



**NAVAL  
POSTGRADUATE  
SCHOOL**

**MONTEREY, CALIFORNIA**

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**JOINT APPLIED PROJECT**

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**Cost Estimating in the Department of Defense and  
Areas for Improvement**

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**By: Shannon McBride  
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September 2010**

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**COST ESTIMATING IN THE DEPARTMENT OF DEFENSE AND AREAS FOR  
IMPROVEMENT**

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Submitted in partial fulfillment of the requirements for the degree of

**MASTER OF SCIENCE IN CONTRACT MANAGEMENT**

from the

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## TABLE OF CONTENTS

|       |                                                                        |    |
|-------|------------------------------------------------------------------------|----|
| I.    | INTRODUCTION.....                                                      | 1  |
| II.   | EVALUATIONS .....                                                      | 3  |
| III.  | TEAM FUNCTIONS, PARTICIPANT INVOLVEMENT.....                           | 11 |
| IV.   | PROCESS .....                                                          | 31 |
|       | A.    STEPS IN DEVELOPING DETAILED INDEPENDENT COST<br>ESTIMATES ..... | 31 |
| V.    | COST ELEMENTS .....                                                    | 39 |
| VI.   | GROUND RULES/ASSUMPTIONS .....                                         | 43 |
| VII.  | PRODUCTION COST ESTIMATION .....                                       | 59 |
| VIII. | DEVELOPMENT COST ESTIMATION .....                                      | 63 |
| IX.   | ENGINEERING SERVICES/TIME AND MATERIAL ESTIMATION .....                | 67 |
| X.    | RECOMMENDATIONS.....                                                   | 71 |
| XI.   | SUMMARY .....                                                          | 77 |
|       | LIST OF REFERENCES .....                                               | 79 |
|       | INITIAL DISTRIBUTION LIST .....                                        | 81 |

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# **COST ESTIMATING IN THE DEPARTMENT OF DEFENSE AND AREAS FOR IMPROVEMENT**

## **ABSTRACT**

The purpose of this Joint Applied Project was to investigate and provide a comprehensive overview of the current process of cost estimation, preparation of Independent Government Cost Estimates, and Technical Evaluation writing practices within the Army Materiel Command, U.S. Army, JM&L Acquisition Center, ARDEC and CECOM. The goal of this project was to identify and document not only the specific types of cost-estimation practices and reports, but also to show the relationships between the IGCE, the Cost Estimation Process, the Request for Proposal (RFP), and the Technical Evaluation. Our purpose was to highlight and prove that the cost-estimation process is the heart of the acquisition process, and that it merges and coordinates the other processes so that the government can obtain the “Best Value” on both its competitive source selections and noncompetitive acquisitions. The reader will come away with a new appreciation for the concept of “Cost as an Independent Variable” after reading this thesis. Treating cost as an independent variable helps to ensure that acquisitions do not go over budget or get wildly out of control. It also contributes to clear thinking and lessens the likelihood of groupthink or “going along with the crowd,” regardless of the consequences. Good cost analysis leads to good cost avoidance or containment, and is a prudent mindset for program officials who are regulated by budgetary constraints and accountable to Congress, and ultimately to the people, for the money they spend. They have good reason to spend it wisely and effectively.

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## LIST OF FIGURES

|           |                                                                                            |    |
|-----------|--------------------------------------------------------------------------------------------|----|
| Figure 1. | The Organization Chart for the JM&L LCMC Acquisition Center at Picatinny Arsenal, NJ ..... | 22 |
|-----------|--------------------------------------------------------------------------------------------|----|

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## LIST OF ACRONYMS AND ABBREVIATIONS

|        |                                                       |
|--------|-------------------------------------------------------|
| ARDEC  | Armament Research, Development and Engineering Center |
| AAA    | Army Audit Agency                                     |
| AMC    | Army Materiel Command                                 |
| BCA    | Business Case Analysis                                |
| CCR    | Central Contractor Registration                       |
| CECOM  | Communications Electronics Command                    |
| CMB    | Configuration Management Boards                       |
| CDRL   | Contract Data Requirements List                       |
| CAIV   | Cost As an Independent Variable                       |
| DCAA   | Defense Contracting Audit Agency                      |
| DCMA   | Defense Contracting Management Agency                 |
| DoD    | Department of Defense                                 |
| DoD IG | Department of Defense Inspecting General              |
| EPA    | Economic Price Adjustment                             |
| FAR    | Federal Acquisition Regulation                        |
| FFP    | Firm Fixed Price                                      |
| FPI    | Fixed Price Incentive                                 |
| GAO    | General Auditing Office                               |
| HCA    | Head of the Contracting Agency                        |
| IGCE   | Independent Government Cost Estimate                  |
| IGE    | Independent Government Estimates                      |
| IPT    | Integrated Process Team                               |
| JM&L   | Joint Munitions and Lethality                         |
| LRIP   | Low Rate Initial Production                           |
| NEC    | Network Enterprise Center                             |
| OCI    | Organizational Conflict of Interest                   |
| PBSOW  | Performance Based Statement of Work                   |
| PD2    | Procurement Desktop 2nd Generation                    |
| PNM    | Post-Negotiation Memorandum                           |

|      |                                   |
|------|-----------------------------------|
| PNO  | Pre-Negotiation Objective         |
| PMO  | Program Management Office         |
| PM   | Project or Product Manager        |
| RFD  | Request for Deviations            |
| RFP  | Request for Proposal              |
| RFW  | Request for Waivers               |
| R&D  | Research and Development          |
| ROM  | Rough-Order-of-Magnitude          |
| TDC  | Technical Drawing Changes         |
| T&M  | Time & Materials                  |
| VECP | Value Engineering Change Proposal |

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## **I. INTRODUCTION**

Defense Acquisitions is an arduous, time consuming and complicated process that requires a wide variety of skills. More importantly, however, numerous steps have to be followed through the acquisition process and the key decision points; important—if not critical—decisions have to be made, any one of which could make or break the total acquisition.

In addition, one cannot leave out the myriad of ethical and legal constraints that govern the acquisition process. This thesis attempts to guide the reader on a tour through the acquisition process, especially from the beginning of the requirement, often before any contract documents are drawn up. Here, the acquisition is in the formative stage of development, and leading towards—but not actually arriving at—the contract execution.

This thesis is designed for ease of reading and is a product of several sources of input, sometimes seemingly disconnected and disperse, but coming together to give the reader an objective, realistic picture of the pitfalls and potholes that may appear in the process of contracting. The reader is presented with proven methods to safeguard the ship through the straights and come out the other side with a contract, or at least the elements of a contract that will ultimately provide the government with its needs at either the lowest cost or the best value, or some combination of the two.

The main thing to keep in mind while reading this study is to begin to understand the thinking, the relationships, and the logic that go into the acquisition and contract formation process, which begin way, way before the contract is let. In addition, the more we understand about what we are getting involved from the very beginning—especially the different motivators of cost, schedule and technical form, fit, and function, along with other factors, such as financial stability of the companies, the economics, labor and management factors—the better position we are in when it comes to avoiding, accepting, changing or mitigating costs, performing trade-offs, and planning long-term or short-term production schedules.

Chapter I begins with what goes into an evaluations and how to evaluate a proposal.

Chapter II outlines the teams, the key players, and the roles.

Chapter III covers the early acquisition process itself and highlights anticipated pitfalls.

Chapters IV, V and VI give insight into the various cost elements and the ground rules for estimating, i.e., legal and organizational constraints.

Chapters VII, VIII and IX discuss types of acquisitions and the various cost estimates that accompany them for production, development or service acquisitions.

## II. EVALUATIONS

All acquisitions require an Independent Government Estimate (IGE), and those acquisitions that are expected to exceed \$100K require that the Independent Government Cost Estimate be certified.

When procuring supplies and/or services greater than the micro-purchase threshold, but less than or equal to the Simplified Acquisition Threshold, a Price Negotiation Objectives/Price Negotiation Memorandum (PNO/PNM) does not have to be prepared, but a Fair and Reasonable Price Determination must be prepared and approved by the Procuring Contracting Officer (PCO). This determination shall be included in the official contract file. **PARC Guidance Memo No. 10-02, 17 May 2010, Documenting Pre-Negotiation Objectives and Price (Post) Negotiation Memorandums**

(Local Policy) FAR 15, 404-1(a) requires contracting officers to ensure that the final contract price is fair and reasonable for all acquisitions through cost analysis. This implies a corresponding cost estimate for all acquisitions (Independent Government Cost Estimates, n.d.).

There are numerous items that will require cost estimating and evaluation activities. They Include:

### Development Acquisitions

- Initial Production Acquisitions
- Full Rate Production Acquisitions
- Services Acquisitions
- Competitive Acquisitions
- Sole Source Acquisitions
- Contract Modifications
- Engineering Changes, Deviations and Waivers
- Value Engineering Changes

- Contract Data Requirements List (CDRL) with applicable Data Item Descriptions
- Product Improvements
- Independent Government Estimates (IGE) and Independent Government Cost Estimates (IGCE)
- Business Case Analyses
- Other Miscellaneous Studies

While all the applications are different and each has some unique characteristics, the principles of Cost Estimating and Evaluation remain primarily the same. Most cost-estimating activities can be grouped into three major categories;

- Production
- Development, and
- Engineering Services or Time & Materials.

**Development Acquisition:** Per Federal Acquisition Regulation (FAR) 35.001, development means “the systematic use of scientific and technical knowledge in the design, development, testing, or evaluation of a potential new product or service (or of an improvement in an existing product or service) to meet specific performance requirements or objectives. It includes the functions of design engineering, prototyping, and engineering testing; it excludes subcontracted technical effort that is for the sole purpose of developing an additional source for an existing product.” When preparing an estimate for this, the “Heavy Hitters” in cost are normally the Engineering Labor, Program Management Functions, and Testing efforts. In the case of Smart Munitions, the Test Hardware Cost can be very significant.

**Initial Production Acquisition:** From the Cost Estimating and Technical Evaluation Handbook for Technical Personnel (Pritchard and Harder, 2009, September), “Initial Production Acquisitions are the first hardware production contracts funded with procurement dollars. These acquisitions are usually characterized by continuing (from development) heavy engineering/production support; and production build-up is often in a “Start-Stop” mode.”

Often, many Engineering Changes take place during this phase so that design and process problems can be remedied; additionally it is a time to straighten out any subcontracting supplier issues.

**Full Rate Production Procurements:** Unlike the Initial Production Phase, the Full Rate Production is characterized by steady production and a greatly reduced engineering support staff. The frequency of engineering changes is diminishing and the change effort is usually focused on cost reduction and improved producibility. The supply chain normally has fewer problems and the number of rejects is reduced. The production process is stable and mature and capable of maximum output.

**Services Acquisition:** Per FAR 37.101, “Service contract means a contract that directly engages the time and effort of a contractor whose primary purpose is to perform an identifiable task rather than to furnish an end item or supply. A service contract may be either a nonpersonal or personal contract. It can also cover services performed by either professional or nonprofessional personnel whether on an individual or organizational basis.” Procuring organizations may have specific tasks in support of a government lab or Program Management Office.

For example, at Picatinny Arsenal, we awarded a Service contract for the provision of Information Technology Service in support of a Program Management Office. The company managed the offices computers, and related services that were not part of the overall base Network Enterprise Center (NEC).

**Competitive Acquisition:** Per FAR 2.101, “Full and Open Competition, when used with respect to a contract action, means that all responsible sources are permitted to compete.” There are other levels of competitive acquisitions, such as full and open after the exclusion of certain sources. This satisfies the government’s socio-economic agenda to encourage maximum participation of government contracts by Small Business, Veteran Owned Small business, Disabled Veteran owned small business and small disadvantage business. See Central Contractor Registration (CCR) <http://www.ccr.gov/> for more information regarding set asides and the different categories of set-asides.

If only one contractor responds to a competitive solicitation, it will continue to be treated procedurally and legally as a competitive acquisition. The reason for this is the presumption of competition. If a presumption of competition can be determined to exist, then any bids received by the single offeror will be treated as competitive. The Contracting Officer must be certain that the one offeror really believed that competition was present and make a determination certifying that this was the case. Otherwise, the procurement could be cancelled or forced to be treated as a sole source acquisition. If the procurement is treated as a single source acquisition, the offeror would have to submit a fully auditable proposal and submit a certificate of current cost and pricing data—after negotiations, but before award.

In accordance with FAR 15.002(b), when contracting in a competitive environment, the procedures of this part are intended to minimize the complexity of the solicitation, the evaluation, and the source selection decision, while maintaining a process designed to foster an impartial and comprehensive evaluation of Offerors' proposals, leading to selection of the proposal representing the Best Value to the government.

**Sole Source Acquisition:** Per FAR 2.101, Sole Source Acquisition means a contract for the purchase of supplies or services that is entered into or proposed to be entered into by an agency after soliciting and negotiating with only one source. This is the opposite situation from a competitive procurement. In this situation, the proposal by the contractor are not under the same competitive pricing pressure that is present in a competitive acquisition where there may be multiple bidders.

In accordance with FAR 15.002(a), “When contracting in a sole source environment, the request for proposal (RFP) should be tailored to remove unnecessary information and requirements; e.g., evaluation criteria and voluminous proposal preparation instructions.”

**Contract Modifications:** Per FAR 2.101, “Contract modification means any written change in the terms of a contract.” It may include schedule, performance, technical enhancements and/or terms and conditions.

**Engineering Changes, Deviations and Waivers:** Any changes to the technical data package are called Engineering Changes and these are normally handled through a Configuration Management System and the associated Configuration Management Board. Most typical in this category are Technical Drawing Changes. Request for Deviations (RFD) and Request for Waivers (RFW) are also handled by Configuration Management Boards. A deviation is a temporary change to the specification or drawing while a waiver is a request to accept already built hardware that is not in conformance to the specification or drawing.

**Value Engineering Changes:** Per FAR 2.101, Value Engineering change proposal “means a proposal that (i) requires a change to the instant contract to implement; and (ii) results in reducing the overall projected cost to the agency without impairing essential functions or characteristics, provided that it does not involve a change (A) in deliverable end item quantities only; (B) in Research and Development (R&D) items or R&D test quantities that are due solely to results of previous testing under the instant contract; or (C) to the contract type only.”

A Value Engineering Change can be initiated by government or contractor personnel.

**Contract Data Requirements List (CDRL):** These are the data items required by the government. Often the individual items are described in Data Item Descriptions (DID) that indicate what is required, when, how often and in what format. Typical examples of these are cost or technical reports.

**Product Improvements:** As stated in the Developmental Acquisition definition, these are “Major changes to an item that may change performance, add a new capability, and/or reduce cost.”

**Independent Government Estimates (IGE) and Independent Government Cost Estimates (IGCE):** These are cost estimates that support procurement actions. They need to be accomplished independent from a contractor and are used to judge the reasonableness of a subsequent contractor(s) proposal(s). An IGE is for acquisitions

anticipated to cost less than \$100,000 and does not require validation by the Cost Analysis Group. An IGCE is required for acquisitions anticipated to exceed \$100,000 and requires validation by the Cost Analysis Group.

**Business Case Analyses:** A Business Case Analysis is commonly used to determine the financial and economic consequences associated with selecting a particular course of action/inaction or between alternative or competing actions.

**Other Miscellaneous Studies:** These are studies conducted for a special purpose outside the normal everyday type of studies or analyses and have some specific research value or use.

In addition to the items above, it is important to know the difference between Cost Analysis and Price Analysis. Per FAR 15.404-1, the definitions are as follows:

**“Cost Analysis** is the review and evaluation of the separate cost elements and profit in an Offeror’s or contractor’s proposal (including cost or pricing data or information other than cost or pricing data) and the application of judgment to determine how well the proposed costs represent what the cost of the contract should be assuming reasonable economy and efficiency.” These elements may include material, labor as well as other direct costs, tooling, etc.

**“Price Analysis** is the process of examining and evaluating a proposed price without evaluating its separate cost elements and proposed profit.” Price analysis involves evaluating a proposal by comparing its bottom line price to competitor’s price or other bottom line price comparisons.

It should be noted that Price Analysis is usually less expensive and quicker than Cost Analysis in determining whether costs are fair and reasonable.

Price Analysis is sufficient when the Contracting Officer determines that any of the following exist:

- Adequate price competition
- Proposed prices are based on established catalog or market prices

- Commercial items are being procured
- Prices are set by law or regulation

Additionally the Contracting Officer may request a waiver of cost or pricing data. This waiver is granted by the head of the contracting agency (HCA) in special cases where the Contracting Officer can use price analysis to determine the cost to be fair and reasonable.

In accordance with FAR 15.305(a)(1), “competition establishes price reasonableness. Therefore, when contracting on a Firm Fixed Price or Fixed Price with Economic Price Adjustment basis, comparison of the proposed prices will usually satisfy the requirement to perform a price analysis, and a cost analysis need not be performed. In limited situations, a Cost Analysis (see 15.403-1(c)(1)(i)(B)) may be appropriate to establish reasonableness of the otherwise successful Offeror’s price.”

When contracting on a Cost Reimbursement basis, evaluations shall include a cost realism analysis to determine what the government should realistically expect to pay for the proposed effort. The Offeror shall demonstrate through their submissions a thorough understanding of the work, and their ability to perform the contract.

**Cost realism analyses** may also be used on Fixed Price Incentive contracts or, in exceptional cases, on other competitive Fixed Price type contracts (see 15.404-1(d)(3)).

The Contracting Officer shall document the cost or price evaluation, stating how prices or costs were determined to be “Fair and Reasonable” (a legal term).

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### **III. TEAM FUNCTIONS, PARTICIPANT INVOLVEMENT**

Cost estimates are developed with an inexact knowledge and only a rough idea as to what the final technical solution will be. Therefore, the cost assessment team must manage a great deal of risk—especially for programs that are highly complex or on technology’s cutting edge.

Since cost estimates seek to define what a given solution will ultimately cost, the estimate must be bound by a multitude of assumptions and an interpretation of what the historical data represent.

This tends to be a subjective effort, and these important decisions are often left to a cost analyst’s judgment. A cost analyst must possess a variety of skills to develop a high-quality cost estimate that satisfies the government’s need.

The following disciplines and concepts apply to Cost Analysis and Estimation, and a good cost analyst should have a working knowledge of the majority of these areas:

- Cost Analysis
- 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
- Accounting
- Cost data analysis
- Financial analysis
- Overhead analysis
- Proposal analysis
- Economics
- Break-even analysis
- Foreign exchange rates
- Industrial base analysis
- Inflation
- Labor agreements
- Present value analysis
- Public and government affairs
- Appropriations process
- Auditors
- Legislative issues
- Outside factors
- Budgeting
- Budget appropriations
- Internal company (industry)
- Program specific

- Interpersonal skills
- Approach
- Estimating knowledge

(Pritchard and Harder, 2009, September).

Each discipline applies to cost estimating in its own unique way. For example, having an understanding of economics and accounting will help the cost estimator better understand the importance of the effect of inflation and the method by which different accounting systems capture costs.

Budgeting knowledge is important for knowing how to properly allocate resources over time so that funds are available when needed.

Because cost estimates are often needed to justify enhancing older systems, having an awareness of engineering, computer science, mathematics, and statistics will help identify cost drivers and the type of data needed to develop the estimate. It also helps for the cost estimator to have adequate technical knowledge when meeting with functional experts so that credibility and a common understanding of the technical aspects of the program can be quickly established.

#### Defending the Cost Estimate:

Finally, cost estimators who are able to “sell” and present their estimate by defending it with solid facts and reliable data stand a better chance of its being used as a basis for program funding. In addition, cost estimators need to have solid interpersonal skills, because working and communicating with subject matter experts is vital for understanding program requirements and for gaining commitment to keep those programs alive and moving forward (Pritchard and Harder, 2009, September).

#### Team Composition and Organization

Program office cost estimates are normally prepared by a multidisciplinary team whose members have functional skills in financial management, engineering, acquisition and logistics, scheduling, and mathematics, in addition to communications. The team

should also include participants or reviewers from the program's operating command, product support center, maintenance depot, and other units affected in a major way by the estimate. Team members might also be drawn from other organizations such as contracting quality, procurement, supply management, or contract management.

In the best case, the estimating team is composed of persons who have experience in estimating all cost elements of the program. Since this is seldom possible, the team leader should be familiar with the team members' capabilities and assign tasks accordingly. If some are experienced in several areas, while others are relatively inexperienced in all areas, the team leader should assign the experienced analysts responsibility for major sections of the estimate while the less experienced analysts work under their supervision. An analytic approach to cost estimates typically entails a written study plan detailing a master schedule of specific tasks, responsible parties, and due dates. For complex efforts, the estimating team might be organized as a formal, integrated product team. For independent estimates, the team might be smaller and less formal. In either case, the analysis should be coordinated with all stakeholders, and the study plan should reflect each team member's responsibilities.

What is required of a cost-estimating team depends on the type and purpose of the estimate and the quantity and quality of the data. More detailed estimates generally require larger teams, more time and effort, and more rigorous techniques. For example, a rough-order-of-magnitude estimate—a quick, high level cost estimates—generally requires less time and effort than a budget-quality estimate. In addition, the estimating team must be given adequate time to develop the estimate.

One of the most time-consuming steps in the cost-estimating process is obtaining the data. Enough time should be scheduled to collect the data, including visiting contractor sites to further understand the strengths and limitations of the data that have been collected. If there is not enough time to develop the estimate, then the schedule

constraint should be clearly identified in the ground rules and assumptions, so that management understands the effect on the estimate's quality and confidence. (Pritchard and Harder, 2009, September).

Schedules are the foundation of the performance plan. Therefore, having a scheduling staff member integrated on the team is critical for validating the plan's reasonableness. A scheduler can determine the feasibility of the proposed schedule by analyzing its durations and making assumptions about the contractor's ability to meet desired schedule outputs.

An independent cost estimate for a major defense acquisition program under 10 U.S.C. § 2434 must be prepared by an office or other entity (such as the Office of the Secretary of Defense Cost Analysis Improvement Group) that is not under the supervision, direction, or control of the military department, defense agency, or other component directly responsible for carrying out the program's development or acquisition. If the decision authority has been delegated to an official of the military department, defense agency, or other DoD component, then the estimate must be prepared by an office or other entity not directly responsible for carrying out the development or acquisition.

Cost estimating requires good organizational skills in order to pull together disparate data for each cost element and to package it in a meaningful way. It also requires engineering and mathematical skills to fully understand the quality of the data available. Excellent communication skills are also important for clarifying the technical aspects of a program with technical specialists. If the program has no technical baseline description, or if the cost-estimating team must develop one, it is essential that the team have access to the subject matter experts—program managers, system and software engineers, test and evaluation analysts—who are familiar with the program or a program like it. The importance of good communication skills among team members cannot be overstated. Experts need to interact in ways that are meaningful and productive.

Cost Estimating Team Best Practices: Centralizing the cost-estimating team and process (cost analysts working in one group but supporting many programs) represents a

best practice in the acquisition field. Our acquisition center at Picatinny operates according to this principle. For acquisitions exceeding 10 million dollars, a mandatory review by the cost/pricing team is required.

Centralization facilitates the use of standardized processes, the identification of resident experts, a better sharing of resources, commonality and consistency of tools and training, more independence, and a career path with more opportunities for advancement. Centralizing cost estimators and other technical and business experts also allows for more effective deployment of technical and business skills while ensuring some measure of independence.

A good example is in the Cost Analysis Improvement Group (CAIG) in the Office of the Secretary of Defense. Its cost estimates are produced by a centralized group of civilian government personnel to ensure long-term institutional knowledge and no bias toward results. Some in the cost-estimating community consider a centralized cost department that provides cost support to multiple program offices, with a strong organizational structure and support from its leadership, to be an appropriate model for success.

Decentralization often results in ad hoc processes, limited government resources (requiring contractor support to fill the gaps), and decreased independence, since program offices typically fund an effort and since program management personnel typically rate the analysts' performance.

The major advantage of a decentralized process is that analysts have better access to technical experts. Under a centralized process, analysts should thus make every effort to establish contacts with appropriate technical experts.

“Finally, organizations that develop their own centralized cost-estimating function but outside the acquiring program represent the best practice rather than organizations that develop their cost estimates in a decentralized or ad hoc manner under the direct control of a program office.” (Pritchard and Harder, 2009, September).

The Picatinny Acquisition Center has a pricing group on the contracting side of the house. The program offices utilize either personnel within the program office itself or else employ the appropriate engineer in Armament Research Development Center (ARDEC) to prepare the Government Cost Estimate.

From what I have observed on the various acquisitions I've been assigned to, the cost estimate as well as the technical evaluation has been done by the program manager or his representative or someone from the ARDEC engineering team.

The PM team has the responsibility of preparing the requirements package and accompanying documents and is also responsible for producing credible cost estimates, learning curves, material, labor, burden, travel etc. ARDEC engineers and technical members are part of the Integrated Process Team (IPT) and serve the program manager by coming up with technical specifications, CDRLs, shipping and packaging requirements, quality requirements, and testing requirements.

One of the many benefits of centralized structure is the ability to resist pressure to lower the cost estimate when it is higher than the allotted budget. Furthermore, reliance on support contractors raises questions from the cost-estimating community about whether numbers and qualifications of government personnel are sufficient to provide oversight of and insight into contractor cost estimates. Other experts in cost estimating suggested that reliance on support contractors can be a problem if the government cannot evaluate how good a cost estimate is or if the ability to track it is lacking. Studies have also raised the concern that relying on support contractors makes it more difficult to retain institutional knowledge and instill accountability.

It would seem from the above that there is very good reason to retain in house cost estimating technicians/practitioners because relying on outsiders to prepare cost estimates make the government dependent to continue retaining and paying these contractors and also the government does not gain the necessary institutional knowledge of this essential skill. This is similar to the way the government keeps, on its pay roll, a full and robust legal department to cover any legal contingencies. The legal department proactively keeps the government from becoming entangled in legal disputes and claims,

common sense would dictate that keeping on staff people who are highly qualified in the discipline of cost estimation makes good economic sense.

In order to mitigate any bias in the cost estimate, government customers of contractor-produced cost estimates must have a high enough level of experience to determine whether the cost estimate conforms to best practices.

The bias that could occur when contractor's prepare estimates is that they would tend to estimate according to what they are used to providing in the way of proposals; there is an unstated interest in keeping prices and cost high so as to maintain, and not degrade, profits and margins. This scenario is also representative of an organizational conflict of interest (OCI), which is further detailed in FAR 9.5. where?

There are a number of Players and Organizations in the Cost Estimating and Evaluation process. The principal ones are as follows:

- Contractor
- Technical Evaluator (Engineer)
- Price/Cost Analyst
- Defense Contracting Audit Agency (DCAA)
- Defense Contracting Management Agency (DCMA)
- Contracting Office
- Legal
- Management or Project or Product Manager (PM)
- Auditors (General Auditing Office (GAO), Department of Defense Inspecting General (DoD IG), Army Audit Agency (AAA), etc.)

The following is an examination of the role that each of the above players performs in the Cost Estimating and Analysis Phase:

Contractor: This is the entity that prepares an offer or proposal. This is most often a team effort involving a number of different skills and functional areas. Typically, there is a single Point of Contact who may be an individual within the Contractor's contracting organization.

Technical Evaluator (Engineer): The Contracting Officer may request that personnel having specialized knowledge, skills, experience, or capability in engineering, science, or management perform a technical analysis of the proposed types and quantities of materials, labor hours and elements, processes, special tooling, facilities, the reasonableness of scrap and spoilage, and other associated factors set forth in the proposal(s) in order to determine the need for and reasonableness of the proposed resources, assuming reasonable economy and efficiency. The Technical Evaluation team is made up of government personnel who have been assigned to perform the technical analysis. These individuals may also be involved in the preparation of the acquisition package containing the IGE or IGCE.

Price/Cost Analyst: The Price/Cost Analyst is an individual who is assigned to develop the government position based on input received from both the technical assessment and the audit report. The Price/Cost Analyst will add the recommended labor rates, overhead rates, general and administrative rates and prepare an overall government assessment. This individual also works closely with DCAA and utilizes their recommended audit reports. This individual also performs a cost realism analysis by independently reviewing and evaluating specific elements of each Offeror's proposed cost estimate to determine whether the estimated proposed cost elements are realistic for the work to be performed; reflect a clear understanding of the requirements; and are consistent with the unique methods of performance and materials described in the Offeror's technical proposal. This is performed on cost-reimbursement contracts to determine the probable cost of performance for each Offeror.

For acquisitions higher than ~\$10 million, there is a mandatory hand-off to the core pricing group. We also seek help from DCMA and DCAA for preaward certifications and surveys, desk audits or forward-pricing rate agreements.

For lesser-valued acquisitions than \$10 million, the core pricing group will help out when available.

Cost Analysis Group: This is the group of individuals who validate IGCEs and provides guidance on inflation indices and other cost areas. In addition, they are the source for “average contractor rates” and perform many other cost analysis tasks.

Defense Contract Audit Agency (DCAA): The DCAA audits the contractor’s cost records and coordinates the government position among multiple Armed Services (Army, Marines, Navy, and Air Force). The Contracting Officer may contact the responsible DCAA audit office directly, particularly when an audit is the only field pricing support required. Often an auditor is assigned to a large company and handles all government audits for that company. When unsure of the auditor’s identity, an e-mail to the DCAA regional office or contact with the DCMA office can quickly uncover the proper contact to request the cost/pricing or desk audit. The audit office staff will send the audit report, or otherwise transmit the audit recommendations, directly to the Contracting Officer. They can provide valuable input for cost evaluations and estimates.

Defense Contract Management Agency (DCMA): The DCMA is an office that performs assigned post-award functions related to the administration of contracts and assigned preaward functions. The office is commonly located at the contractor’s plant or in a regional office nearby. The organization could include an Administrative Contracting Officer (ACO) and various specialty engineers, inspectors and other subject matter experts. They can provide valuable input for cost evaluations and estimates.

Per FAR 42.1701, the DCMA contract administration agency field office shall determine whether a Forward Pricing Rate Agreement (FPRA) will be established. It may be requested by the Contracting Officer, the contractor, or initiated by the ACO.

The mission of DCMA is as follows: (Taken from DCMA’s Web site)

The Defense Contract Management Agency (DCMA) is the Department of Defense (DoD) component that works directly with Defense suppliers to help ensure that DoD, Federal, and allied government supplies and services are delivered on time, at projected cost, and meet all performance requirements. DCMA directly contributes to the military readiness of the United States and its allies, and helps preserve the nation's freedom.

DCMA professionals serve as "information brokers" and in-plant representatives for military, Federal, and allied government buying agencies—both during the initial stages of the acquisition cycle and throughout the life of the resulting contracts.

Before contract award, DCMA provides advice and services to help construct effective solicitations, identify potential risks, select the most capable contractors, perform technical evaluations, perform preaward surveys, and provides pricing support that meet the needs of our customers in DoD, Federal and allied government agencies.

After contract award, DCMA monitors contractors' performance and management systems to ensure that cost, product performance, and delivery schedules are in compliance with the terms and conditions of the contracts.

Contracting Office: Per FAR 2.101, the contracting office “means an office that awards or executes a contract for supplies or services and performs post-award functions not assigned to a contract administration office.” The office is a multi-functional entity of Contracting Officers, Contract Specialists, and Price/Cost Analysts. A Contracting Officer “means a person with the authority to enter into, administer, and/or terminate contracts and make related determinations and findings. The term includes certain authorized representatives of the Contracting Officer acting within the limits of their authority as delegated by the Contracting Officer.”

- Note: The Contracting Officer is the sole individual authorized to bind the government contractually.

The Contract Specialist (or Contracting Officer) is responsible for initiation of the Contractor Performance Assessment Report (CPAR). Once the initial contractual information is inputted, the Contracting Specialist or Contracting Officer will notify the Acquisition Analyst or Technical point of contact to input their assessment of the contractor's performance into the system. The CPAR database is useful in evaluating past performance during best value source selections.

The Picatinny JM&L LCMC Acquisition Center organization chart is inserted below.

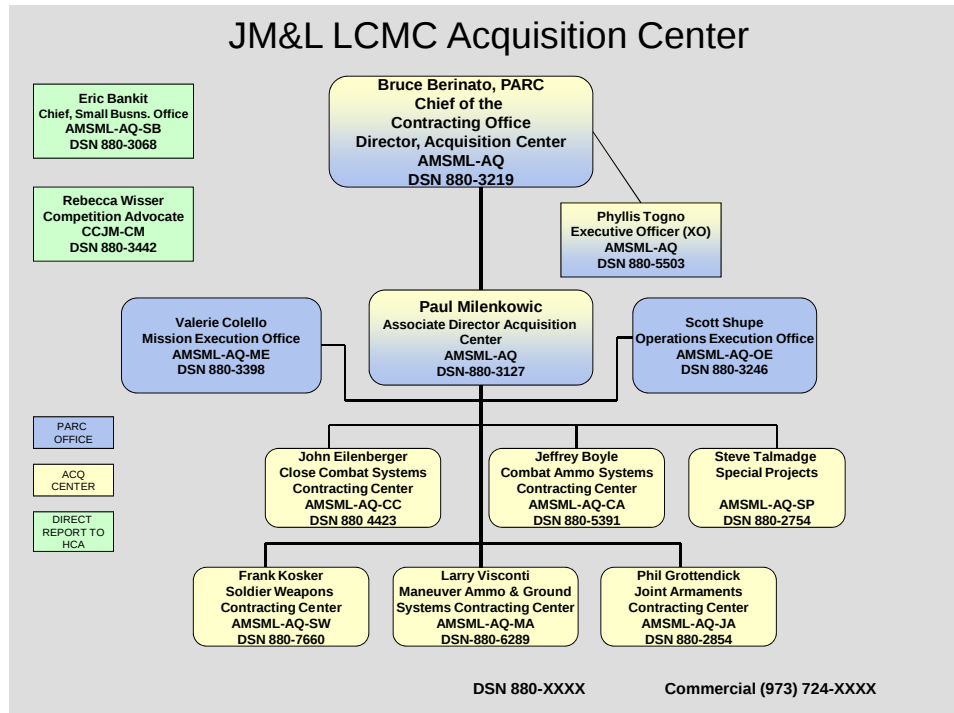


Figure 1. The Organization Chart for the JM&L LCMC Acquisition Center at Picatinny Arsenal, NJ

Legal: The Legal group reviews all proposed contract documents prior to agreement with contractors. Their level of involvement increases with competitive procurement actions.

Every solicitation and award document with few exceptions is reviewed by the legal staff to ensure compliance with applicable laws and regulations. Many modifications and contract letters are also reviewed to protect the government's interests. Legal also gets involved with source selections, reviewing documents to make sure they are legal, ethical and fair, so as to help the government avoid protests—or at least not suffer financial loss in the event of a protest.

The Picatinny Arsenal Legal Office NEED A CITATION provides the following services with respect to contracts, review of contracts and related documents:

**MISSION:** To provide legal services and advice involving the administration and execution of acquisition programs at Picatinny and the use of appropriated and non-appropriated funds thereof.

**FUNCTIONS:**

(a) Provide Legal Advice in the following areas:

- (1) Acquisition laws, procurement regulations such as FAR, DFARS, AFARs and local procurement regulations, procedures and policies.
- (2) Contract matters such as invitations for bid, requests for proposals/quotations; negotiations, evaluation of offers and proposed awards; contract provisions and special contract clauses, deviations from regulations; contract modifications, including change of name agreements; approvals of award; acquisition plans and strategy reports.
- (3) Contract types such as services contracts, facilities contracts, small purchase procedures, IT procurement, and indemnification against extra hazardous risks.
- (4) Special research and development problems such as proposal evaluation and source selection, grants, other transactions and cooperative agreements, and procurements of scientific and technical knowledge.
- (5) Test service agreements and other selling arrangements.
- (6) Contract terminations and settlement agreements, including acquisition and disposal of termination inventory.
- (7) Conflicts of interest involving organizations as distinguished from personal conflicts of interest.
- (8) Interdepartmental, interservice, and interagency transactions, including Economy Act Determinations.
- (9) Contract financing, including advance payment, progress payments, and assignment of claims.
- (10) Contract cost and pricing matters, allow ability of costs, price redetermination, and truth in negotiation act matters.
- (11) Performance, payment and other bonds, consent of surety, insurance, and indebtedness.

- (12) Availability, obligation, and disbursement of appropriated funds.
  - (13) External audit reports of General Accounting Office, Army Audit Agency, Office of Management and Budget, and other fiscal and business reports.
  - (14) Activities under various statutes relating to procurement such as the Freedom of Information Act.
  - (15) Debarment and suspension of bidders.
- b. Control, coordinate, and evaluate all protests against award and mistake in bid matters concerning Picatinny site solicitations and contracts.
  - c. Provide legal assistance to all active and retired military personnel and their dependents respecting personal legal problems.
  - d. Review delegations of authority to the Commander of RDECOM-ARDEC, and re-delegations thereof.
  - e. Provide legal advice to the Program Executive Office (PEO) for Ammunition, as well as to the Program Executive Officer (PEO) for Ground Combat Systems, and Program Executive Officer (PEO) Soldier; provides legal advice to the PEOs on all acquisition matters concerning programs within the PEOs assigned mission area. This mission area includes all programs falling within the purview of PM Unit of Action-LSI, PM Joint Lightweight Howitzer, PM Close Combat Systems (CCS), PM Combat Ammunition Systems (CAS), PM Maneuver Ammunition Systems (MAS), PM Soldier Weapon and PM Joint Services.

Management / PM: This is the management chain of any of the evaluator's organization (Project Manager, Product Manager, Labs, etc.). They may be involved in reviewing the assessment and/or estimate activities and reports. They may also give guidance and request status reports and reviews.

The Close Combat Services group at Picatinny provides contracting and acquisition support to the Close Combat Services (CCS) Program Management Office, a subset of Program Executive Office, Ammunition or PEO Ammo.

The mission of CCS is as follows:

PM CCS Overview:

We are developing a broad set of capabilities to deal with and quickly adapt to, the full spectrum of challenges we will face. Our forces are becoming more powerful, more flexible, and more deployable.—from the 2007 Army Posture Statement

Project Manager Close Combat Systems (PM CCS) is committed to helping our warfighters maintain freedom to move on the battlefield by developing, fielding and supporting technologically advanced capability in the following mission areas:

Networked Munitions

Intelligent Munitions System

Countermine

Improvised Explosive Device Defeat

Demolitions

Non-Lethal Systems and Munitions

Grenades

Pyrotechnics (Flares, Simulators and Signals)

Shoulder Launched Munitions

Explosive Ordnance Disposal Equipment

Special Projects (for SOCOM)

PM CCS manages over 200 separate programs that meet Army Transformation goals of providing smaller, lighter, more lethal munitions that will ensure increased mobility and counter mobility to the full spectrum of Army forces as currently organized and envisioned for the next 20 years. PM CCS' strategy crosswalks needed capabilities with technologies available, resulting in a roadmap for the Transformation.

PM CCS also has an aggressive, in-stride modernization strategy that applies acquisition reform and product modernization principles to its management of newly assigned legacy munitions—some decades old. Using performance specifications, best value competition and active partnering between government and contractor personnel on Integrated Product Teams, PM CCS is qualifying updated ammunition designs, materials and production technologies while maintaining timely munitions delivery to multi-service customers.

The PM was established in 1961 as the Project Manager for Mines, Countermines and Demolitions. In 2002, the PM became Project Manager Close Combat Systems, part

of the newly established PEO Ammunition and assumed responsibility for the life-cycle management of several new product lines in addition to munitions already under management.

Auditors: These are organizations and individuals that are external to the organization and may audit the program at both the government and contractor sites. Among these are the GAO, the DoD IG, and the AAA.

Typically, in a large dollar acquisition, we request a comprehensive audit from Defense Contract Audit Agency (DCAA) on all proposed subcontracting, direct labor rates, overhead rates, indirect rates, forward pricing rate agreements, etc.

The DCAA mission is to:

1. Perform all necessary contract audits for DoD and provide accounting and financial advisory services regarding contracts and subcontracts to all DoD components responsible for procurement and contract administration. These services are to be provided in connection with the negotiation, administration, and settlement of contracts and subcontracts.
2. Provide contract audit services to other government agencies as appropriate.
3. DCAA consists of six major organizational components: a Headquarters and five regions. The five regional offices manage more than 300 Field Audit Offices (FAO) and sub offices located throughout the United States and overseas. A FAO is identified as either a branch office or a resident office. Sub offices are established by regional directors as extensions of FAOs when required to furnish contract audit service more economically. A sub office is dependent on its parent FAO for release of audit reports and other administrative support.

Headquarters is located at the Headquarters Complex, Fort Belvoir, VA. Principal elements of Headquarters are the Director, Deputy Director, Executive Officer, Special Assistant for Quality, General Counsel (Defense Legal Services), and the Assistant Directors for Operations, Policy and Plans, and Resources.

Regional offices are located in Irving, TX; Smyrna, GA; Philadelphia, PA; Lowell, MA; and La Mirada, CA. The regions direct and administer the accomplishment of the DCAA audit mission for assigned geographical areas; manage personnel and resources assigned to the regions; manage the contract audit program; and direct the operation of FAOs within their region. Principal elements of regional offices are the Regional Director, Deputy Regional Director, and Special Assistant to the Regional Director for Quality, Regional Audit Managers, Regional Special Programs Manager, and Regional Resources Manager.

A resident office is established at a contractor's location when the audit workload justifies the assignment of a permanent staff of auditors and support staff.

A branch office is established at a strategically situated location within the region, and is responsible for performing all contract audit service within the assigned geographical area, exclusive of contract audit service performed by a resident or liaison office within the area.

A DCAA liaison office is established at a DoD procurement or contract administration office to provide effective communication and coordination among procurement, contract administration, and contract audit elements.

DCAA provides a wide variety of products and services to contracting officers:

Preaward Contract Audit Services

- Price Proposals
- Preaward Surveys
- Forward Pricing Labor & Overhead Rates
- Postaward Contract Audit Services
- Incurred Costs/Annual Overhead Rates
- Truth in Negotiation Act Compliance
- CAS (Cost Accounting Standards) Compliance & Adequacy
- Claims
- Financial Capability
- Contractor Internal Control System Audits
- Accounting
- Estimating
- EDP (Electronic Data Processing)
- Compensation
- Billing
- Budgeting
- Material Management
- Labor
- Purchasing
- Indirect and Other Direct Cost

In addition to performing formal audit activities, Agency auditors provide:

Negotiation Assistance, including:

- Fact-finding and analysis of contractor information after audit
- Procurement liaison assistance

In FY 2008, DCAA audited \$138 billion of costs incurred on contracts and reviewed 8,113 forward pricing proposals amounting to \$313 billion. Approximately \$3.3 billion in net savings were reported as a result of audit findings. When compared to the \$470 million expended for the Agency's operations, the return on taxpayers' investment in DCAA was approximately \$7.00 for each dollar invested.

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## **IV. PROCESS**

### **A. STEPS IN DEVELOPING DETAILED INDEPENDENT COST ESTIMATES**

Detailed cost estimates are sometimes required by the Contracting Officer, depending upon the circumstances of the particular acquisition. Usually the more complex the acquisition, and the higher the potential dollar value, the more need to anticipate and estimate the costs involved. It can be a determining factor in contract type selection as well as an overall determining factor in whether the effort will be successful.

The following step-by-step procedures may be used in developing detailed cost estimates.

Here are the basic steps in the development of the IGCE.

1. Divide the effort into identifiable tasks or logical steps.
2. List the categories of labor that will be required in each task or step (e.g., clerical, engineer, research scientists, etc.). In a “level of effort” acquisition, it is necessary to identify, in as much detail as possible, the categories of expertise desired and the training and experience that will be required for each category. This will yield a more accurate estimate.
3. Estimate the per-hour cost of each category of labor.
4. Estimate the total number of hours for each labor category, by task.
5. Multiply the number of hours in each category by the estimate of time required. This will yield the estimated direct labor costs.
6. Estimate the amount and type of materials and supplies that will be required and the cost of each.
7. Identify any other elements of direct cost that the acquisition may require, such as consultant services, computer rentals, etc., and estimate the cost of these.

8. Estimate the travel requirements, if any. Identify the designation, the number of people involved, the length of each trip, and the total cost of this travel in terms of both transportation and per diem.
9. If subcontracting is expected, identify the tasks to be subcontracted and estimate the cost.
10. Estimate the amount of overhead that will be charged.
11. When all of this information has been collected, a detailed cost estimate can be prepared.

Key to developing a credible estimate is having an adequate understanding of the acquisition program—the acquisition strategy, technical definition, characteristics, system design features, and technologies to be included in its design. The cost estimator can use this information to identify the technical and program parameters that will bind the cost estimate. The amount of information gathered directly affects the overall quality and flexibility of the estimate. Less information means more assumptions must be made, increasing the risk associated with the estimate. Therefore, the importance of this step must be emphasized, because the final accuracy of the cost estimate depends on how well the program is defined.

The objective of the technical baseline is to provide in a single document a common definition of the program—including a detailed technical, program, and schedule description of the system—from which all Life Cycle Cost Estimates will be derived—that is, program and independent cost estimates. At times, the information in the technical baseline will drive or facilitate the use of a particular estimating approach.

However, the technical baseline should be flexible enough to accommodate a variety of estimating methodologies. It is also critical that the technical baseline contain no cost data, so that it can be used as the common baseline for independently developed estimates. In addition to providing a comprehensive program description, the technical baseline is used to benchmark life-cycle costs and identify specific technical and program risks. In this way, it helps the estimator focus on areas or issues that could have a major cost effect.

In general, program offices are responsible for developing and maintaining the technical baseline throughout the life cycle, since they know the most about their program. A best practice is to assign an integrated team of various experts—system engineers, design experts, schedulers, test and evaluation experts, financial managers, and cost estimators—to develop the technical baseline at the beginning of the project. The program manager and the senior executive oversight committee approve the technical baseline to ensure that it contains all information necessary to define the program's systems and develop the cost estimate.

Furthermore, the technical baseline should be updated in preparation for program reviews, milestone decisions, and major program changes. The credibility of the cost estimate will suffer if the technical baseline is not maintained. Without explicit documentation of the basis of a program's estimates, it is difficult to update the cost estimate and provide a verifiable trace to a new cost baseline as key assumptions change during the course of the program's life.

A work breakdown structure (WBS) is the cornerstone of every program because it defines in detail the work necessary to accomplish a program's objectives. For example, a typical WBS reflects the requirements, what must be accomplished to develop a program, and provides a basis for identifying resources and tasks for developing a program cost estimate. A WBS is also a valuable communication tool between systems engineering, program management, and other functional organizations because it provides a clear picture of what needs to be accomplished and how the work will be done. Accordingly, it is an essential element for identifying activities in a program's integrated master schedule. In addition, it provides a consistent framework for planning and assigning responsibility for the work. Initially set up when the program is established, the WBS becomes successively detailed over time as more information becomes known about the program.

A WBS is a necessary program management tool because it provides a basic framework for a variety of related activities like estimating costs, developing schedules, identifying resources, determining where risks may occur, and providing the means for

measuring program status using Earned Value Management (EVM). Furthermore, a well-structured WBS helps promote accountability by identifying work products that are independent of one another. It also provides the framework to develop a schedule and cost plan that can easily track technical accomplishments—in terms of resources spent in relation to the plan, as well as completion of activities and tasks—enabling quick identification of cost and schedule variances.

The Picatinny Acquisition guidebook had this to say about Work Breakdown Structures:

A WBS deconstructs a program's end product into successive levels with smaller specific elements until the work is subdivided to a level suitable for management control. By breaking work down into smaller elements, management can more easily plan and schedule the program's activities and assign responsibility for the work. It also facilitates establishing a schedule, cost, and EVM baseline. Establishing a product oriented WBS is a best practice because it allows a program to track cost and schedule by defined deliverables, such as a hardware or software component. This allows a program manager to more precisely identify which components are causing cost or schedule overruns and to more effectively mitigate the root cause of the overruns. A WBS breaks down product-oriented elements into a hierarchical structure that shows how elements relate to one another as well as to the overall end product. A 100 percent rule is followed that states that "the next level of decomposition of a WBS element (child level) must represent 100 percent of the work applicable to the next higher (parent) element." This is considered a best practice by many experts in cost estimating, because a product-oriented WBS following the 100 percent rule ensures that all costs for all deliverables are identified. Failing to include all work for all deliverables can lead to schedule delays and subsequent cost increases. It can also result in confusion among team members. To avoid these problems, standardizing the WBS is a best practice in organizations where there is a set of program types that are standard and typical. This enables an organization to simplify the development of the top-level program work breakdown structures by publishing the standard. It also facilitates an organization's ability to collect and share data from common WBS elements among many programs. The more data that are available for creating the cost estimate, the higher the confidence level will be.

Its hierarchical nature allows the WBS to logically sum the lower-level elements that support the measuring of cost, schedule, and technical analysis in an EVM system. A good WBS clearly defines the logical relationship of all program elements and provides a systematic and standardized way for collecting data across all programs. Therefore, a WBS is an essential part of developing a program's cost estimate and enhancing an agency's ability to collect data necessary to support future cost estimates. Moreover, when appropriately integrated with systems engineering, cost estimating, EVM, and risk management, a WBS provides the basis to allow program managers to have a better view into a program's status, facilitating continual improvement.

A WBS is developed and maintained by a systems engineering process that produces a product-oriented family tree of hardware, software, services, data, and facilities. It can be thought of as an illustration of what work will be accomplished to satisfy a program's requirements. The WBS diagrams the effort in small discrete pieces, or elements, to show how each one relates to the others and to the program as a whole. These elements such as hardware, software, and data are further broken down into specific lower level elements. The lowest level of the WBS is defined as the work package level.

The number of levels for a WBS varies from program to program and depends on a program's complexity and risk. Work breakdown structures need to be expanded to a level of detail that is sufficient for planning and successfully managing the full scope of work.

Each WBS should, at the very least, include three levels.

The first level represents the program as a whole and therefore contains only one element—the program's name.

The second level contains the major program segments, and;

Level three contains the lower-level components or subsystems for each segment.

All effort of technical and functional activities associated with the design, development, and production of mating surfaces, structures, equipment, parts, materials, and software required to assemble level 3 equipment (hardware and software) elements into level 2 mission equipment (hardware and software).

When following the product-oriented best practice, there should not be WBS elements for various functional activities like design engineering, logistics, risk, or quality, because these efforts should be embedded in each activity.

System engineering: The technical and management efforts of directing and controlling a totally integrated engineering effort of a system or program.

Program management: The process of managing several related projects, often with the intention of improving an organization's performance. In practice and in its aims it is often closely related to Systems engineering.

Training Deliverable: The end item or knowledge which the learner should have acquired as a result of the training given.

Data: The term data means groups of information that represent the qualitative or quantitative attributes of a variable or set of variables. Data (plural of "datum," which is seldom used) are typically the results of measurements and can be the basis of graphs, images, or observations of a set of variables. Data are often viewed as the lowest level of abstraction from which information and knowledge are derived. (Wiki)

System test and evaluation: The use of prototype, production, or specifically fabricated hardware and software to obtain or validate engineering data on the performance of the system in developing program (in DoD, normally funded from research, development, test, and evaluation appropriations); also includes all effort associated with design and production of models, specimens, fixtures, and instrumentation in support of the system-level test program.

Peculiar support equipment: Equipment uniquely needed to support the program: vehicles, equipment, tools, and the like to fuel, service, transport, hoist, repair, overhaul, assemble and disassemble, test, inspect, or otherwise maintain mission equipment, as well as equipment or software required to maintain or modify the software portions of the system.

Common support equipment: Equipment not unique to the program and available in inventory for use by many programs.

Operational and site activation: Installation of mission and support equipment in the operations or support facilities and complete system checkout or shakedown to ensure operational status; may include real estate, construction, conversion, utilities, and equipment to provide all facilities needed to house, service, and launch prime mission equipment.

Facilities: Includes construction, conversion, or expansion of existing industrial facilities for production, inventory, and contractor depot maintenance required as a result of the specific system Initial spares and repair parts Includes the deliverable spare components, assemblies, and subassemblies used for initial replacement purposes in the materiel system equipment end item

Therefore, in addition to having a product-oriented WBS for the prime mission equipment that breaks down the physical pieces of, for example, an aircraft, information technology system, or satellite, the WBS should include these common elements to ensure that all effort is identified at the outset. This, in turn, will facilitate planning and managing the overall effort, since the WBS should be the starting point for developing the detailed schedule.

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## V. COST ELEMENTS

A contractor's proposal may be a voluminous document, but it normally includes a Cost Breakout as part of the submission. In this manner, the contractor is not only giving the government their price for the product or service; they are also providing the details that make up that Price. Note that some types of competitive procurements may have price only, with no cost breakout based on the nature of the procurement.

Cost breakouts may vary somewhat depending upon the preparer, but most follow a general type "build-up" format.

The elements of material, labor and other direct costs are usually shown first, followed by the burden costs (Overhead (O/H) and General and Administrative (G&A)) and Profit.

In addition to this "Top Level" breakout, the contractor may also supply more detailed breakouts as follows:

- By year (either fiscal or calendar) of performance.
- By quantities and/or options
- By Work Breakdown Structure (WBS)
- By Subcontractor
- By Facility (if more than one facility is involved)

These break-outs are also useful to track back to see how the individual Basis of Estimate (BOE) totals up or not and possibly spot a discrepancy in the contractor's submission. BOE is the contractor's back-up information relating to a particular section or element of a proposal and is given to justify labor hours, material dollars, other direct costs, etc.

There are some other terms that may appear in the proposal itself or in the supporting data:

- Recurring Costs and Non-recurring Costs
- Fixed Costs and Variable Costs

Recurring Costs are repetitive costs that vary with the quantity being produced such as production line workers and purchased parts that go into each end item.

Examples of Recurring Costs:

- “Touch Labor” (fabrication, assembly and touch)
- Production support labor (includes quality, production control, industrial and production engineering, etc.)
- Consumable tooling (tool bits that wear out)
- Lot Acceptance Testing
- Consumable supplies (paint, adhesives, etc.)
- Consumable (perishable) tooling such as tool bits
- Data requirements (CDRLs: technical, program and financial)

Recurring, but declining due to program maturity:

- Program Management
- System Engineering
- Quality Engineering including reliability and test support
- Technical engineering support
- Data requirements (CDRL’s: technical, program and financial)

Non-Recurring Costs are costs that normally occur only once in the life cycle of a process activity or work output such as tooling.

Non-Recurring examples:

- First Article Test
- Specific Engineering Changes
- Permanent Tooling
- Facility Improvements and modifications
- Special Test Equipment and Acceptance Test Equipment
- Failure Investigations
- Cost Reduction Actions
- Parts obsolescence (specific actions)
- Specific Individual one – time tasks
- Non-Recurring Engineering (NRE)
- Individual producibility efforts
- Engineering labor to handle a “one time” project or event

Fixed Costs are costs that do not vary with the volume of business. Examples are taxes, insurance, and certain utilities, etc rent, electricity, heating, air conditioning.

Variable Costs are costs that do change based on the rate of production or performance of services. Payroll taxes for production line workers are an example of this type of cost. The amount of material changes bases upon how many units you are producing.

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## **VI. GROUND RULES/ASSUMPTIONS**

Dr. Joseph Lannon director of ARDEC at Picatinny related in a personal interview that, “he prefers to practice a policy of cost avoidance as opposed to cost containment or assumption.” What I think he meant by that comment was that sometimes we need to avoid costs as an initial strategy. Often acquisition planners and contracting officers are not proactive enough to ward off costs up front and rather than avoid cost and risk we assume them without realizing it and by the time we realize if we ever do, it is too late at that point. The risk and cost has already been transferred from the contractor to the government and we never even realized it.

Dr. Lannon’s approach is not quite as easy as it sounds. Nevertheless, the key here is recognition and awareness when we as government buyers are taking on costs and risks. The shifting of cost and risk is almost automatic and unless we realize what is going on, and bring it up during negotiations, the contractor is not going to say anything. We would all like contractors to take their fair share of the costs and risks involved with doing business with the government and helping to make sure that the success of government programs and spending is a shared one. However, we cannot trust the contractor to do anything other than look out for its own interests.

We also need to think in terms of not only how to limit costs or risk mitigation but to actually start out right at the beginning seeing if the assumptions about cost are correct and if in fact some of the costs that we assume are the government’s responsibility could be avoided altogether (i.e., don’t pick up costs or risks we don’t have to).

Working in acquisitions has taught me that upfront planning and a realistic assessment of costs and risks go a long way towards not only managing them when they do occur but in helping to make sure that costs and risks are shared fairly and responsibly between the contractor and the government.

We simply cannot leave it to the contractors to estimate every cost and anticipate every contingency. If we do that, we will end up with many modifications and paying out far more than we even imagined. Furthermore, it is our job as contracting and program management specialists to make sure that unnecessary cost and risks are avoided upfront whenever possible so that we have a balanced and fair partnership between contracting parties.

I think that Dr. Lannon would agree with our position as far as the fact that costs are real and risk is real, and how we plan for, estimate for and account for determines how prepared we are to handle those events should they indeed occur.

Cost estimates are typically based on limited information and therefore need to be bound by the constraints that make estimating possible. These constraints usually take the form of assumptions that bind the estimate's scope, establishing baseline conditions the estimate will be built from. Because of the many unknowns, cost analysts must create a series of statements that define the conditions the estimate is to be based on. These statements are usually made in the form of ground rules and assumptions (GR&A).

By reviewing the technical baseline and discussing the GR&A's with customers early in the cost estimating process, analysts can flush out any potential misunderstandings.

#### GR&As:

1. Satisfy requirements for key program decision points; what are the key milestones, deliveries, performance parameters?
2. Answer detailed and probing questions from oversight groups; is the contractor able to provide detailed answers that provide clarity on costs?
3. How complete and professional is the estimate? Is it easy to work with, ex. In excel so that data can be manipulated easily.
4. Is there sufficient breakdown of work and costs?
5. Are overhead costs explained and tied to meaningful, relevant cost drivers?

6. Does the estimate look and sound believable and reasonable for what is to be delivered/performed?
7. Are the estimating data and techniques useful to other cost estimators, is the cost estimate a shining example of a good cost estimate or is it a messy, hair pulling nightmare?
8. Can estimate be reconstructed once the original estimators are no longer available?
9. Does cost estimate provide insight and breadth about the work to be done as well as the risks involved and how they can be dealt with and eventually resolved?

Ground rules and assumptions are similar and are often grouped together yet they are slightly different and distinct from one another in the following ways:

Ground rules represent a common set of agreed on estimating standards that provide guidance and minimize conflicts in definitions.

When conditions are directed, they become the ground rules by which the team will conduct the estimate. The technical baseline requirements represent cost estimate ground rules.

Therefore, a comprehensive technical baseline should provide the analyst with all the necessary ground rules for conducting the estimate. After all, if the technical baseline cannot be met, why are we contracting out this work? Perhaps we should go back to the drawing board or find a contractor who is capable of doing the work. Any contractor who does not demonstrate an ability to conform to the technical baseline is usually eliminated from consideration for award. It does not mean the contractor is of no value and may be of use in some sort of developmental effort or pure research and development, outsourced services. However, if we are looking at a mature baseline or at least a clearly defined one, then one of the starting ground rules is that the contractor has been or should have been qualified to meet the basic standards or requirements that will be necessary to provide the deliverable or provide the service at an acceptable level of quality.

In less complex acquisitions, it is up to the technical and contracting team to do a technical evaluation to determine the rating that the offeror will receive on the source selection factors, thus determining whether or not that offeror is considered for award or eliminated from the competition since other offerors are more highly rated. This is the case in a best value source selection where price is one, but not the only factor involved in the final selection.

This leads us into the next topic, assumptions.

## **Assumptions**

Without firm ground rules, the analyst is responsible for making assumptions that allow the estimate to proceed. In other words, assumptions are required only where no ground rules have been provided.

Assumptions represent a set of judgments about past, present, or future conditions postulated as true in the absence of positive proof. The analyst must ensure that assumptions are not arbitrary, that they are founded on expert judgments rendered by experienced program and technical personnel.

Many assumptions profoundly influence cost; the subsequent rejection of even a single assumption by management could invalidate many aspects of the estimate.

Therefore, it is imperative that cost estimators brief management and document all assumptions well, so that management fully understands the conditions the estimate was structured on. Failing to do so can lead to overly optimistic assumptions that heavily influence the overall cost estimate which, in turn can lead to cost overruns, and what we wind up with in the end is inaccurate estimates and budgets and ultimately, loss of control.

## Global and Element-Specific Ground Rules and Assumptions

GR&As can be either global or element specific.

Global GR&As apply to the entire estimate; element-specific GR&As are driven by each WBS element's detailed requirements.

GR&As are more pronounced for estimates in the development phase, where there are more unknowns; they become less prominent as the program moves through development into production.

While each program has a unique set of GR&As, some are general enough that each estimate should address them. For example, each estimate should at a minimum define the following global GR&As:

- Program schedule.
- Cost limitations (for example, unstable funding stream or staff constraints), high-level time phasing, base year, labor rates, inflation indexes, participating agency support, and government furnished property and equipment.
- Overhead rates and what they are based upon.
- Travel requirements.
- Type and number of reports, data requirements.
- Place of performance.
- Hours of operation, number of shifts, etc.
- Deliverables, quantities, locations.
- Shipping instructions
- Marking and packaging requirements.

Government furnished property and equipment can also be an assumption and is not always a ground rule.

On the use of government furnished property and equipment the FAR says the following:

### **45.102—Policy**

- (a) Contractors are ordinarily required to furnish all property necessary to perform government contracts.
- (b) Contracting officers shall provide property to contractors only when it is clearly demonstrated—
  - (1) To be in the government's best interest;
  - (2) That the overall benefit to the acquisition significantly outweighs the increased cost of administration, including ultimate property disposal;
  - (3) That providing the property does not substantially increase the government's assumption of risk; and
  - (4) That government requirements cannot otherwise be met.
- (c) The contractor's inability or unwillingness to supply its own resources is not sufficient reason for the furnishing or acquisition of property.
- (d) *Exception.* Property provided to contractors for repair or overhaul is not subject to the requirements of paragraph (b) of this section.

### **45.103—General**

- (a) Agencies shall—
  - (1) Allow and encourage contractors to use voluntary consensus standards (see FAR [11.101\(b\)](#)) and industry-leading practices and standards to manage government property in their possession;
  - (2) Eliminate to the maximum practical extent any competitive advantage a prospective contractor may have by using government property;
  - (3) Ensure maximum practical reutilization of contractor inventory for government purposes;

- (4) Require contractors to use government property already in their possession to the maximum extent practical in performing government contracts;
  - (5) Charge appropriate rentals when the property is authorized for use on other than a rent-free basis; and
  - (6) Require contractors to justify retaining government property not needed for contract performance and to declare property as excess when no longer needed for contract performance.
- (b) Agencies will not generally require contractors to establish property management systems that are separate from a contractor's established procedures, practices, and systems used to account for and manage contractor-owned property.

#### **45.104—Responsibility and Liability for Government Property**

- (a) Generally, contractors are not held liable for loss, damage, destruction, or theft of government property under the following types of contracts:
- (1) Cost-reimbursement contracts.
  - (2) Time-and-material contracts.
  - (3) Labor-hour contracts.
  - (4) Fixed-price contracts awarded on the basis of submission of cost or pricing data.
- (b) The contracting officer may revoke the government's assumption of risk when the property administrator determines that the contractor's property management practices are inadequate and/or present an undue risk to the government.
- (c) A prime contractor that provides government property to a subcontractor shall not be relieved of any responsibility to the government that the prime contractor may have under the terms of the prime contract.

## SUBPART 45.2 -- SOLICITATION AND EVALUATION PROCEDURES

### **45.201—Solicitation**

(a) The contracting officer shall insert a listing of the government property to be offered in all solicitations where government-furnished property is anticipated (see [45.102](http://farsite.hill.af.mil/reghtml/regs/far2afmcfars/fardfars/far/45.htm#P33_5722)), [http://farsite.hill.af.mil/reghtml/regs/far2afmcfars/fardfars/far/45.htm#P33\\_5722](http://farsite.hill.af.mil/reghtml/regs/far2afmcfars/fardfars/far/45.htm#P33_5722)

The listing shall include at a minimum—

- (1) The name, part number and description, manufacturer, model number, and National Stock Number (if needed for additional item identification tracking and/or disposition);
- (2) Quantity/unit of measure;
- (3) Unit acquisition cost;
- (4) Unique-item identifier or equivalent (if available and necessary for individual item tracking); and
- (5) A statement as to whether the property is to be furnished in an “as-is” condition and instructions for physical inspection.

(b) When government property is offered for use in a competitive acquisition, solicitations should specify that the contractor is responsible for all costs related to making the property available for use, such as payment of all transportation, installation or rehabilitation costs.

(c) The solicitation shall describe the evaluation procedures to be followed, including rental charges or equivalents and other costs or savings to be evaluated, and shall require all offerors to submit the following information with their offers—

- (1) A list or description of all government property that the offeror or its subcontractors propose to use on a rent-free basis. The list shall identify the accountable contract under which the property is held and the authorization for its use (from the contracting officer having cognizance of the property);

- (2) The dates during which the property will be available for use (including the first, last, and all intervening months) and, for any property that will be used concurrently in performing two or more contracts, the amounts of the respective uses in sufficient detail to support prorating the rent;
  - (3) The amount of rent that would otherwise be charged in accordance with FAR [52.245-9](#), Use and Charges; and
  - (4) The voluntary consensus standard or industry leading practices and standards to be used in the management of government property, or existing property management plans, methods, practices, or procedures for accounting for property.
- (d) When use of property on more than one contract is anticipated, any additional instructions to the contractor regarding property management, accountability, and use, not addressed in FAR clause [52.245-1](#), government property, should be specifically addressed in the statement of work on the contract providing property.

#### **45.202—Evaluation Procedures**

- (a) The contracting officer shall consider any potentially unfair competitive advantage that may result from the contractor possessing government property. This shall be done by adjusting the offers by applying, for evaluation purposes only, a rental equivalent evaluation factor.
- (b) The contracting officer shall ensure the offeror's property management plans, methods, practices, or procedures for accounting for property are consistent with the requirements of the solicitation.

Principles and Laws that apply when authorizing GFP listed below:

### **SUBPART 45.3—AUTHORIZING THE USE AND RENTAL OF GOVERNMENT PROPERTY**

#### **45.301—Use and Rental**

This subpart prescribes policies and procedures for contractor use and rental of government property.

(a) Government property shall normally be provided on a rent-free basis in performance of the contract under which it is accountable or otherwise authorized.

(b) Rental charges, to the extent authorized do not apply to government property that is left in place or installed on contractor-owned property for mobilization or future government production purposes; however, rental charges shall apply to that portion of property or its capacity used for nongovernment commercial purposes or otherwise authorized for use.

(c) The contracting officer cognizant of the government property may authorize the rent-free use of property in the possession of nonprofit organizations when used for research, development, or educational work and—

- (1) The use of the property is in the national interest;
- (2) The property will not be used for the direct benefit of a profit-making organization; and
- (3) The government receives some direct benefit, such as rights to use the results of the work without charge, from its use.

(d) In exchange for consideration as determined by the cognizant contracting officer(s), the contractor may use government property under fixed-price contracts other than the contract to which it is accountable. When, after contract award, a contractor requests the use of government property, the contracting officer shall obtain a fair rental or other adequate consideration if use is authorized.

(e) The cognizant contracting officer(s) may authorize the use of government property on a rent-free basis on a cost type government contract other than the contract to which it is accountable.

(f) In exchange for consideration as determined by the cognizant contracting officer, the contractor may use government property for commercial use. Prior approval of the Head of the Contracting Activity is required where non-government use is expected to exceed 25 percent of the total use of government and commercial work performed.

One of the most important GR&As is to define a realistic schedule. It may be difficult to perform an in-depth schedule assessment early to uncover the frequent optimism in initial program schedules. Ideally, members from manufacturing and the technical community should be involved in developing the program schedule, but often information is insufficient and assumptions must be made. In this case, it is important that this GR&A outline the confidence the team has in the ability to achieve the schedule so that it can be documented and presented to management.

One major challenge in setting realistic schedules is that the completion date is often set by external factors outside the control of the program office before any analysis has been performed to determine whether it is feasible.

Another predominant problem is that schedule risk is often ignored or not analyzed—or when it is analyzed, the analysis is biased. This can occur on the government (customer) or contractor side or both. Risk analysis conducted by a group independent of the project manager has a better chance of being unbiased than one conducted by the program manager.

However, it should also be noted that many organizations are not mature enough to acknowledge or to apply program schedule or cost risk realism because of the possible repercussions. For example, a contractor may be less likely to identify schedule or cost risk if it fears negative reaction from the customer. Likewise, the customer may be unwilling to report cost or schedule risk from fear that the program could be canceled.

So what we see from the above is that both the contractor and customer have incentives that affect both cost and schedule risk, but little or no power to change anything that impacts them. Therefore, there is no motivation by either party to really debate and discuss as they are both fearful of losing their market share/contract/program. This is something to be aware of as these issues are often not discussed since neither side has much if any control and would be wary to bring them up and discuss them.

Sometimes, management imposes cost limitations because of budget constraints. The GR&A should then clearly explain the limitation and how it affects the estimate. Usually, cost limitations are handled by delaying program content or by a funding shortfall if program content cannot be delayed. In many cases, such actions will both delay the program and increase its final delivered cost. Either way, management needs to be fully apprised of how this GR&A affects the estimate.

Estimates are time phased because program costs usually span many years. Time phasing spreads a program's expected costs over the years in which they are anticipated to aid in developing a proper budget.

Depending on the activities in the schedule for each year, some years may have more costs than others. Great peaks or valleys in annual funding should be investigated and explained, however, since staffing is difficult to manage with such variations from one year to another. Anomalies are easily discovered when the estimate is time phased. Cost limitations can also affect an estimate's time phasing, if there are budget constraints for a given fiscal year. Additionally, changes in program priority will affect funding and timing—often a program starts with high priority but that priority erodes as it proceeds, causing original plans to be modified and resulting in later delivery and higher cost to the government. These conditions should be addressed by the estimate and their effects adequately explained.

Programs are estimated and tracked by the base year. The base year is used as a constant dollar reference point to track program cost growth. Expressing an estimate in base year dollars removes the effects of economic inflation and allows for comparing separate estimates “apples to apples.” Thus, a global ground rule is to define the base year dollars that the estimate will be presented in and the inflation index that will be used to convert the base year costs into then-year dollars that include inflation. At a minimum, the inflation index, source, and approval authority should be clearly explained in the estimate documentation. Escalation rates should be standardized across similar programs,

since they are all conducted in the same economic environment, and priority choices between them should not hinge on different assumptions about what is essentially an economic scenario common to all programs.

Some programs result from two or more agencies joining together to achieve common program goals. When this happens, agreements should lay out each agency's area of responsibility. An agency's failing to meet its responsibility could affect the program's cost and schedule. In the GR&A section, these conditions should be highlighted to ensure that management is firmly aware that the success of the estimate depends on the participation of other agencies.

Equipment that the government agrees to provide to a contractor can range from common supply items to complex electronic components to newly developed engines for aircraft. Because the estimator cannot predict whether deliveries of such equipment will be timely, assumptions are usually made that it will be available when needed. It is important that the estimate reflect the items that it assumes government will furnish, so that the risk to the estimate if items are delayed can be modeled and presented to management. In general, schedules represent delivery of material from external sources, including the government, with date-constrained milestones. A better approach is to include the supplier's work to produce the product by a summary activity in the schedule, examine the possibility of delayed delivery, include that risk in a schedule risk analysis, and monitor the work of the supplier as the date approaches.

In addition to global GR&As, estimate-specific GR&As should be tailored for each program, including:

- life-cycle phases and operations concept;
- maintenance concepts;
- acquisition strategy, including competition, single or dual sourcing, and contract or incentive type;
- industrial base viability;

- quantities for development, production, and spare and repair parts;
- use of existing facilities, including any modifications or new construction;
- savings for new ways of doing business; example, value engineering proposals;
- commonality or design inheritance assumptions;
- technology assumptions and new technology to be developed;
- technology refresh cycles;
- security considerations that may affect cost; and
- items specifically excluded from the estimate.

The cost estimator should work with members from the technical community to tailor these specific GR&As to the program. Information from the technical baseline and WBS dictionary help determine some of these GR&As, like quantities and technology assumptions. The element-specific GR&As carry the most risk and therefore should be checked for realism and should be well documented in order for the estimate to be considered credible.

### Assumptions, Sensitivity, and Risk Analysis

Uncertainty is a part of every estimate mainly because of the assumptions that must be made about future projections and outcomes.

Sensitivity analyses examine how changes to key assumptions and inputs affect the estimate and help to mitigate uncertainty by understanding where the critical change elements lie and understanding how they affect outcomes.

Best practice cost models incorporate the ability to perform sensitivity analyses without altering the model so that the effect of varying inputs can be quickly determined. For example, suppose a decision maker challenges the assumption that 5 percent of the installed equipment will be needed for spares, asking that the factor be raised to 10

percent. A sensitivity analysis would show the cost impact of this change. A cost model should be in a format that allows for different variables, ex. Time, percentages, cost elements, materials to be switched around, adjusted without changing the model. This way, the estimate can try out different scenarios and based upon the level of risk ranging from ultra conservative to moderately or high risk.

Try analyzing an estimate with various levels of time, risk, etc. Try validating such estimates and see how the outcomes are changed by moving various variables around. Such analyses can often provide management with an invaluable perspective on its decision making. Figure out what elements are the major cost drivers in different cost estimates and see how by adjusting different variables the cost estimate can be better tailored to meet the requirement of the acquisition strategy.

In addition to sensitivity analysis, factors that will affect the program's cost, schedule, or technical status should be clearly identified, including political, organizational, or business issues. Because assumptions themselves can vary, they should always be inputs to program risk analyses of cost and schedule. A typical approach to risk analysis emphasizes the breadth of factors that may be uncertain. In a risk identification exercise, the goal is to identify all potential risks stemming from a broad range of sources. A good starting point would be to examine the program's risk management database to determine which WBS elements these risks could affect. Another option would be to examine risks identified during a program's integrated baseline review—a risk based assessment of the program plan to see whether the requirements can be met within cost and schedule assumptions.

Regardless of what method is used to identify risk, it is important that more than just cost, schedule, and technical risks are examined. For example, budget and funding risks, as well as risks associated with start-up activities, staffing, and organizational issues, should also be considered. Risks from all sources such as external, internal organizational, financial/budget, political and even project management practices, in addition to the technical challenges, need to be addressed.

Well-supported assumptions should include documentation of an assumption's source and should discuss any weaknesses or risks. Solid assumptions are measurable and specific. For example, an assumption that states "transaction volume will average 500,000 per month and is expected to grow at an annual rate of 5 percent" is measurable and specific, while "transaction volumes will grow greatly over the next 5 years" is not as helpful. Provide as much detail as possible so that cost estimators can perform risk and sensitivity analysis to quantify the effects of changes in assumptions.

Assumptions should be realistic and valid. This means that historical data should back them up to minimize uncertainty and risk. Understanding the level of certainty around an estimate is imperative to knowing whether to keep or discard an assumption. Assumptions tend to be less certain earlier in a program, and become more reliable as more information is known about them. A best practice is to place all assumptions in a single spreadsheet tab so that risk and sensitivity analysis can be performed efficiently and effectively. Explicit assumptions should be available and verifiable. However, implicit assumptions should be recognized and accounted for as well.

Certain scenarios should always be tested for risk. For example, the effects of the program schedule's slipping on both cost and schedule should always be modeled and the results presented to management. This is especially important if the schedule was known to be aggressive or was not assessed for realism.

Too often, when schedules are compressed, for instance to satisfy a potential requirements gap, the optimism in the schedule does not hold and the result is greater costs and schedule delays.

## **VII. PRODUCTION COST ESTIMATION**

Production Cost Estimating has some significant differences depending upon whether it is Low Rate Initial Production (LRIP), which may also be referred to as Initial Production or Full Rate Production (FRP), which may be referred to as Mature Production.

LRIP may have some “carry-over” characteristics of Development. These include Design Engineering support and various Non-Recurring Costs. FRP contracts are normally Fixed Price Contracts; however, LRIP Contracts may be some form of a Cost Type Contract if it is of a complex nature.

The largest cost elements in production contracts are typically Material, Labor and Overhead, and to a lesser expense, General and Administrative expenses (G&A).

Production Material can include Subcontractor Material, Purchased Parts, and Raw Material.

Production Labor normally includes Direct Labor, sometimes known as “Touch Labor,” and Support Labor. Direct Labor is the “hands-on” labor to fabricate, assemble, and test the item. Support Labor is the labor that directly supports the Direct Labor and the production process. Some typical categories of this labor are Production Control, Quality Assurance, and Production Engineering. Supervision of labor may be a Direct Charge included in the labor category or could be included in an Overhead Account (not directly charged).

Overhead is the supervisor’s salaries that are allocated to the individual projects, the lighting, electricity, depreciation of equipment used in the manufacturing process, the rents, and other expense of running the business.

The official definition of overhead is, “The operating expenses of a business, including the costs of rent, utilities, interior decoration, and taxes, exclusive of labor and materials.”

The company’s Disclosure Statement will indicate how supervision is charged and accounted for.

The definition of G&A is, “general and administrative expense (G&A) and includes money spent in operating a business (rent, salaries, telephone charges, etc.) that is not directly associated with production of goods or services.”

In preparing production cost estimates or analyzing a contractor’s production proposal, it is helpful to gather as much of the following data as possible:

- Production Delivery Schedule
- Technical Data Package (Drawings)
- Sequence of Production Operations
- Test, Inspection, and Quality Requirements
- Listing of subcontractors and their involvement
- Equipment requirements
- Government Furnished Equipment (GFE)
- Subcontract Proposal, Purchase Orders, and Quotes
- Basis of Estimates (BOE)

**Material Estimating:** A material listing or Bill of Material (BOM) should be the starting place for analyzing the material cost of a proposal. You should follow the estimating and analysis techniques shown in Chapter 10A, Material Section.

Special attention should be given to the major subcontractors since they may represent a large portion of the overall cost (often averaging between 25 to 40% of the total cost). You may need to scrutinize this material cost as closely as the Prime

Contractor. This may require additional scrutiny by looking below the top-line subcontractor material entry into the next tier breakout of the subcontractor's labor, material cost, and other cost elements. If this breakout (to include the BOE) did not come with the Prime Contractor's Proposal, request it immediately for your analysis.

**Labor Estimating:** Estimating labor requirements in a production contract may differ depending upon whether it is an initial or a mature production effort. An initial production effort can be quite different from a mature production effort. Below are some of the differences:

Initial Production may have a "carry-over" of Design Engineers to handle start up difficulties and address any design issues and failure analysis that may be required.

- There may be higher levels of support labor such as Quality Assurance, Production Control, and Manufacturing Engineering.
- There is often more rework and production workers are in the "start up" phase of the learning curve.
- Subcontractors may also have start up problems before settling into rate production.
- There may be more intensive testing than recurring production, i.e., First Article Testing.
- More Non-recurring costs such as tooling.

Engineering and Support Labor for production contracts are estimated on a time basis, i.e., monthly while Direct Labor (Touch Labor) is on a unit basis such as 10 minutes per projectile.

**Data Requirements:** The starting point in analyzing the cost of Data Items is the requirement. First, become familiar with the government's requirement for the individual data elements. Usually, that is found in the Contract Data Requirement List (CDRL). This CDRL lists each of the data elements that the government is requesting of the contractor and/or subcontractors. For each of these CDRL elements, there is usually a Data Item

Description (DID) document. The DID gives a detailed description of what is required, when required, and the frequency (i.e., once, quarterly, monthly, etc.).

First step in evaluating a CDRL item is to determine the frequency of the report. Common periods are a single report during the contract period, an initial and final, quarterly and monthly. Or, it may be only “as required,” i.e., a Safety Incident Report.

To determine the labor hours required to support these reports, realize that setting up the report for the initial time is the most time consuming. Subsequent reporting should be considerably less. Repetitive cycles or contracts should further reduce the labor hours. Realize that many of these people are multi-tasked and are not dedicated just to these tasks. Also, much of the data comes from automated reports thereby reducing workload.

**Proposal Preparation Costs:** Proposal preparation costs vary depending on the complexity and dollar amount of the proposal. Complex high-dollar value proposals can cost as much as One Million Dollars or more to prepare. Realize also that with competitive procurements, proposal preparation costs are normally an overhead charge (Bid and Proposal (B&P) Account), not a direct charge. For direct charge proposals, analyze the contractor’s hours and types of skills on the proposal preparation tasks. This is normally an intense adhoc team effort over a short time frame. Analyze the hours to be sure they are consistent with the timeframe and the individual tasks. Be aware some or all of these costs may be actuals when you are reviewing the proposal. Check with the Contract Specialist or Contracting Officer for more data on actuals that are not provided in the proposal. Note also that the contractors must reveal how they charge this effort (direct or indirect) in their disclosure statement.

There are additional areas that might be relevant in a production contract such as Tooling. Special tooling may need to be purchased in order to produce a certain item or shape in the manufacturing process for that unique, non-commercial item in which case the contractor will present the costs for that tooling and any replacement costs throughout the contract life to the government for reimbursement.

## VIII. DEVELOPMENT COST ESTIMATION

Analyzing or estimating development costs have several differences from those involved with production. Development Programs historically have been some variation of a cost type contract, while established production programs are normally Fixed Price.

Production estimates are centered on the item's manufacture and its support. That is only one element of the development program. Typically, Development Programs have a considerable amount of test (both components and end items). The schedule is a big cost driver, and there may be numerous cycles of testing, followed by remediation and then further testing until the results are satisfactory. Engineering Labor cost is usually a significant element of this cycle. The fabrication of prototype hardware for test is another cost element. Highly specialized test equipment/hardware is significantly more expensive than the type of equipment or facilities needed to test conventional ammo items or systems.

In preparing development cost estimates or analyzing a contractor's development proposal, it is helpful to gather as much of the following data as possible:

- Development Schedule (the more detail the better)
- Hardware Description
- Contract deliverables (quantities and type)
- Detailed Testing Plan
- Test requirements
- Hardware requirements
- Equipment requirements
- Government Furnished Property and Equipment

Material Estimating: A material listing or BOM should be the starting place for analyzing the material cost of a proposal. There are several important differences between material costs used for production and those used for development.

Development hardware quantities are always less than production quantities and that reflects in a higher unit costs. While this may not be significant for common Commercial-Off-The-Shelf (COTS) parts, such as fasteners and standard electronic components; it does become very significant for many custom parts and subcontract items. Inefficiencies due to lower quantities and higher fixed costs associated with small quantities drive up the unit hardware prices in development. In addition, the quantities may even be smaller for selected hardware items since often the test hardware is of different configurations.

Special attention should be given to the major subcontractors since they may represent a large portion of the overall cost (often averaging between 25 to 40% of the total cost). Because of this fact, you may need to scrutinize this material cost as closely as the Prime Contractor looking below the top line subcontractor material entry into the next tier breakout of labor, the subcontractor's material cost, and other cost elements. If this breakout (to include the BOE) did not come with the Prime Contractor's Proposal, request it immediately for your analysis.

Labor Estimating: Estimating labor requirements in a Development contract is somewhat different than used for production. Some of the differences are as follows:

Fabrication of hardware may be performed by skilled technicians or professional staff at higher labor rates rather than by lower rate production workers.

Tooling may be lower cost soft tooling with lower production capacity and a shorter useful life. Also inspection equipment may need to be upgraded to meet higher rates of production.

Engineering labor heavily weighted towards Design and System Engineers.

Documentation requirements are usually much greater, with a focus on comparing data with the base line or what was originally planned and deemed to be an acceptable performance level.

Prior to analyzing the proposal, refresh yourself with the SOW or SOO with its associated Performance Specifications and review the overall Program Schedule as well

as the Test Schedule if appropriate. If using a SOO or Performance Based Statement of Work (PBSOW), make sure you closely review the resultant Performance Work Statement (PWS) submitted by the contractor with his Quality Assurance Surveillance Plan (QASP).

The first task is to evaluate the contractor's BOE justification. If the description of the task is vague or only described at a "top level," ask for a more detailed break out and justification. Looking at the individual work elements; are they relevant to the SOW, do they appear to be reasonable, and do they support the overall schedule (on occasion a contractor will propose hours that could not be expended before the event milestone)? In breaking out the individual tasks you can put them in perspective and ask: Is two weeks reasonable for this task? Remember in evaluating test oriented tasks that some of the events may need repetition depending on the test results and this may need to be factored in.

Realize also that 2,000 hours of engineering labor, whether senior or junior or other, in whatever category it falls under, certainly does not represent a single engineer working one year. It could also be two engineers each working a half year or four engineers getting the task done in three months or any other feasible combination. In evaluating labor hours, the category of the labor is also important. For example, a contractor may have its engineers listed as:

- Engineer 1 Senior Engineer (Highest Pay Scale)
- Engineer 2 Engineer (Middle Pay Scale)
- Engineer 3 Junior Engineer (Lowest Pay Scale)

Most development contracts would use a mix of these engineers, it is important that your analysis address this labor category breakout. As a starting point, consider 50% of engineering at the middle level with 25% at the senior and 25% at the junior category.

This is not a hard and fast rule by any means, but if the contractor is showing 80 to 90% as Senior Engineers across the spectrum of tasks that should be challenged.

Realize, however, that individual tasks may require more or less of these labor categories based on their content. It should be noted that if testing is involved, it may be performed at the Contractor's or government's facilities. If performed at a government facility, this testing cost is normally directly funded by the government. Prior to analyzing the proposal, refresh yourself with the SOW; review the overall Program Schedule, and the Test Schedule, if appropriate. The contractor may support the test with personnel and equipment, which would be allowable costs.

Data Requirements: The starting point in analyzing the cost of Data Items is to start with the requirement. First, become familiar with the government's requirement for the individual data elements. Usually, that is found in the CDRL. This lists each of the data elements that the government is requesting of the contractor or subcontractors. For each of these CDRL elements there is usually a Data Item Description (DID). The DID gives a detailed description of what is required, when required and frequency (i.e., once, quarterly, monthly, etc.).

First step in evaluating a DID is to determine the frequency of the report. Common periods are a single report during the contract period, an initial and final, quarterly and monthly. Or, it may be only "as required," i.e., a Safety Incident Report.

To determine the labor hours required to support these reports, realize that setting up the report for the initial time is the most time consuming. Subsequent reporting should be considerably less. Repetitive cycles or contracts should further reduce the labor hours. Realize that many of these people are multi-tasked and are not dedicated just to these tasks. Also, much of the data comes from automated reports thereby reducing workload.

## **IX. ENGINEERING SERVICES/TIME AND MATERIAL ESTIMATION**

Sometimes it is advantageous to the government to have contracts that pre-agree to certain parameters such as Labor Rates, Material Costs, Task Elements, etc. These special-purpose contracts recognize that, for various reasons, all the parameters of a contract scope cannot be defined at contract signing. For example: The exact quantity of Materials or Purchase Parts, or the exact amount of Labor Hours or Task durations. However, the parties (government and contractors) could agree on such items as Unit Costs, Labor Elements, Labor Rates, and Task Descriptions. In this way, the contract could be awarded and utilized as requirements are needed.

**Engineering Services Contracts** may define Engineering or Technical Tasks as a series of contract line items as part of the scope. The Hourly Rates for the various appropriate Labor Categories (as well as Overhead and G&A rates) could also be agreed to ahead of time. The amount of effort hours and duration of these tasks then can be somewhat flexible.

**Time and Material (T&M)** is a type of pricing arrangement in which the buyer agrees to pay the contractor for (1) its time spent (based on pre-established fixed hourly labor rates) and (2) materials purchased in support of the buyer's requirements. T&M contracts are most often used to procure engineering services and equipment repair and maintenance services when the cost to repair or overhaul a piece of equipment is uncertain. However, these contracts are also used to procure other support services.

**T&M and Labor-Hour (LH)** Contracts are two types of contracts that provide for acquiring Supplies or Services on the basis of Direct Labor Hours at specified fully burdened (meaning that they include wages, overhead, G&A expenses, and profit) Fixed Hourly Rates and the actual cost for materials. Although the hourly labor rates are fixed, the number of hours delivered and the cost of materials and parts are not. Materials are defined to include:

- (1) Direct materials (including supplies transferred between divisions, subsidiaries, or affiliates under a common control);
- (2) Subcontractor for supplies and ancillary services (for which there is not a labor category specified in the contract);
- (3) Other direct costs (including incidental services for which there is not a labor category specified in the contract); and
- (4) Applicable indirect costs. A variation of the T&M contract, the LH contract differs only in that the contractor does not supply materials. T&M and LH contracts are considered hybrid types of contractual pricing arrangement that contain aspects of both Fixed Price and Cost Reimbursement. They resemble cost type arrangements in that they share many of the risk characteristics of a cost type contract, and they also resemble fixed price arrangements because direct labor is acquired at specified fixed hourly rates. As conveyed by the FAR, these types of contracts are used only when it is not possible to accurately estimate the extent or duration of the work or to anticipate costs with a reasonable degree of confidence.

With T&M and LH, there is the risk of expending a lot of contractor effort with nothing substantial to show for it. The contractor is required to deliver the agreed amount of effort up to a specified ceiling price, using its “best efforts.” The key is to manage them well.

The application of T&M contracts has evolved to include a wide range of professional services. More flexible and expedient than other contract types, T&M arrangements are providing government agencies access to consulting, technical services, program management, software development, and facilities maintenance services.

There are three primary regulatory requirements related to the use of T&M and LH contracts as per FAR Part 16:

- (1) The Contracting Officer must conclude that no other contract type is suitable to the requirement before executing a T&M or LH contract;
- (2) The contract must include a ceiling price that the contractor exceeds at its own risk; and
- (3) The contract (including base plus option years) should not exceed three years, unless approved by the Head of the Contracting Activity (HCA)

prior to the execution of the base period. T&M and LH contracts can also be used for commercial services (FAR Part 12, Acquisition of Commercial Items).

In a similar fashion to the Engineering Services described above, the contractor and government agree ahead of time to the Unit Cost of the Material or the Hourly Rate of the appropriate Labor Category. The Overhead and G&A rates are also pre-agreed to. The quantity of Material and LH can also be somewhat flexible as long as progress is being made in the right direction and the effort is deemed by the experts to be in the best interest of the program, and of course within the budget and cost constraints of the particular program.

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## **X. RECOMMENDATIONS**

Recommendations are as follows:

1. Send more experienced GS12 level employees to locations where there are only limited higher-level employees with surplus interns.
2. Provide better financial and cost-accounting training to employees so that they understand cost drivers and how contractors capture and attempt to transfer costs to the government.
3. Provide improved training in the use of the FAR and how to best utilize it's laws and regulations in order to protect the government's interest (explain to employees what the government's interests are how the at times conflict with the contractors)
4. Employ experts in the higher echelons of the Army and DoD to make recommendation to the Congress on how the procurement process can be simplified and made more efficient in terms of cost savings.
5. Perhaps design a standardized proposal system that contractors must use to submit their proposals and legally make them use it, just like we have standardized contracting systems that we, as contracting officers and specialists, have to use.
6. Scrap PD2 and find a more user-friendly system to simplify the contracting process. Have experienced contracting personnel involved with the designing of the system so that it is a contracting-friendly system, not some fancy Information Technology system that was obviously not designed with the end user in mind, but rather captures the thinking of the computer techs. We need a contracting system, not an information technology system. Government contracting is very specific. The PD2 systems does not work well with clause selection; it has a lot of features that we do not need and do not use, and in the areas that are important, it falls way short of what we need.
7. In examining the process of building a reliable cost estimate, the difference between the theoretical aspects of cost estimating compared to what happens in the day-to-day working world demonstrates that there is room for and a need for improvement and change.

The list above and the material below make up our recommendations, which, if enacted, will provide points for improvement in the field of cost estimating. These recommendations have been developed through the act of analyzing the process of cost estimating and gauging what happens in the day-to-day world. Personal experiences have been used to assist in developing these recommendations, as well as interviews with several personnel who work within the cost-estimating world.

A big thanks to the valuable input from cost analysts, budget personnel and staffs that work within the Earned Value Management (EVM) and cost-estimating world.

The most significant recommendation that is talked about by most everyone who was interviewed at Aberdeen Proving Ground is the lack of qualified government employees.

In examining the process of building a reliable cost estimate, the difference between the theoretical aspects of cost estimating, compared to what happens in the day-to-day working world, indicates that there is room for improvement and change. The following section includes recommendations that, if enacted, will provide points for improvement in the field of cost estimating. These recommendations were developed by analyzing the process of cost estimating and gauging what happens in the day-to-day world.

Personal experiences were used to assist in developing these recommendations, as well as interviews with several personnel who work within the cost-estimating world. I have received input from cost analysts, budget personnel and staff who work within the Earned Value Management (EVM) world.

The most significant recommendation, one that is talked about by almost everyone interviewed, is the lack of qualified government employees to complete the cost estimation process. Jim Steinberger, Business Management Directorate (BMD) chief for Project Management office Force XXI Battle Command Brigade and Below (FBCB2), states,

There are very few government cost analysts; so much of the work is done by outside contractors. These are independent contractors who support the Govt program office. Typically government personnel are used to assist the cost analyst in specific fields such as software (sw) engineering, sw security, systems engineering.

With a large percentage of cost analysts being employed as contractors, CECOM is experiencing a very low percentage of retention, especially for contractors, as the BRAC move to APG under way. In a move to preemptively help the acquisition community, the CECOM Contracting Command is creating a branch of price/cost analysts. Previously CECOM had three price/cost analysts for about 325 contract specialists. The current plan is to create a branch with thirty price/cost analysts. In a similar move, the Defense Contract Management Agency (DCMA) is also increasing its staff of price/cost analysts. Ironically, both CECOM and DCMA had a full staff of price/cost analysts as little as eight to ten years ago. The opinion at the time was that the contract specialists should be able to conduct their own price/cost analysis, so the analyst jobs were paired down. From personal experience, the authors have become good at cost/price analysis because they had no choice due to the lack of analysts. In conducting the cost analysis, which could sometimes take upward of two weeks, the authors would not have any time to accomplish other responsibilities as a contract specialist. The time needed to conduct price/cost analysis is steadily increasing as proposals become more complicated due to greater dollar values and more complicated requirements.

Al Matos, Software engineer for DCMA, responded to an author question about having enough government personnel to develop an accurate cost estimate by saying the following:

I personally do not believe that enough independent government cost analysts are utilized in having a higher fidelity estimate. Like statistics, having independent cost estimates would be helpful in giving a true ball park range of expected costs for products acquired.

Mr. Matos is a DCMA representative at a contractor's facility. This contractor performed a software development effort for the U.S. Army. In this particular instance,

the contract overran the estimated cost of the project, both due to a flawed initial cost estimate and technical creep, which is addressed in the next paragraph.

Technical creep can be defined as changing the baseline of an effort after the base contract has been awarded. A cost estimate uses historical costs, in most instances along with other criteria, in developing the final value for the cost of an upcoming effort. A cost estimate also should be updated each time there is a change to the baseline to ensure that the value of the estimate is reliable. Capturing the baseline changes is detrimental in maintaining a cost estimate that is reliable and can be used as a database for historical purposes. Mr. Matos provides the following example,

Let us assume that an original cost estimate for requirements development, design, implementation, and test of 500 requirements has been projected at \$5M or \$10K per requirement. This assumes that the process utilized is followed the same way each time with the same rigor. Let us assume that 50 additional requirement are added to current baseline. This translates into new work for requirements development, design, implementation, and test with a potential cost impact of \$500K. The original baseline cost of \$5M is no longer valid. The new cost estimate based on the new baseline is \$5.5M which could be considered a major cost impact or 10% change. The new cost estimate should take into account the overhead charged to factor final cost.

So essentially, just updating the cost estimate for the costs of the basic effort and not including indirect costs will not reflect the true cost of the effort. Over time, the total of the cost estimate will be skewed to the low side. Additionally, in working with software in particular, Mr. Matos gives the following insight as to the complexity to updating a cost estimate

The scope of baseline change needs to be well understood. Not all requirements are equal. One software requirement change may affect one-to-many software components. This would translate into rework in requirements development, design, implementation, and test. If only implementation is reworked, this will translate into a hidden cost impact towards maintenance of the product.

Therefore, within the updated cost estimate, there may be several levels of adjustments that need to be made. Unless all adjustments are captured in the revised cost

estimate, the estimate going forward will be invalid and will give false information that may be used in the historical aspect of cost estimation.

Another problem area is the drive the Program Management Office has (PMO) in completing an effort, regardless of the data that is available from current cost estimates. The PMO is a major stakeholder in the programs that they oversee; therefore, they tend to overlook, or ignore, the constraints that the PMO could be facing. Mr. Chuck Campbell Earned Value Management/Cost Estimator Analyst for PM FBCB2 notes that “sometimes organizations or individuals who have a stake in the program may be too optimistic in estimating their ability to execute within budget constraints.” I have seen this happen too often in the realm of software development efforts. Mr. Matos adds,

From my experience on the C-130 AMP, FBCB2, and GPS MUE programs; Program Managers tend to be optimistic because there are several commitments that have been made to deliver a product. The politics start to take over.

To complicate matters on this subject even further Mr. Steinberger indicates that Program Managers are not optimistic in forecasting successful completion of their program. In fact, he states,

The PM’s forecast is only as good as the forecast he gets from the contractor. While there are analysis tools available to the PM to do as much evaluation of the contractor’s information as possible (in my experience), most contractors lie and they do not provide accurate or truthful information until they can no longer hold it from the government. On several occasions, I was able to conduct analysis and identify schedule slips and cost overruns that the contractor was aware of but did not identify to the government.

Once a cost estimate is drawn up, the government should use this as guidance and not ignore the discrepancies between the cost estimate and the proposal. After an effort is awarded and changes are made to the baseline, the cost estimate should be updated to reflect the value of the change. If the proposed changes affect the budget of the program adversely, the proposed changes should be re-evaluated to make sure the changes are necessary.

Another issue is that the PMO does not actually put much effort into developing a cost estimate for procurements that are considered to be small. I have been involved in procurements where the period of performance is five years, with an estimated value of \$30 million. I received a cost estimate that did not address all the requirements of the anticipated contract, so we did not have a true cost estimate of what this effort would cost. When I went back to the PMO office to inquire about the missing parts of the cost estimate, the answer I received was “I do not know what this costs; how should I know.” Nevertheless, due to political reasons, this procurement is moving forward without having an updated corrected cost estimate. Many of the PMO offices, in my experience, do not put a great deal of effort into developing a cost estimate, except for highly visible programs. At this time, I am working in a Base Closure and Realignment Commission (BRAC) environment, and all organizations are understaffed. The PMOs are all struggling to get/keep qualified cost/price people. This is a major problem in government organizations: the retention of qualified personnel. Some suggested solutions to this issue are to hire interns who can be trained from the ground up, and who will tend to stay with the organization. This solution will take a couple years and will be painful. Another solution is to hire contractors to perform these services. Contractors tend to be three to four times more expensive than government employees, and contractors might not have the same goals as government employees. Contracted personnel do not have to take an oath and will tend to do what is in the best interests of their company. Nevertheless, at this time, contracted employees are filling the void.

A buy-in from all stakeholders in the acquisition process is needed to effectively change the problems that we are seeing in the area of cost estimation. Cost estimates should be among the first documents reviewed before procurement is started. The PMO office uses this document in preparing a request for funding. If the cost estimate is wrong, then everything that comes after the development of that document will be affected.

## **XI. SUMMARY**

We have shown the reader many topics of interest that should provide important insight and guidance into the pre-award phase of contracting for various types of items and services. Hopefully, this overview will serve as a reference and a guide for the contract specialist and contracting officer to build upon as they go through the steps from market research to requirements to solicitation to pre-award, and all the way up to the award phase of the procurement. None of the information is new and very little is original. We have simply tried to compile and present the best of what knowledge is available, either from our experience, our learning at the Naval Postgraduate School or the sources that are available to the Government Contracting Community. All sources have been identified and noted in the bibliography section of this thesis.

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