GAO Cost Estimating and Assessment Guide

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Outline

• Background
• The Guide’s Layout
• GAO’s 12-step Process
• Linking the Estimate to Earned Value Management
• Validating the Cost Estimate
• Past GAO Assessments
• Other GAO Guides
Background
What Is Cost Estimating?

- The International Cost Estimating and Analysis Association (ICEAA) has defined cost estimating as
  - The process of collecting and analyzing historical data and applying quantitative models, techniques, tools, and databases to predict the future cost of an item, product, program, or task.

- Cost estimating cannot
  - Be applied with cookbook precision but must be tailored to a particular system;
  - Be a substitute for sound judgment, management, or control;
  - Produce results that are better than input data; or
  - Make final decisions.

- Despite these limitations, cost estimating is a powerful tool because it
  - Leads to a better understanding of a problem;
  - Improves management insight into resource allocation problems, and
  - Provides an objective baseline for measuring progress.
Estimating vs. Analysis

• Cost estimating typically comes before cost analysis
  • Cost estimating involves
    • collecting and analyzing historical data;
    • applying quantitative models, techniques, tools, and databases;
    • predicting a program’s future cost.

• Cost analysis can be defined as
  • the effort to develop, analyze, and document cost estimates with analytical approaches and techniques;
  • the process of analyzing the incremental and total resources required to support past, present, and future systems;
  • a tool for evaluating resource requirements at key milestones and decision points in the acquisition process.
Background
Cost Estimating in the Acquisition Process

• Cost estimating is a part of total systems analysis
  • Realistic cost estimates allow better decision making
  • Cost estimates help ensure that systems are affordable.

• Cost estimates are closely related to the budgeting process
  • Credible cost estimates help program offices effectively defend budgets to the Congress, OMB, department secretaries, and others.
Background

Cost Estimating Disciplines and Concepts

**Economics**
- Break-even analysis
- Foreign exchange rates
- Industrial base analysis
- Inflation
- Labor agreements
- Present value analysis

**Budgeting**
- Budget appropriations
- Internal company (industry)
- Program specific

**Engineering**
- Design
- Materials
- Performance parameters
- Production engineering
- Production process
- Program development test
- Scheduling
- System integration

**Computer science/mathematics**
- Analysis of commercial models
- Analysis of proposals
- Development of cost estimating relationship
- Model development
- Programming

**Statistics**
- Forecasting
- Learning curve applications
- Regression analysis
- Risk/uncertainty analysis
- Sensitivity analysis

**Public and government affairs**
- Appropriations process
- Auditors
- Legislative issues
- Outside factors

**Interpersonal skills**
- Approach
- Estimate
- Knowledge

**Accounting**
- Cost data analysis
- Financial analysis
- Overhead analysis
- Proposal analysis

Source: GAO.

Slide 6
Background
Cost Estimating Challenges

Source: GAO.
The Guide’s Layout

- The GAO Cost Estimate and Assessment Guide consists of 20 chapters and supporting appendixes
  - Chapters 1-17 address the importance of credible cost estimates and the 12-step process for creating them
  - Chapters 18-20 address managing program costs
  - Several chapters also include case studies of GAO audits that provide real life examples that highlight the topics in the guide.

- GAO has also published a Schedule Guide that expands on topics in chapter 18 of the Cost Guide.
How to Develop a Reliable Cost Estimate

GAO’S 12-STEP PROCESS
Overview of the 12-Step Estimating Process

Figure 1: The Cost Estimating Process

**Initiation and research**
Your audience, what you are estimating, and why you are estimating it are of the utmost importance.

**Assessment**
Cost assessment steps are iterative and can be accomplished in varying order or concurrently.

**Analysis**
The confidence in the point or range of the estimate is crucial to the decision maker.

**Presentation**
Documentation and presentation make or break a cost estimating decision outcome.

Analysis, presentation, and updating the estimate steps can lead to repeating previous assessment steps.

1. Define the estimate’s purpose
2. Develop the estimating plan
3. Define the program
4. Obtain the data
5. Determine the estimating structure
6. Identify ground rules and assumptions
7. Develop the point estimate and compare it to an independent cost estimate
8. Conduct sensitivity
9. Conduct a risk and uncertainty analysis
10. Document the estimate
11. Present estimate to management for approval
12. Update the estimate to reflect actual costs/changes

Source: GAO.
### In the Cost Guide

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<th>Phase in Process</th>
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<td>Define estimate’s plan</td>
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<td>Define program characteristics</td>
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<td>Determine estimating structure</td>
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<td>Identify GR&amp;As</td>
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<td>Assessment</td>
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<td>Obtain data</td>
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<td>Assessment</td>
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<td>7</td>
<td>Develop point estimate and compare</td>
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<td>Assessment</td>
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<td>8</td>
<td>Conduct sensitivity analysis</td>
<td>13</td>
<td>Analysis</td>
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<td>9</td>
<td>Conduct risk and uncertainty analysis</td>
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<td>10</td>
<td>Document the estimate</td>
<td>16</td>
<td>Analysis</td>
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<td>11</td>
<td>Present estimate to management</td>
<td>17</td>
<td>Presentation</td>
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<td>12</td>
<td>Update the estimate</td>
<td>16, 18, 19, 20</td>
<td>Presentation</td>
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Initiation and Research

**Initiation and research**
Your audience, what you are estimating, and why you are estimating it are of the utmost importance.

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**Presentation**
Documentation and presentation make or break a cost estimating decision outcome.

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**Define the estimate’s purpose**

**Develop the estimating plan**

- Determine the estimating objective and scope
- Identify ground rules and assumptions
- Develop the point estimate and compare to an independent cost estimate

**Conduct sensitivity**

**Conduct a risk and uncertainty analysis**

**Document the estimate**

**Present estimate to management for approval**

**Update the estimate to reflect actual costs/changes**

Analysis, presentation, and updating the estimate steps can lead to repeating previous assessment steps.

Source: [GAO](https://www.gao.gov)
Step 1: Define the Estimate’s Purpose

- A cost estimate’s scope is determined by the customer’s needs
  - Scope is driven by the program phase and the availability of data.

- A program’s purpose should relate to agency missions, goals, and objectives
  - The estimate’s purpose should address benefits and performance measures.

- The following are examples of what an estimate’s purpose can be
  - Help managers evaluate and select alternative systems and solutions
  - Support the budget process by providing estimates of the funding required to efficiently execute a program
  - Provide valuable data for use in trade studies, independent reviews, and evaluating baseline changes.
Step 2: Develop the Estimating Plan

- The following should be included as part of the estimating plan
  - Determine the estimate’s schedule
  - Determine members of the estimating team.

- In order to ensure that a consistent plan is used across estimates, it is beneficial to develop a centralized cost team and process. This results in
  - Standardized processes
  - A strong institutional structure and leadership support
  - Identification of resident experts
  - Sharing of resources
  - Commonality of cost estimating tools and training
  - More independence and less bias
  - Opportunities for advancement in the cost estimating field.

- The level of detail in the estimating plan is driven by the type of estimate to be developed.
Assessment

Initiation and research
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Assessment
Cost assessment steps are iterative and can be accomplished in varying order or concurrently

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Documentation and presentation make or break a cost estimating decision outcome

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Source: GAO.
Step 3: Define the Program

• Adequate information must be available to identify the technical and programmatic parameters on which to base the estimate.

• A best practice is to include this information in a single document called a Technical Baseline Description
  • The technical baseline should be developed by qualified personnel
  • The technical baseline should include technical, programmatic and schedule information.

• The accuracy of the cost estimate depends on how well the program is defined
  • The program definition serves as the basis for developing any cost estimate.
Step 3: Define the Program
Baseline Documents around the Government

- All these documents should include (at a minimum)
  - System’s purpose
  - Performance characteristics
  - Work breakdown structure
  - Acquisition strategy, quantities, and schedule
  - Test and evaluation plan
  - Deployment and training plans
  - Environmental impacts
  - Operational concept, logistics, and maintenance philosophy
  - The level of risk associated with assumptions.

**DHS**
- Cost Estimating Baseline Document (CEBD)

**DOD**
- Cost Analysis Requirements Description (CARD)

**NASA**
- Cost Analysis Data Requirement (CADRE)
Step 4: Determine the Estimating Approach

- A Work Breakdown Structure (WBS) defines in detail the work necessary to meet program objectives
  - The WBS should be product-oriented and hierarchical
  - In addition to product-oriented elements, a WBS should include other common elements like program management, systems engineering, and systems test and evaluation.

- The WBS is updated as the program changes and becomes better defined.
Step 4: Determine the Estimating Approach

Example WBS

Automated Information System (AIS)

Prime Mission Product (Release 1)
- Custom Application Software
  - Subsystem Hardware
  - Subsystem Software
- Enterprise Service
- Development Test and Evaluation
- Operational Test and Evaluation
- Systems Test and Evaluation
- Systems Engineering
Step 5: Identify Ground Rules and Assumptions

• Cost estimates are based on limited information.

• Ground rules and assumptions (GR&A) help establish the estimate’s boundaries
  • **Ground rules**: a common set of agreed upon estimating standards that provide guidance and minimize definition conflicts
  • **Assumptions**: are made in the absence of ground rules; they are judgments about past, present, or future conditions.

• Both ground rules and assumptions should be tested and adjusted for risk (see steps 8 and 9).
Step 5: Ground Rules vs. Assumptions

<table>
<thead>
<tr>
<th>Ground Rules</th>
<th>Assumptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Low Rate Initial Production (LRIP) will begin in 2018</td>
<td>• Labor rate for a carpenter is $31/hr</td>
</tr>
<tr>
<td>• The Operating and Support period will be 30 years</td>
<td>• Empty aircraft weight is 42,000 lbs</td>
</tr>
<tr>
<td>• Costs are in Base Year 2014 Dollars</td>
<td>• Nonrecurring costs are 2.54 times the recurring costs</td>
</tr>
</tbody>
</table>
Step 6: Obtain Data

- Data are the foundation of every cost estimate
  - The quality of the data affects the overall credibility of the cost estimate
  - Crosschecking different data sets for concurrence provides a high degree of confidence in the data.

- Estimators rely on data from existing programs in order to estimate the cost of new programs.

- All WBS elements will need data for support
  - Both cost and noncost data are needed to support various estimating techniques.
Step 6: Obtain Data

Data Cycle

- Collect
- Archive
- Document
- Normalize
**Step 6: Obtain Data**

**Types of Data**

- Historical cost and noncost data need to be collected to support various estimating techniques.

<table>
<thead>
<tr>
<th>Type of data</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost</td>
<td>Labor dollars, hours, overhead rates, cost of money, fee, and material</td>
</tr>
<tr>
<td>Schedule and program parameters</td>
<td>Lead time, start and duration of effort, delivery dates, contract types, quantity profiles</td>
</tr>
<tr>
<td>Technical characteristics</td>
<td>Length, weight, horsepower, sizing measures (drawings, SLOC, interfaces, square footage).</td>
</tr>
</tbody>
</table>
Step 6: Obtain Data

Data Validity

• It is important to ensure that the collected data apply to the cost estimate
  • For example, do not use data from a mainframe technology if the new program will use servers.

• Cost data eventually become dated
  • New data must continually be collected in order to make comparisons and develop trends.

• To address data limitations, an analyst must
  • Ensure that the most recent data are collected
  • Have a thorough knowledge of the data’s background
  • Discuss limitations and uses with the data provider
  • Identify the correlation between cost and performance data.
Step 7: Develop the Point Estimate and Compare It to an Independent Cost Estimate

- In order to develop a point estimate, an estimator must
  - Develop the cost estimate for each WBS element
    - Add all WBS elements to develop the overall point estimate
  - Include all estimating assumptions in the cost model
  - Express costs in constant-year dollars
  - Time-phase the results by spreading the costs in the years they are expected to occur based on the program schedule.

- Once the overall point estimate has been developed, the estimator must then
  - Validate the estimate
  - Compare the estimate to an independent cost estimate
  - Perform crosschecks on cost drivers
  - Update the model as more data become available.
Step 7: Develop the Point Estimate

Cost Estimating Methodologies

- analogy
- engineering
- parametric
- expert opinion
- extrapolation

Choice of estimating methodology depends on

<table>
<thead>
<tr>
<th>Type of system</th>
<th>Software, infrastructure, vehicle, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase of program</td>
<td>Research, development, production, maintenance.</td>
</tr>
<tr>
<td>Available data</td>
<td>Historical data points from legacy or similar systems’ technical parameters.</td>
</tr>
</tbody>
</table>
Analysis

Initiation and research
Your audience, what you are estimating, and why you are estimating it are of the utmost importance

Assessment
Cost assessment steps are iterative and can be accomplished in varying order or concurrently

Analysis
The confidence in the point or range of the estimate is crucial to the decision maker

Presentation
Documentation and presentation make or break a cost estimating decision outcome

Define the estimate’s purpose → Develop the estimating plan → Define the program → Obtain the data → Determine the estimating structure → Identify the estimating assumptions → Conduct sensitivity → Conduct a risk and uncertainty analysis → Document the estimate

Analysis, presentation, presentation, estimate steps can be repeated to fine-tune decision outcomes

Source: GAO.
Step 8: Conduct Sensitivity Analysis

- All estimates are uncertain and sensitivity analysis helps create a range of best and worst case costs.

- What is sensitivity analysis?
  - Sensitivity analysis is the examination of the effect of changing one assumption or cost driver at a time while holding all other variables constant
  - The result is that it is easier to understand which variable most affects the cost estimate.

- Sensitivity analysis is useful because it
  - Establishes a method for performing what-if analysis
  - Provides a range of possible costs in addition to a point estimate
  - Provides a careful assessment of what drives that range
    - Identifies the underlying risks
    - Supporting data are necessary for making informed decisions
  - Can help determine what level of risk reserve may be required
  - Can help decision makers choose alternatives.
Step 8: Sensitivity Analysis

Five Steps to Success

1. Identify drivers
   - Examine what parameters and assumptions drive them

2. Re-estimate
   - Total cost is reestimated by varying each parameter and assumption between a range

3. Document
   - Document the results

4. Repeat steps 2-3
   - Recalculate the estimate for each cost driver

5. Evaluate
   - Evaluate all the outcomes to determine which parameters the estimate is most sensitive to
Step 9: Conduct Risk and Uncertainty Analysis

- **Risk vs. Uncertainty**
  - **Risk** is the chance of loss or injury; it is the probability of an unfavorable event.
  - **Uncertainty** is the indefiniteness about the outcome of a situation; it is assessed in cost estimate models to estimate the probability that a specific funding level will be exceeded.

- **Uncertainty analysis is used to capture the cumulative effect of risks**
  - Uncertainty is present in all estimates since the future is always unknown. Therefore, a point estimate, by itself, is meaningless.

- **Cost risk analysis aims to**
  - Identify program level confidence for development schedules
  - Provide credibility to the target estimate and budget
  - Identify technical, schedule, and cost estimating risk drivers for use in risk management.
Step 9: Risk and Uncertainty Analysis

Application Process

Determine
- Determine program cost drivers and associated risks

Develop
- Develop distributions to model various types of uncertainty

Account
- Account for correlation between cost elements

Recommend
- Recommend sufficient contingency reserves to achieve a confidence level

Identify
- Identify the probability level of the point estimate

Perform
- Perform the analysis using a simulation model

Allocate
- Allocate, phase, and convert a risk-adjusted estimate to then-year dollars
Step 9: Risk and Uncertainty Analysis

Risk Management

- Risk management is a structured and efficient process for identifying risks, assessing their effect, and developing ways to reduce or eliminate them.

- The risk management process should address five steps
  1. Identify risks
  2. Analyze risks
  3. Plan for risk mitigation
  4. Implement a risk mitigation plan
  5. Track risks.
Step 10: Document the Estimate

• Thorough documentation presents a convincing argument for why an estimate is valid
  • “Thorough” indicates that someone unfamiliar with the estimate will be able to update or recreate the estimate from its documentation.

• Good documentation describes the estimating process, data sources, and methodologies
  • Documentation should occur in parallel with the estimating process and not be done at the last minute as an afterthought.
Step 10: Document the Estimate
What Is Included in the Documentation?

- Cover Page and Introduction
- Executive Summary
- Introduction
- System Description
- Program Inputs
- Methodology by Cost Element
- Data by Cost Element
- Narrative text
- Cost tables
- Sensitivity analysis
- Uncertainty analysis
- Management approval
- Tracked updates
- Contingency derivation
Presentation

Initiation and research
Your audience, what you are estimating, and why you are estimating it are of the utmost importance.

Assessment
Cost assessment steps are iterative and can be accomplished in varying order or concurrently.

Analysis
The confidence in the point or range of the estimate is crucial to the decision maker.

Presentation
Documentation and presentation make or break a cost estimating decision outcome.

Analysis, presentation, and updating the estimate can lead to repeating previous assessment.

Define the estimate’s purpose → Develop the estimating plan → Define the program → Determine the estimating structure → Identify ground rules and assumptions → Obtain the data → Develop the point estimate and compare it to an independent cost estimate → Conduct sensitivity analysis → Conduct risk and uncertainty analysis → Present estimate to management for approval → Update the estimate to reflect actual costs/changes.

Source: GAO.
Step 11: Present the Estimate to Management

- Management must approve estimates before they can be considered valid.

- Cost estimators should prepare a briefing for decision makers that
  - Provides the final cost estimate’s outcome
  - Illustrates key points regarding the cost drivers
  - Provides program and technical information specific to the program
  - Displays budget implications.

- After the briefing, actions and management approval should be acted on and recorded as part of the cost estimate documentation.
Step 11: Present the Estimate
What Is Included in a Management Briefing?

Introduction
• Title page, outline, purpose

Overview
• Program technical foundation and objectives

Estimate Results
• Life cycle costs in time-phased constant year dollars
• Track results to previous versions

Discussion
• Ground rules and assumptions
• Estimating methodology and data sources for each WBS element

Credibility
• Sensitivity and identified cost drivers
• Risk and uncertainty analysis, S-curve
• Basis for contingency

Reconciliation
• Comparison of the point estimate to an independent cost estimate

Affordability
• Analysis of funding profile and contingency reserve

Conclusions
• Discussion of concerns or challenges
• Recommendations and request for management approval of estimate
Step 12: Update the Estimate to Reflect Actual Costs and Changes

- The estimate must be updated to reflect changes in assumptions and to keep it current
  - Replace estimates with independent estimates at completion (EAC) from the integrated Earned Value Management (EVM) system
  - Report progress on meeting cost and schedule estimates
  - Perform a post mortem and document lessons learned
  - Document all changes to the program and how they affect the cost estimate.
Summary of the 12-Step Estimating Process

What Is a Cost Estimate?

- A cost estimate is more than just a single dollar value
- A cost estimate is more than just an estimating model
- While an estimate reflects a single point in time, it should be updated as programmatic and technical changes occur.
Linking the Estimate to EVM
Planning, Execution, Updating

Planning
• A cost estimate is used to measure performance against the plan using EVM
• The EVM system complies with EIA-748 guidelines

Execution
• An IBR assessed the adequacy of the baseline budget and schedule
• EVM data are summarized with a contract performance report and analyzed by the PMO

Updating
• The estimate is updated with actual costs
• Updated EACs and EVM data are continually reported to management
Validating the Cost Estimate

- Four characteristics identified by the GAO Cost Guide reflect a reliable estimate:
  - **Well-Documented**
    - The estimate is thoroughly documented, including source data and significance, clearly detailed calculations and results, and explanations for choosing a particular method of reference
  - **Comprehensive**
    - The estimate’s level of detail ensures that cost elements are neither omitted nor double counted
  - **Accurate**
    - The estimate is unbiased, not overly conservative or overly optimistic, and based on an assessment of most likely costs
  - **Credible**
    - The estimate discusses any limitation of the analysis from uncertainty or biases surrounding data or assumptions.
# Past GAO Assessments

## Overview by Agency or Department

<table>
<thead>
<tr>
<th>Agency/Department</th>
<th>Comprehensive</th>
<th>Well Documented</th>
<th>Accurate</th>
<th>Credible</th>
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<tr>
<td>Agriculture</td>
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<td>Internal Revenue Service (IRS)</td>
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<td>Veterans Affairs (VA)</td>
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- **Fully Met**
- **Substantially**
- **Partially**
- **Minimally**
- **Not Met**
Past GAO Assessments
What Is Typically Missing from LCCEs?

- In general, program offices
  - Do not include all life cycle costs and do not break costs into sufficient detail
  - Rarely use standardized product-oriented WBS with common support elements
  - Do not document the cost estimate to a level that would allow an analyst unfamiliar with the program to replicate the results
  - Do not properly account for risk or uncertainty while developing the estimate
  - Fail to crosscheck estimating methodologies or reconcile with an independent cost estimate
  - Cannot demonstrate management approval
  - Fail to update the cost estimate.

- Additionally, many government program offices lack effective internal controls
  - No centralized cost estimating organization
  - No policy or guidance
  - No established databases or data collection process
  - No independent estimating organization.
Past GAO Assessments

Results

- **DHS**
  - **GAO Recommendation:** Because estimates at multiple DHS Components did not follow best practices, GAO found that they were not reliable
  - **Results:** DHS established a cost estimating capability at headquarters in 2008. The group has provided DHS-wide expertise to improve cost estimating and analysis services in support of DHS’s investment and funding decisions. In 2014, the group was moved under the DHS CFO to continue to support all DHS major acquisitions.

- **MDA**
  - **GAO Recommendation:** MDA take steps to ensure that its cost estimates are high in quality, reliable, and documented fully to facilitate external review
  - **Results:** MDA has taken action in line with GAO best practices to improve its cost estimating practices

- **NASA**
  - **GAO Recommendation:** establish a standard framework for developing the life cycle cost estimates
  - **Results:** NASA created a Cost Analysis Division within the Office of Program Analysis and Evaluation.
GAO Acquisition Guides

- Cost Assessment Guide (update in process)
- Schedule Assessment Guide
- Technology Readiness Assessment Guide
- Agile Guide
Why the GAO Best Practice Guides are Important

- Legislators, government officials, and the public want to know
  - Whether government programs are achieving their goals
  - What these programs are expected to cost and when they will be finished

- Developing reliable program cost and schedule estimates are critical to
  - Effectively using public funds
  - Meeting OMB’s capital programming process
  - Avoiding cost overruns, missed deadlines, and performance shortfalls
GAO Relies on Best Practice Guides to Develop Audit Findings

- **Purpose of the Guides is to**
  - Address best practices for ensuring credible program cost and schedule estimates for both government and industry
  - Provide a detailed link between cost estimating, scheduling, and EVM
    - OMB has endorsed EVM for measuring cost, schedule, and technical performance
    - Guide demonstrates how realistic cost and schedule estimates are necessary for setting achievable program baselines and managing risk

- **Original intent was to provide auditors with a standardized approach for analyzing program costs**
  - Our research, however, found federal guidelines to be limited on the processes, procedures, and practices for ensuring credible estimates
    - We decided to fill the gap and shifted the intent of the Guide from an auditor’s manual to a best-practice manual
    - To help GAO auditors fully utilize this Guide, we included a number of “auditor checklists” for use on program assessments

- **We developed the GAO Guides to**
  - Establish consistent best practices that can be used across the federal government
  - Provide auditors with a standardized approach for analyzing program costs, earned value management (EVM) data, schedules, and technology readiness assessments
The GAO Schedule Assessment Guide develops the scheduling concepts introduced in the GAO Cost Estimating and Assessment Guide.

- Best practices for developing and maintaining high-quality schedules
- Contains explanatory text, illustrations, and detailed case studies
- Includes appendixes that list key questions, documentation, and technical guidance

The GAO Schedule Guide can be downloaded for free at www.gao.gov/products/GAO-16-89G
Technology Readiness Assessment Guide

- Public exposure draft released in 2016
- Outlines GAO’s criteria for evaluating technological readiness assessments
- Contains 10 chapters with supporting appendixes
- Chapters 1 & 2 define TRAs and describe their importance and limitations
- Chapter 3 outlines a reliable process for conducting TRAs
- Chapters 4-10 address the associated best practices
- Provides case studies of prior GAO audits to show typical findings related to the TRA process
Agile Guide

**Purpose**: to identify and address leading practices and structural barriers to overcome when implementing Agile methodologies at the agency level and to discuss the relationship of those methodologies to common program control disciplines.

- GAO has established an Agile Expert Panel to review proposed guide chapters and provide input in order to establish an exposure draft
  - To volunteer for the Agile Expert Panel contact Jennie Leotta ([leottaj@gao.gov](mailto:leottaj@gao.gov)) or Mat Bader ([baderm@gao.gov](mailto:baderm@gao.gov))
  - Exposure Draft Goal Date: late FY17/early FY18

- The exposure draft will be released on the GAO website for comment from the general public
Guides - Conclusions

- The GAO Cost Guide, Schedule Guide, and TRA Guide can provide criteria to evaluate many types of large technology-oriented and/or capital acquisition projects.

- Risk assessments such as technology readiness assessments, and independent cost and schedule assessments are often not performed – or are incomplete or lacking in independence, resulting in significant program risk and cost overruns.

- GAO recommendations have been aimed at improving oversight to keep projects on cost and schedule and to risk manage critical technologies in complex acquisitions.

- Programs/projects which do follow the best practices tend to demonstrate greater success in terms of outcomes and resource utilization.
Deeper Dives, Graphics, and Additional Information

BACK UP
Cost Data: Deeper Dive

- The two types of cost data are
  - **Direct costs**: costs that have a direct bearing on the production of goods
  - **Indirect costs**: costs that are typically charged to the company as a whole
- An estimator must understand which historical costs are burdened to avoid double-counting or underestimating

<table>
<thead>
<tr>
<th>Type of cost data</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct (&quot;touch labor&quot;)</td>
<td>Direct manufacturing, engineering, quality assurance, material, training, supplies, related travel</td>
</tr>
<tr>
<td>Indirect costs (&quot;overhead&quot;)</td>
<td>General and administrative support, rent, utilities, insurance, network charges, fringe benefits, leave, retirement, health insurance</td>
</tr>
</tbody>
</table>
Inflation: Deeper Dive

• Inflation is a lack of cost data uniformity that results from upward movement in prices and services over time
  • Example: It is incorrect to compare 1980 costs to costs today without accounting for inflation.

• “Types” of dollars
  • **Constant dollars**: dollars that reflect the reference year’s prices
  • **Current dollars**: dollars that include inflation and should be used to develop the budgets in order to prevent budget shortfalls.

• Analysts use an inflation index to inflate or deflate prices
  • It is important to pick the “market basket” of goods index that most closely matches the costs to be estimated.
Learning Curves: Deeper Dive

- Definition: A learning curve is a CER based on the theory that labor hours per unit decrease over time
  - Repetitive production often results in learning

- The following is the basic Learning Curve Formula:
  - As the quantity of units produced doubles, the amount of effort declines by a constant percentage

\[ Y = ax^b \]

- Cost of the Lot Midpoint
- Cost of the First Unit
- Algebraic Lot Midpoint
- Learning Curve Slope
Sensitivity Analysis: Tornado Chart
# Develop

## Develop Distributions to Model Various Types of Uncertainty

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost Growth Factor</td>
<td>Usually a % increase, based on actual historical data from other programs</td>
</tr>
<tr>
<td>Expert Opinion</td>
<td>Experts get together and quantify the estimate’s uncertainty</td>
</tr>
<tr>
<td>Mathematics</td>
<td>Statistics describe the variance associated with a method to develop probability distributions</td>
</tr>
<tr>
<td>Technology Readiness Levels</td>
<td>Capture the risk associated with developing state-of-the-art technology</td>
</tr>
<tr>
<td>Software Engineering Institute</td>
<td>Framework for assessing an organization’s process disciplines</td>
</tr>
<tr>
<td>Schedule Risk Analysis</td>
<td>Examines the effect of activities and events slipping on a program’s critical path and how the delay will affect program costs</td>
</tr>
</tbody>
</table>
Step 9: Risk and Uncertainty Analysis

S-Curve
Cost Guide Table of Contents

Chapter 1: Characteristics of Credible Cost Estimates and a Reliable Process for Creating Them
Chapter 2: Why Government Programs Need Cost Estimates and the Challenges in Developing Them
Chapter 3: Criteria Related to Cost Estimating, EVM, and Data Reliability
Chapter 4: Cost Analysis Overview
Chapter 5: The Cost estimate’s Purpose, Scope, and Schedule
Chapter 6: The Cost Assessment Team
Chapter 7: Technical Baseline Description Definition and Purpose
Chapter 8: Work Breakdown Structure
Chapter 9: Ground Rules and Assumptions
Chapter 10: Data
Chapter 11: Developing a Point Estimate
Chapter 12: Estimating Software Costs
Chapter 13: Sensitivity Analysis
Chapter 14: Cost Risk and Uncertainty
Chapter 15: Validating the Estimate
Chapter 16: Documenting the Estimate
Chapter 17: Presenting the Estimate to Management
Chapter 18: Managing Program Costs: Planning
Chapter 19: Managing Program Costs: Execution
Chapter 20: Managing Program Costs: Updating
Cone of Uncertainty

Figure 4: Cone of Uncertainty

Uncertainty about cost estimate is high

- Cost estimate baseline
  - Estimate becomes more certain as program progresses
  - Estimate tends to grow over time as risks are realized

- Concept refinement gate
  - Technology development gate
  - Start of program and start of system integration gate

Uncertainty is low
Affordability (Sand Chart)

Figure 5: An Affordability Assessment

Dollars (in billions)

Projected budget

FY1 FY2 FY3 FY4 FY5 FY6 FY7 FY8 FY9 FY10 FY11 FY12 FY13 FY14 FY15 FY16 FY17 FY18 FY19 FY20

- Program A
- Program B
- Program C
- Program D
- Program E
- Program F
- Program G
## Cost Estimating Background

### Different Types of Cost Estimates

<table>
<thead>
<tr>
<th>Life Cycle Cost Estimate</th>
<th>Business Case Analysis</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Independent Cost Estimate (ICE)</td>
<td>Analysis of Alternatives (AOA)</td>
<td>Rough Order of Magnitude (ROM)</td>
</tr>
<tr>
<td>Total Ownership Cost (TOC)</td>
<td>Economic Analysis (EA)</td>
<td>Independent Cost Assessment (ICA)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Independent Government Cost Estimate (IGCE)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Estimate at Completion (EAC)</td>
</tr>
</tbody>
</table>