the affordability requirement using the GEAC process

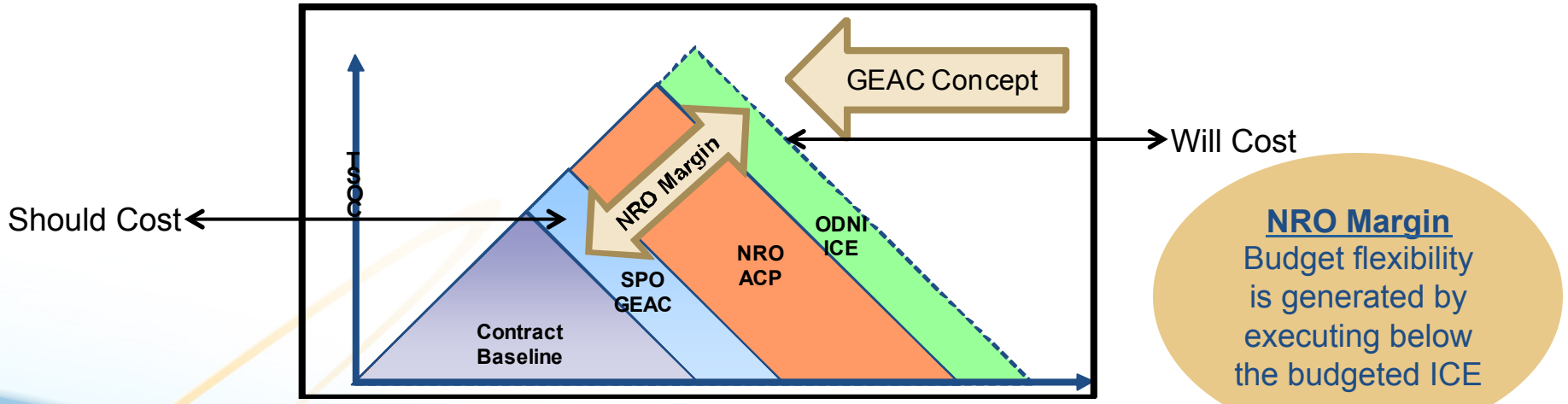
GEAC Premise

- Process enables identification and management of Program margin
- Provides budget flexibility to address budget shortfalls and priority requirements
- Facilitates identification of program and execution issues
- Provides a tool for PMs to manage and track program

The Will Cost/Should Cost management process allows NRO senior management to understand the performance of programs in the portfolio and influence acquisition outcomes

GEAC Policy…(ND 20-6, NI 20-6-1)

- GEAC process built to support NRO Budget Flexibility initiative (i.e. budget margin)
  (NRO –DNI budget flexibility MOA, Aug 2008)
- Current process established in 2009
- "Program Office Estimate provides 'should cost' …creates the GEAC" (CBPI 10-1)
- "The GEAC is the Directorate and Office most likely estimate plus reasonable PM-held margin"
- "Enables management of program margin"
- "Establishes the corporate-held margin position"
- "Margin between the GEAC and the ICE will be corporately managed"
- "Includes potential opportunities…initiatives, consolidations, efficiencies"



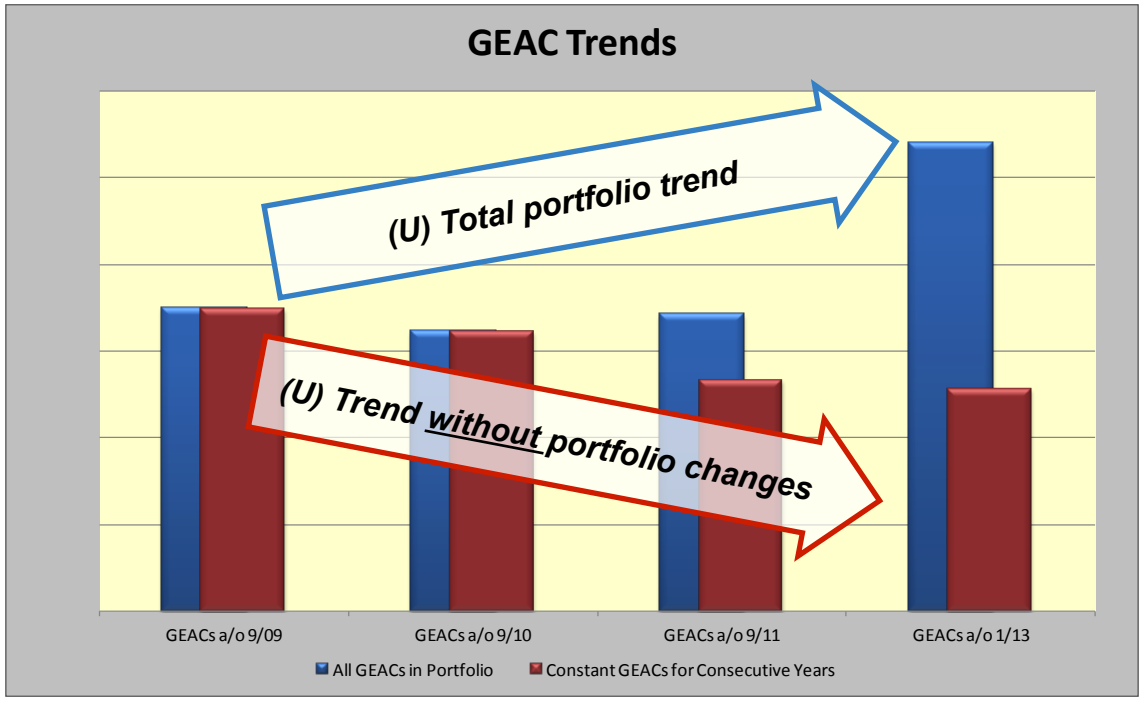
NRO Margin
Budget flexibility is generated by executing below the budgeted ICE

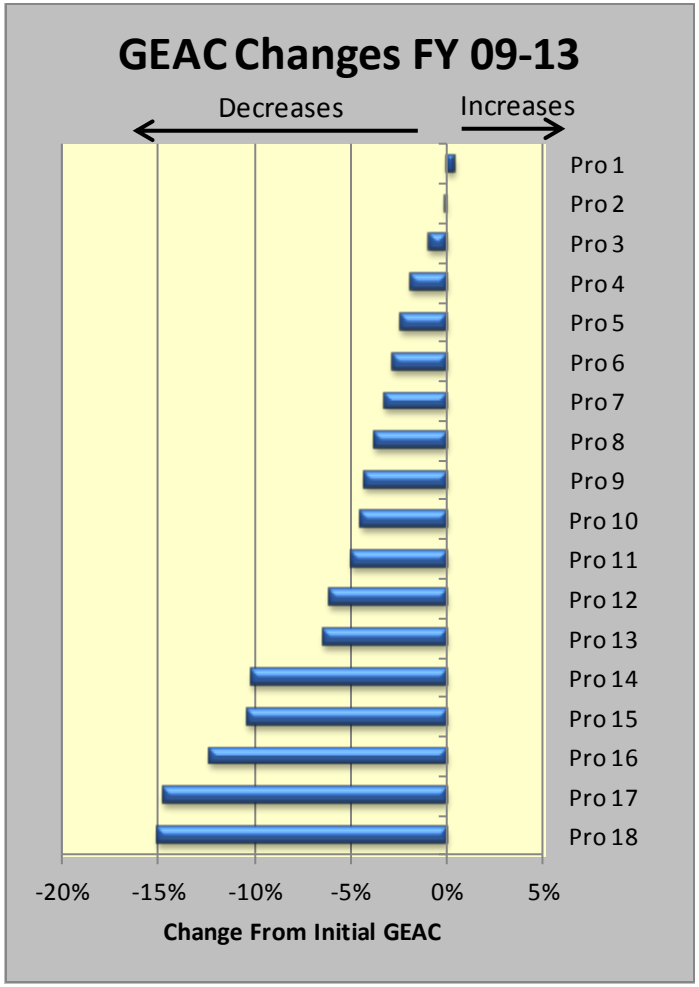
GEAC Structure

The GEAC WBS
Definitized and Authorized
• Acquisition Contracts (includes 'on-contract' margin breakout)
• Other Government Costs (OGCs)
○ CORE Contractor
○ Other OGCs
Planned and Potential Requirements
• Planned Requirements
• Potential Requirements
• Specific and Generic Risks
• Other Directed Liabilities
• PM Margin
Potential Opportunities (efficiencies, initiatives, consolidations…)
• Investment required
• Savings

GEAC Policy: Opportunities are potential savings due to efficiencies, initiatives, consolidations and schedule accelerations

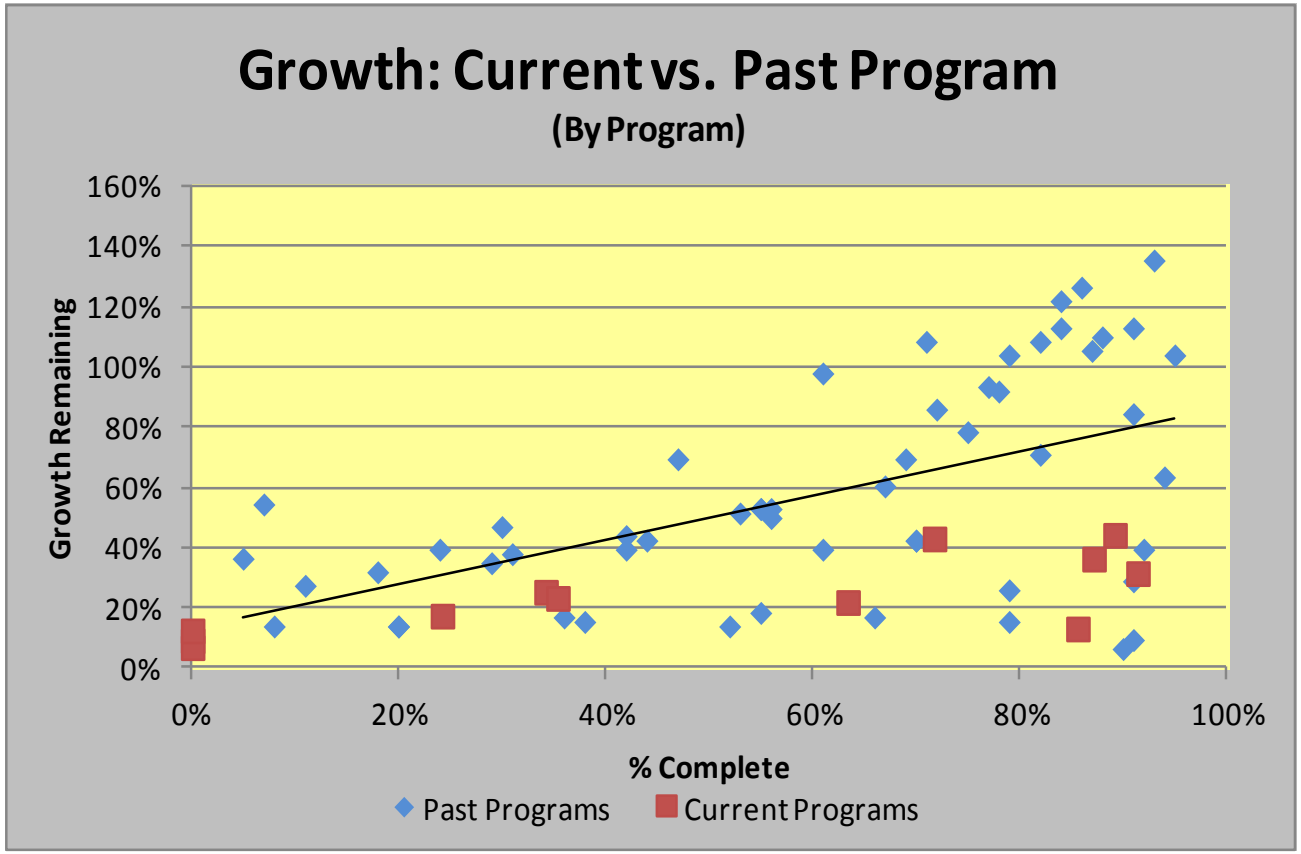
Are GEACs increasing/decreasing?





- GEAC portfolio is dynamic; trend impacted by:
  - Expanding GEACs coverage
  - New starts and program completions
  - Major scope changes
- Excluding portfolio changes, GEACs decreased 7% since 2009
- Half of that decrease realized by better than forecasted execution in FY10-12
- Estimates are declining: maturing GEAC process, better cost realism
- 95% of programs in the portfolio declined over 4 year period

How do current programs compare to time-phased growth benchmarks?



$$\text{Growth Remaining} = \frac{\text{Remaining Planned \& Potential}}{\text{Remaining Definitized}}$$

- History based contract growth on 21 space programs; growth increases over program life as a percent of costs remaining (a declining base)
- Lower growth (therefore margin) on current programs expected due to: more realistic cost/schedule baselines, evolutionary acquisition approach
- Current programs have similar pattern but below benchmarks
- Growth margin on current programs appears generally equitable

How Do We Make These Predictions?

- In order to keep up with the dynamic nature of EAC prediction:
  - We develop and apply innovative techniques for quantitative analysis of performance to date to generate forecasts of future cost growth, and predict the need for margin
  - Recently developed tools used to forecast the Will Cost using historical data
  - The Estimate at Complete (EAC) Maturity Model is a parametric way to estimate future EAC growth based on cost drivers
  - The Weibull Analysis Method (WAM) determines our confidence that funds remaining above liability will be sufficient to cover expected growth

- In addition to the models, the NRO Cost and Acquisition Assessment Group (CAAG):
  - Assesses contract performance in an Estimate to Complete, for the purpose of determining a reasonable amount of margin and how that margin should be managed and controlled
  - Provides tracking and monitoring against the should cost estimate provided by program offices, and trending and forecasting relative to the will cost estimate
  - Performs cross program analysis to assess program performance and margin across the portfolio of programs
  - Uses historical, quantitative data, so it is testable and defensible, in order to strengthen our analysis

What needs to be added to the EAC for a forecast of the program costs at complete?

Translating the EAC to a forecast of final program costs for estimating requires adjusting for the following:

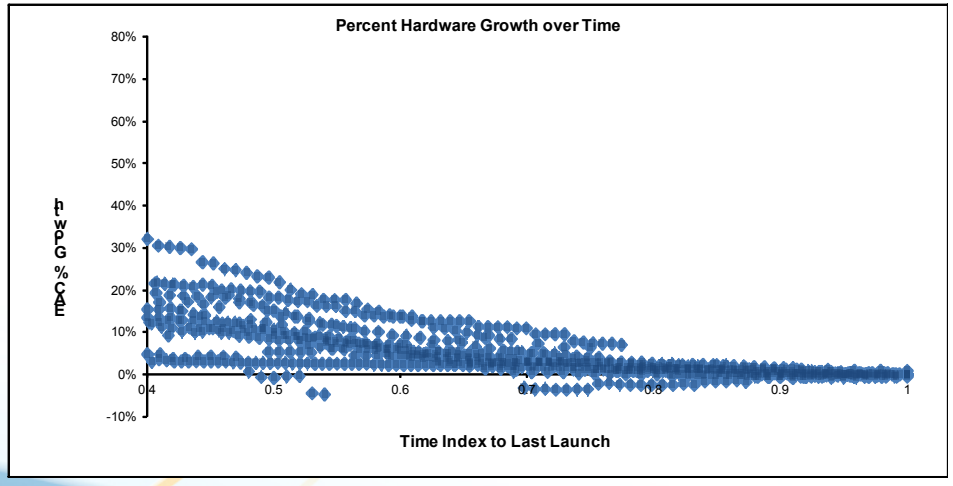
- Independent Estimate at Complete (IEAC) formulas based on backward-looking CPI, despite different phases of the program
- Christensen finding: "in most cases, the cumulative CPI only worsens as a contract proceeds to completion"*
  - Gold Card formulas do not consider worsening cost efficiency, because they use a cumulative efficiency factor based on past performance rather than a projection of future performance
- Factored Risk List is often incomplete, covering the next 6-12 months, and unknown risk is often not included
  - Risks included in the Most Likely EAC are usually short-term, not covering the length of the program
  - Quantitative Risk analysis cannot be performed on EVM data without subjective inputs
- EAC is constrained to the scope on contract, and not inclusive of even minor changes to a program
  - Minor contract modifications and scope changes are not captured in the EAC until added to scope of the contract
- Traditional EVM formulas are not based on statistical analysis of past programs

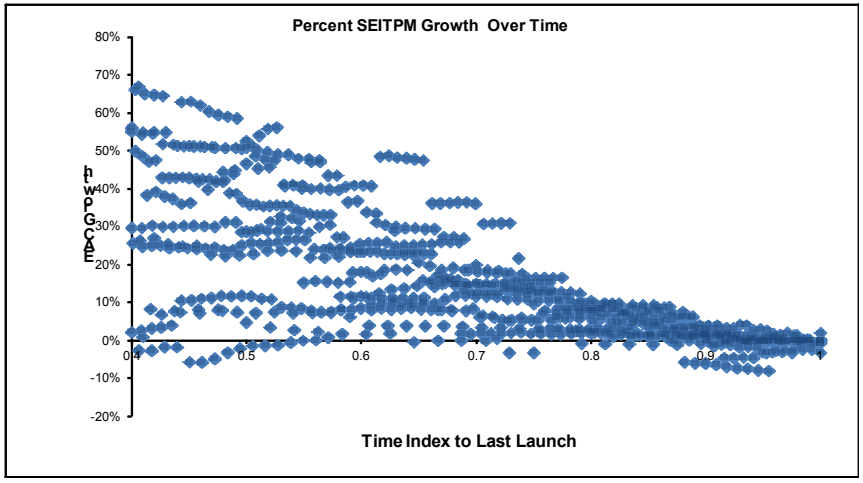
* Christensen, David S (1994 Spring). "Using Performance Indices to Evaluate the Estimate at Completion" Journal of Cost Analysis and Management, pp 17-24

As a result, the contractor's EAC does not reflect final program costs until program is 91% through lifecycle

Perform Regression Analysis: Calculate remaining cost growth

- Goal:
  - Develop model to predict growth remaining
  - Use program-specific "drivers," such as percent new design, schedule slip, and number of vehicles per contract
- Basic decay-type model
  - % Growth remaining = a*(time index^b -1)*(other potential cost drivers)^c
  - Used data after 40% time (when NRO does initial cost and technical data collect)
  - Cost Growth Drivers tested: time index, % New Design (Spacecraft, Payload, Bus), Satellite Quantity, Schedule Slip, Mission Type
- Regression analysis
  - Pool data from 13 space programs including NRO and DoD
  - Estimate a, b, and c to minimize sum of squared errors





Recommended EAC Adjustment Factor: Formulas for remaining cost growth on Space Programs

Remaining Cost Growth = a*(time index^b-1)*(%ND Spacecraft)^c

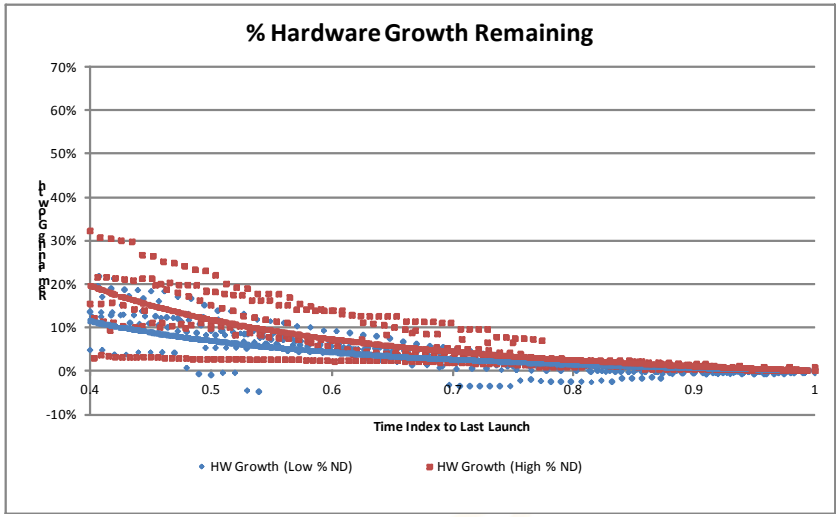
a = 0.0534
b = -1.694
c = 0.162

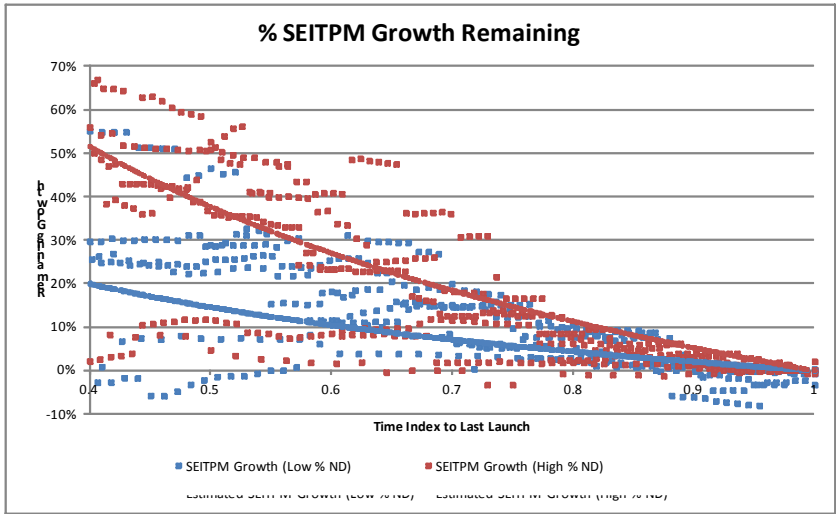
Time index is between 0.00 (ATP) and 1.00 (Last Launch)
% New Design is between 0.00 (clone) and 1.00 (no heritage)

Remaining Cost Growth = a*(time index^b-1)*(%ND Spacecraft)^c

a = 1.749
b = -0.294
c = 0.284

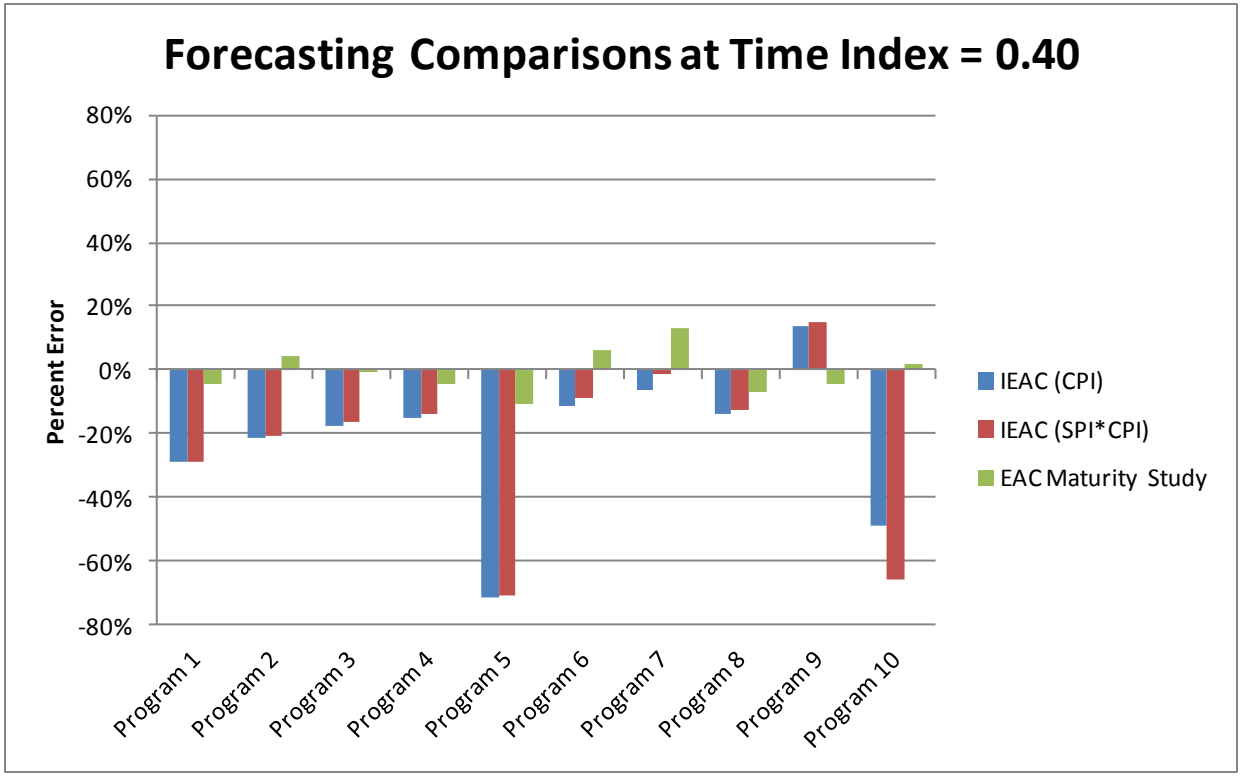
Time index is between 0.00 (ATP) and 1.00 (Last Launch)
% New Design is between 0.00 (clone) and 1.00 (no heritage)





This analysis strengthens our estimates and methodologies by providing cost growth factors to apply to historical data and/or new estimates based on a contractor's EAC

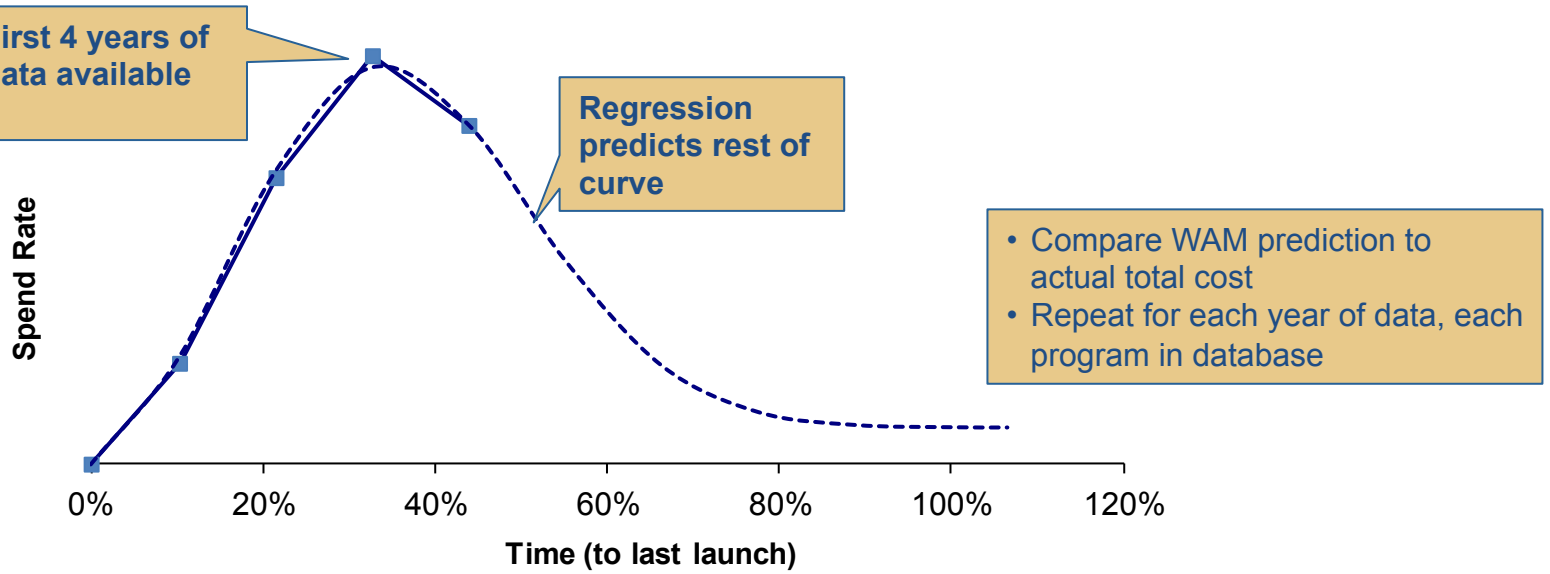
EAC Maturity method performs better than IEAC forecast



Method	Min	Max	Average
IEAC (CPI)	-71%	14%	-22%
IEAC (SPI*CPI)	-71%	15%	-22%
EAC Maturity Study	-11%	13%	-1%

Weibull Analysis Method

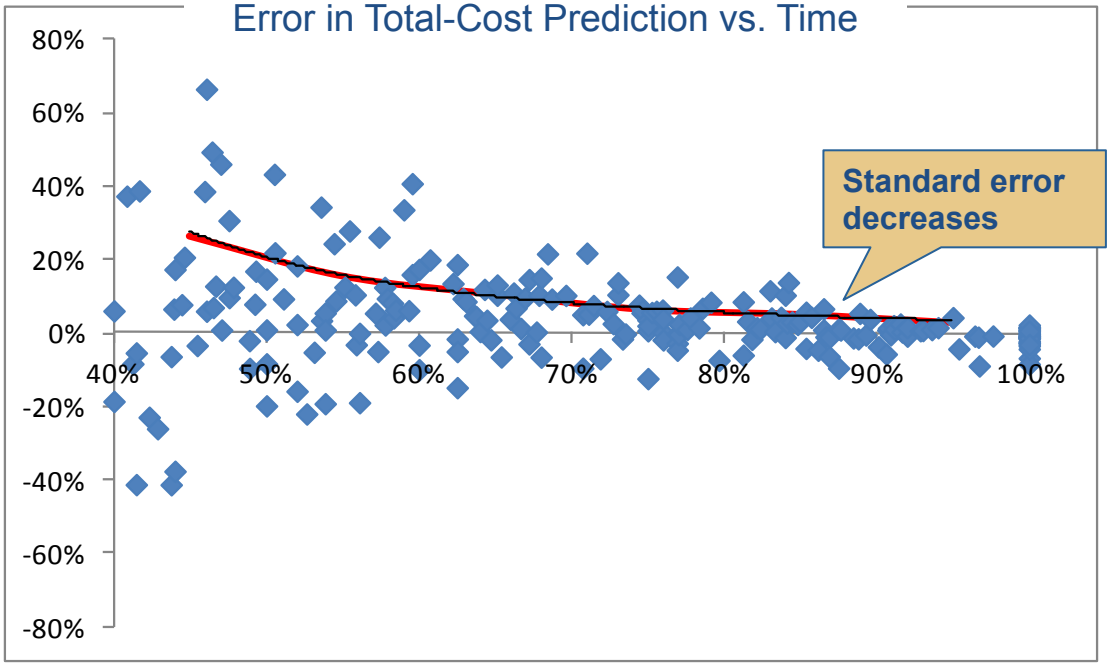
- Actual costs to date can be used to forecast total contract requirements
  - Use a Weibull functional form plus a constant-rate term
    - Same form as the CAIG phasing models
    - Phasing models themselves are not used in WAM
  - Similar method published by LMI[1] and Center for Naval Analysis[2]
    - Used Rayleigh curves (a constrained form of Weibull)
    - No accuracy metrics
- Adding accuracy metrics can make this a useful tool



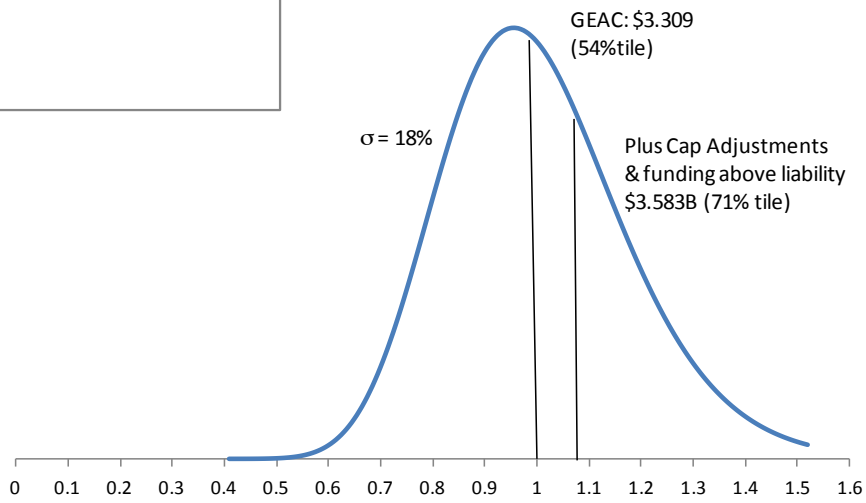
[1] Dukovich, John, Scott Houser and David Lee. The Rayleigh Analyzer, Theory and Applications (Vol.1). LMI - AT902C1. October 1999.

[2] Davis, Dan. Early Warning Model for Acquisition Program Cost and Schedule Growth. Center for Naval Analysis, 15 April 2008.

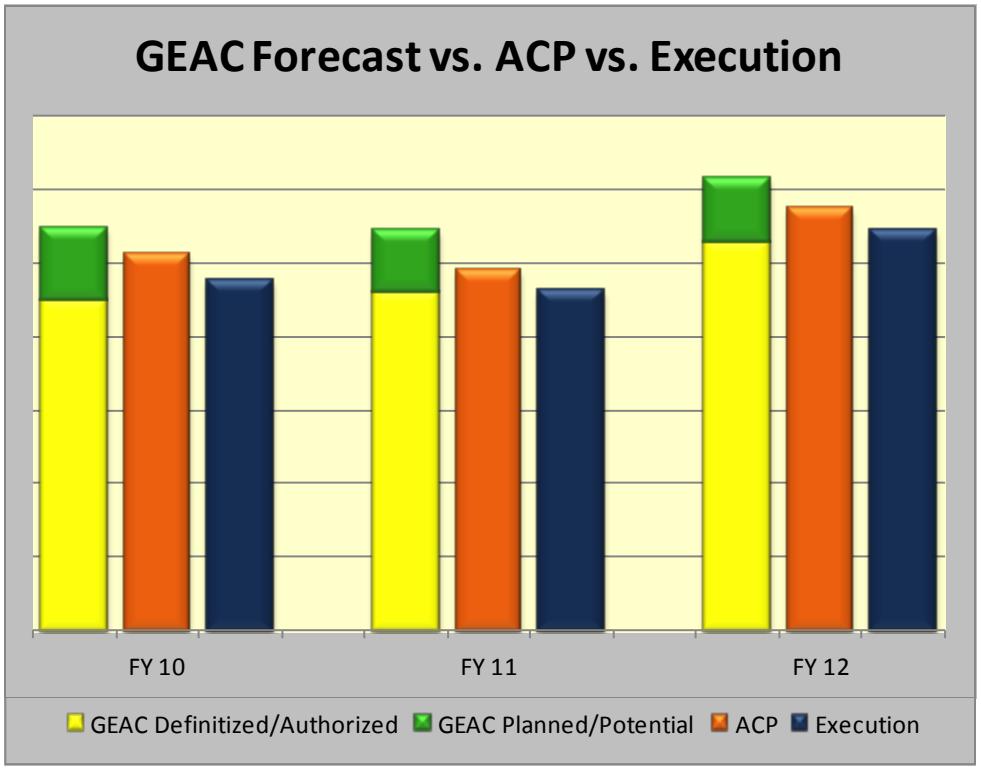
Error Model Based on 38 Programs



Gives confidence percentile for any number you want – GEAC, funding, ACP, etc.



How does recent execution compare to GEAC projections?



- Execution was 11- 15% below GEAC forecasts (FY10-12)
- 90% of programs in the portfolio have this profile
- The majority of GEAC margin (green) was not needed
- Forecasts slightly above execution is reasonable strategy -- but is 11-15% too much?
- Same analysis shows ACPs 6% delta to execution – suggests GEAC s are too high

Summary

- Positive GEAC trends since 2009 reflects maturing process
- Some indications that GEACs are slightly too conservative – comparison/analysis of GEACs to ICE/ACP, execution, opportunities
- Overall, funding available for GEAC requirements – some minor difference on specific programs
- First-ever analysis/comparison of GEAC margin provides historical context and insights
- Opportunities section added to GEACs this cycle – room to mature
- NRO CAAG continues to develop and improve existing methods, adjusting models by incorporating new data

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