DEFENSE ACQUISITION UNIVERSITY

Business, Cost Estimating and Financial Management Department

February 2011

TEACHING NOTE

COST ESTIMATING METHODOLOGIES

Professor Tomeka S. Williams, CDFM, PCEA
Professor Ellen Barber, CDFM, CCE/A

INTRODUCTION

A cost estimate is an evaluation and analysis of future costs of hardware, software and/or services. Cost estimates are generally derived from historical cost, performance, schedule, and technical data associated with similar items or services. Chapter 2 of DoD 5000.4-M (December 1992) identifies four analytical cost estimating methods and techniques commonly used to develop cost estimates for DoD acquisition programs (OSD, 1992, pp. 31-33). The ones commonly used are the **a) Analogy; b) Statistical (Parametric); c) Engineering (Bottoms Up); and d) Extrapolation of Actual Costs methods** (OSD, 1992, pp. 31-32). This teaching note will address these four cost estimating methodologies based on this policy document.

Generally, the cost estimating methodology used for a major defense acquisition programs (MDAPs) and major acquisition information systems (MAISs) progresses from the analogy to the extrapolation of actual costs method as the program matures. The Analogy method is most appropriate to use early in the program life cycle when the system is not yet well defined. This assumes that there are analogous systems available for comparative evaluation. As a system begins to become more defined (such as when the program enters Engineering & Manufacturing Development (EMD) phase), cost estimators are able to apply more robust methods such as a Statistical (Parametric) method which is based on proven cost estimate relationships (CERs) algorithms. Estimating via Engineering (Bottoms-Up) tends to begin in the latter stages of EMD and Low Rate Initial Production (LRIP). Technical drawings and cost details become available when the design is fixed and more detailed as the program matures. Once the system has been produced or constructed (typically at LRIP and during Full Rate Production), the extrapolation of the actual cost method can be more readily applied (See **Figure 1**).

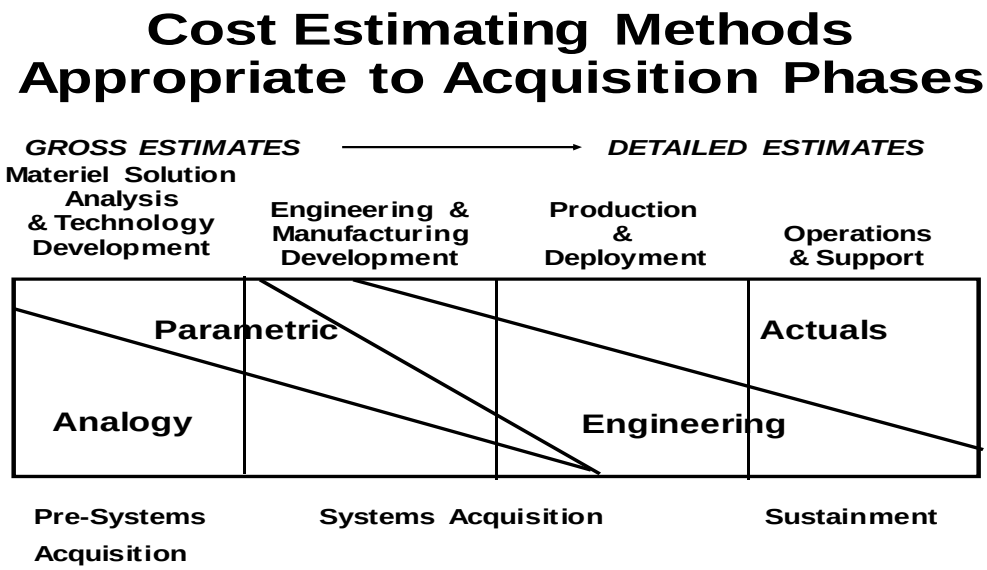

Figure 1

Few estimates employ the same estimating technique for every cost. Techniques used for developing estimates for various cost elements should take into account the stage of the acquisition life cycle that the program is in when the estimate is being developed (i.e., Materiel Solution Analysis (MSA), Technology Development (TD), EMD, etc.), data available, and time to complete the estimate. The Office of the Secretary of Defense for Cost Assessment and Program Evaluation (OSD CAPE) prefers that heavy reliance be placed on the parametric method (although the analogy and engineering methods are acceptable) for Milestone B and C decision reviews. However, extrapolation from actual costs using information from sources such as Earned Value Management (EVM) reports and learning curve data from previous production lots should be used to the maximum extent possible in preparing estimates for the Full Rate Production Review and any subsequent actions. A best practice is crosscheck your estimate using a different estimating methodology to strengthen the reliability of the developed cost estimate.

ESTIMATING BY ANALOGY

The analogy method compares a new or proposed system with one homogeneous (i.e., similar) system in which the form, fit, and function are alike. The analogous system should be acquired in the recent past, for which there is accurate cost and technical data. There must be a reasonable and logical correlation between the proposed and "historical" systems identified by the cost estimator. This subjective evaluation of the differences between the new system of interest and the historical system is documented by the estimator. The analogy method is typically performed early in the cost estimating process, such as the pre-Milestone A and Milestone A stages of a program. This is early in the life of a potential acquisition program when there may be a limited number of historical data points and the cost estimator may be dealing with technology that experiences rapid change. The analogy method is also a very common technique used for cross checking more detailed estimates (i.e., sanity check).

With so many new and emerging technologies and ideas, an analogy is often the only method available. Estimating by analogy may be the best technique for estimating the cost of state-of-the-art systems such as a space vehicle, next-generation submarine, a future computer or a proposed microprocessor.

Multiplicative and Additive Factors

There are countless ways and variations to estimate by analogy. The most common way is to generate an additive or multiplicative factor. For example, gas price fluctuations can be described in additive or multiplicative fashion. If you were to predict that the average price of a gallon of regular unleaded gasoline in 2011 would increase by $0.19 compared to the $3.80 price in 2010, then the "additive" impact is depicted as $Gas_{2011} = Gas_{2010} + Adjustment_{2011}$ = $3.80 + $0.19 = $3.99. A similar logic applies for showing gas price fluctuations from a multiplicative perspective. If you were to predict that the average price of gasoline in 2011 were to increase by 5% over the previous year, then the "multiplicative" impact is depicted as $Gas_{2011} = Gas_{2010}$ x $Adjustment_{2011}$ = $3.80 x 1.05 = $3.99.

Adjustment Factors

An adjustment factor is derived from physical or performance differences between two similar systems. For example, suppose you want to estimate the cost of a new car that is of similar design and type as your current car. The only cost information you have is what you paid for your current car in 2005 ($20,000 in constant 2005 dollars). In order to compare all costs in today's dollars (i.e. 2011 dollars); you must first adjust your current car's cost to a 2011 cost. In order to make that transition, it is necessary to account for inflation and other factors that would influence the estimated cost in 2011 dollars. For the inflation portion, assume inflation averaged 2.5% a year from 2005 to 2011. That means the inflation factor over that six-year period is equal to $(1+.025)^6 = 1.16$ or 116%. In other words, $1.16 in 2011 has the equivalent purchasing power as $1.00 in 2005. To account for inflation, multiply the 2005 constant dollar amount ($20,000) by the inflation factor to arrive at an estimate of what the equivalent cost of your current car would be in 2011 dollars ($23,194). This step, a part of data normalization, is required for all cost estimating methodologies, but is described here to show the complete process for applying adjustment factors. For more information on the subject of inflation and outlay rates and how they are used for financial forecasting purposes, the reader is referred to the Teaching Note titled ***"Building the Program Budget"***. Under the heading "Budget Preparation at Organizational Level", the reader will find information on how budget personnel in a program office would transition from constant year dollars to "then year" or "budget year" dollars for budgeting purposes by applying the proper ***escalation index*** to the constant year dollar amount.

Now that the car's cost has been adjusted by an escalation index, it is necessary to make another adjustment to account for technical differences between the current car and the new car. Normally, you would interview experts, such as engineers, asking them for a technical evaluation of the differences between the two cars. Based on the engineers' evaluation, a cost estimator must assess the cost impact of the technical difference(s). Upon evaluation of the technical data, engineers estimate that the new car is 5% more complex than the current car, primarily due to added electronic systems.

If your credible subject matter expert out of the engineering division confirmed that a 5% complexity factor should be used, you would then increase the current car's cost ($23,194 in constant 2011 dollars) by 5% to account for this increase in complexity. The 5% complexity increase is equal to 5% x $23,194 = $1,126 in constant 2011 dollars. For the final step, add the cost for added complexity ($1,160) to the current car cost ($23,194) to estimate the new car cost at $24,354 (constant 2011 dollars).

Cost Factors

Unlike an adjustment factor, a cost factor is derived from cost-to-cost relationships between two similar systems. To derive a cost factor, one must select analogous tasks or products that represent a cost-to-cost relationship in the form of a ratio (i.e. numerator divided by denominator). This ratio applies to what you are estimating. As with all analogies, you must (1) collect the data, (2) normalize the data so that it is in the same economic year and there are no quantity-effects, (3) apply the cost factor (based upon a derived ratio) and (4) document your process and assumptions.

Uncertainty in a cost estimate using analogy is due to subjective evaluations made by the technical staff and cost estimators in their determination of the cost impacts of the differences between the old and new systems. In many cases, objective technical comparisons can be made. For example, a new system may have 100 square inches of circuit board with 10 discrete components and 500,000 operations compared to the old system of 500 square inches, 250 discrete components, and 100,000 operations. The problem then is to develop a cost relationship based on the technical differences.

You do not have to compare the new system to just one other analogous system. It may be desirable to compare some subsystems of the new system to subsystems of old system A, and others to subsystems of old system B. For example, to estimate the cost of a new radar, you may find an analog for the transmitter which is different from the analog(s) for the exciter, antenna, processors, etc. The key is in making pair-wise comparisons for each system or subsystem being evaluated. The total system cost estimate thus may be the sum of many single analogy-based cost estimates.

Pros and Cons of Estimating by Analogy

Estimating by analogy has many advantages. It is reasonably fast and inexpensive to generate such an estimate and easy to change. However, an estimate produced by analogy typically includes a high degree of cost risk because it is based on a single historical data point and tends to require subjective judgment as to what system is analogous and the extent of the similarities. Estimating by Parametrics is one way to address some of this cost risk.

ESTIMATING BY PARAMETRICS

The parametric, or statistical, method uses regression analysis of a database of two or more similar systems to develop ***cost estimating relationships (CERs)*** which estimate cost based on one or more system performance or design characteristics (e.g., speed, range, weight, thrust). The parametric method is most commonly performed in the initial phases of product description, such as after Milestone B when the program is in the EMD phase. Although during this phase an acquisition program is unable to provide detailed information (e.g., drawings and standards), the

program can specify top-level system requirements and design characteristics. In other words, estimating by parametrics is a method to show how parameters influence cost.

Parametric estimating is used widely in government and industry because it can yield a multitude of quantifiable measures of merit and quality (i.e., probability of success, levels of risk, etc.). Additionally, CERs developed using the parametric method can easily be used to evaluate the cost effects of changes in design, performance, and program characteristics. Note the parametric method, which makes *statistical inferences* about the relationship between cost and one or more system parameters is very different from drawing analogies to multiple systems.

A critical consideration in parametric cost estimating is the similarity of the systems in the underlying database, both to each other and to the system which is being estimated. A good parametric database must be timely and accurate, containing the latest available data reflecting technologies similar to that of the system of interest (design, manufacturing/assembly, material). Of course, a general rule when collecting data for statistical analysis is the more data, the better. Finally, as with estimating by analogy, parametric data must be normalized to represent a given economic year and remove any quantity effects.

For example, attempting to estimate the cost of a “today” computer (electronic memory chips) using a database of older computers (magnetic core memory) would yield an estimate much higher than the actual cost of the current system because the memory chips are much cheaper to produce and install than the old core memory. In addition, changes in manufacturing technology or processes have occurred, such as the use of automatic insertion equipment instead of hand insertion of components onto printed circuit boards (PCBs). This has led to major reductions in the labor content associated with the assembly of PCBs.

Additionally, the database must be homogenous. A data element entry for one system must be consistent with the same data element entry for every other system included in the database. For example, in a rocket motor database where there is an element called the "motor weight", each weight entry should be based on the same assumptions for each system. Assume that each motor is defined to include the rocket grain, motor case, and nozzle. If some systems report a motor weight that does not include one or more of these components (or includes additional components), then the database is not homogenous and CERs developed from the database are questionable. Too often a database is built over time, with inputs from various sources, without any one individual responsible for insuring the homogeneity of the data.

The validity of a CER is usually judged by its regression statistics, which measure the accuracy of the fit of the CER to the sample data points used in developing the CER. The most commonly used regression statistic is the coefficient of determination (R^2), sometimes described as “goodness-of-fit.” A CER that perfectly predicted each sample point in the database would have an R^2 of 1.0. For CERs, an R^2 value of .9 or better is considered desirable, although in practice, CERs with R^2 values of .8 or better may be accepted for use in a cost estimate.

A CER which meets the criteria of data homogeneity and good regression statistics may still be unsuitable for use in a particular system’s cost estimate if the value of the new system’s parameters fall outside the range of the parameter values for the existing systems in the database. For example, a CER developed from data on aircraft that travel at less than the speed of sound may not predict costs well for a system which is to travel at supersonic speeds.

Estimating by the parametric method is appropriate relatively early in the program life cycle (Figure 1) when a detailed design specification is not available, but a database of like systems and a performance specification are available. The parametric method is also useful as a check against an estimate made using another method.

Pros and Cons of Estimating by Parametrics

Estimating by the parametric method has many advantages over other estimating methods. Because the CER is based upon more than a single data point, estimating by parametrics is less risky than estimating by analogy. A major benefit of applying statistical methods is that one can also measure error from a derived CER and readily perform cost sensitivity analysis based on parameters within each derived CER. The biggest downside of estimating by parametrics is that such a technique is constrained by the amount and quality of the data. Many times an analyst unknowingly incorporates flawed data into the database, in effect producing inaccurate CERs. For this reason and a variety of other reasons, the resulting statistics can be misleading. By providing a much more detailed view of what is being estimated, estimating by engineering circumvents the necessity for statistical analysis.

ESTIMATING BY ENGINEERING

The engineering or "bottoms-up" method of cost analysis is the most detailed of all the techniques and the most costly to implement. It reflects a detailed build-up of labor, material and overhead costs. Estimating by engineering is typically performed after Milestone C (i.e., Low Rate Initial Production (LRIP) approval) when the design is firm, minimal design changes are expected to occur, data is available to populate the Work Breakdown Structure (WBS), drawings and specifications are complete and production operations are well-defined in terms of labor and material.

Hypothetical Example of Estimating by Engineering

Numbers and values associated with WBS, weights and CERs vary from system to system and from service to service. All numeric values shown in this example are for illustrative purposes only. For this example, weight was selected as the unit of measure (UOM). However, there are other commonly used UOMs such as length, square feet, cubic feet and horsepower.

When estimating by engineering, an analyst would need to estimate direct labor hours associated with assembling a sub-system (widget) associated with (as an example), a hypothetical WBS 123. For example:

DIRECT LABOR HOURS TO ASSEMBLE WBS 123

WBS	WEIGHT	x	Labor CER	=	DIRECT LABOR
123	20 Tons	x	300 Hours/Ton	=	6,000 Hours

The direct labor hours can be converted to direct labor cost by applying a labor rate as follows:

DIRECT LABOR COST TO ASSEMBLE WBS 123

WBS	DIRECT LABOR	x	LABOR RATE	=	DIRECT LABOR COST
123	6,000 Hours	x	$30/Hour	=	$180,000

Overhead cost must be estimated by applying an overhead rate factor against direct labor cost:

OVERHEAD COST ASSOCIATED WITH WBS 123

WBS	DIRECT LABOR COST	x	OVERHEAD RATE	=	OVERHEAD COST
123	$180,000	x	1.20	=	$216,000

Material cost must also be estimated. The example below assumes a material cost of $15,000 per unit ton:

MATERIAL COST OF WBS 123

WBS	WEIGHT	x	Material CER	=	MATERIAL COST
123	20 Tons	x	$15,000/Ton	=	$300,000

Finally, we add the costs of direct labor, overhead and material to estimate the cost of WBS 123. This is denoted as: Cost $_{WBS\ 123}$ = Direct Labor Cost + Overhead Labor Cost + Material Cost. Substituting our estimates for each cost category yields Cost $_{WBS\ 123}$ = $180,000 + $216,000 + $300,000. Therefore, Cost $_{WBS\ 123}$ = $696,000. Note that Cost $_{WBS\ 123}$ is just one of many cost elements of the engineering estimate.

Deriving Engineering Cost Elements

With this technique we start at the lowest level of definable work within the Work Breakdown Structure (WBS) (i.e., milling a flange). The direct labor hours required to complete the work are estimated from engineering drawings and specifications, usually by an industrial engineer (IE) using company or general industry "standards." The engineers also estimate raw materials and purchase parts requirements. The remaining elements of cost, such as tooling, quality control, other direct costs, and various overhead charges including systems engineering and project management, are factored from the estimated direct labor and/or material content of the work. The actual portion of the cost estimated directly is thus a fraction of the overall cost of the system.

The IE may use a variety of techniques in estimating the direct labor and material cost of each discrete work element. For example, the IE may use an analogy to estimate one work element; a parametric CER based on an industry database of like work elements to estimate a second work element; and a set of work standards based on work activities (e.g., milling .002 inches from a 6 inch diameter rod 3 inches long) to estimate a third work element.

Uncertainty in this type of cost estimate is due to the use of multiplicative factors derived from various methods on the relatively small direct labor/material base that was estimated. This can result in significant error in the total system cost estimate. The uncertainty, however, can be assessed and managed. Another potential problem is that because the cost estimate is the summation of many estimates, it may be hard to maintain the documentation to support the estimate.

Since, in most cases, the engineering estimate is based on standards, either company-specific or industry-wide, the contractor's cost estimate should be "attainable." By definition, standards are attainable values for specific work under given conditions. The engineering estimate is thus a tool for the manufacturer to control the work on the floor (process control). The technique has its greatest value once the design has stabilized and the system is in production.

As DoD weapon systems development programs tend to be on the leading edge of technology, much effort is spent getting the system to work, which translates into redesign and modifications. This design metamorphosis should be reflected in the engineering estimate. However, the IE may, due to the unknown aspects of the program, underestimate the number of design iterations and therefore underestimate the cost of the work element(s).

The engineering cost estimate is most often used during the production and deployment phase **(Figure 1).** This technique encourages the contractor to do his homework early on and define all the work down to the lowest level of the WBS. It is also a great process control technique at the production facility. The technique, generally accomplished by hardware manufacturers, is the most costly in time and people.

Pros and Cons of Estimating by Engineering

The source and structure of an engineering estimate provides much more detail than estimates by analogy or parametrics. Therefore, an engineering estimate enables better visibility into cost drivers. The tradeoff, however, is that producing an engineering estimate is labor intensive, slow and expensive. In addition, there are still risks. We often apply factors or overhead rates (known as wrap rates) to the estimated costs to estimate those costs that are not directly attributed to parts and direct labor. A small error at a lower level can translate into a huge error once the wrap rates have been applied.

Over the past decade, DoD has developed fewer estimates by engineering. The reason for this is that Acquisition Reform encourages DoD to let industry (contractor) retain detail design drawings as a cost savings measure. Many more DoD programs are strictly using EVM to evaluate cost and contractor performance. As a result, the contractor performs the bottoms-up estimate but provides its DoD customer only what it (the customer) needs in terms of cost and EVM data which does not include profit when reported in the Contract Performance Reports Formats 1-4 earned value metrics. Contingent on how the contractor writes its variance report narrative in Format 5 of the Variance Analysis, this area may or may not include EVM data that includes profit in its EVM data.

ESTIMATING BY ACTUAL COSTS

Actual cost experience on prototype units, early engineering development hardware and early production hardware for the program under consideration should be used to the maximum extent possible. If development or production units (or components) have been produced, the actual cost information should be provided as part of the documentation. Estimates for Full Rate Production decision reviews are to be based at least in part on actual production cost data for the systems under review.

Estimating by actual costs, also called extrapolation of actual, is essentially, an extrapolation of current program cost. In other words, you would estimate a trend from your current contract to estimate your final system's cost. The cost data is internal to current system being constructed, not the same as "actual" historical data. There are several conditions that enable this estimating method to be possible. First and foremost, a program must be in the stage when the process of prototype development (LRIP) or full rate production decision review (FRPDR) has at least started – otherwise there is nothing "actual" from which to base actual costs. Second,

there must be a reporting process already in-place that enables the DoD agency the ability to review accumulated actual costs as the system or prototype is being constructed. Although such a reporting process can vary significantly from program to program, the process typically (a) occurs monthly or quarterly, (b) requires the contracting agent to provide percent-of-work completed to date and (c) requires the contracting agent to provide the cumulative cost it has expended for the completed work-to-date.

Note that the other cost estimating methods (analogy, parametrics and engineering) primarily rely on historical cost data. Such historical cost data is commonly described in terms such as "bid data," "budget data" and "actual data," to name a few. The "actual data" used for estimates by analogy, parametrics and engineering is NOT synonymous with estimating by actual costs because the "actual data" is NOT internal to the current system being constructed. That is, such "actual data" comes from a different contract or a predecessor of the current contract and does not truly reflect the "latest and greatest" costs of the system currently being built.

Pros and Cons of Estimating by Actual Costs

The technique of using actual cost data (or extrapolating future estimated cost from actual costs) is based on data from previous units of the same system. This is typically the most accurate cost estimating method when the data is available. The OSD CAPE prefers this method since it uses actual or near actual data for the system of interest. The uncertainty associated with this method is based, as with the analogy method, on the technical assessment of the differences between an earlier version of the system, such as a prototype, and the current model under consideration. Obviously, the more the two versions are alike, and the further along the system is in the acquisition process, the more easily an accurate estimate can be made.

A drawback of estimating by actual costs is that it is usually too late to use actual costs to adjust or build a budget. In addition, an estimate of a prototype (actual) typically does not have a 1:1 correlation to the first production unit or lot. Therefore, one may need to repeat the actual cost method for a first production unit or lot.

CURRENT PRACTICE

Our cost estimating methodology does change as we go through the acquisition life cycle of a program. Even though we only covered the four main cost estimating methods cited in DOD 5000.4-M (October, 1992), the cost estimating community does use additional cost estimating methodologies if the data is available during the appropriate phase of the program's acquisition life cycle. Some additional options include the use of forecasting techniques based on time series data analysis, earned value management (EVM) estimate at complete (EAC) data, and unit and cumulative average learning curve formulas. Based on the current DoDI 5000.02 Operation of the Defense Acquisition System, (December 2, 2008.

SUMMARY

The matrix presented in **Figure 2** provides a summary of each of the four estimating methods. Each method is described in terms of what it is, when is it used, how is it done and the advantages and disadvantages of using such an estimating method.

	Estimating by **ANALOGY**	Estimating by **PARAMETRICS**	Estimating by **ENGINEERING**	Estimating by **ACTUAL COSTS**
WHAT IS IT?	**Single value from single data point**	**Measure of trends across programs**	**Detailed build-up of Lab, Mtl & OH $**	**An extrapolation of current program cost**
WHEN USED?	**Early in Program Pre-MS A & MS A**	**MS B**	**Late in Program MS C & LRIP**	**LRIP Full Rate Production**
HOW IS IT DONE?	**Adjust analogous system cost *or* create cost factor**	**Apply statistical methods to cost of 2 or more systems; i.e. Develop a CER**	**Estimate at lowest cost level & sum costs by WBS**	**Use trend from your current contract to estimate your final system $**
PROS	**Fast, Inexpensive** **Easy to change**	**Based on >1 data point =>less risky** **Can measure error** **Easy for what-ifs**	**More detail enables better visibility into cost drivers**	**Most costs are known** **CAIG prefers over other methods**
CONS	**Based on single historical data point => risky!** **Tends to be more subjective**	**Constrained by amount & quality of data (GIGO)** **Statistics can be misleading**	**Labor Intensive** **Slow, Expensive** **Can lose sight of "big picture"**	**Usually too late to use actual costs to adjust or build budget** **Not a 1:1 correlation of prototype-to-production costs**

Figure 2

Of the four cost estimating methods presented, the use of actual costs is the most supportable, but difficult to accomplish early in the acquisition program. The analogy method is most often used early in the program, when little is known about the specific system to be developed. The parametric technique is useful throughout the program, provided there is a database of sufficient size, quality, and homogeneity to develop valid cost estimating relationships. The engineering estimate is used later in program development and production, when the scope of work is well defined and an exhaustive WBS can be developed. Finally, estimating by actual costs produces the lowest risk estimate due to the fact that the system cost is derived from a trend from the current contract to estimate.

Expert opinion, although not addressed in this section, can be used to support any or all the four estimating methods. One or more experts can provide the basis for the cost estimate by bringing a wealth of experience and knowledge. Experts can identify analogous systems and recommend "most intuitive" CERs. Expert judgment can prove invaluable for estimating parameter impacts along with impacts to labor and material costs. For example, experts have been used to provide estimates of software lines of code (SLOC), weight, dimensions, system complexity, specifications and performance impacts. Many times, experts have already collected data on labor hours to build, operate or maintain a system. At the very least, an expert can provide his or her opinion on cost drivers, functional form of a regression and engineering rules-of-thumb.

No matter what the estimating technique, the program manager must ensure the cost estimate completely defines the program and is technically sound and reasonable. The cost estimate must

be defensible with well-reasoned analysis. A program manager who is totally familiar with the program's cost estimate, including the rationale for the method(s) used to develop that estimate, generally has a greater chance of maintaining control of the cost of that program.

REFERNCES

DOD POLICY & GUIDANCE

OSD (2007) DoDD 5000.01 Defense Acquisition System. Retrieved on February 8, 2011 from http://www.dtic.mil/whs/directives/corres/pdf/500001p.pdf

OSD (2008) DoDI 5000.02 Operation of the Defense Acquisition System. Retrieved on February 8, 2011 from http://www.dtic.mil/whs/directives/corres/pdf/500002p.pdf

OSD (1992) DoD Cost Analysis Guidance and Procedures, DoD Directive 5000.4-M, Washington D.C., Dec 11, 1992. Retrieved on January 3, 2011 from http://www.dtic.mil/whs/directives/corres/pdf/500004m.pdf

GAO Cost Guide (2009) GAO Cost Estimating and Assessment Guide: Best Practices, GAO-09-3SP, March 2, 2009. Retrieved on February 8, 2011 from http://www.gao.gov/products/GAO-09-3SP

DIRECTIVE TYPE MEMORANDUMS

AT&L **DTM 09-025**. (2010) Space Systems Acquisition Policy, (December 18, 2010) Retrieved on February 8, 2011 from https://acc.dau.mil/adl/en-US/401841/file/54056/20101018%20-%20DTM%2009-25%20-%20Space%20Systems%20Acquisition%20Policy%20-%20ATL.pdf

DTM 09-027 *Incorporating Change 1, October 21, 2010* Implementation of the Weapon Systems Acquisition Reform Act of 2009 (WSARA) http://www.dtic.mil/whs/directives/corres/pdf/DTM-09-027.pdf

DOD Position on Acquisition Reform (May 2009) https://dap.dau.mil/policy/Documents/Policy/Department%20Position%20on%20Acquisition%20Reform.pdf

DAU WEBSITES AND RESOURCES

Defense Acquisition Portal (DAP) https://dap.dau.mil/pages/dapdirectory.aspx

Defense Acquisition Guidebook (DAG) https://dag.dau.mil/Pages/Default.aspx

Acquisition Community Connection (Cost Estimating): https://acc.dau.mil/ce

Continuous Learning Modules: http://clc.dau.mil

CLB 007 Cost Analysis
CLB 023 Software Cost Estimating
CLB 024 Cost Risk Analysis Introduction
CLM 016 Cost Estimating

Business- Cost Estimating Courses: Blackboard Public Use Site
https://myclass.dau.mil/webapps/portal/frameset.jsp?tab_id=_54_1

BCF 106 Fundamentals of Cost Analysis
BCF 107 Applied Cost Analysis
BCF 204 Intermediate Cost Analysis
BCF 302 Advanced Cost Analysis

OTHER LINKS

OSD Cost Assessment and Program Evaluation (OSD CAPE) http://www.cape.osd.mil/

Air Force Cost Analysis Agency (AFCAA) http://www.saffm.hq.af.mil/afcaa

Naval Center for Cost Analysis (NCCA) http://www.ncca.navy.mil

Dept of the Army -Cost & Economics (DASA-CE)
http://www.asafm.army.mil/offices/office.aspx?officecode=1400

NASA Cost Estimating Handbook
http://www.nasa.gov/offices/pae/organization/cost_analysis_division.html

Army Cost Manual
http://asafm.army.mil/Documents/OfficeDocuments/CostEconomics/Guidances//cam.pdf

NAVSEA Cost Estimating Handbook (2005)
http://www.ncca.navy.mil/resources/2005_NAVSEA_CEH_Final.pdf

Society of Cost Estimating and Analysis (SCEA) http://www.sceaonline.org/

Institute Society Parametric Analysis (ISPA) http://www.ispa-cost.org/

Military Operations Research (MOR) http://www.mors.org/

BOOKS

Cost Estimating Handbook, 2nd ed., Rodney D. Stewart, Wiley, 1991

Engineering Cost Estimating, 3rd ed., Phillip F. Ostwald, Prentice-Hall, 1991