LIFE-CYCLE COSTING: AN EFFECTIVE TOOL FOR TOTAL ASSET MANAGEMENT

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Contents

Summary

Our decision-making processes through the years have been based primarily on "short-term" time horizons, and the design, development, and production (or construction) of new systems have only considered the initial procurement and acquisition costs. The consequences of this approach have been rather costly, since experience has indicated that many of the engineering and management decisions made in the early phases of the system life cycle have had a great impact on the sustaining operation and maintenance support of that system later on. Further, these "downstream" activities often constitute a large percentage of the total cost of a system. Thus, it is essential that we extend our planning horizon and decision-making to address system requirements from a total *life-cycle* perspective from the beginning. The purpose here is to identify the need for and applications of life-cycle costing, describe the life-cycle cost analysis process, and to discuss some of the benefits from its application.

1. The Need for Life-Cycle Costing

Do you know the actual true cost of your system? Can you identify the cost of each functional element or activity? Are you aware of the high-cost contributors? Can you identify the causes for these high-cost areas? Can you truly assess the risks associated with the development, production, operation, support, and retirement of your system and its components? The answer to these and many questions of a related nature is a definite "NO!"

A *system* in this instance constitutes a complex combination of resources in the form of materials, equipment, software, facilities, humans, computer resources, data and information, integrated in such a manner in order to accomplish some designated function in response to an identified need. There are many categories of systems, including electrical and electronic systems, transportation systems, communication systems, production or manufacturing systems, information processing systems, and the like. Included within the structure of these "systems" are not only those elements that are directly involved in the accomplishment of a give mission scenario, but also the maintenance and support infrastructure that is necessary to ensure that the system will be able to successfully meet its objectives. If one is to manage all *assets* in an effective and efficient manner, then it is necessary to view these assets in the context of a system and in terms of its life cycle.

In recent years, experience has indicated that the complexity and the costs of systems, in general, have been increasing! A combination of introducing new technologies in response to a constantly changing set of performance requirements, the increased external social and political pressures associated with environmental issues, the requirements to reduce the time that it takes to design and produce a new system, and the requirement to extend the life cycle of systems already in operation constitutes a major challenge! Further, many of the systems currently in use today are not adequately responding to the needs of the consumer, nor are they cost-effective in terms of their operation and support. This is occurring at a time when available resources are dwindling and international competition is increasing worldwide.

In addressing the issue of cost-effectiveness, one often finds that there is a lack of total cost visibility, as illustrated by the "iceberg" effect in Figure 1. For many systems, the costs associated with design, production, the initial procurement of capital items, etc., are relatively well known. We deal with, and make decisions based on, these costs on a regular basis. However, the costs associated with utilization and the maintenance and support of the system throughout its planned life cycle are somewhat hidden. In essence, we have been successful in addressing the short-term aspects of cost, but have not been very responsive to the long-term effects.

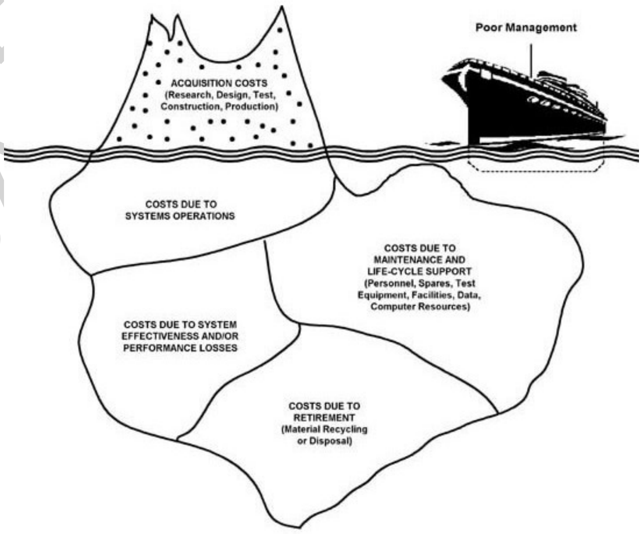

Figure 1: Total Cost Visibility

At the same time, experience has indicated that a large percentage of the total life-cycle cost for a given system is attributed to operating and maintenance activities (e.g., up to 70 per cent to 75 per cent for some systems). When looking at "cause-and-effect" relationships, one often finds that a significant portion of this cost stems from the consequences of decisions made during the early phases of advance planning and conceptual design. Decisions pertaining to the design of a process, the selection of a technology, the selection of materials, the selection of an item of capital equipment, equipment packaging schemes, decisions pertaining the use of humans versus the incorporation of automation, etc., have a great impact on the "downstream" costs and, thus, on the life-cycle cost. Additionally, the ultimate maintenance and support infrastructure selected for a system throughout its period of utilization can significantly impact the overall cost-effectiveness of that system. There are many interactions that can occur when dealing with systems and their respective elements. As illustrated in Figure 2, it is at the early stages in a program where the greatest gains can be realized in terms of the ultimate life-cycle cost of a given system.

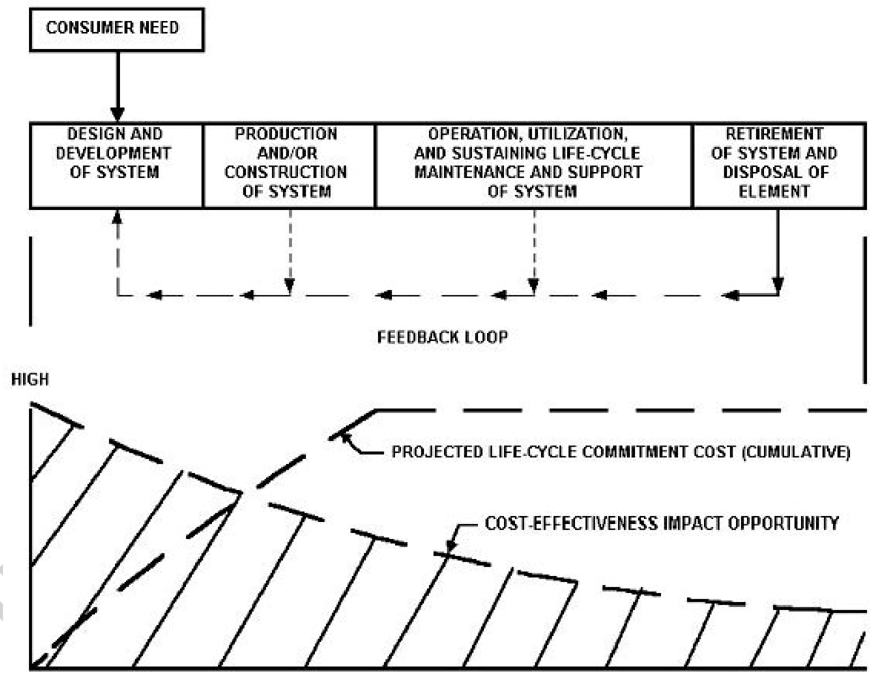

Figure 2: Opportunity for Impacting Cost-Effectiveness

Given these relationships in today's environment where available resources are dwindling and international competition is increasing, there is a need to re-evaluate our methods used not only in the design, development, and production of new systems but in the sustaining operation and maintenance of existing systems that are currently in use. Addressing system requirements from a total life-cycle perspective is essential, and the application of life-cycle cost analysis methods can be highly beneficial in facilitating this objective.

2. Application of Life-Cycle Costing Methods

The application of life-cycle costing methods can be effectively implemented in:

1. The design, development, and production (or construction) of a NEW system. Every time there is a newly identified need, there is a new system requirement. Further, there are a series of top-down steps required in evolving from the identified need to the delivery of the ultimate system for operational use (i.e., definition of system requirements, functional analysis and requirements allocation, trade-off studies and design optimization, synthesis, and test and evaluation). The objective is to establish, from a top-down perspective, a quantitative "design-to-life-cycle-cost" requirement, and then design, build, and operate to meet this requirement. This must be accomplished from the beginning, as illustrated in Figure 2.
2. The evaluation of an EXISTING system capability, with the objective of implementing a "continuous-product/process-improvement" approach to increase the effectiveness while reducing the life-cycle cost of that system. This involves the initial determination of some quantitative goal(s) based on a defined need (i.e., the establishment of some "metric" for benchmarking purposes), describing the system and its processes in functional terms, collecting the appropriate data and identifying the resources being consumed in accomplishing the various functions, identifying the high-cost contributors and determining the cause-and-effect relationships, and initiating the necessary recommendation(s) for improvement of the system and its operation. This is an on-going iterative process.

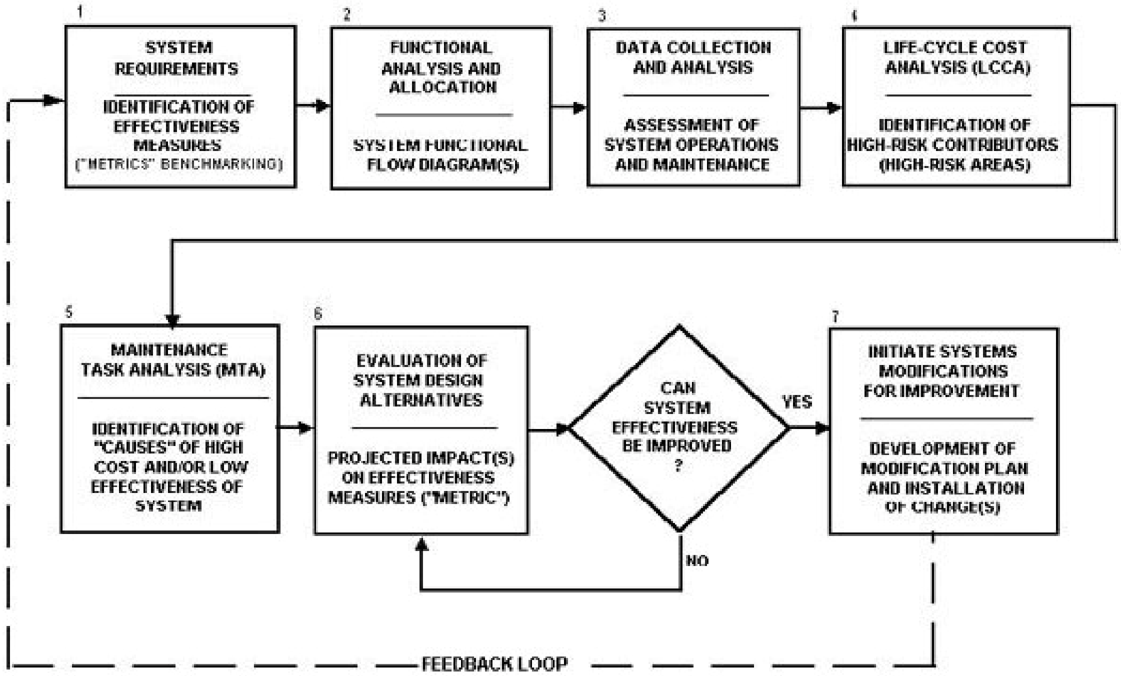

Figure 3: System Evaluation and Improvement Process

The process recommended for both applications is illustrated in Figure 3. One would commence with the establishment of some initially-specified system requirement and then proceed through the steps shown, "tailored" to the requirements of the specific system evaluation effort.

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Bibliography

Blanchard, B .S. (2004). *Logistics Engineering and Management.* 6th Ed.. Upper Saddle River, NJ: Prentice-Hall. [A basic text on logistics and logistic cost analysis.]

Blanchard, B .S., and W. J. Fabrycky (2006). *Systems Engineering And Analysis.* 4th Ed. Upper Saddle River, NJ: Prentice-Hall. [A basic text in systems engineering and analysis.]

Canada, J. R., W. G. Sullivan, and J. A. White (1996). *Capital Investment Analysis for Engineering and Management.* 2nd ed. Upper Saddle River, NJ: Prentice-Hall. [An excellent systems engineering and analysis based discussion of financial analysis.]

Sage, A. P., and W. B. Rouse (Eds.) (1999). *Handbook of Systems Engineering and Management*, John Wiley and Sons, New York. [A handbook of the methods, processes, and management efforts in systems engineering with chapters relating to economic considerations.]

Thuesen, G. J., and W. J. Fabrycky (2001). *Engineering Economy.* 9th Ed. Upper Saddle River, NJ: Prentice-Hall. [A classic work in engineering economics.]

Biographical Sketch

Benjamin S. Blanchard ,is a Professor of Engineering-Emeritus at Virginia Polytechnic Institute & State University and a consultant in such fields as systems engineering, reliability and maintainability, maintenance, logistics, and life-cycle costing. He is also currently serving as an Adjunct Professor of Systems Engineering for Virginia Tech. Prior to his current role, he served as Assistant Dean of Engineering for Public Service, College of Engineering (until June 1995), and as Chairman of the Systems Engineering Graduate Program, Virginia Tech (1979-1996). He has taught courses in systems engineering, reliability and maintainability, and logistics engineering. Before joining Virginia Tech in 1970, he was employed in industry for 17 years where he served in the capacity of design engineer, field service engineer, staff engineer, and engineering manager (Boeing Airplane Co., Sanders Associates, Bendix Corp., and General Dynamics Corp.). In conjunction, he also served as an Adjunct Professor for several years at the Rochester Institute of Technology (1966-1969). Prior to his industry career, he was an electronics maintenance officer in the U.S. Air Force.Professor Blanchard's academic background includes a BS degree in Civil Engineering, graduate course work in Electrical Engineering, and a MBA degree (through an Executive Development Program at the University of Rochester). He has authored four textbooks, and has co-authored five additional texts. He has published numerous journal articles and has lectured extensively throughout Africa, Asia, Australia, Europe, and North America. Professor Blanchard is a Charter member, Fellow, CPL, member of the Board of Advisors, and past-president of the International Society of Logistics (SOLE); a Fellow of the International Council on Systems Engineering (INCOSE); and a member of several other professional organizations (ASEE, CSCMP, IIE, IEEE, and NDIA.