Introduction to Cost Estimation - Part I

Best Practice Checklists

Best Practice 1: Estimate Purpose and Scope

- ☑ The estimate's purpose is clearly defined
- ☑ The estimate's scope is clearly defined
- ☑ The level of detail the estimate is to be conducted at is consistent with the level of detail available for the program

Best Practice 2: Develop the Estimating Plan

- ☑ The estimating team's composition is commensurate with the assignment
  - The team has the proper number and mix of resources
  - Team members are from a centralized cost-estimating organization
  - The team includes, or has direct access to, analysts experienced in the program's major areas
  - Team members' responsibilities are clearly defined
  - Team members' experience, qualifications, certifications, and training are identified
  - The team participated in on-the-job training, including plant and site visits
- ☑ A schedule with a written study plan has been developed
- ☑ The team has access to the necessary subject matter experts

Best Practice 3: Define the Program

- ☑ There is a technical baseline description that
  - Has been developed by qualified personnel
  - Has been updated with technical, program, and schedule changes
  - Contains sufficient detail of the best available information
  - Contains information that drives the cost estimate and the cost estimating methodology
  - Has been approved by management
  - The technical baseline answers the following questions
  - What the program is supposed to do (requirements)
  - How the program will fulfill its mission (purpose)
  - What it will look like (technical characteristics)
  - Where and how the program will be built (development plan)
  - How the program will be acquired (acquisition strategy)
  - How the program will operate (operational plan)
  - Which characteristics affect cost the most (risk)

Best Practice 4: Determine the Estimating Structure

- ☑ A product-oriented WBS represents the best practice
  - The WBS contains at least 3 levels of indenture
  - It is flexible and tailored for each unique program
  - The 100 percent rule applies—i.e., the sum of the children equals the parent
  - The WBS defines all cost elements and includes all relevant costs
  - In addition to hardware and software elements, the WBS contains common elements to capture all the effort
  - Each system has one program WBS but it may have several contract WBSs that are extended from the program WBS, depending on the number of subcontractors
  - The WBS is standardized so that cost data can be used for estimating future programs
  - It is updated as changes occur and the program becomes better defined
  - It provides for a common language between the government program management office, technical specialists, prime contractors, and subcontractors

- A schedule with a written study plan has been developed
- The team has access to the necessary subject matter experts

☑ The WBS has a dictionary that

- Defines each element and how it relates to others in the hierarchy
- Clearly describes what is and is not included in each element
- Describes resources and processes necessary to produce the element
- Links each element to other relevant technical documents

Best Practice 5: Identify Ground Rules and Assumptions

☑ All ground rules and assumptions have been

- Developed by estimators with input from the technical community
- Based on information in the technical baseline and WBS dictionary
- Vetted and approved by upper management
- Documented to include the rationale behind the assumptions and historical data to back up any claims
- Accompanied by a level of risk of the assumption's failing and its effect on the estimate

☑ Risk and sensitivity analysis can be performed quickly and efficiently on all GR&As

☑ A schedule assessment has been performed to determine its realism

☑ Budget constraints have been clearly defined and the effect of delaying program content has been identified

☑ Peaks and valleys in time-phased budgets have been explained

☑ Inflation index, source, and approval authority are identified

☑ Dependence on participating agencies and the availability of government-furnished equipment have been identified, as have the effects if these assumptions do not hold

☑ Items excluded from the estimate have been documented and explained

☑ If technology maturity was assumed, the estimate addresses the effect of the assumption's failure on cost and schedule

☑ Cost estimators and auditors met with technical staff to determine risk distributions for all assumptions

☑ Management has been briefed, and the results have been documented

Best Practice 6: Obtain Data

- ☑ As the foundation of an estimate, its data
  - Have been gathered from historical actual cost, schedule and program, and technical sources
  - Apply to the program being estimated
  - Have been analyzed for cost drivers
  - Have been collected from primary sources, if possible, and secondary sources as the next best option, especially for cross-checking results
  - Have been adequately documented as to source, content, time, units, assessment of accuracy and reliability, and circumstances affecting the data
  - Have been continually collected, protected, and stored in a database for future use
  - Were assembled as early as possible, so analysts can participate in site visits to understand the program and question data providers
- ☑ Before being used in a cost estimate, the data were
  - Fully reviewed to understand their limitations
  - Segregated into nonrecurring and recurring costs
  - Validated, using historical data as a benchmark for reasonableness
  - Current and found applicable to the program being estimated
  - Analyzed with a scatter plot to determine trends and outliers
  - Analyzed with descriptive statistics
  - Normalized to account for cost and sizing units, mission or application, technology maturity, and content so they are consistent for comparisons
  - Normalized to constant base-year dollars to remove the effects of inflation, and the inflation index was documented and explained

Best Practice 7: Develop the Point Estimate and Compare it to an Independent Cost Estimate

The cost estimator considered various cost estimating methods

- Analogy is used early in the life cycle when little information is known and data is adjusted for new estimate
- Expert opinion is used very early on when estimate can be derived no other way
- The build-up method later, in acquisition, when the scope of work is well defined / WBS complete

- Parametrics used if a sufficient database exists and data has been normalized correctly
- Extrapolating from actual cost data at the start of production
- Before using a CER, the cost estimator
- Examined the underlying data set to understand anomalies
- Checked equations to ensure logical relationships
- Normalized the data
- Ensured that CER inputs were within the valid dataset range
- Checked modeling assumptions to ensure they applied to the program

☑ Learning curve theory was applied if

- Much manual labor was required for production
- Production was continuous or adjustments had to be made
- Items to be produced required complex processes
- Technological change was minimal between production lots
- The contractor's business process was being continually improved
- Production rate and breaks in production were considered

☑ The point estimate was developed by aggregating the WBS element cost estimates by one of the cost estimating methods

☑ Results were checked for accuracy, double-counting, and omissions and were validated with cross-checks and independent cost estimates

Estimating Software:

☑ Software was sized with detailed knowledge of program scope, complexity, and interactions

☑ It was sized with source lines of code, function, object, feature point, or other counts

☑ The software sizing method was appropriate:

- Source lines of code were used if requirements were well defined and if there was a historical database of code counts for similar programs and a standard definition for a line of code
- Function points were used if detailed requirements and specifications were available, software did not contain a lot of algorithmic functions, and an experienced and certified function point counter was available
- Feature points were used instead of function points if the software had a high degree of algorithms

  - Object points were used if computer-aided software engineering tools were used to develop the software
  - Use cases were used if system and user interactions were defined
  - Auto-generated and reused source lines of code were identified separately from new and modified code to account for pre-implementation and post-implementation efforts

☑ Software cost estimates included

  - Development labor costs for coding and testing, other labor supporting software development, and non-labor costs like purchasing hardware and licenses.
  - Productivity factors for converting software size into labor effort, based on historical data and calibrated to match program size and development environment

☑ If no historical data were available, industry average productivity factors and risk ranges were used

☑ Assumptions about productive labor hours in a day and work days in a year

☑ Development schedules accounting for staff availability, prior task dependencies, concurrent and critical path activities, number and length of shifts, overtime allowance, down time, and worker locations

☑ Costs for help desk support and corrective, adaptive, and preventive maintenance as part of the software's life cycle cost

☑ Cost estimators were trained to calibrate parametric tools to match the program

☑ Estimators accounted for integrating commercial off-the-shelf software into the system, including developing custom software and glue-code