# USING LIFE CYCLE COSTING TECHNIQUES TO IMPROVE THE VALUE ANALYSIS PROCESS

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## ABSTRACT

This paper will explore the need to utilize life cycle cost techniques to consider product or system costs over the entire life. This paper presents a means of applying fundamental life cycle cost techniques early in a program to identify high cost drivers and thus allowing for the capability to influence design of the system to reduce cost of the identified burdens. Using these techniques in the value analysis process will improve the value analysis and result in a more cost effective product or system. This paper will describe the process used in identifying cost drivers and the importance of utilizing these techniques early in programs. In addition, a hypothetical example of the life cycle cost process in use will be included.

## INTRODUCTION

Through time customers expectations have changed. Customers expectations of the past may have included developing products at the lowest price, as quickly, or perhaps as reliable as possible. In today's market, customer's requirements have moved to providing better quality products or processes at lower costs. To meet these expectations means the individual(s) who is most successful in expanding business or getting contracts will be the one who gives the customer the best value at the highest quality per cost.

To meet the high value demands requires an optimum combination of performance, quality and cost. A good way to do this is to use life cycle cost techniques in the Value Analysis process. Utilizing life cycle cost techniques provides a means to quickly assess the system design and potential alternatives early in programs. The results aid in identifying potential impacts on the item or processes' life cycle cost.

Using life cycle cost techniques makes cost a visible parameter to the design and value analysis teams and makes them consider cost as a design requirement. Using these techniques also makes the teams look beyond the costs experienced in the acquisition phase (development and production) and consider the effects that may be experienced in later phases including operation and support, and disposal.

Life cycle costing techniques can be used in the information, functional analysis, and evaluation phases of value analysis. In the information phase, life cycle costing techniques can aid in identifying the areas that allow the most improvement and isolate the major cost elements/items. During the functional analysis phase, baseline development and value/cost mismatch identification can be improved through these techniques. Both initial and detailed evaluation of alternatives can be improved by using these techniques in the evaluation phase of value analysis.

It is important to use these techniques as early as possible in programs. Decisions made early in programs (during the concept phase) commit a large portion of the life cycle resources for the system. Sometimes fifty percent or more of the budget can be committed in this early phase. With such a large portion of the budget and resources being committed early means the opportunity to influence the design in quality and cost has its greatest potential in these early stages.

Some simple steps for implementing these life cycle cost techniques during the value analysis process will be discussed in the following paragraphs.

## ANALYSIS ENVIRONMENT

The following paragraphs will introduce the analysis environment that the life cycle cost techniques and value analysis should be used in. Some of the key points that will be discussed include the importance of a well diverse team, the level of detail to perform the analysis, and at what stage of the program the best results can be expected.

The most important characteristic when setting up the Value Analysis team is to make sure the team is a well diversified group of individuals. To maximize the potential improvement in value, and for the purposes of this paper, reducing an item or processes cost, a well diverse team will provide greater insights to potential alternatives and the true impacts of the various alternatives on life cycle cost. Although an individual can perform a value analysis, a well diverse team allows for a more effective value analysis. The team should be made up of individuals from an assortment of design and support backgrounds.

In the beginning of the analysis it is essential that each team member be familiar with the requirements of the desired product or process under analysis. Familiarization of the requirements should be done well in advance of any discussions that the team may have as a group. If an individual is unclear of any of the requirements it is necessary for that individual to get clarification and understanding before the actual analysis process begins. If the team is unclear of the requirements or waits until the group meeting time to become aware of the requirements, the analysis will not be efficient in a best case sinario. There is the risk that the analysis could potentially result in more expenditures than its worth, as well as loss of actual added value.

When performing this analysis it is important to remember that the analysis is being performed to the level of detail where the issues exist and where decisions are being made. The team should not get caught up in the specific details of the item or process but operate or define the system or alternatives at a meaningful level. Initially in a program there will be little details of the system so it is important to operate at a higher level. As more details become available then the analysis will develop to a lower level of detail. At the early stages it is not important that every number/value being used be correct. It is only important that they are representative of the system and considered reliable. Otherwise the results of the analysis do not mean anything or can be misleading.

The level of detail of the analysis is defined by the level that the issues are at the time of the analysis. The definition of the level of detail is essential in determining where to define the baseline system and should really be developed in conjunction with one another. In addition, it is essential that the alternatives and models for evaluating the alternatives all be at the same level of detail as the baseline. The model should be able to perform trade-offs at the level of detail where the issues are at and at the level where the data is available.

Initially the analysis will be at a very top level but it is important to develop the tools and processes for macro level analysis to allow for identification of drivers and influence of the system design in the early stages of a program. If the tools and techniques incorporated or used in the early stages are not at a meaningful level or do not address the requirements then the results will be of no value to the analysis.

In the early stages (preconcept and concept phase) of a project there are many desired characteristics and design constraints but usually little direction or details of the system. This can scare people from the thought of the unknown. These early phases, however, allow the most opportunity to add value by reducing costs due to the flexibility of the design and lack of committed resources. Even though the cost is most easily addressed in the early stage, it is important to remember that the costs should be addressed on a continual basis as the product or process evolves.

## LIFE CYCLE COST PROCEDURES

The need to utilize life cycle costing techniques in the value analysis process begins in the preconcept phase when the need for a system is identified. The need may be generated from a current system's growing inadequacy to perform a particular mission or the desire of a system to perform an all-together new type of mission. This need should be defined into a set of requirements that may include schedule and resources required for its acquisition. The definition should be detailed enough to constitute the progress of the project to the next step.

The team should start with the customer as the focal point. This will identify what is important to the customer and aid in determining what the customer's true requirements are. The customer can provide the "worth" of the requirements to aid the team when a worth/cost ratio is determined.

After a set of requirements exist a baseline system needs to be defined. At the beginning of a program there will be little or no definition of the desired system or its components. The baseline will describe functional requirements of the system and establish the performance and operational requirements. As alternatives are evaluated the system design will be further defined and thus the baseline updated to a lower level of detail. This baseline will undergo quick changes but will eventually level out to allow for better understanding of the system and cost drivers associated with the system. The baseline will need to be reviewed on a continual basis to ensure that the baseline system meets the requirements of the future product or process.

When defining the baseline system, the exact values of the various system functions are not important, only that they are representative of the system under analysis and at the level of detail that the analysis is being performed. There is no quicker way to lose value in a system than moving away from the requirements established by the customer.

The main function of the baseline is to provide a means of varying influences to elements of the system under analysis with the goal of obtaining insights. At the initial stages of system development there will be many uncertainties. As these uncertainties are defined more clearly, opportunities will surface to define the areas to which the system is most sensitive.

After a definition of the system life cycle and the system operational requirements have been established, baseline requirements will be further broken down into functional subdivisions tailored to the system or process under analysis. These subdivisions will be at a level that allows identification of the high cost areas and provides enough visibility to determine the source of these high costs.

After identification of these subdivisions, data will be input into the baseline model based on historical data and the team's past experience. These inputs will provide rough estimates to support this phase of the analysis. The baseline will consist of a definition of the system and allocated costs for each of the areas identified in the model used. It should be noted that it is essential that the system definition and other supporting data be documented and shared with the entire team.

Defining alternatives is done with the goal of improving the value of the assets by reducing life cycle cost and improving the performance or quality of the system. After defining the baseline costs, certain areas will immediately manifest themselves as the main drivers to life cycle cost. The areas that are found to be high cost contributors and have high worth will be assessed as to what in particular is the main cause of this element being a cost driver. Through the Pareto principle it is expected that 20 percent of the items will contain 80 percent of the costs and thus a relatively small population of areas will be the primary focus. The key is to identify these areas. For example, all maintenance of a system is being performed at depot level and is costing the user 10 million dollars a year to support this function. An alternative for this high cost driver might be to perform maintenance at the intermediate and organizational levels.

The identification of alternatives should begin with asking, What are the high cost drivers of the baseline system? Once the high cost elements are identified, one should consider alternative ways of providing the same function. It is important to be knowledgeable of the aspects of the high cost elements and any technological advances that may be available when determining feasible alternatives. Having a diverse team aids in this process. The alternatives may or may not allow for life cycle cost reductions; these details will become more evident during the evaluation of the alternatives.

In the concept phase, the alternative area of focus may include: improving reliability, reducing maintenance costs, reducing supply support, or improving operational availability. These areas of focus are based on the type of system or process under analysis. Some potential improvements may come from some of the list below.

- Repetitive elements/items
- Expensive elements/items
- Limited availability elements/items
- Customized elements/items
- Cost not proportional to function worth
- Elements/items with no apparent benefit
- Elements/items too complex

The best way to identify alternatives is through a brainstorming session that includes all members of the team and therefore all areas of expertise.

The next step of the process is to evaluate the alternatives or in other words perform a trade study. This may be done by an existing model or may require the generation of a new model tailored to the system under analysis. This tool will be used to evaluate the alternatives against the established baseline.

After a model has been selected, data should be gathered for the alternative system. The data that is collected should be put into the model for evaluation. The developed model will determine how the data will be input. Alternative evaluation worksheets should be used during this process either directly in the model or in conjunction with the model. This will provide a means of providing a "paper trail" for each of the alternatives. Each of the worksheets should contain the individual responsible for the alternative so any specific questions on that alternative can be directed to that individual. There should also be some way of attaching rationale, assumptions, or sources of information for the values used. A sample worksheet is presented with the example later in this paper.

During the trade study the team members should discuss how the alternatives affect their specific areas or disciplines of expertise. The results of the evaluation process will provide a recommended alternative concept. During the evaluation process, additional issues or risks may be identified. Do not overlook risk in evaluating the alternatives. Include uncertainty in estimates during the evaluation process. Once again it is important to share any insights and updates with the team as they occur and get the results to the "decision makers."

## BENEFITS AND RISKS

Utilizing life cycle cost techniques in the value analysis process provides opportunities for value improvements but also has some potential risks. Some of the potential benefits and risks are provided below.

### Potential Benefits

Utilizing life cycle cost techniques early in programs can result in significant improvement in value while reducing life cycle cost. Performing this analysis early in the concept phase allows for identification of the major cost drivers, and it allows time to influence the design. If not performed early in the concept phase, the opportunity to influence the design of the system diminishes.

This analysis technique is an extremely useful tool when defining the system requirements. It identifies costs that are not proportional to the item or functions worth at an early stage so more appropriate requirements are identified.

### Potential Risks

It is important to have good communication skills within the program group and to inform each member to the insights discovered during this process. If the team does not communicate effectively, the opportunity to maximize the value decreases. Poor communication will also result in additional resources being spent in the value analysis process.

Not looking at all costs of an alternative can be a large risk. It is important to realize that when evaluating alternatives, one should not look only at their direct impact on life cycle cost, but also their indirect impacts on other elements of the system. For example in a military application if an alternative results in the discontinuation of some personnel skill specialty by technological advances, all personnel with that skill will have to be retrained in another skill and therefore cost the government expenses for training new skills. The point here is to look beyond the direct benefits of each alternative because there may be hidden costs associated with that alternative.

## EXAMPLE

For example purposes, this paper will demonstrate the use of life cycle costing techniques for the requirement of having a surface search radar system and a navigation radar system be installed on United States Navy vessels. This example is completely hypothetical but provides a means of presenting the process. It is assumed that some of the steps of this process have already occurred. The system's baseline will initially be defined as follows.

*Description.* The products being designed are both new technological radar systems, one a surface search radar and the other a navigation radar. They will be installed on a new class of United States Navy vessels. There will be a total of 75 new vessels requiring one each of these radar systems. The radar systems will each require a 3-year development period. Delivery of the systems will take place over the following 2 years. Installation of these systems will take 60 days inport. The systems will be designed to have a Mean Time Between Failure (MTBF) of no less than 350 operating hours. The systems will be employed on naval vessels operating in climates ranging from tropical to below freezing. The anticipated annual operating hours are 4000 hours per system. The systems will be designed to have a life of 15 years each.

*Maintenance Planning.* Initially the systems will be installed by the contractor facility. Once installed the systems will employ a three level maintenance concept to include organizational (on-board), intermediate (shore based or a specialized ship facility), and depot level repairs. The systems will be designed to allow for easy removal and replacement at the organizational level with an average replacement time of 20 minutes. The Mean Time To Repair (MTTR) at the intermediate level will be no longer than 1 hour and at the depot no longer than 8 hours.

*Supply Support.* Sufficient spares and repair parts will be stocked aboard each ship to fill a spare availability rate of 93 percent for the radar systems. There will be a delay time of 45 days to receive parts.

*Support Equipment.* Each system will be designed to allow for repair by commercial off the shelf (COTS) equipment.

*Packaging, Handling, Storage and Transportation.* All spare and repair parts will be able to be packaged using standard materials and transported by common modes of transportation.

*Manpower and Personnel.* Each system will require a skilled electronics technician and an operator dedicated to manning the system. The system will be supported by 15 intermediate and 5 depot repair facilities. Each ship will contain one maintenance technician dedicated to maintenance of the radar systems. The ship's operator and maintenance technician will have a tour of duty of 4 years aboard each ship. Each intermediate facility will staff 8 technicians and each depot facility will staff 8 technicians, all of whom will be qualified radar technicians skilled in the repair of radar systems.

*Training.* The training required for each maintenance technician will include basic electronic theory schooling of 150 days and specialized radar training of an additional 90 days. Each operator will require 60 days of radar system training.

After identification of this baseline, cost data for each parameter would be allocated. The cost data established would be based on similar systems, if available, and engineering estimates.

There are many possible alternatives for this example. This paper will focus on the alternative of developing a new radar system that can be utilized as both a surface search radar and a navigation radar. Figure 1 presents the sample baseline worksheet used for the example and Figure 2 presents a sample alternative. The values used are hypothetical and the comments would be more descriptive than

*Alternative Summary.* This alternative will result in a cost savings of $51 million over the specified system life. Even if these numbers are incorrect, with such a large life cycle cost savings, there would still be significant savings. Based on this analysis, this alternative concept should be further evaluated and considered for incorporation.

## SUMMARY

Quite frequently when performing a value analysis, the analysis team gets focused on the acquisition costs and does not consider the effects for the entire life cycle. Utilizing life cycle costing techniques provides a means of aiding the value analysis process to add value to the product or process. In addition, life cycle costing techniques can and should be applied very early in programs to identify high cost drivers of the system. These results will provide the primary focus during the value analysis. The following list provides a recap of the steps in using these techniques.

- Compare the cost of the element of the product or process to its functional worth.
- Identify the items that have the greatest impact on cost. This will tend to be Pareto in nature.
- Perform a functional analysis and analyze those items or functions determined to be the high cost drivers.
- Get the team together and have a brainstorming session to identify alternatives to the high cost drivers.
- Perform a trade study to evaluate the alternatives with respect to the baseline.
- Select the preferred alternative and update the concept to reflect these changes.

When performing the analysis and through out the program it is important to establish a good line of communication between all members of the team. Each individual needs to share insights they gain through the analysis with all the other members of the team. All insights and supporting resources should be documented to provide a "paper trail."

| | | | | | |
|---|---|---|---|---|---|
| **Alternative No.** | | **Baseline** | | **Issue Date:** | 6/25/00 |
| **Short Title:** | | **Baseline** | | **Initiated By:** | John Doe |
| Number of Units | | 75 | | Base Year | 2000 |
| Implementation Year | | 2002 | | Phase Out Year | 2016 |
| | | | Element Cost Change | | Comments |
| *Development* | | | | | |
| Engineering ($) | | | 10,000,000 | | Baseline Data |
| Material ($) | | | | | |
| Software ($) | | | | | |
| *Total Development Change ($)* | | | **10,000,000** | | |
| *Production* | | | | | |
| Unit Cost ($) | | | 2,000,000 | | Baseline Data |
| Support Equipment/Unit ($) | | | 200,000 | | Baseline Data |
| Initial Spares/Unit ($) | | | 200,000 | | Baseline Data |
| Training Equipment/Unit ($) | | | 200,000 | | Baseline Data |
| Technical Documentation ($) | | | 200,000 | | Baseline Data |
| Facility Cost/Unit ($) | | | | | |
| *Total Production Cost Change ($)* | | | **2,800,000** | | |
| *Operating & Support Cost/Unit/Year* | | | | | |
| Operator Manpower $/Yr | | | 400,000 | | Baseline Data |
| Maintenance Manpower $/Yr | | | 400,000 | | Baseline Data |
| Replenishment Spares $/Unit | | | 20,000 | | Baseline Data |
| Technical Documentation Maint ($) | | | 10,000 | | Baseline Data |
| Training Operators $/Yr | | | 40,000 | | Baseline Data |
| Training Maintenace $/Yr | | | 40,000 | | Baseline Data |
| Support Equipment Support/Unit/Yr ($) | | | 20,000 | | Baseline Data |
| Facility Maintenance/Unit/Yr ($) | | | 20,000 | | Baseline Data |
| Transportation $/Yr | | | 4,000 | | Baseline Data |
| Software Maintenance ($) | | | | | |
| *Total O&S Cost Change ($)* | | | **954,000** | | |
| *Disposal* | | | | | |
| Disposal Cost/Unit ($) | | | 2,000 | | Baseline Data |
| Disposal Cost Support Resource ($) | | | | | |
| *Total Disposal Cost Change ($)* | | | **2,000** | | |
| *Cost Change ($) (For Total Population)* | | | **233,356,000** | | Baseline Total Cost |
| | | | | | |

**Figure 1. Sample Baseline Worksheet**

| | | | | |
|---|---|---|---|---|
| **Alternative No.** | 1.1.XXX | | **Date:** | 6/25/00 |
| **Short Title:** | Combine Surf. And Nav. Radars | | **Initiated By:** | John Doe |
| Number of Units | 75 | | Base Year | 2000 |
| Implementation Year | 2002 | | Phase Out Year | 2016 |
| | | Element Cost Change | | Comments |
| *Development* | | | | |
| Engineering ($) | | 5,000,000 | | More costs for design |
| Material ($) | | | | |
| Software ($) | | | | |
| *Total Development Change ($)* | | **5,000,000** | | |
| *Production* | | | | |
| Unit Cost ($) | | 500,000 | | 25% saved from combining |
| Support Equipment/Unit ($) | | 50,000 | | 25% saved from combining |
| Initial Spares/Unit ($) | | 50,000 | | 25% saved from combining |
| Training Equipment/Unit ($) | | 50,000 | | 25% saved from combining |
| Technical Documentation ($) | | 50,000 | | 25% saved from combining |
| Facility Cost/Unit ($) | | | | |
| *Total Production Cost Change ($)* | | **-700,000** | | |
| *Operating & Support Cost/Unit/Year* | | | | |
| Operator Manpower $/Yr | | 100,000 | | 25% saved from combining |
| Maintenance Manpower $/Yr | | 100,000 | | 25% saved from combining |
| Replenishment Spares $/Unit | | 10,000 | | 50% saved from combining |
| Technical Documentation Maint ($) | | 5,000 | | 50% saved from combining |
| Training Operators $/Yr | | 10,000 | | 25% saved from combining |
| Training Maintenace $/Yr | | 10,000 | | 25% saved from combining |
| Support Equipment Support/Unit/Yr ($) | | 10,000 | | 50% saved from combining |
| Facility Maintenance/Unit/Yr ($) | | 10,000 | | 50% saved from combining |
| Transportation $/Yr | | 2,000 | | 50% saved from combining |
| Software Maintenance ($) | | | | |
| *Total O&S Cost Change ($)* | | **-257,000** | | |
| *Disposal* | | | | |
| Disposal Cost/Unit ($) | | 1,000 | | 50% saved from combining |
| Disposal Cost Support Resource ($) | | | | |
| *Total Disposal Cost Change ($)* | | **-1,000** | | |
| *Cost Change ($) (For Total Population)* | | **-51,098,000** | | Total Savings |

**Figure 2. Sample Alternative Worksheet**