Making Business Cases to Support Obsolescence Management

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Abstract

Cost models are needed so that the ramifications of system design, material, technology, part, and architecture decisions on sustainment costs can be clearly understood during decision making, and the value of later management actions can be clearly established. To influence strategic decisions about the management of systems, predictive models are needed that can provide engineers with information that they can use to develop sound proposals (i.e., support for business cases) to influence program-level management.

1. Introduction

Engineers communicate to program-level management every day that the "sky is falling" due to a range of technical and logistical issues (lead-free parts, tin whiskers, counterfeit parts, obsolete parts, etc.), but management is rarely moved to action without either the occurrence of a catastrophic event or a comprehensive quantitative demonstration of the system- or enterprise-level risks posed by the issue.

When determining where to put resources and what problems to focus on, management asks the following questions: 1) Has a serious event occurred in the field due to this problem (loss of life, equipment or mission)? and 2) What future impact will this problem have on me if I don't address it (e.g., cost, availability)?

If a serious event has not occurred, a business case will probably be needed before management is moved to action. While engineers have experience managing systems and know that risks exist, they often lack the ability to articulate the risks and impacts of sustaining systems in terms of life cycle cost and availability metrics that management will understand. As a result, sustaining systems (in particular managing obsolescence) remains a largely reactive activity.

This paper briefly discusses the state of cost modeling for obsolescence management and describes several approaches for performing life cycle cost modeling of system sustainment to support business cases for strategic management. In this paper, DMSMS (Diminishing Manufacturing Sources and Materials Shortages) cost analysis is categorized into two distinct activities: 1) The use of life cycle costing as a factor in planning DMSMS actions (Section 2), and 2) The determination of the value of DMSMS management activities performed (Section 3).

2. Cost as a Factor in DMSMS Planning

Being able to predict the life cycle cost of managing obsolescence within a system is important for two reasons. First it allows an estimation of the cost associated with managing a system in a specific way to be determined as part of the budgeting or bidding process for supporting the system. Secondly, it enables optimization of the management of a system by measuring and trading off the cost impact of multiple management approaches.

Budgeting/Bidding Support

Methods have been developed in [1] to facilitate accurate budgeting or bidding. These methods perform two actions, first they determine the probabilities of using specific resolution activities, and then they predict an application-specific cost of performing the predicted group of resolution activities. Both actions are performed based on practitioner surveys, expert opinion and other historical information. The result is an estimation of the obsolescence management costs for a defined contract period using commonly defined resolution approaches. For organizations that wish to estimate management costs for systems based on prior system management experience, this approach is very valuable. It may be possible to use this approach to perform tradeoffs associated with shifting the resolution approach focus within organizations.

Strategic Planning

Strategic solutions to DMSMS usually involve the insertion of design refreshes into the support life of the system to concurrently manage multiple obsolescence events.[1] Determining when those refreshes are performed (or the frequency of them), what is done to the system at the refreshes, and how the system should be reactively managed between the refreshes is a strategic planning exercise.

Unfortunately strategic solutions to DMSMS problems are hard to sell. Program management struggles with the concept of spending money now to reduce future problems and future spending. However, strategic actions are fundable if convincing business cases can be made.

MOCA [2] is a design refresh planning tool for determining the optimum timing of refreshes within the support life of a system. MOCA's inputs include the system's bill of materials, associated obsolescence forecasts, deployment plans, and sparing requirements. Based on a detailed life cycle cost analysis model, the methodology determines the optimum design refresh plan during the support-life of the product. The design refresh plan consists of the number of design refresh activities, their respective calendar dates and content to minimize the life cycle sustainment cost of the product (alternatively, the optimum frequency of refresh can be found).

A sample result from MOCA is shown in Figure 1. Each of the data points in the graph on the left slide of Figure 1 represents a unique combination of design refresh completion dates (the points are plotted as the mean of the refresh completion dates that make up the plan), each has a an associated life cycle cost. The point circled next to the vertical axis on the graph on the left side of Figure 1 is the solution with no refreshes (all reactive management). When uncertainties in obsolescence dates, demand for future manufacturing and spares, end of support date, and all

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[1] We do not wish to imply that design refreshes are necessarily an economically viable alternative for all systems. In many cases, reactive management (without refreshes) may be the least expensive strategy if it fulfills system constraints.

cost inputs are taken into account, the life cycle cost difference between the two solutions circled in the left graph (these solutions have no refreshes – all lifetime buys and one refresh in 2011 with bridge buys prior to it and lifetime buys after it) is expressed as a distribution of life cycle cost differences (right side of Figure 1). From the graph on the right we can see that the cost avoidance possible when moving from an all reactive solution to a solution with a single refresh in 2011 ranges from $27M to $36M and that we have an 84% confidence that it will be $30M or more. This example result represents an actionable business case result that can be used to sell a future refresh.

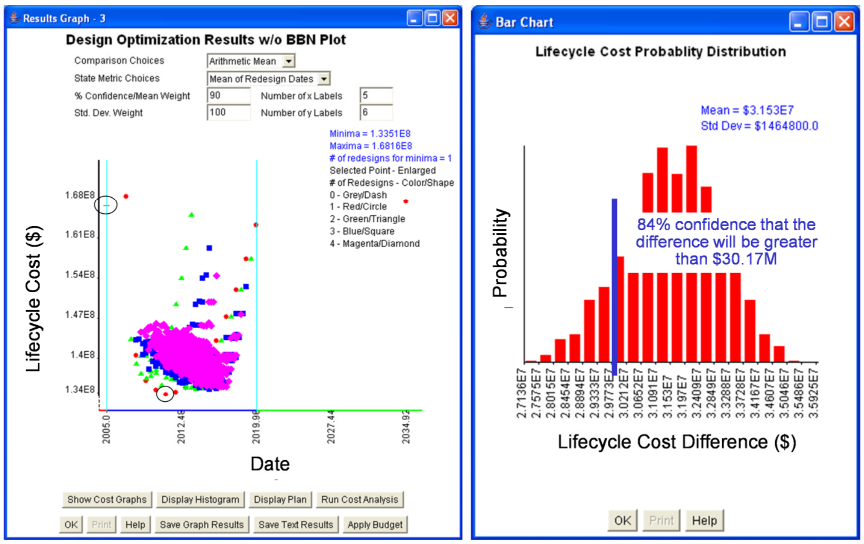


Fig. 1. Example MOCA result with life cycle cost analysis.

Lifetime Buy Optimization

Lifetime buy is one of the most prevalent obsolescence mitigation approaches employed for DMSMS management. Purchasing sufficient parts to meet current and future demands is simpler in theory than practice due to many interacting influences and the complexity of multiple concurrent buys, Figure 2. The lifetime buy problem has two facets, demand forecasting and optimizing the buy quantities based on the demands forecasted.

Stochastic lifetime buy quantity forecasts calculate the quantities of parts necessary to meet a given demand with a specified confidence and generally only treat a single part in isolation. Alternatively, one can calculate the quantities of parts necessary to minimize life cycle cost (depending on how you are penalized for running short or running long on parts these quantities could be different than what simple lifetime buy quantity forecasting tells you to purchase). In order to work the cost minimization problem, multiple factors that contribute to the life cycle cost must be considered: procurement cost, inventory cost, disposition cost, and penalty cost. Each of these costs has its own contributing elements. For example, penalty cost is a summation of the alternative sources availability cost, system unavailability cost, inventory shortage cost, equal run-out cost, and more.

Lifetime buy optimization is more generally referred to as the final order problem, which is a special case of the of the newsvendor problem.[2] Several models specific to DMSMS, [3], and outside of the DMSMS community have appeared for costing lifetime buys, e.g., [4].

[2] This problem seeks to find the optimal inventory level for an asset given an uncertain demand and unequal costs for overstock and understock.

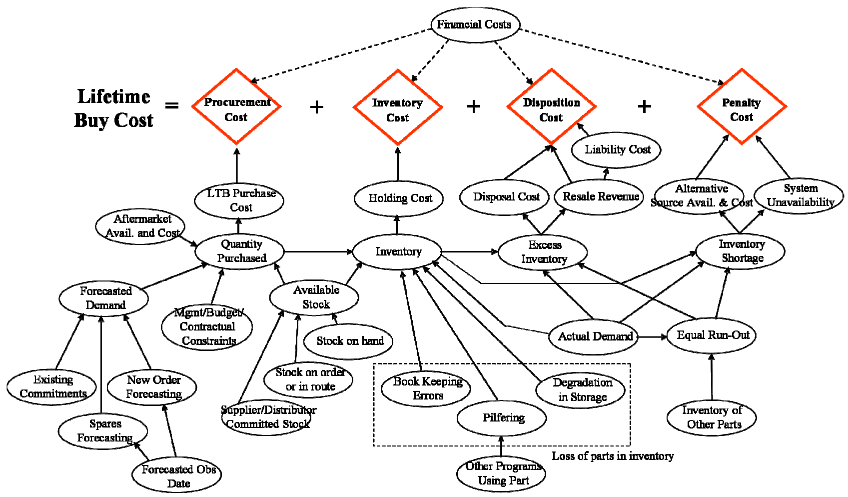


Fig. 2. Lifetime buy costs, [3].

Sourcing for Long Sustainment Life Systems

Existing methods used to study part sourcing decisions are procurement-centric where cost tradeoffs focus on part pricing, negotiation practices and purchase volumes. These methods are commonplace in strategic part management for short life cycle products; however, they offer only a limited view when assessing parts used in long life cycle products. Procurement-driven decision-making provides little to no insight into the accumulation of life cycle cost, which can be significantly larger than procurement costs in long life cycle products.

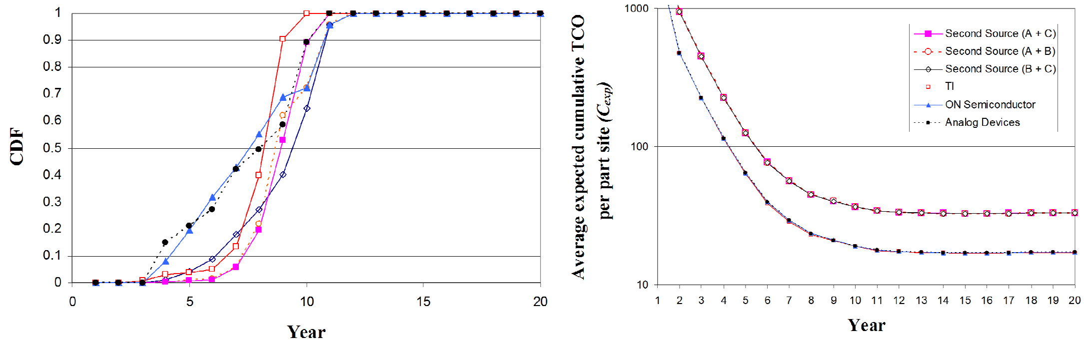
The value of second sourcing for long field life products has been addressed in [5] and [6]; in [6] a method to quantify obsolescence risk in order to compare sourcing strategies of electronic parts used in long life cycle products and systems is presented. This method utilizes a part total cost of ownership model (TCO) and historic obsolescence data to quantify obsolescence risk, which is suitable for comparing sourcing strategies over long life cycles. Figure 3 (left side) shows the cumulative distribution functions (CDFs) of obsolescence risk for three single-source suppliers and the combined CDFs for three second-source combinations of the suppliers. Applying the sourcing risk within a total cost of ownership model for the part generates the cost curves in the right side of Figure 3. In this example, the savings (over single sourcing) associated with extending the effective procurement life of the part through second sourcing is negated by the qualification and support cost associated with using a second supplier.

In the example shown here there is no way to make a case to second source this part solely based on obsolescence risk mitigation if one has to pay to qualify both suppliers and both parts for this single application. However, depending on the part and other risk reduction motivations second sourcing may be viable.

3. Determining the Value of DMSMS Management

Determining the value of DMSMS management activities is an important metric for establishing the value of DMSMS management organizations.

The value of DMSMS management activities is usually quantified as a cost avoidance. "Cost avoidance is a cost reduction that results from a spend that is lower than the spend that would have otherwise been required if the cost avoidance exercise had not been undertaken" [7]. A simpler definition is a reduction in costs that have to be paid in the future to sustain the system. While management can (with a bit of effort) understand cost avoidance, it is not always a



Average expected cumulative TCO after 20 years @ $0.5/part:
TI + ON Semiconductor = $29.70 per part site
ON Semiconductor + Analog Devices = $30.24 per part site
TI + Analog Devices = $29.58 per part site

Fig. 3. (left) CDF of obsolescence likelihood by sourcing strategy, and (right) annual expected cumulative TCO per part site over time by sourcing strategy (price independent case for the linear regulator example) [6].

"sellable" quantity. Requesting resources to create a cost avoidance is not as persuasive as making a cost savings or a return on investment argument.

Conventional Cost Avoidance Calculations

The most common cost avoidance approach used by DMSMS management organizations is based on a bookkeeping approach first articulated in a DMEA report written by ARINC from 1999 [8] and is also articulated in the 2010 versions of the DMEA DMSMS cost resolution numbers [9], SD-22 [10], and UK MOD documents [11]. In this approach, Figure 4, the cost avoidance associated with the chosen mitigation solution is equal to the difference between the cost of your solution and the next most expensive mitigation option.

To establish the total cost avoidance enabled by a DMSMS management organization during some selected time period, the number of occurrences of each resolution are multiplied by their respective cost avoidance values (the difference between the average non-recurring costs of the selected approach and the next most expensive approach) and summed. The result is often reported as the value that the DMSMS management organization generates.

The question is, what does the $3.5M (from Figure 4) mean? Is this real money? Would the life cycle cost of the system actually have been $3.5M higher if the DMSMS management organization had not existed? For that matter, is $3.5M in Lockheed Martin's Aegis Program valued the same as $3.5M in Lockheed Martin's C-130 Program?

The cost avoidance calculated using the conventional approach is the cost avoidance associated with the DMSMS program if not having a DMSMS program resulted in the resolution of each individual DMSMS case using the "next most expensive" resolution approach. The conventional approach assumes that the role of the DMSMS program is to move each individual part resolution to the next less expensive resolution. So, the cost avoidance calculated the conventional way is relative to some less sophisticated DMSMS management program that would have resolved each DMSMS case using the "next most expensive resolution".

Some additional observations on the conventional cost avoidance calculation include:

Non-Recurring Cost Factors

Resolution	NRE Cost
Existing Stock	0
Reclamation	2000
Alternate	7000
Substitute	20,000
Aftermarket	52,000
Emulation	75,000
Redesign-Minor	122,000
Redesign-Major	450,000

Cost Avoidance Calculation

Next most costly feasible resolution (columns); Resolution chosen (rows)

Resolution	Cost	Reclamation	Alternate	Substitute	Aftermarket	Emulation	Redesign -Minor	Redesign-Major
Existing Stock		2000	7000	20,000	52,000	75,000	122,000	450,000
Reclamation	2000		5000	18,000	50,000	73,000	120,000	448,000
Alternate	7000			13,000	45,000	68,000	115,000	443,000
Substitute	20,000				32,000	55,000	102,000	430,000
Aftermarket	52,000					23,000	70,000	398,000
Emulation	75,000						47,000	375,000
Redesign-Minor	122,000							328,000
Redesign-Major	450,000							

=7000-2000

=52,000-20,000

Example Organizational Cost Avoidance Calculation

Resolution	Number of Occurrences	Cost Avoidance	Total Cost Avoidance
Existing Stock	8	2000	16,000
Reclamation	0	5000	0
Alternate	123	13,000	1,599,000
Substitute	35	32,000	1,120,000
Aftermarket	9	23,000	207,000
Emulation	5	47,000	235,000
Redesign-Minor	1	328,000	328,000
Redesign-Major	0	0	0
Total	181		3,505,000

Reported cost avoidance

Fig. 4. Conventional cost avoidance analysis.

- The conventional calculation has no mechanism to accommodate resolution actions that have either no effect or a negative effect, i.e., every resolved case results in a positive cost avoidance, which is probably not true.
- The conventional cost avoidance calculation approach captures how hard a DMSMS management group has worked, but not how smart, i.e., the greater the quantity of individual resolutions the faster the cost avoidance accumulates. In general, the conventional cost avoidance calculation approach rewards only reactive management.
- The conventional cost avoidance calculation has no way of valuing strategic DMSMS management approaches (i.e., refreshes or other actions that solve future problems), therefore DMSMS management groups who are measured or justified based on their conventionally calculated cost avoidance have no incentive to consider strategic solutions.

Return on Investment (ROI) Calculation

Requesting resources to create a cost avoidance is not as persuasive as making a return on investment (ROI) argument. Because of the problems with the conventional cost avoidance calculation articulated in the last section and the need for more persuasive arguments to management, ROI based evaluation methods have been developed.

ROI is a useful quantitative means of gauging the economic merits of a decision. ROI measures the cost savings, profit, or cost avoidance that result from a given use of money. In general, ROI is the ratio of gain to investment. An ROI computed over a product's life cycle is given by,

$$\text{ROI} = \frac{\text{Cost Avoidance} - \text{Investment}}{\text{Investment}} \tag{1}$$

ROI > 0 indicates that there is a cost benefit. Constructing a business case for an activity does not necessarily require that the ROI be greater than zero; in some cases, the value of an activity is not fully quantifiable in monetary terms, or the activity is necessary in order to meet a system requirement that could not otherwise be attained, such as an availability requirement.

An ROI-based valuation of DMSMS management organizational value is detailed in Appendix C of [9] – a sample result from this approach is shown in Figure 5. Unlike the conventional cost avoidance calculation, this approach results in the calculation of numbers that have real meanings, is independent of program-specific value of money, and can account for resolutions that treat multiple parts concurrently.

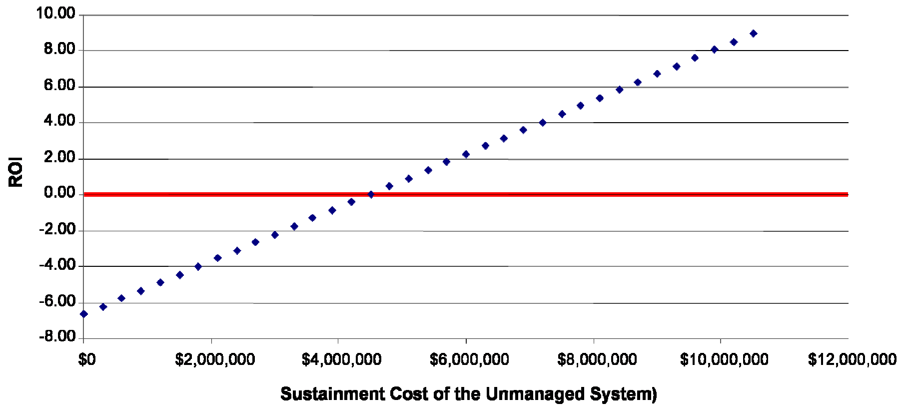


Fig. 5. Return on investment (ROI) calculation for a DMSMS management program, [9].

4. Discussion

Unfortunately engineers often lack the ability and tools to provide the appropriate business case support for their proposals.

Viable life cycle cost modeling is at the core of business case support. Determining the best action to take depends, in large part, on the life cycle cost ramifications of the decision. Ideally one should have a method of determining the total cost of ownership of system and part-specific sustainment decisions made.

There are numerous issues that have to be addressed in order to perform viable life cycle cost modeling and potentially build actionable business cases to support DMSMS management. Some of these include:

- Hardware and software – DMSMS management is not just a hardware management problem. Both types of cost estimations (Sections 2 and 3) need to address the cost of managing software obsolescence concurrently with hardware obsolescence.
- Sourcing disruptions – Obsolescence isn't the only disruption in sourcing parts for long periods of time. Unfortunately, several global issues have recently conspired to complicate this issue in the shorter term – the emergence from a worldwide economic recession and the earthquake in Japan. Right now, many electronic part suppliers have either not fully ramped up from production cutbacks made during the recession or they are hindered by the supply chain disruptions in Japan. As a result, low-volume customers get to go the "back of the line" for their parts (i.e., this is an allocation problem). Some non-obsolete electronic parts are currently quoting 18-24 month lead times.
- Constraints – Just because you can model a sustainment approach does not mean that people can actually perform it. The constraints that can be applied in strategic planning of systems include budget, timing and policy. See [12] for a discussion of the inclusion of constraints in the refresh planning process.
- Outcome/availability-based contracts – Outcome-based contracts (also called performance based logistics in the U.S.) are changing how the OEMs for sustainment-dominated products do business. Strategic management concerns will make more sense

to the OEMs as real outcome-based contracts are transacted, however, a host of new problems come to the forefront, e.g., how do you make a lifetime buy when your outcome-based contract only pays you quarterly?

- Cost of money – DMSMS management takes place over long periods of time. Therefore, cost of money has to be considered. This is relevant when tradeoffs include lifetime buys of parts that require large outlays of capital early in a program to acquire inventories of parts that will not be used for many years. Also realize that cost of money is not a constant, you can't just pick today's number and assume it for the next 20 years.
- Relative versus absolute costs – Absolute costs are much more difficult to accurately determine than relative costs. For example, calculating the difference between the cases need not include the "wash" costs (costs that are the same for both cases). For example, the absolute costs on the vertical axes in the graph on the left side of Figure 1 are not meaningful, but the difference between two cases is meaningful.
- Concurrent consideration of cost and availability – Just like cost and yield cannot be separated in manufacturing assessment; cost and availability are coupled together when the sustainment of systems is considered.

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