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A Cure for Unanticipated Cost and Schedule Growth

We have lots data. Let's use it create more credible estimates to help tame the growth beast

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+ Why Are We Here?

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- In spite the estimating community's efforts to provide credible estimates, government programs still seem to deliver less than promised, cost more than planned, and take longer than needed.
- Lots of reasons. Some well established; some hypothesized
- When estimates are consistently biased low
 - Decisions of choice are distorted
 - Cost growth causes more growth as programs are stretched out to fund portfolios with fixed budgets
 - Taxpayers become more cynical and negative about government
 - **The estimating community's credibility is seriously questioned**

+ Why are We Here? (Concluded)

- This presentation will
 - Summarize many of the reasons documented and hypothesized why programs deliver less, cost more and are late;
 - Provide a broad brush of what the community has done to improve the imbalance;
 - Assert that we can not solve all the root causes, but we can effectively use historical experience (reference class forecasting) to provide more credible estimates for future systems; and
 - Propose and discuss a number of changes needed in estimating, acquisition, and the contracting communities to restore balance and credibility and go a long way to tame the growth beast

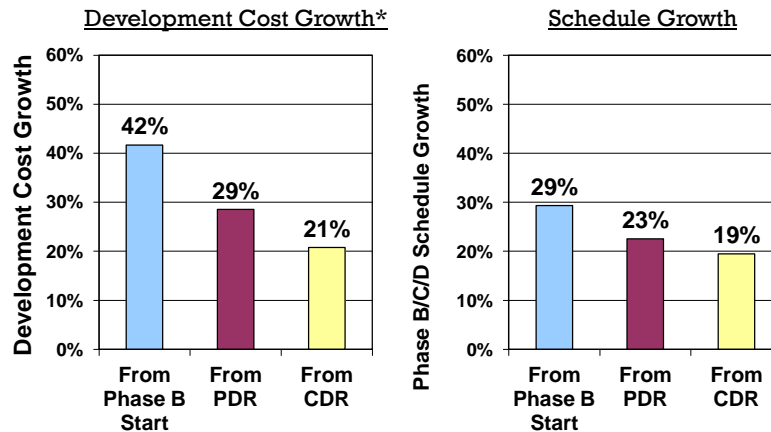
+ Cost and Schedule Growth

“In 1982, an unnamed witness at a House Armed Service Committee stated, ‘Enough material has been written on the subject of cost growth during the last ten years to fill a Minuteman silo’. Unfortunately, cost growth is still with us. In a decade since that testimony enough additional information on cost growth has been written to fill a second minuteman silo”¹

Study	Cost/Budget Growth ²		Percent of Projects Which Experienced Growth
	Average	Median	
NASA in the 90s	36%	26%	78%
NASA in the 70s	43%	26%	75%
NASA in the 80s (GAO)	83%	60%	89%
DoD RDT&E	45%	27%	76%

1. Cost Growth in DoD Major Programs: A Historical Perspective, Col. Harry Calcutt, April 1993, <http://www.dtic.mil/dtic/tr/fulltext/u2/a276950.pdf>
 2. Hamaker and Schaffer, NASA, 2004

+ Cost & Schedule Growth Summary at NASA - Combined 30 Mission Growth Average Over & Above Reserves³



³ Internal NASA Study, 2009

+ Cost and Schedule Growth (Continued)

- Many researcher have tried to understand the root causes for growth. Here is a list from one study⁴
 - Requirements related
 - Poor initial requirement definition
 - Poor performance/cost trade-off during development
 - Changes in quantity requirements
 - Estimating related
 - Errors due to limitation is estimating procedures
 - Failure to understand and account for technical risks
 - Poor inflation estimates
 - Top down pressure to reduce estimates
 - Lack of valid independent cost estimates

⁴ Calcutt, April 1993

+ Cost and Schedule Growth (Continued)

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Root causes from Col. Calcutt's study (continued)

- Program Management related
 - Lack of program management expertise
 - Mismanagement/human error
 - Over optimism
 - Schedule concurrency
 - Program stretch outs to keep production lines open
- Contracting related
 - Lack of competition
 - Contractor buy-in
 - Use of wrong type of contract
 - Inconsistent contract management/admin procedures
 - Too much contractor oversight
 - Waste
 - Excess profits
 - Contractors overstaffed
 - Contractor indirect costs unreasonable
 - Taking too long to resolve undefinitized contracts

+ Cost and Schedule Growth (Continued)

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Root causes from Col. Calcutt's study (Concluded)

- Budget related
 - Funding instabilities caused by trying to fund too many programs
 - Funding instabilities caused by congressional decisions
 - Inefficient production rates due to stretching out programs
 - Failure to fund for management reserves
 - Failure to fund programs at most likely cost

+ Cost and Schedule Growth (Concluded)

Root causes cited by the Office of Program Assessment and Root Cause Analysis (PARCA)⁵

- Inception related
 - Unrealistic performance expectations
 - Unrealistic baseline estimates for cost or schedule
 - Immature technologies or excessive manufacturing or integration risk
- Execution related
 - Unanticipated design, engineering mfg or technology integration issues
 - Changes in procurement quantities
 - Inadequate program funding or funding instability
 - Poor performance by government or contractor personnel

⁵ Report to Congress on Performance Assessment and Root Cause Analyses, Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, March 2014, p. 7, <http://www.acq.osd.mil/parca/docs/2014-parca-report-to-congress.pdf>

+ A Broad Brush Of What The Estimating Community Has Done to Tame the Growth Beast

- Instituted independent estimating organizations at various levels with DoD and civilian agencies
 - Developed cost estimates using analogous historical data (reference class forecasting)
- Required a Cost Analysis Requirements Description (CARD) to ensure cost estimates are based on the agreed requirements
- Developed a variety of professional training and certification programs, e.g., Certified Cost Estimator/Analyst (CCEA), Certified Parametric Practitioner (CPP), AACE certifications, and PMI
- Augmented independent estimating teams with program management and scheduling personnel e.g., NASA and DoE
- Continued to collect historical cost and technical data to improve parametric cost estimates
- Began to develop estimates using planned top-level schedules and historical head counts (recognition that time and people are big cost drivers)
 - Another form of reference class forecasting

+ A Broad Brush Of What The Estimating Community Has Done (Concluded)

- Begun to set cost and schedule targets based on the historical variability of cost and schedules
 - The Weapon System Acquisition Reform Act (WSARA) of 2009 required DoD programs to be budgeted at the 80% cost confidence level ⁶
 - NASA requires programs to budgeted with a 70% probability of meeting both cost and schedule targets

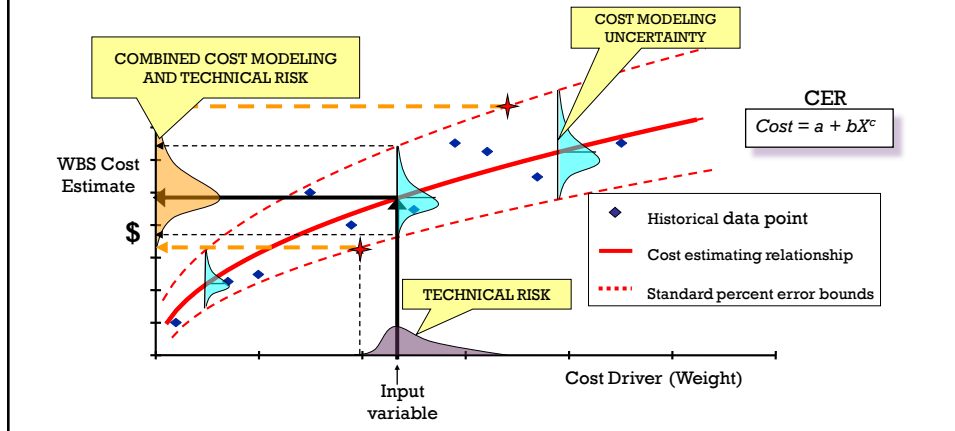
⁶ According to the FY 2011 Annual Report on Cost Assessment Activities by the Director, Cost Assessment and Program Evaluation (CAPE), the WSARA requirement for confidence levels was eliminated in the National Defense Authorization Act for Fiscal Year 2011, Public Law 111-383. "Today, the requirement is to select a confidence level such that it provides a high degree of confidence that the program can be completed without the need for significant adjustment to program budgets".
http://www.pae.osd.mil/files/Reports/CA_AR_20120508.pdf

+ So What?

- The estimating community is the best position to understand, document and communicate the myriad reasons for cost and schedule growth.
 - We are the masters at collecting the data and evidence!
- But it is not our role to make the changes. We can only advise
- We can, however, improve our estimates by using our historical data more effectively
- We can persuade government leadership to require contractors to do the same

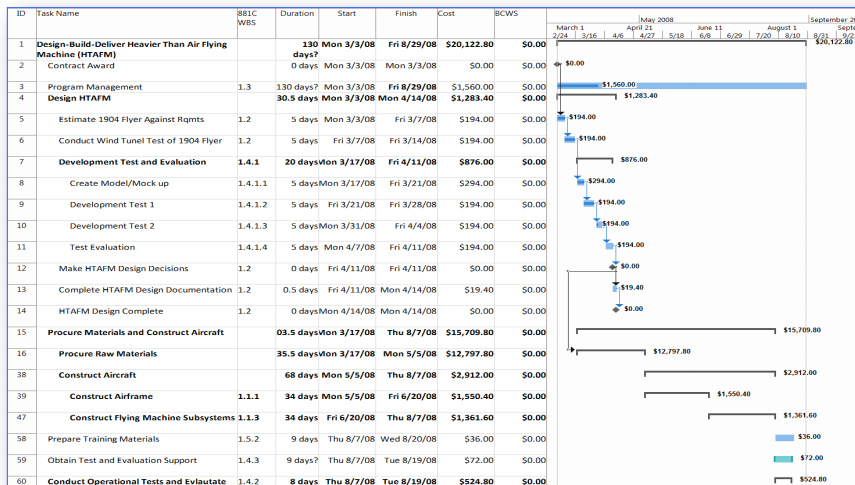
+ A Few Observations

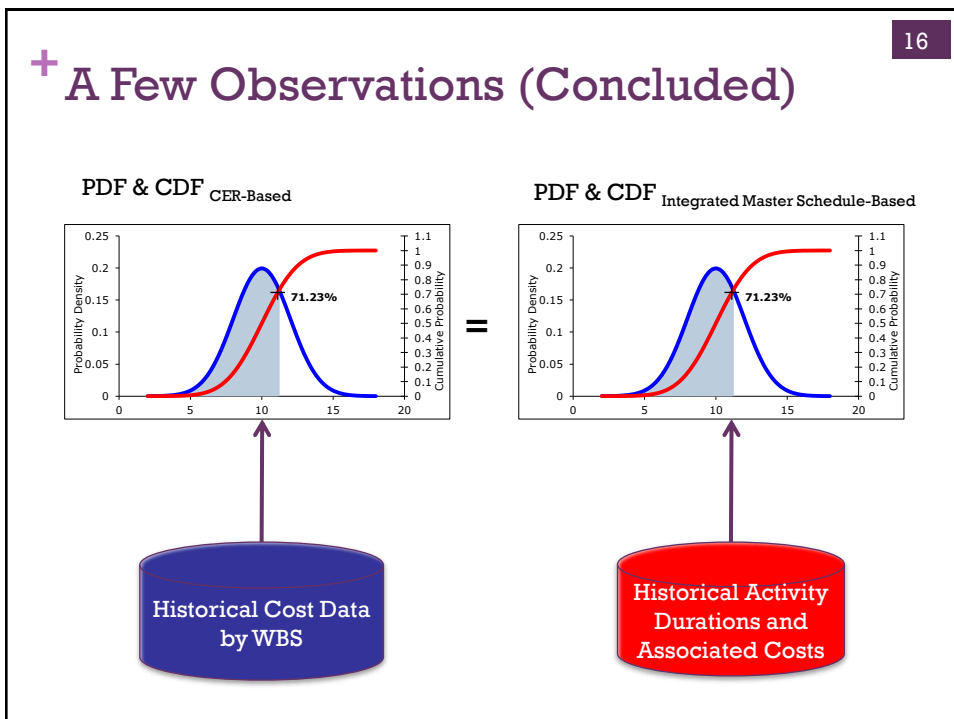
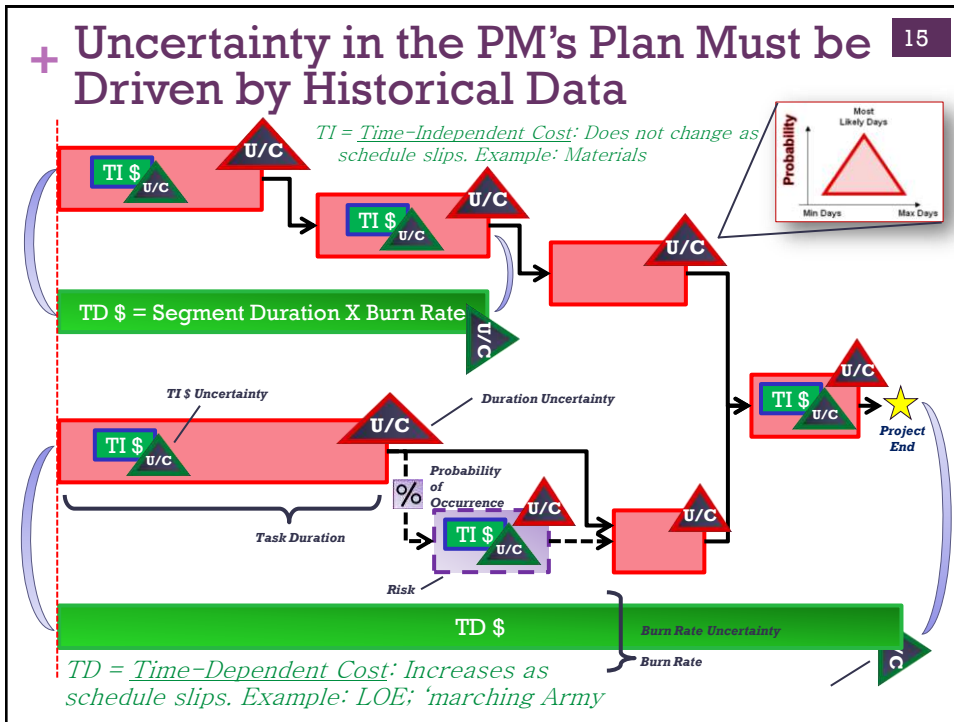
- Our estimates are typically formed around a product-oriented structure. We have great historical databases upon which to develop credible estimates.
- We typically estimate individual WBS elements by developing Cost Estimating Relationships (CERs) like this:



+ A Few Observations (Continued)

- But we have difficulty persuading government leadership to increase their estimates that reflect the historical variances because they can't relate it to their implementation plans that look like this:

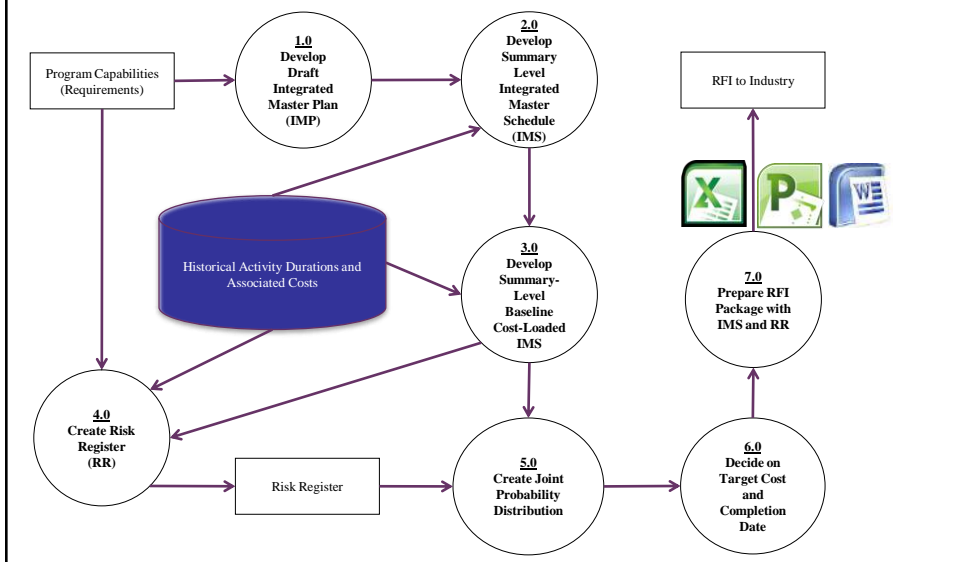




+ Rationale for Budgeting at the 70 percent Joint Confidence Level

- Schedule drives a large component of cost
- We want programs to deliver on or before promised and at or below the budgeted cost. This is the problem we are trying to solve.
- We should have a better than 50/50 change of meeting planned targets. (Don't we owe this to the taxpayers?)
- There is no general consensus within the estimating community about the right joint confidence level upon which to set budgets
 - Little empirical data (Too soon to tell if NASA's experiment is working)
 - More research needed
- Until then, pick a "reasonably" high number and see if it works.

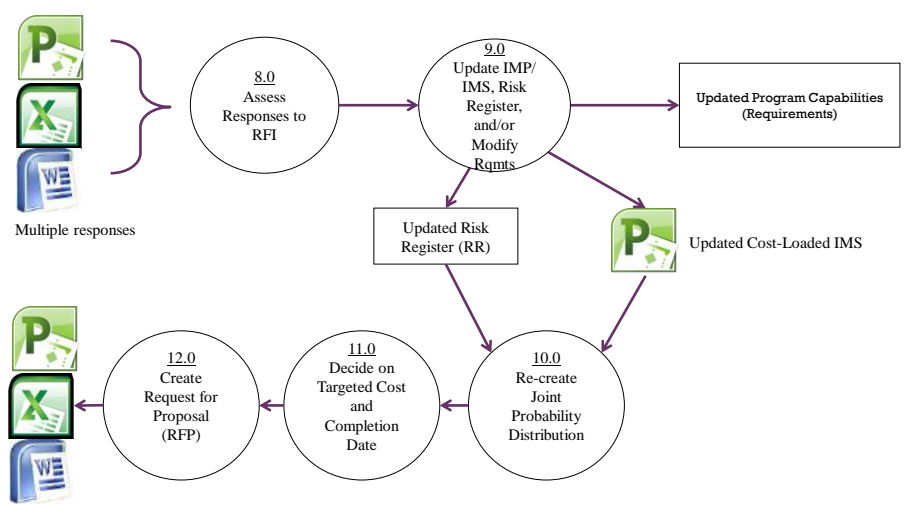
+ A Proposed Solution - Step 1: Program Office Creates a Request for Information (RFI)



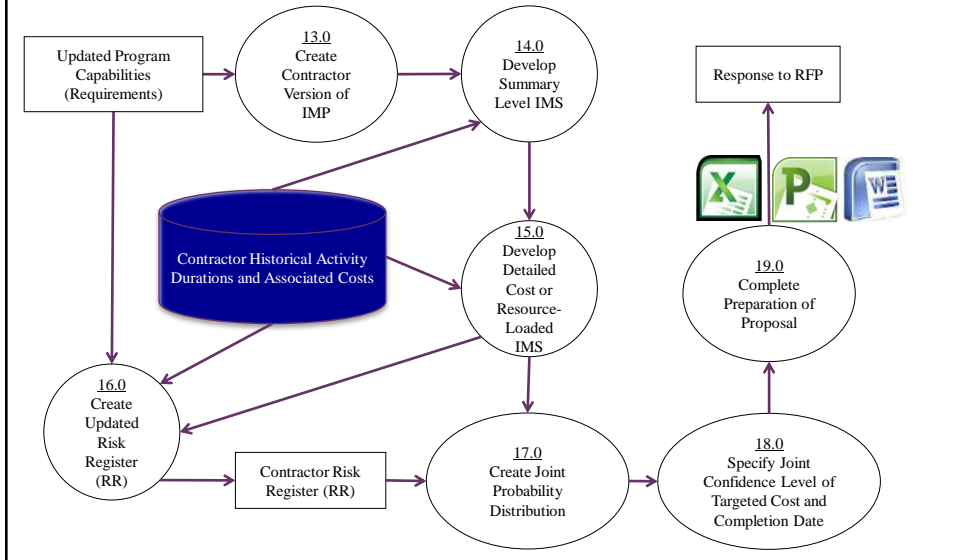
+ A Proposed Solution - Step 2: Contractors Review and Submit Revised Plan

- Is the top-level plan logical given the technical challenges and capabilities required? If no,
 - What other activities should be included or dropped?
 - What changes in logic are required?
- Are activities durations “consistent” (within family) of your experience?
- Are the costs “consistent” (within family) of your experience?
- Is the PMO’s perspective on risks realistic? If not,
 - Which risks are overstated?
 - Which risks are understated?
 - Which risks were missed? And what is your assessment of probabilities and consequences for those risks?
- Revise and submit contractor-modified high level cost-level plan, updated Risk Register, and Probability Assessment

+ A Proposed Solution - Step 3: Program Office Uses the Responses to RFIs to Improve an RFP



+ A Proposed Solution - Step 4: Bidders Prepare Responses to Proposals



+ A Proposed Solution - Step 5: Program Office Evaluates and Oversees the Contractors

- Government program offices should:
 - Award contracts based on the “credibility” of the historical uncertainty data used and discrete risks for the joint cost and schedules proposed
 - Hold requirements stable after contract awards
 - Require contractors to submit updated Risk Registers, and probability statements associated with Best Case, Worse Case and Mostly Likely Estimates at Complete in Format 5 of the Integrated Program Management Reports (IPMRs) every six months (What gets measured, gets managed)

+ A Proposed Solution - Step 6: Contractors Execute to the Plan

- Winning contractors should:
 - Set Program Management Baselines (PMBs)
 - Using more detailed cost or resource-loaded Integrated Master Schedules (IMSEs)
 - With at least a 50% joint probability of meeting cost and schedule targets
 - Set up objective measures of progress at IBRs that are directly connected back to user-desired capabilities through appropriate Technical Performance Measures (TPMs)
 - Record progress (Budgeted Cost of Work Performed) using the pre-defined set of progress criteria
 - Maintain risk registers and use them to provide probability statements of cost and completion dates every six months

+ More on Why

- We don't really need to understand why we have cost and schedule growth; we just need to estimate future programs using all the historical experience
- We need to speak the same language that the government PM speaks. Independent product-oriented estimates based on historical data are "right" if the probabilities are set right, but government program managers have difficulty relating these estimates to their plans or potential bidders' plans
- Activity-based estimates that are grounded with historical data help government PMs to revise their plans based on well communicated reasons for the cost and schedule variations, i.e., what happened to similar programs in the past
- Initial government probabilistic estimates that are based on a program's activity-based plan that recognize the "natural variation" of cost and schedule performance of historical projects, should tame the growth beast if the joint probabilities are greater than 70 percent
- Estimates that are activity-based aid government PMs and contractors to manage the contracts during execution. The language is the same and the focus is on their plan (the PMB) and the risks!

+ Some How Challenges

- Estimating community needs to start collecting common development activity duration data and associated costs
 - Some of this may already be available from the schedule data contained in the Earned Value Management Central Repository (EVM-CR)
- Government program office have to step up their game
 - Need to think through the development of the system capabilities and document those in an IMP
 - Need to create a notional summary-level cost-loaded activity-based plan
 - Need to get help on the historical variation of activity durations and associated costs
- Need to coordinate with the acquisition community on the RFI and follow-on RFP process
- Integrate Program Management Report (IPMR) Data Item Description (DID) would need to be updated
 - Require the Integrated Master Plan (IMP) as part of the RFP submission
 - Add submission of the contractor's Risk Register and instrumented native probability models every six months
- Others?