

How GAO Evaluates Cost Estimates

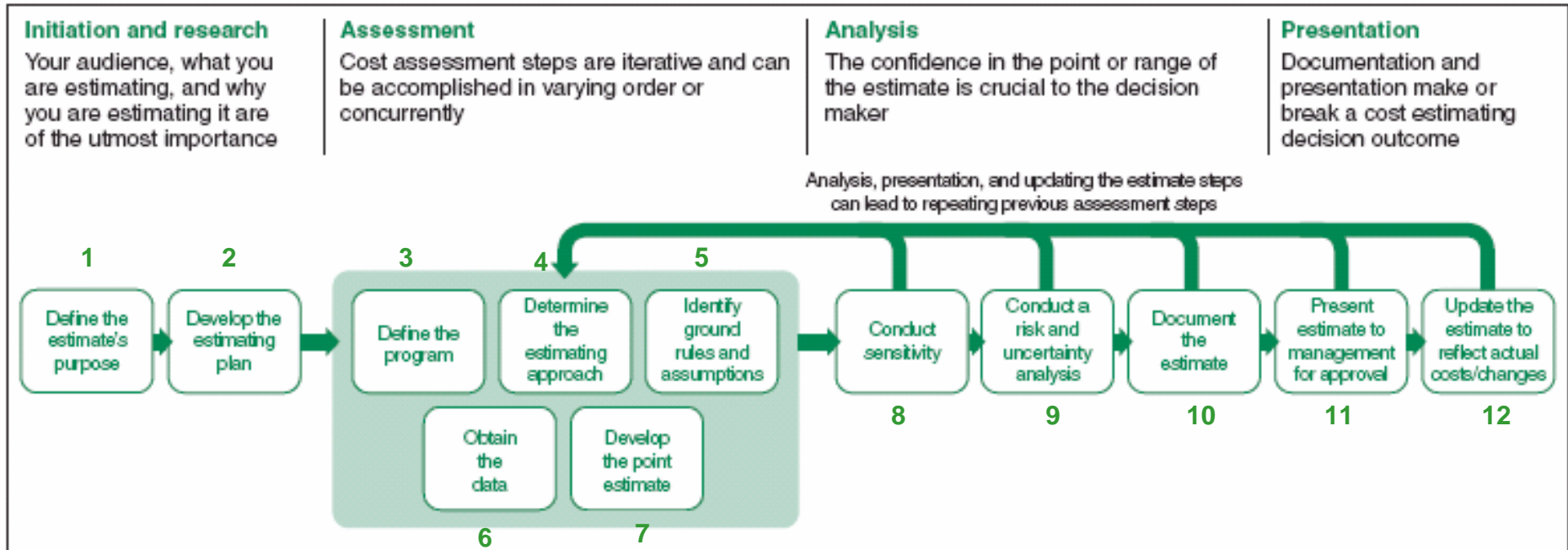
Objectives

- **Be familiar with the Government Accountability Office (GAO) Cost Estimating and Assessment Guide.**
- **Understand the GAO four phase/twelve step process.**
- **Be aware of the 4 characteristics of High Quality Estimates that the GAO scrutinizes.**
- **Evaluation examples from recently published reports.**

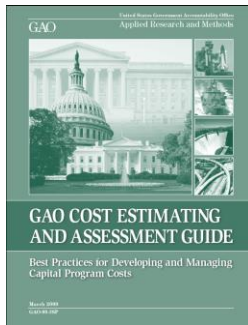
GAO Guide Origin & Purpose

- **GAO assists Congress in its oversight of the federal government.**
- **Intent to provide auditors a standardized approach was met with the truth that federal guidelines are limited on the processes, procedures, and practices for credible cost estimating.**
- **Therefore, the intent of the Guide became to fill the void by addressing and documenting best practices for ensuring credible program cost estimates for both government and industry.**
- **Panel of experts convened to meet with this intent.**
 - 106 developing and/or reviewing experts.
 - 32 Government Organizations & 37 Companies.

GAO Four Phase/Twelve Step Process



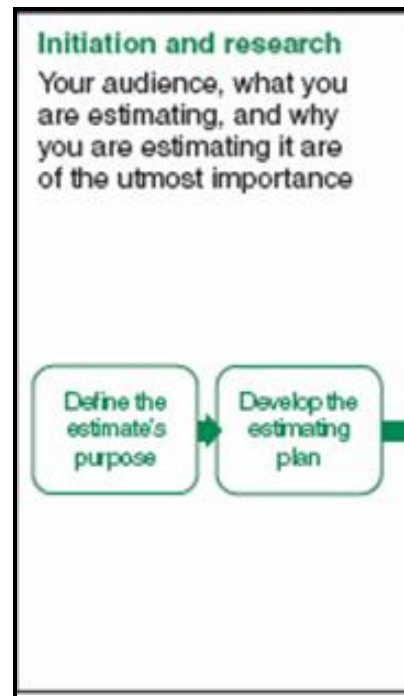
Source: GAO.



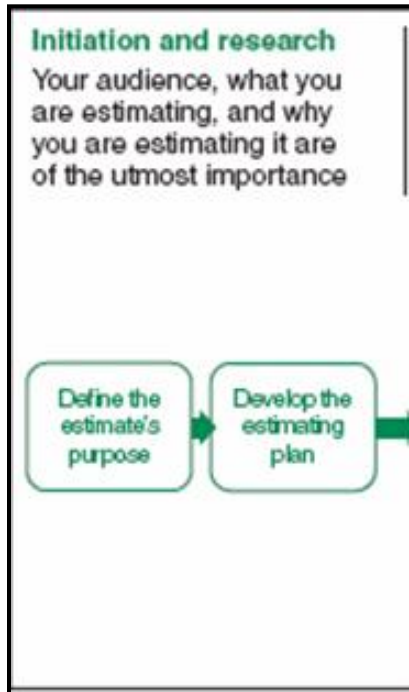
<http://www.gao.gov/new.items/d093sp.pdf>

Initiation & Research Phase

- **2 Steps of the Initiation & Research Phase are:**
 - Define the estimate purpose.
 - Develop the estimating plan.



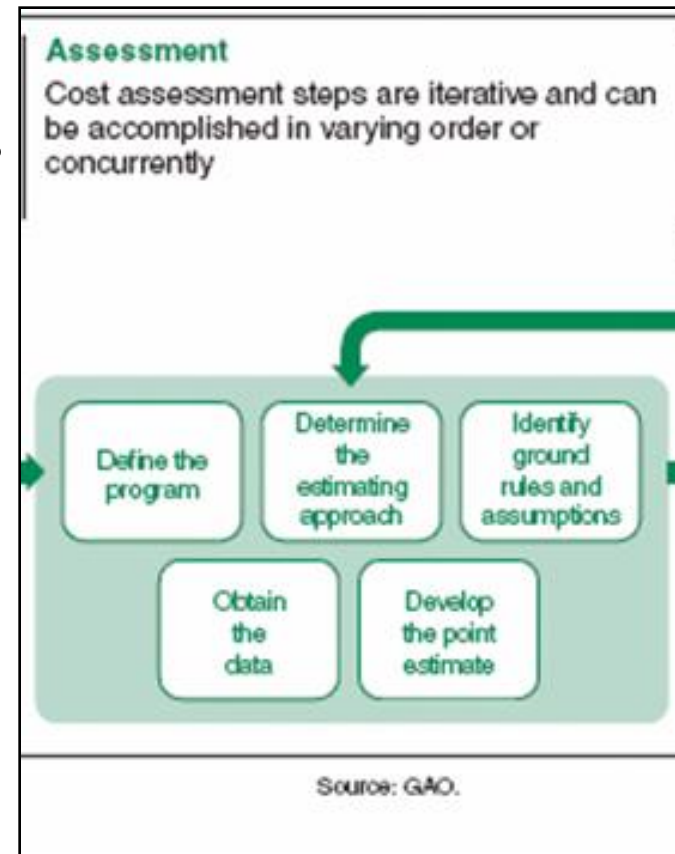
Initiation & Research Phase



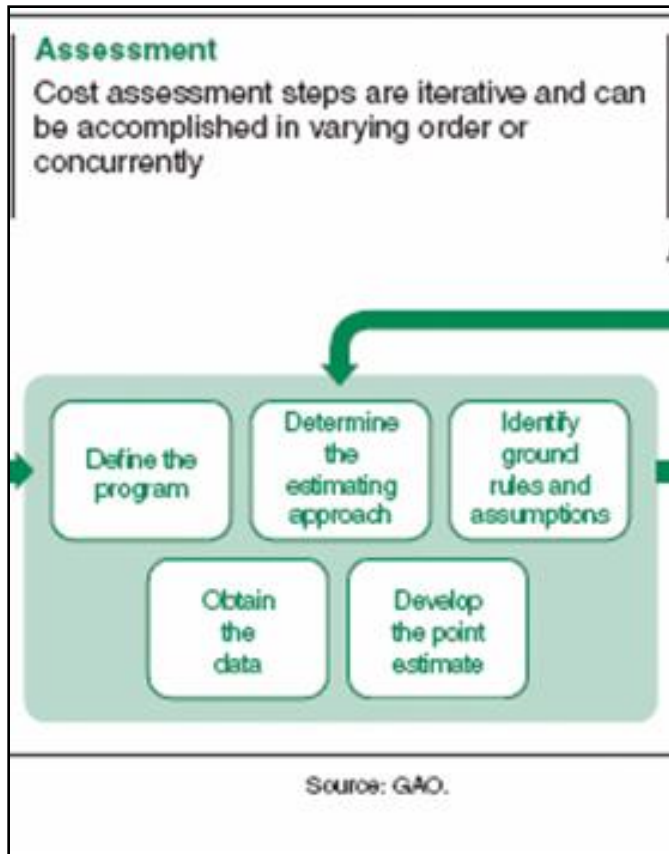
- Purpose almost always to help a decision maker; ensure the need (including scope) has been communicated correctly.
- Plan driven by purpose and time; includes:
 - Purpose statement
 - Team composition
 - GR&A (of plan)
 - Proposed method(s) and sources
 - Estimate activity schedule
 - Plan risks
- Get the Plan Approved!

Assessment Phase

- **5 Steps of the Assessment Phase are:**
 - Define the Program
 - Determine the Estimating Approach
 - Identify Ground Rules & Assumptions
 - Obtain Data
 - Develop the Point Estimate



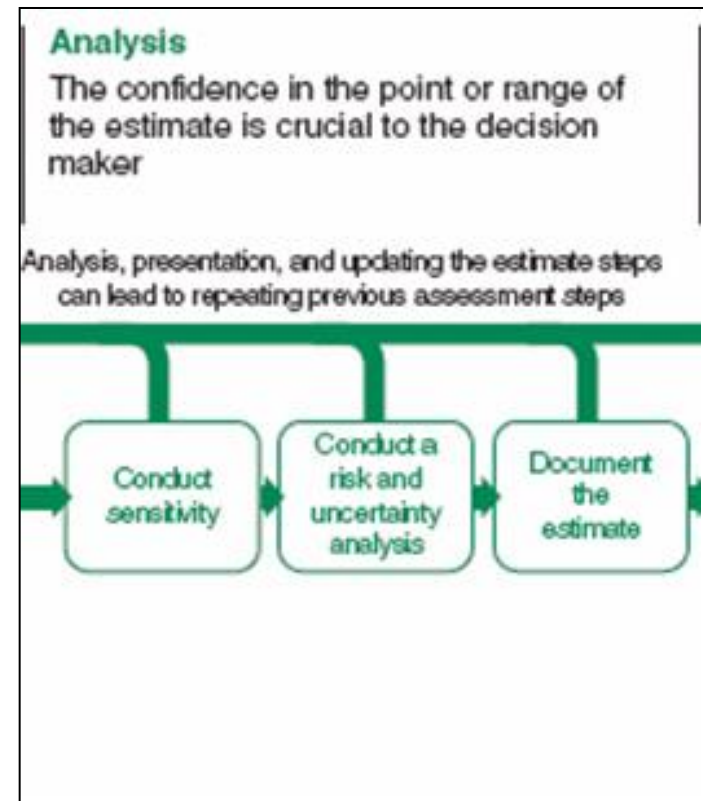
Assessment Phase



- Define structurally, technically and programmatically. Use baseline or create a proxy if necessary.
- Approach usually a slave to data.
- GR&A need to be up-front, visible, and right – think decision maker.
- Getting, understanding and normalizing data (cost, technical, programmatic) usually the schedule driver. Needs to be applicable, current, accurate and complete.
- Final point estimate will probably be arrived at in steps; don't forget the ICE

Analysis Phase

- 3 Steps of the Analysis Phase are:
 - Conduct Sensitivity Analysis.
 - Conduct Risk and Uncertainty Analysis.
 - Document the Estimate.



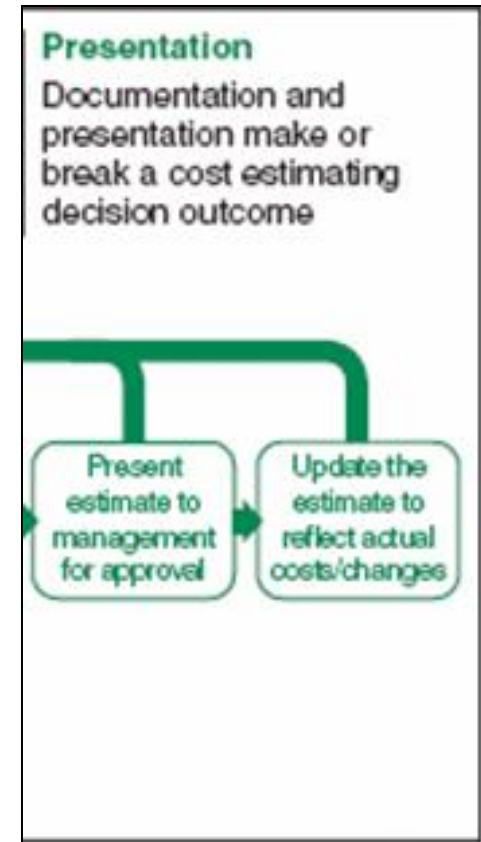
Analysis Phase



- Sensitivity identifies the major and minor cost drivers.
- Risk identifies degree of point estimate confidence based on known unknowns.
- Uncertainty identifies degree of point estimate confidence based on unknown unknowns.
- “Poorly documented estimates can cause a program’s credibility to suffer” GAO Cost Guide

Presentation Phase

- **2 Steps of the Presentation Phase are:**
 - Present estimate to management for approval.
 - Update the estimate to reflect actual costs/changes.



Presentation Phase



- Presentation usually precedes and substitutes for document completion
 - Get lead estimator in the room
 - Maximize use of graphics
 - No careless mistakes
 - Complete yet crisp
- Updates may be triggered or random events; use what has happened to help produce ETC

GAO focusing on High Quality Estimates

- **Recently reviewed GAO publications evaluate worthiness of estimates based upon High-Quality characteristics.**
- **Characteristics of a High-Quality Cost Estimate ***
 - Comprehensive: includes all possible costs in a structure that minimizes omissions and double counting; team composition alignment
 - Well Documented: Clear narrative explaining process and sources and presents the data used
 - Accurate: Assesses most likely cost w/o bias or attribution
 - Credible: Supported by supplemental analyses including, but not limited to: ICE, Risk, Uncertainty & Sensitivity Analyses

* GAO: Government Accountability Office

Process Steps Influence on Quality Characteristics

Table 1: Twelve Steps of a High-Quality Cost Estimate and Corresponding Characteristics

Key cost estimating step	Characteristic
Define the estimate's purpose	Well documented
Develop the estimating plan	Comprehensive
Define the program characteristics	Well documented
Determine the estimating structure	Comprehensive
Identify the ground rules and assumptions	Well documented
Obtain the data	Well documented
Determine the point estimate and compare it to an independent cost estimate	Credible and accurate
Conduct a sensitivity analysis	Credible
Conduct a risk and uncertainty analysis	Credible
Document the estimate	Well documented
Present the estimate to management for approval	Well documented
Update the estimate to reflect actual costs and changes	Accurate

Source: GAO.

Example: Navy 2nd Homeport Estimate

- LCC of the US Navy for establishment of a 2nd East Coast Homeport for nuclear powered ACC – ref. GAO-11-309, March 2011, *Navy Can Improve the Quality of Its Cost Estimate to Homeport an Aircraft Carrier at Naval Station Mayport*
- GAO found Navy estimate did not fully meet any of the 4 quality characteristics, specifically:

Characteristic	Not Met	Minimally Met	Partially Met	Substantially Met	Met
Comprehensive			X		
Accurate		X			
Well Documented		X			
Credible	X				

Example: Navy 2nd Homeport Estimate

- **On Comprehensiveness**

- Failed to include 2 small recurring cost elements
- GR&A not presented
- Doubt created
 - ◆ Estimates from 2 non-integrated teams merged;
 - ◆ Lack of a robust CES/WBS.

- **On Accuracy**

- Some elements of estimate based on historical records
- Lack of risk/uncertainty analysis prevented confidence bounding of estimate
- Calculation errors didn't help
- No evidence that the Navy evaluated the estimate produced by their contractor

Example: Navy 2nd Homeport Estimate

- **On Well Documented**
 - Some, but not enough technical content revealed
 - Data not revealed, not qualified for suitability, normalization not evident
 - Method not revealed sufficiently for replication
 - Inadequate as baseline for updates
- **On Credibility**
 - No sensitivity analysis and no ICE
 - Not all methods/models used were accredited
 - No single point of responsibility for estimate QA
 - Some conflicting GR&A across components of the estimate (e.g. fixed date vs. as spent costs co-mingled)

Example: Navy 2nd Homeport Estimate

- **GAO is not faultless**
 - Used Naval Air Station North Island (San Diego) as Mayport (Florida) analogy for their ICE
 - Identified category 4 hurricane tolerance as added complexity for Mayport
 - “...our estimate includes a factor of 10 percent of the total construction cost to account for hurricane-related construction complexities....”
 - Basis for 10% factor is a study of residential structures
 - Consequences of loss/ damage Residential =
Consequences of loss/damage Nuclear Ship
- **GAO should find their own estimate to be lacking in credibility and accuracy due to this one GR&A alone.**

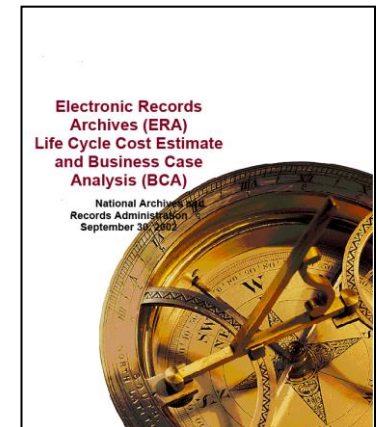


Example: NARA ERA 2011 Plan

- Assessment of 2011 Expenditure Plan – ref. GAO-11-299, March 2011, *National Archives and Records Administration's Fiscal Year 2011 Expenditure Plan*.
- Observation 1 – Plan is unreliable as basis for informed investment decision-making.
- Functions delivered and costs to date not clearly identified.
- 2011 work plans not clearly identified from among 3 different proposed scenarios (range: \$61M - \$86M).
- Little, if any attempt to explain reasons for 2010 planned versus actual differences.
- Undemonstrated understanding of what has been acquired to date, what funding has been expended to date, and any differences between planned and actual does not foster confidence in new plan.

Example: NARA ERA 2011 Plan

- **Estimates lack documented proof of accuracy and credibility**
- **Estimating methods not clearly described**
 - Includes basis for input values selected by experts
 - “The contractor estimated it.”
 - No evidence of attempt to validate with cross-checks
- **Issues confined to step 12 – Update the Estimate to reflect actual costs/changes**
- **Unfortunate - it didn't begin this way**



Example: F-35 Sustainment

- **Reference:** *F-35 SUSTAINMENT; Need for Affordable Strategy, Greater Attention to Risks, and Improved Cost Estimates; September 2014.*
- Illustrates Maturing Process
 - Increased attention to GAO Guide by agencies and services
 - Increased scrutiny by GAO (more detailed and deeper)
- Assumptions
 - Previous: Mostly cited for non disclosure
 - Now: Validity & Reasonableness challenged
 - e.g. fuel burn rate in this report
- Incomplete Risk/Uncertainty picture clouded by lack of understanding difference between sensitivity analysis and risk analysis.

Example: F-35 Sustainment (con't)

- Alignment with CAPE no guarantee of meeting GAO criteria for High Quality Estimate
 - CAPE ICE at 11% higher than JPO estimate might have once been accepted as supporting the JPO estimate
 - GAO takes issue with both the JPO estimate and the CAPE ICE in this report
 - Both estimates challenged on validity of assumptions;
 - Both estimates unclear in rationale and/or treatment of Intermediate level maintenance;
 - Included in unit level maintenance?
 - None at all?
 - Semantics? What is intermediate level anyway?

Example: F-35 Sustainment (con't)

Summary Estimates Assessment

Table 3: Summary Assessment of Joint Program Office (JPO) and Cost Assessment and Program Evaluation (CAPE) Cost Estimates

Characteristic	Overall assessment	Best practice ^a	Individual assessment
Comprehensive	Met (JPO) Met (CAPE)	The cost estimate includes all operating and support costs.	Met (JPO) Met (CAPE)
		The cost estimate completely defines the program, reflects the current schedule, and is technically reasonable.	Met (JPO) Met (CAPE)
		The cost estimate work breakdown structure (WBS) is product-oriented, traceable to the statement of work/objective, and at an appropriate level of detail to ensure that cost elements are neither omitted nor double-counted.	Met (JPO) Met (CAPE)
		The estimate is based on reasonable and fully documented cost-influencing ground rules and assumptions.	Partially Met (JPO) Partially Met (CAPE)
Credible	Partially Met (JPO) Minimally Met (CAPE)	The cost estimate includes a sensitivity analysis that identifies a range of possible costs based on varying major assumptions, parameters, and data inputs.	Met (JPO) Partially Met (CAPE)
		A risk and uncertainty analysis was conducted that quantified the imperfectly understood risks and identified the effects of changing key cost driver assumptions and factors.	Not met (JPO) Not met (CAPE)
		Major cost elements were cross-checked to see whether results were similar.	Minimally Met (JPO) Partially Met (CAPE)
		An independent cost estimate was conducted by a group outside the acquiring organization to determine whether other estimating methods produce similar results.	Met (JPO) Not applicable (CAPE) ^b

Source: GAO analysis of JPO and CAPE documentation and data. | GAO-14-778

Observations

- An estimate can be “good” without being high-quality, but it is unlikely to be approved or used
- High-quality alone is not an assurance that the estimate is “good”
- An estimate is incomplete if any of the 4 quality characteristics are not met
- High-quality is more about complete and clear disclosure of sound thinking and repeatable process than it is about error between estimate and eventual outcome.
- Like it or not, estimators must be effective communicators and prepared defenders of their estimates – the judge of quality will be the decision maker, not the estimate helper.



Additional Material

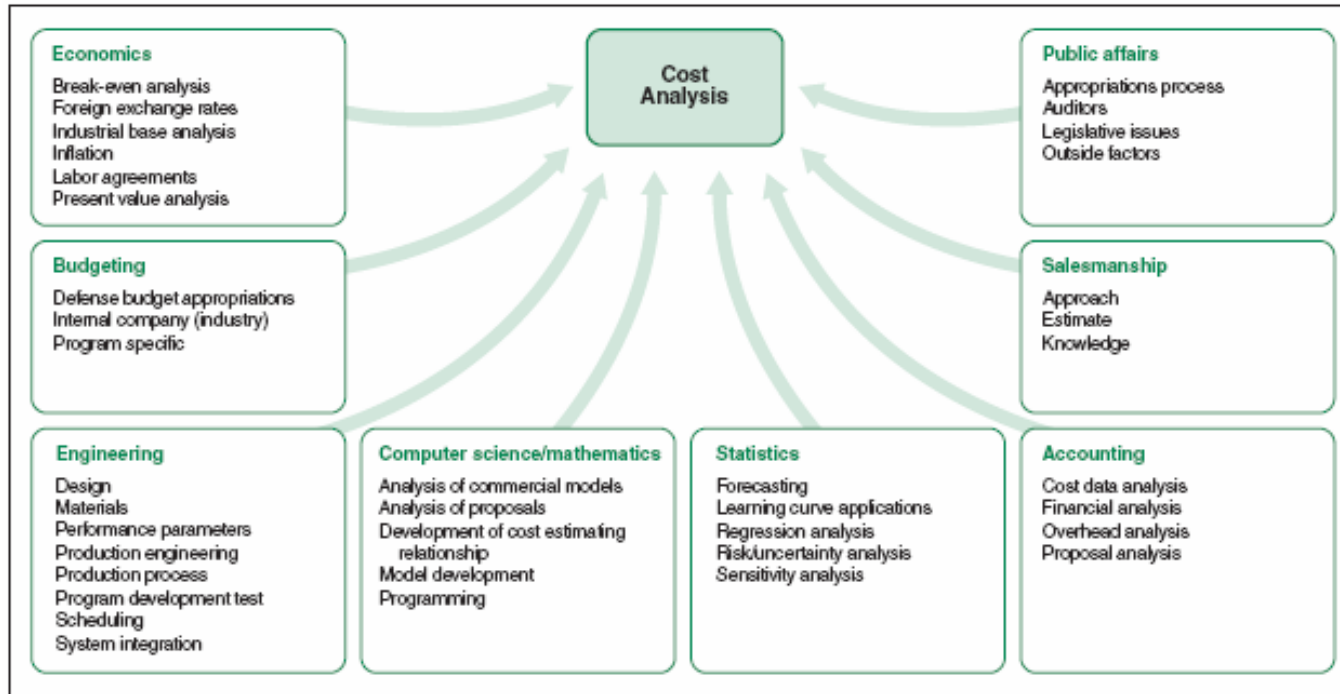
Initiation & Research Phase

Step 1. Define Estimate Purpose

- **Purpose defined by intended use; use defines scope and detail required of estimate.**
- **2 general purposes are:**
 - To help decision makers evaluate and select among alternatives; or
 - To support budgeting.
- **Scope, while defined by intended use, must also be consistent with data availability and time requirement for the estimate.**
- **Don't forget to factor in the Cost Assessment Team.**

Initiation & Research Phase

Step 1. Define Estimate Purpose (continued) The Cost Assessment Team



Source: GAO and DOD.

Team size, composition, and expertise will directly affect the quality of the estimate, the time required to produce it, and estimate credibility (perceived or otherwise).

Initiation & Research Phase

Step 2. Develop Estimating Plan

- **Resolve any time conflict before developing the plan.**
 - Time conflict: disconnect between amount of detail customer desires and amount of time allotted for the estimate.
 - Estimator must surface and manage the issue.
- **Under no circumstances should an estimate be undertaken when there is reason to believe it cannot be completed to customer satisfaction.**
- **Insist upon documented agreement; preferably before beginning the plan, but never later than its completion.**

Initiation & Research Phase

Step 2. Develop Estimating Plan (continued)

- **Purpose & Scope:** of the estimate.
- **Team Composition:** skill sets & names identified.
- **Ground Rules and Assumptions:** under which the plan is formulated and/or the estimate.
- **Proposed Methodology:** specify the tools/methods to be used.
- **Proposed Data Sources:** include degree of familiarity with sources, known pros and cons associated with sources, and identify data source voids, if any.
- **Schedule:** for conducting, reviewing, revisiting, presenting, and delivering the estimate – identify milestones.
- **Risk Assessment:** for estimate in not meeting intended purpose; of not meeting schedule; or of not achieving any precondition underlying the plan as written.

Assessment Phase

Step 3. Define the Program

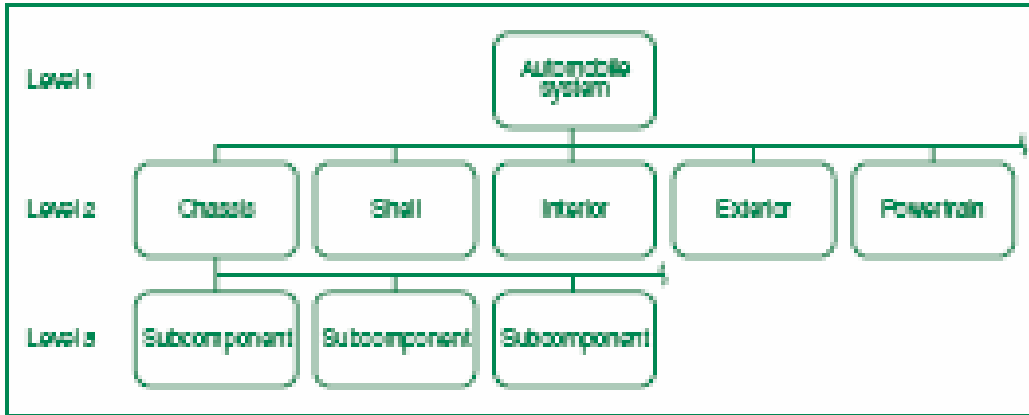
- **To develop a credible estimate, you need to know:**
 - Acquisition strategy: Competition? Sole-Source? Fixed-Price? Multiple Lot/Build?
 - Technical definition: What is the program intended to do?
 - Program characteristics: What's HW? What's SW? What kind?
 - At least system level design features: a PBS showing structure.
 - Intended technologies: Mature? Evolving? Immature?

- **Technical Baseline**
 - A document that will address all of the above needs.
 - Be sure you have the most current version.
 - You will have to create an equivalent if none exists.

Assessment Phase

Step 3. Define the Program (Continued)

- **Work Breakdown Structure (WBS) defines much about the program.**



Source: Sharon MCR, LLC, "Developing a Work Breakdown Structure"

Level 1 – Program Name

Level 2 – Major Program Segments

Level 3 – Components or Subsystems

- **WBS is usually developed early and evolves over the program life.**
- **WBS is product oriented and should be accompanied by a dictionary.**

Assessment Phase

Step 4. Determine the Estimating Approach

- Approach is inexorably linked to the quality and availability of data.
- **Historically the data is:**
 - Never complete.
 - Rarely consistent.
 - Never aligned to the cost accumulation system & WBS.
- **These data realities make calibration of parametrics to historical cost and technical data the best approach candidate most of the time.**
- **More on approach under the data discussion that follows.**

Assessment Phase

Step 5. Identify Ground Rules & Assumptions (GR&A)

- **Ground Rules: Common set of estimating standards that provide guidance and minimize conflicts.**
- **Assumptions: Set of judgments about past, present, and future conditions postulated in absence of positive proof.**
 - Assumptions make or break the estimate, because;
 - Rejection can invalidate the estimate.

Assessment Phase

Step 5. Identify Ground Rules & Assumptions (GR&A) (Continued)

- **GR&A are either global or element specific.**
 - Global – Apply to entire estimate.
 - Element Specific – Specific to an individual WBS element or subset.

- **GR&A might address the following:**
 - Operations concept – how the program functions to deliver its intended mission capability.
 - Life-cycle phases – those included or excluded from the estimate.
 - Maintenance concepts – for an estimate scoped to included maintenance cost.
 - Acquisition strategy – if not already called out in the technical baseline document.

Assessment Phase

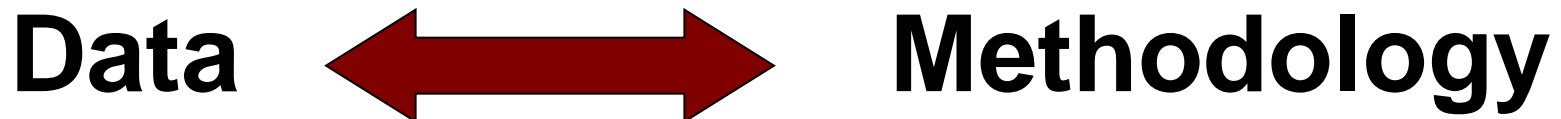
Step 5. Identify ground rules & assumptions (GR&A) (Continued)

- **GR&A might address the following:**
 - Technology assumptions – rationale for cost of technology changes from present known conditions.
 - Security considerations – to account for the degree of oversight, monitoring, inspecting, and associated potential time delays.
 - Items specifically excluded from the estimate – activities, resources, or both.
 - Any other condition that puts the estimate in context.

Assessment Phase

Step 6. Obtain the Data

- **Data are the foundation of every cost estimate.**
 - Data affects estimate credibility.
 - Estimates are rooted in historical data.
 - Data collection is key step in developing sound estimate.
 - Most difficult, time-consuming, costly activity.



Assessment Phase

Step 6. Obtain the Data (Continued)

■ Data Types

- Cost data – usually historical.
- Schedule or program data – sometimes called “programmatics”.
- Technical data – physical and performance specifications.

■ Data Sources

Basic Primary and Secondary Data Sources

Data type	Primary	Secondary
Basic accounting records	x	
Data collection input forms	x	
Cost reports	x	x
Historical databases	x	x
Interviews	x	x
Program briefs	x	x
Subject matter experts	x	x
Other organizations	x	x
Technical databases	x	x
Contracts or contractor estimates		x
Cost proposals		x
Cost studies		x
Focus groups		x
Research papers		x
Surveys		x

Source: DOD and NASA.

Assessment Phase

Step 6. Obtain the Data (Continued)

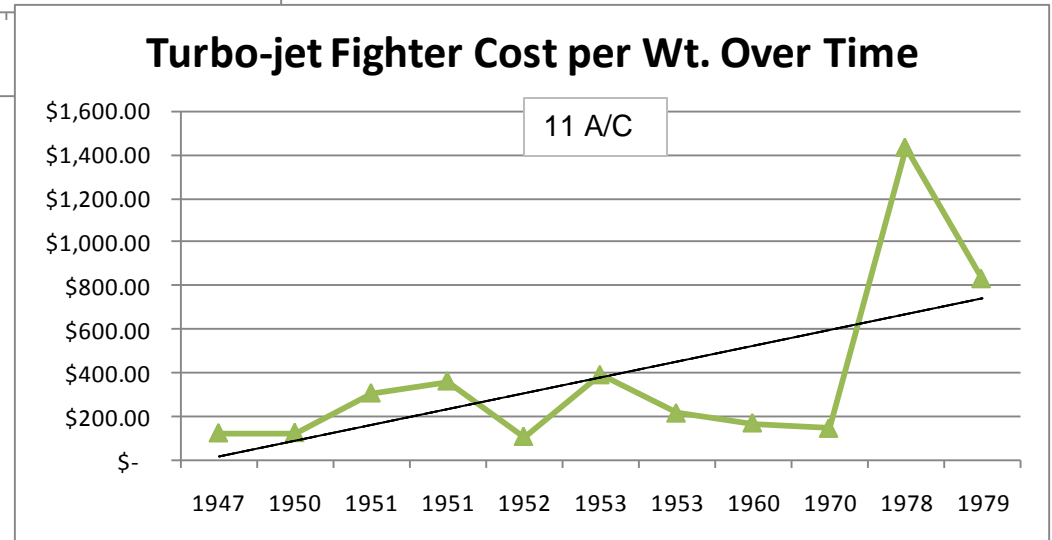
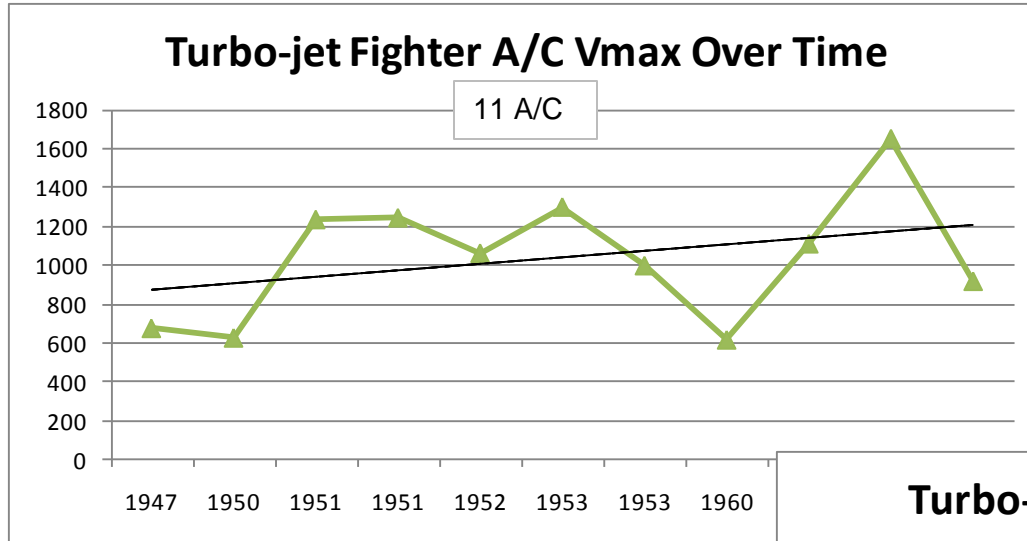
■ Applicability Questions

- Is normalization required (due to differences in base years, inflation rates, calendar vs. fiscal year accounting)?
- Is the work content of the current element consistent with the historical cost element?
- Does the data show unambiguous trends between cost and performance over time? Has that analysis been undertaken?
- How real are the cost data? Actuals? Proposed? Negotiated? What type of contract?
- Is the cost data available at the appropriate level of detail?
- Are cost segregations clean and clear (recurring vs. nonrecurring, manufacturing vs. engineering, labor vs. material)?
- Have risk and uncertainty for each data element been taken into account?
- Have there been legal or regulatory changes that affect cost for the same requirement?

Assessment Phase

Step 6. Obtain the Data (Continued)

- Trend Analysis over Time



Assessment Phase

Step 6. Obtain the Data (Continued)

- **Historical cost data have two predominant limitations:**
 - The data represent contractor marketplace circumstances that must be known if they are to have future value.
 - Current cost data eventually become dated.

- **A best practice is to continuously collect new data so it can be used for making comparisons and determining and quantifying trends.**

Assessment Phase

Step 6. Obtain the Data (Continued)

- **Nonrecurring vs. Recurring:**

- Nonrecurring costs generally occur only once in a system's life cycle.
- Recurring costs are incurred for each item produced or each service performed .

- **Fixed vs. Variable:**

- Fixed costs are static - regardless of the number of quantities to be produced.
- Variable costs are directly affected by the number of units produced.

Assessment Phase

Step 7. Develop the Point Estimate

- Point estimate — the best guess at the cost estimate.
- Three commonly used methods for estimating costs:
 - Analogy
 - Engineering Build-up
 - Parametric

Method	Strength	Weakness	Application
Analogy	<ul style="list-style-type: none">• Requires few data• Based on actual data• Reasonably quick• Good audit trail	<ul style="list-style-type: none">• Subjective adjustments• Accuracy depends on similarity of items• Difficult to assess effect of design change• Blind to cost drivers	<ul style="list-style-type: none">• When few data are available• Rough-order-of-magnitude estimate• Cross-check
Engineering build-up	<ul style="list-style-type: none">• Easily audited• Sensitive to labor rates• Tracks vendor quotes• Time honored	<ul style="list-style-type: none">• Requires detailed design• Slow and laborious• Cumbersome	<ul style="list-style-type: none">• Production estimating• Software development• Negotiations
Parametric	<ul style="list-style-type: none">• Reasonably quick• Encourages discipline• Good audit trail• Objective, little bias• Cost driver visibility• Incorporates real-world effects (funding, technical, risk)	<ul style="list-style-type: none">• Lacks detail• Model investment• Cultural barriers• Need to understand model's behavior	<ul style="list-style-type: none">• Budgetary estimates• Design-to-cost trade studies• Cross-check• Baseline estimate• Cost goal allocations

Source: ©2003, MCR, LLC, "Cost Estimating: The Starting Point of EVM."

Assessment Phase

Step 7. Develop the Point Estimate (Continued)

- **Validating the point estimate is a best practice.**
- **Characteristics of a high-quality, reliable estimate:**
 - Well-documented
 - Comprehensive
 - Accurate
 - Credible
- **Independent Cost Estimate (ICE) is best and most reliable.**
 - Provides objective and unbiased assessment.
 - Two issues:
 - Degree of Independence
 - Depth of the Analysis

Analysis Phase

Step 8. Conduct Sensitivity Analysis

- **Sensitivity vs. Risk vs. Uncertainty Analysis**
 - Sensitivity analysis identifies high and low cost drivers and helps gauge the importance of GR&A to the estimate.
 - Risk analysis identifies the degree of confidence in the point estimate based upon known program uncertainties.
 - Uncertainty analysis identifies the degree of confidence in the point estimate based upon unknown program uncertainties.
- **Sensitivity analysis should always accompany an estimate.**
- **Sensitivity analysis is performed one cost parameter at a time.**
 - Identify key drivers and GR&A for analysis.
 - Vary each parameter associated with identified keys and use same model to produce results for analysis.

Analysis Phase

Step 8. Conduct Sensitivity Analysis (Continued)

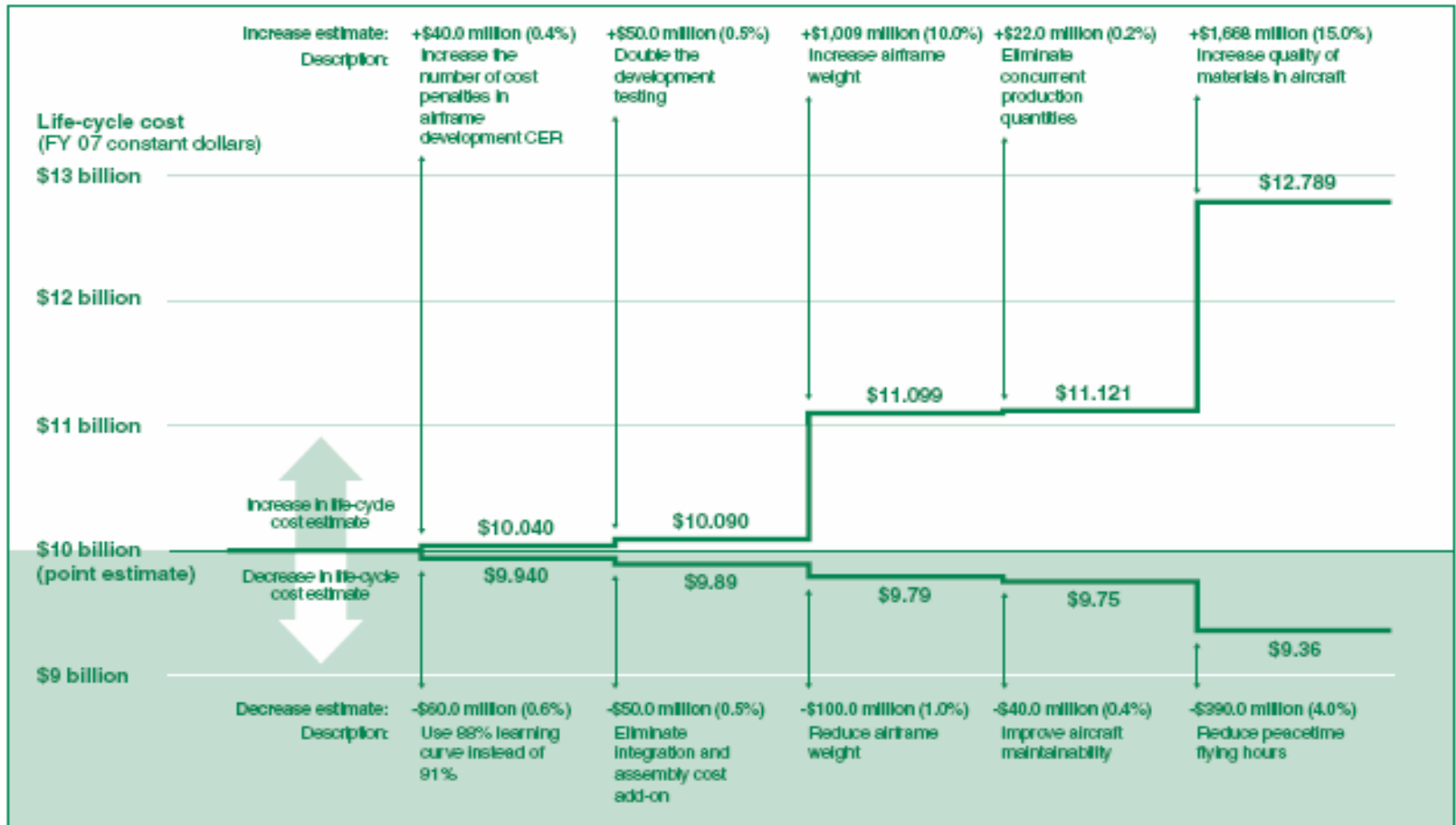
- **Intent of sensitivity analysis is to get at least one, “Gee, I didn’t realize that,” statement from Program Executive.**

- **Among the possible program changes suggested by sensitivity analysis are:**
 - Shorter or longer economic life (compress or stretch).
 - Relaxing non-critical requirements, including performance.
 - Configuration change in hardware or software.
 - Alteration of program operation and maintenance concepts and/or deployment strategy.
 - Change in acquisition strategy.
 - Down-scoping the program.

Analysis Phase

Step 8. Conduct Sensitivity Analysis (Continued)

Example



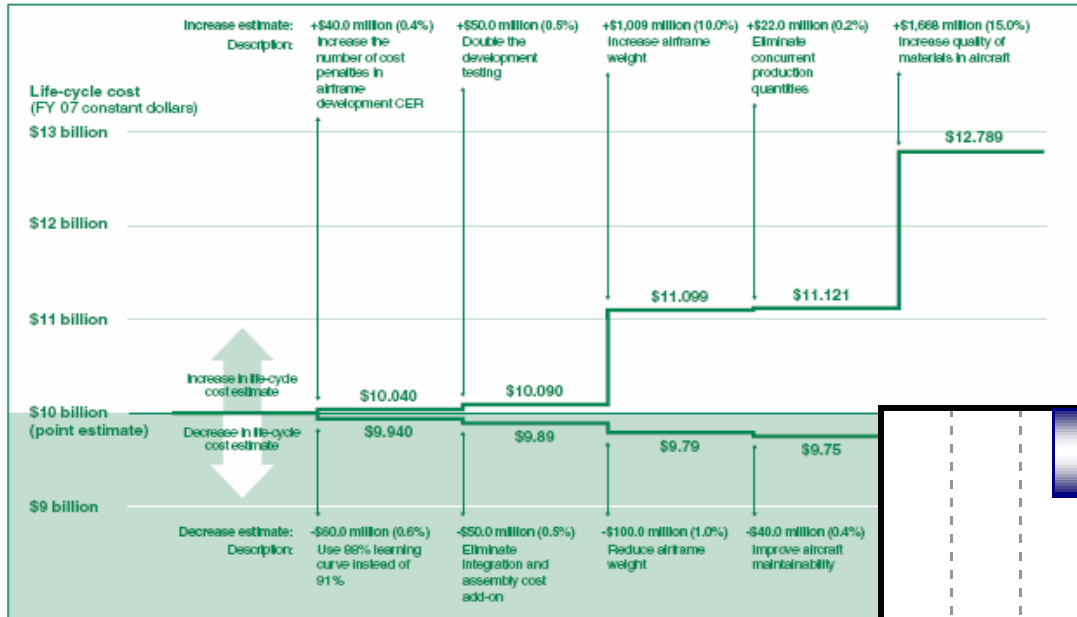
Source: GAO.

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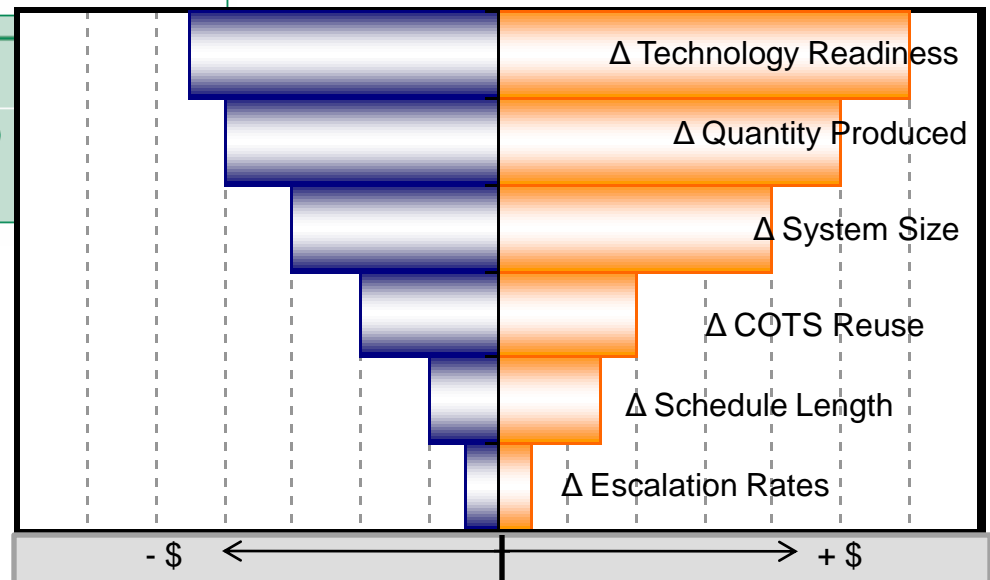
Sensitivity Analysis Artifacts

Scenario Specific What If



Source: GAO.

Tornado Chart

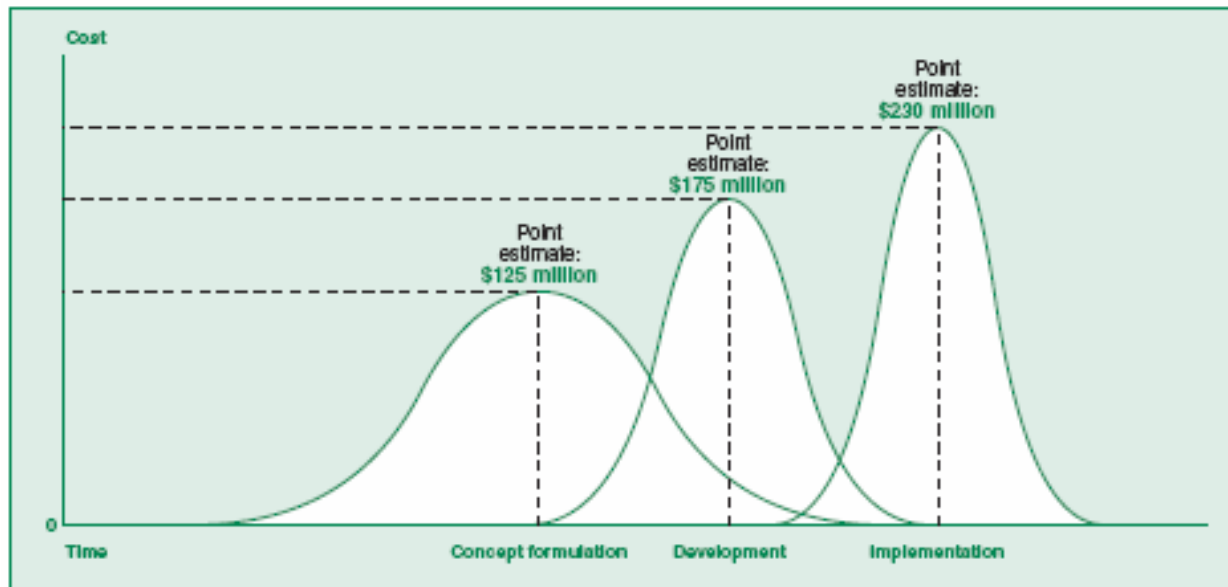


Analysis Phase

Step 9. Conduct Risk & Uncertainty Analysis

■ Risk vs. Uncertainty

- Risk occurs when outcome is subject to uncontrollable random event with known probability distribution.
- Uncertainty occurs when outcome is subject to an uncontrollable random event with unknown probability distribution.



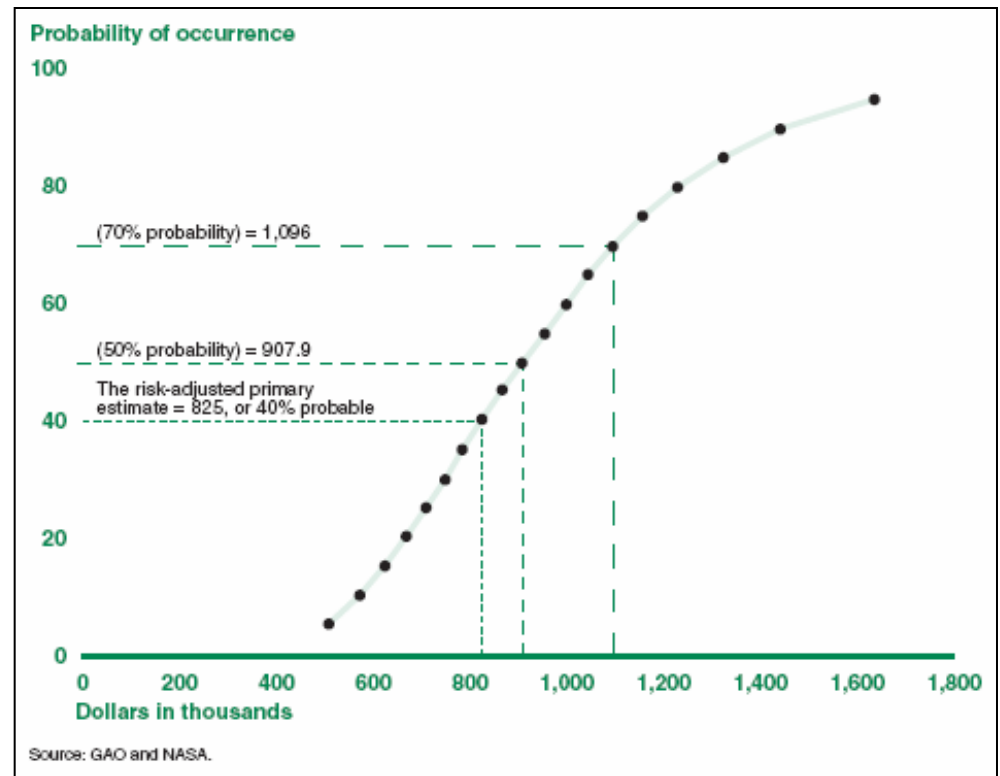
Generally Accepted View of Risk over Time

Analysis Phase

Step 9. Conduct Risk & Uncertainty Analysis (Continued)

■ Risk Based Budgeting

- GAO suggests budgeting programs to a risk adjusted estimate – study indicates a greater likelihood of success.
- Cumulative probability, or “S” curve is a common tool.



Analysis Phase

Step 9. Conduct Risk & Uncertainty Analysis (Continued)

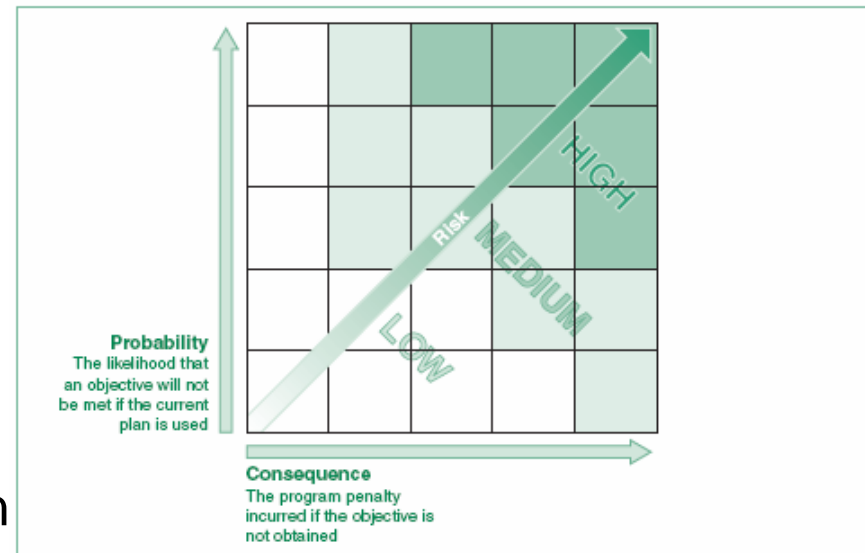
■ Steps of a Risk Analysis

- Determine the program cost drivers and associated risks.
- Develop probability distributions to model the uncertainty.
- Account for correlation between cost elements to properly capture risk.
- Perform the uncertainty analysis using a Monte Carlo simulation model.
- Identify the probability level associated with the point estimate.
- Recommend sufficient contingency reserves to achieve levels of confidence acceptable to the organization.
- Allocate, phase, and convert risk adjusted cost estimate to then-year dollars and identify high-risk elements to help in risk mitigation efforts.

Analysis Phase

Step 9. Conduct Risk & Uncertainty Analysis (Continued)

- Risk Analysis is vital to effective Program Risk Management.
- Steps of Risk Management
 - Identify Risks
 - Analyze Risks
 - Plan for Risk Mitigation
 - Implement the Risk Mitigation Plan
 - Track Risks



Source: GAO.

Analysis Phase

Step 10. Document the Estimate

- **A well-documented cost estimate is a best practice.**
 - The document tells the story; it must be clear, concise, and believable.
 - Very often, too little time and too little effort are expended in documenting the estimate.

“Poorly documented estimates can cause a program’s credibility to suffer”

Source: GAO Cost Guide

Analysis Phase

Step 10. Document the Estimate (Continued)

■ Why document?

- To satisfy policy requirements for recording basis of estimate.
- To convince estimate consumers that the estimate is credible.
- To provide supporting data useful in creating a historical database.
- To help answer questions about estimate approach and/or data.
- To record lessons learned and provide tracking history for cost changes.
- To define the scope of the analysis.
- To allow for replication of the estimate by another estimator.
- To help in conducting future cost estimates.
- To use in training junior analysts.

Analysis Phase

Step 10. Document the Estimate (Continued)

- **Document contents should include:**
 - Executive Summary – 1 page or less.
 - Introduction – Purpose and background information.
 - System Description – Program defined and context established.
 - Programmatic Inputs – Program deliverables and due dates.
 - Estimating Method and Data by WBS Element - Often the most voluminous section; methods and drivers are fully described.
 - Sensitivity Analysis – Drivers and cost impact ranking.
 - Risk and Uncertainty Analysis – Description of risks and display of results.
 - Management Approval – Of plan, GR&A, and results.
 - Updates Reflecting Actual Costs and Changes – Amendments and additions to previous report documents.

Presentation Phase

Step 11. Present Estimate for Approval

- **Estimate is not valid until approved.**
- **Estimator should prepare the presentation even if he/she is not the presenter.**
- **Do**
 - Ensure the presentation is crisp and complete.
 - Focus attention to cost drivers.
 - Use a consistent format throughout and across other presentations.
 - Use illustrations or simple analogies to establish key points.
 - Include program and technical information.
- **Don't**
 - Make careless errors.
 - Over explain estimating approach.

Presentation Phase

Step 11. Present Estimate for Approval (Continued)

■ Include in the presentation:

- The obligatory items: title page with date, names, and outline.
- The purpose - why the estimate was done, what approval is needed and why?
- Overview of program: physical and performance characteristics, acquisition strategy, any unique aspects.
- Estimating ground rules and assumptions .
- Estimate results: presented in appropriate detail and format; as much graphic presentation as possible; include a track to any previous estimates; show pie-charts to identify key cost drivers.
- Description of estimating process and data sources; explain by WBS as necessary; call out cost drivers and high-value items.

Presentation Phase

Step 11. Present Estimate for Approval (Continued)

- **Include in the presentation:**
 - Sensitivity analysis – displays, like tornado charts.
 - Discussion of risk and uncertainty analysis – define the risks and parameters used to measure them; how uncertainty, bounds, and distributions were defined; display the “S” curve results.
 - Independent Estimate – show the comparison; explain differences and discuss results.
 - Compare estimated funding requirement to any existing available budget profile - be sure currency values are the same; identify problem areas and offer suggested solutions where possible.
 - Conclusions and recommendations; include concerns and/or challenges that surfaced during estimate conduct, even if they have been stated before.

Presentation Phase

Step 12. Update the Estimate

- **Programs should be continuously monitored for cost effectiveness - compare planned and actual performance against approved program baseline.**
- **Periodically update estimate with actual costs for relevancy purposes.**
- **Updating results in:**
 - Higher quality estimate.
 - Opportunity to incorporate lessons learned .
- **Estimating is a recurrent process; the estimate is just a snapshot in time.**

Presentation Phase

Step 12. Update the Estimate (Continued)

■ Trigger Events

- Contract modifications, including engineering change proposals.
- Shift in funding streams.
- Changes in funding levels.
- Major rate changes, including overhead rates.
- Changes to program scope or schedule.
- Revision of the acquisition plan or strategy.
- Executive management decisions.
- Scheduled revisions.

Presentation Phase

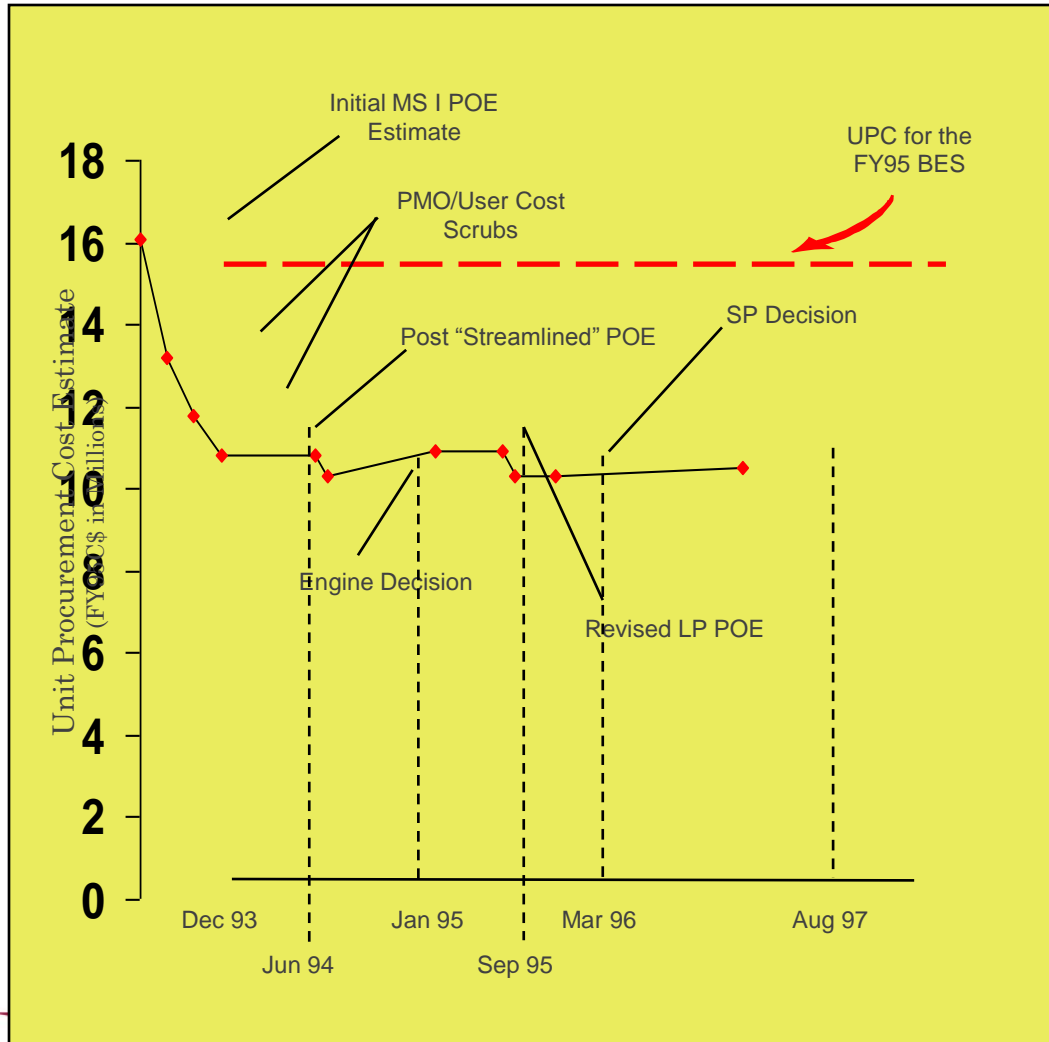
Step 12. Update the Estimate (Continued)

- **Estimate update activities should always include:**
 - Documentation and references for all changes that affect the program estimate and a tracking of the updated estimate to past estimates.
 - Tracing of requirements changes through to affected WBS elements and entire program.
 - Revealing the actual costs and how they were used to update the estimate.
 - Recording all GR&A and actual information so they can be used for estimating future programs.
 - Getting guidance and obtaining feedback from the estimate consumers – don't work in a vacuum.

Presentation Phase

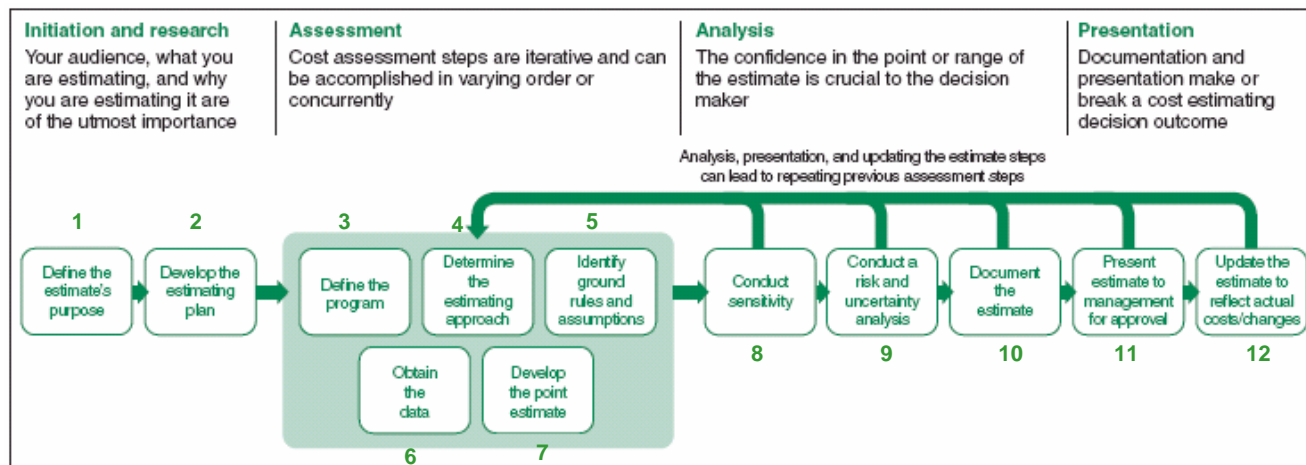
Step 12. Update the Estimate (Continued)

- Example of an update with previous estimate history.



Process Fit to Data Driven Parametric Estimating

- Data driven parametric estimating revolves around use of information (data) about like programs to form the basis of estimate (BOE) for new programs.
- Every step of the 12 steps involves some activity to establish the linkage between the program in question and the like programs.



Source: GAO.

Process Fit to Data Driven Parametric Estimating (Continued)

■ Initiation & Research (Steps 1 & 2)

- Unless the program is completely unique, lineage to other programs will help state the purpose and make the plan.
- The plan may well be to use pre-established cost modeling based upon analysis of past like programs; if not pre-existing, then creation is needed.

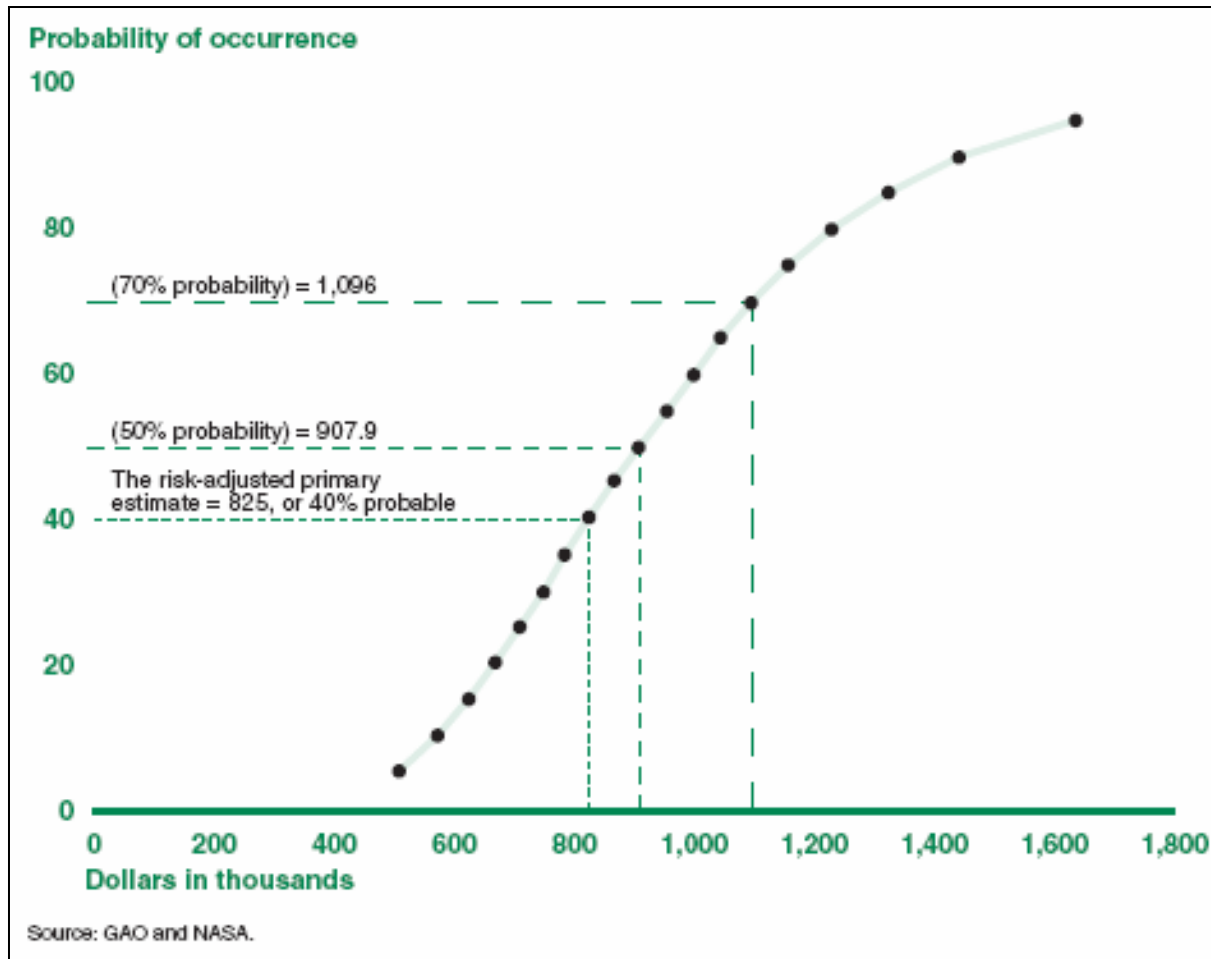
■ Assessment (Steps 3 – 7)

- Definition of a program includes comparison and contrast to existing or past programs.
- The approach explains the mechanics of using data to estimate.
- Some GR&A are data forced; all require data alignment.
- Point estimates result when new program data meets like program BOE.

Process Fit to Data Driven Parametric Estimating (Continued)

- **Analysis (Steps 8- 10)**
 - Sensitivity, uncertainty, and risk are data analyses under varying conditions and assumptions; like programs are more likely to be similar than different in these analysis areas.
 - Much of the credibility in the estimate document flows from the data used and the soundness of analysis with it.
- **Presentation (Steps 11 & 12)**
 - Like the estimate document, the data and analysis will tell a story that is believable or not.
 - Updating is nothing more than repeating the process with new information (data).

Risk/Uncertainty Analysis Artifact



Possibly the single most important item to decision maker