Appendix H: Documenting and Presenting the Results

H.1. Introduction

An estimate is not complete until it has been documented and communicated to stakeholders. The primary purpose of the documentation is to capture sufficient information and data that allow the reader to understand the scope and content of the estimate and allow another estimator to recreate the estimate. The documentation also supports the conclusions of the estimate and allows for updates to be made throughout the program or project's life cycle. The value of the estimate can be measured by the degree to which the stakeholders understand the estimate, use the estimate to make informed decisions, and take ownership of the estimate. This can only be accomplished by effectively communicating the results to the stakeholders, answering the questions that initiated the estimate, and bringing to light the cost drivers and risks of the system in question. [1]

The ability to document an estimate and clearly communicate the results is vital to establishing the analyst's credibility and, consequently, the credence of the estimate and supporting analyses. Good documentation and presentation cannot overcome a poor estimating job, but poor documentation can hurt the authority of the analysis and hinder the ability of the estimator to convince management of the data's value. Most managers are supportive of cost estimating because of its inherent importance to overall project feasibility and execution, but some view the results with a skeptical eye since cost estimating is neither a precise science nor an engineering discipline. By ensuring that proper care and thoroughness are integral to documentation and communication, cost analysts have the opportunity (and obligation) to overcome management's skepticism and transform it into constructive discussion and interaction. The key is remembering that credibility is earned, not assumed, and can be achieved only through careful documentation and communication.

The emphasis of this Cost Estimating Handbook (CEH) is on the cost and schedule aspects of a project. However, the temporal aspects are equally important, and they are mutually inseparable. Since 2009, senior NASA leaders have asked the cost/schedule/risk community to answer the following question at Key Decision Point (KDP)-C for each new major undertaking: What is the joint probability of achieving a cost that does not exceed $XX and is completed no later than YYYY? The answer should include relevant aspects of both cost and schedule uncertainty analysis—all applicable risks must be integrated into the documentation package.

This appendix provides guidance on building a solid documentation package; developing presentations for stakeholders and management that clearly communicate the results of the analysis; and using the documentation process to perform an objective, critical assessment of the estimate.

H.2. Documenting the Cost Estimate

The documentation process is an integral part of developing the estimate and confidence level assessment. Documenting the sources of model inputs, the rationale for model settings, and the conversations with design engineers, etc., become the Basis of Estimate (BOE) and form the foundation for communicating the analysis results to the customer and other stakeholders. Having a well-documented BOE makes it easier for the estimator to revise or update the estimate at any point in the future or for another cost analyst to modify the estimate. Good documentation establishes a credible BOE

[1] For more detail on this subject, refer to the Association for the Advancement of Cost Engineering (AACE) International Recommended Practices, No. 34R-05, Cost Estimating and Budgeting—Basis of Estimate, May 2007.

that can facilitate reviews by internal organizations such as the NASA Independent Program Assessment Office (IPAO) and external reviewers such as the Government Accountability Office (GAO).

The elements of a good BOE are simple: anything that has an impact on the estimate should be documented. The easiest way to organize the information is by Work Breakdown Structure (WBS) (or Cost Element Structure [CES]) element. The following list gives examples of the types of information that should be included:

- The name and level of the WBS element.
- The type of WBS element (summation or estimating).
- The model (including version number), analogy, or factor chosen, with rationale.
- If the estimate element is a throughput, the source and rationale for the value.
- The calibration data used (if applicable).
- The source for all model inputs, including rationale and documentation to support judgment-based inputs (such as new design and complexity factors).
- Other information that influenced the estimate (e.g., project schedules, milestones, cost-sharing opportunities).
- Backup information such as Master Equipment Lists (MEL), mass properties estimates, design documentation, or conversations with design engineers or technologists (configuration/version information should be included whenever applicable).

The preferred documentation method is a narrative format augmented with tables, figures, and diagrams. While most estimation work is performed using one or more models and/or Microsoft Excel and presented in PowerPoint, both tools have drawbacks when it comes to performing the primary documentation function. PowerPoint files, model data files, and Excel files all make excellent source documents and backup material for the estimate and should be part of the documentation package. A narrative enables the analyst to bring together all of the documentation into a coherent form that can both explain the BOE and provide references and links to source material.

There are barriers to preparing good BOE documentation. Cost estimators and analysts may find documentation work to be tedious and incorrectly conclude that the results are of limited value, especially if they are still working on the project. In many cases, the analysts or estimators are already starting their next big project while completing the current one, leaving little time to prepare a detailed documentation package.

While these are explanations for not properly documenting the estimate, they are not valid reasons for deciding not to do so. Current NASA policy clearly places the cost estimator in the project approval process. While the cost community welcomes the increased visibility of the cost estimation evaluations, it also opens the community up to increased scrutiny, which emphasizes the need to ensure that estimates are credible, supportable, and defendable. Without adequate, detailed BOE documentation, this work can neither be defended nor can it provide the objective and independent cost-voice the Agency needs. An argument can also be made that by documenting assumptions while building the estimate, analysts are less prone to make mistakes and overlook inconsistencies. While this may add time to the estimating task, it may actually save time when deadlines are imminent.

H.3. Presenting the Cost Estimate

The NASA management culture requires the ability to document the estimate in a well-organized package (combined with good presentation skills). For most studies and analyses, an important element of the

documentation of record is the presentation. Because cost estimation is an inexact science based on historical experiences and subjective judgments, it is vital that the cost estimator prepare a solid presentation package that provides the context and rationale for the estimate in a way that is clearly understood and accepted by the customer and other stakeholders.

It is beyond the scope of the CEH to develop the estimator's presentation skills. NASA offers classes in presentation skills, and every analyst should receive training. However, the CEH does provide the following guidance and recommendations on the content and format of the presentation. For example, the best approach is to develop a presentation that is clear and concise, with sufficient information to ensure that people understand how the results were obtained, but does not incorporate so much detail that the presentation gets bogged down. (Tip: Include the more detailed charts as an appendix.)

The remainder of this section focuses on the content needed to establish the estimate as credible, supportable, and defendable.

H.3.1. Presentation Outline

A typical outline of an estimate presentation includes the following:

- Title Page
- Introduction/Overview/Objectives
- Approach
- Ground Rules and Assumptions (GR&A)
- Cost-Estimate Results (Point, Probabilistic)
- Validation, Sensitivities, Cost-Risk Assessment, and other Analyses
- Findings/Summary/Conclusions

H.3.1.1. Title Page

Every presentation should begin with a title page. At a minimum, the title page should contain a descriptive title, the name of the presenter, and the date of the presentation. Other information that can be shown includes subtitles; to whom the estimate is being delivered; affiliation of the presenter; contact information of the presenter; and names, affiliations, and contact information for other estimators who participated in the estimate.

H.3.1.2. Introduction

The introductory section can cover several topics including an agenda or table of contents, a roster of the estimating team (for a large effort), and an overview or description of the system being estimated. Care should be taken to clearly identify the configuration information of the system along with the description. This information should include the actual design configuration and version number. The introduction should include a description of the intended scope of the estimate, as well as a reference to the date of the source information.

H.3.1.3. Approach

The approach section describes the methods and rationale that the estimator used to perform the estimate, with any limitations from the intended scope of the estimate described. Depending upon the size and complexity of the problem, the approach section can be large or small. Typical content includes the following:

- The estimating WBS (at the appropriate level).
- A flow chart of the estimating process.
- A detailed description of all the models used, the model settings, and the use by each WBS element.
- A model calibration approach, including data used.
- A description of analogy estimates and the adjustment process used for the analysis.
- The throughput costs and sources.
- The key sources of input data used in the estimate.
- For probabilistic estimates, the assumed range and distribution of uncertainties and risks.

Because the level of detail needed to explain an estimating approach can be extensive, backup charts are often used to capture information that either is too detailed for the main body of the presentation or would not be needed for most audiences.

H.3.1.4. GR&A

The GR&A capture the decisions made by the analyst (in consultation with the customer or design team) in performing the estimate. These decisions are often termed engineering judgment, analyst assumptions, or estimating ground rules. Areas addressed by the GR&A include the following:

- The assumptions about the hardware development approach and the amount of systems test hardware.
- The Base Year (BY) dollars of the estimate and inflation factors used.
- The number of flight articles produced.
- The life-cycle content of the estimate.
- The schedules and milestones.
- The contractor labor rates and fee percentage.
- The technology readiness level of key components.
- Any reserve or contingency factors.
- The identification of any elements that are absent or missing (e.g., mission operations costs).

Overlap between the GR&A and the approach section is not uncommon. Key information affecting the estimate, such as the quantities of systems test hardware or the development schedule, can be documented in either (or both) section. It is reserved to the judgment of the estimator to determine how best to present the data.

H.3.1.5. Cost Estimate Results

The cost estimate should be a logical outcome of the approach taken to solve the estimating problem. The estimator must decide on how best to present the results.

- A tabular approach works well for presenting detailed subsystem or component-level costs.
- For showing the cost of several alternative concepts, bar charts make quick comparisons easy.
- Line charts or area charts are good for showing the costs phased over time.

- When showing the cost of several major elements over time, sand charts (or stacked charts) are often used.
- Pie charts are useful for illustrating the composition of a cost estimate.

There are two important criteria for designing the charts in the results section. The first criterion is the level of detail needed for the audience. Generally, the higher the level of management, the less detail is needed in the results. Also, less detail is usually required for an informational briefing versus a review. The second criterion is the point that the analyst (or manager) is trying to make. While the cost estimate itself is usually the point of the presentation, there may be secondary messages that the customer is trying to communicate. For example, the study lead for a technology demonstration mission may want the estimator to highlight the impact of technology maturation on the estimate, or a Launch Vehicle (LV) design team may want to emphasize the effect a legacy design has on reducing the cost. It is incumbent upon the analyst to take these considerations into account when developing the charts, but not become overly influenced to the point where the presentation fails to establish the credibility of the underlying cost estimate.

H.3.1.6. Validation, Sensitivities, Risk Assessment, and Other Analyses

The presentation of any supporting analyses should follow the same general guidelines as the presentation of the primary estimate results. The charts should clearly state the reason for the analysis, the method and approach, any GR&A, and the results. The goal is to present an analysis that is credible, supportable, and defendable. To that end, the analyst should ensure that key details such as supporting data, rationale, and assumptions are readily apparent either in the primary presentation or in backup charts. Sensitivity plots can also be included to demonstrate which assumptions within the estimate drive the results and which allow visualization of the magnitude of variation within those assumptions.

H.3.1.7. Findings/Summary/Conclusions

The final section of the presentation is an opportunity for the estimator to summarize findings or conclusions. The summary/findings/conclusion section does not need to be long—probably only a chart or two. However, it should bring the presentation to a close, provide a logical exit for the estimator, and serve to reinforce the key conclusions.

Sometimes the analyst will use the end of the presentation to present a forward work plan. The forward work plan lists tasks that the analyst has identified as necessary to either complete or improve the estimate. The analyst should be prepared to discuss a time period for completing the tasks when presenting a forward work plan.

H.4. Critical Assessment of the Estimate

Good estimate documentation allows the analyst to perform a critical assessment of the estimate, either individually or with the help of other estimators. A critical assessment is vital to ensure that the estimate is credible, supportable, and defendable. The customers and stakeholders will perform a critical assessment as part of their normal reviews; therefore, by using the documentation to perform a critical assessment prior to presenting the results to customers and stakeholders, the estimator will be prepared with results that stand up under scrutiny.

The easiest approach to performing a critical assessment is to simply question every aspect of the estimate. The better the answers the analyst can provide, the more credible, supportable, and defendable the estimate. Examples of these questions include:

- Does the WBS cover everything that needs to be included in the estimate?
- Why was a particular model chosen?
- What is the basis of the model?
- What was the source of the input data?
- What is the basis of the more subjective inputs?
- How was the model calibrated?
- How were design inheritance and technology maturity handled?
- What was the source of throughput costs?
- How were uncertainty ranges established?
- Were all identified discrete risks included in the estimate?
- How was the estimate validated?
- Are there alternative approaches, methods, models, etc., that would have yielded better results?

Objectively assessing the estimate improves its credibility in four ways. First, it forces the estimator to revisit all assumptions, judgments, models, etc., in order to understand the rationale behind the estimating approach. Second, the objective assessment, especially when performed with help from other cost analysts, will identify areas in the estimate that are either missing or not well supported. Third, it provides a final sanity check to ensure that overall trends and behavior are intuitive within the estimate. Most stakeholders have the experience and intuition to expect certain logical trends within the data (i.e., subsystem X is generally more expensive than subsystem Y), and many will be quick to identify inconsistencies. Some counterintuitive trends may be correct, but the estimator needs to know how to explain them. Lastly, it helps improve the presentation by anticipating other questions that the stakeholders may ask.

By reviewing the estimate, the estimator is better prepared to defend his or her work. Identifying weaknesses in the estimate gives the estimator the opportunity to take corrective action to either fill holes or improve the quality of the estimate. In cases where the estimate is weak for a valid reason, such as lack of data, the analyst will be aware of the weakness and prepare a forward work plan to address those weaknesses. By anticipating potential questions, the analyst can make modifications to the presentation and be prepared to respond to questions from the audience.