The Role of Value Engineering In Affordability Analysis

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ABSTRACT

The purpose of this white paper is to describe the role Value Engineering plays within the affordability process. The paper is not a step by step "How To Conduct or Execute" Value Engineering (VE) but is a discussion of the context, input, setup, execution hints, and output of Value Engineering in support of conducting affordability analysis and management. ***As such it is important to understand the concept of affordability within the Systems Engineering paradigm***. This paper is designed to provide insights, lessons learned, and suggestions for using Value Engineering in the affordability process.

Affordability is that characteristic of a product or service that enables consumers to

- Procure it when they need it
- Use it to meet their performance requirements at a level of quality that they demand
- Use it whenever they need it over the expected life span of the product or service
- Procure it for a reasonable cost that falls within their budget for all needed products or services

Figure 1 Affordability Characteristics

Affordability is an abstract term that most people think they understand but have difficulty defining or explaining. The Department of Defense acquisition regulations require program managers to address affordability, detail affordability constraints, and achieve affordability during the procurement of new systems without providing a definition or even a clear idea of what affordability means. The Department of Defense has difficulty in defining affordability and therefore, it is no wonder that program managers have difficulty understanding or explaining the term. Perhaps the process of selecting an affordable product or service will yield some insights.

Definition of Affordability

The Department of Defense defines affordability as the degree to which the life-cycle cost of an acquisition program is in consonance with the long-range investment and force structure plans of the Department of Defense or individual DOD Components. Affordability procedures establish the basis for fostering greater program stability through the assessment of program affordability and the determination of affordability constraints.

- Components shall plan programs consistent with the DOD Strategic Plan, and based on realistic projections of likely funding available in the future years
- Affordability shall be assessed at each milestone decision point beginning with program initiation-usually-MILESTONE 1.
- Cost Analysis Improvement Group (CAIG) reviews shall be used to ensure cost data of sufficient accuracy is available to support reasonable judgments on affordability for ACAT 1 programs.

This definition implies the concept of best value. Best value in this context is achieved by identifying and accepting the most affordable, feasible, and effective system or alternative. The need to evaluate and assign a best value is essential to both the government (DoD) and the contractors supplying systems / alternatives to the government. Having the ability to quantify or evaluate best value is the primary means by which the government will determine the best use of acquisition funds / budget. Best value to achieve affordability also implies achieving a minimum acceptable mission capability at the least cost. This does not necessarily mean “a cheap” or a singular system solution. Acceptable mission capability may be a very high requirement with rigorous demands and specifications. Traditionally meeting these demands were focused on building “A” system to meet this need. However, the need to create an affordable solution requires the war fighting and acquisition communities to see affordability and cost in a broader perspective.

Figure 2 suggests that creating affordable solutions requires the war fighter, acquisition agent, and the contractor / supplier to consider to seek requirements satisfaction not in a self-contained single system solution but to think in terms of capabilities. By focusing on capabilities and not system solutions allows the program to seek cost effective solutions which can be met by a single system or its interaction within a system of systems or even by distributing the requirement.

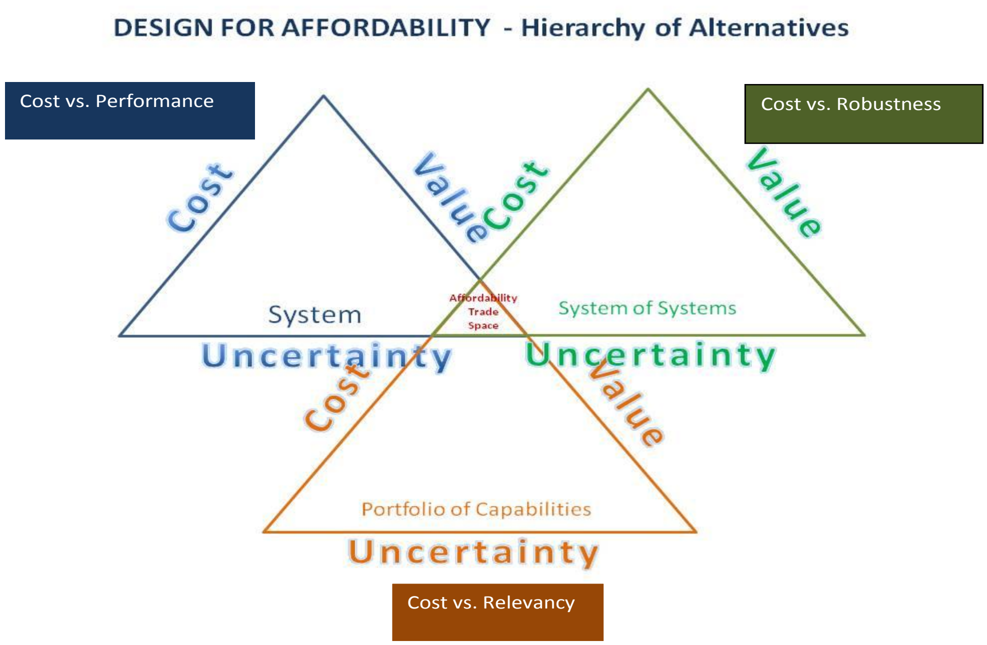

Figure 2 Affordability Context of Best Value

In order to allocate capabilities to a system, system of systems, or a portfolio of systems the concept of best value should be introduced. Best value in this context is achieved by identifying and accepting the most affordable, feasible, and effective system(s), combination of systems or alternative approaches (materiel and operational). The need to evaluate and assign a best value is essential to both the government (DoD) and the contractors supplying systems / alternatives to the government. Having the ability to quantify or evaluate best value is the primary means by which the government will determine the best use of acquisition funds / budget. So how does a program manager, or government official know that they have an affordable solution? They will recognize an affordable solution when they can judge benefit in accordance with their predetermined value scale applied to performance, cost and program executability.

Of course, this definition is from the customer's point of view. Note that while it includes the purchase price and implies an ability to pay that price, it also covers the performance and availability requirements of the product or service. Regardless of price, if a product or service will not respond to the buyer's needs or will not be available when they need it, they can't afford it.

Relationship of Affordability in the Systems Engineering Process

"WHY"
AFFORDABILITY IS A SYSTEMS ENGINEERING METRIC

- **Because affordability is a decision making tool – these methodologies will support selection of the most affordable technologies and systems.**
- **Because affordability can be improved, measured and predicted – these techniques enable analysts to forecast expected affordability of alternative technologies and systems, and to measure improvement in affordability of a given system**
- **Provides a structures analytical path from determining requirements to fielding affordable systems.**
- **Conducting research into the concepts of affordability and methods to implement the approach.**
- **Establishes a foundations for creating Affordability Systems Engineering Science.**
- **Initiates research of Complexity Sciences to understand links between fitness and affordability.**
- **Investigation of game theoretical modeling and other advanced Systems Engineering concepts to focus on System thrusts that will leverage significant downstream system affordability.**

Figure 3 Affordability as a Systems Engineering Metric (Redman, 2011)

Systems engineering is both a technical and management process. It is a discipline that ties together all aspects of a program to assure that the individual parts assemblies, subsystems, support equipment and associated operational equipment will effectively function as intended in the operational environment. It also is a logical sequence of activities and decisions transforming an operational need into a description of system performance parameters as well as a preferred system configuration. Earlier, affordability was defined using Webster and the DOD from the customer point of view specifically DoD. However to fully appreciate the role of affordability in the design production and fielding of a system one also defined affordability from the contractor's/producer's point of view. From the contractor's point of view, affordability is that characteristic of a product or services that:

CONTRACTOR VIEW OF AFFORDABILITY

- Makes it available when the customer initially needs it
- Enables it to meet customers' performance requirements at a level of quality they demand
- Makes it available whenever customers need it during its expected life span (life-cycle)
- Allows customers to fit it into their budget for all competing products or services

Figure 4 Contractor View

The contractor's view of affordability appears to be a mirror image of affordability from the customer's point of view. However, the contractor is faced with satisfying many customers. Each contractor wants many potential customers, each with unique requirements, to select that one available alternative. On the other hand, each customer wants to select one affordable alternative from many competing contractors.

The answer to the contractors' dilemma may be in the identification of general affordability attributes with which all (or at least many) customers can identify. Several candidate attributes immediately come to mind; inherent adaptability to a wide range of operating scenarios, self-adjustment to physical or environmental changes, and minimum consumption of resources, to name a few. Although these are general types of attributes there is an affordability process that follows closely to the definition for the contractor.

Although DoD literature reads as if there is a well defined step by step process flow with an input - process - output structure for affordability analysis, the truth is that the assessment of affordability is more akin to a framework than a process flow. The affordability process (framework) plays a key role in the rationalization of requirements and thus capabilities. Program Affordability Assessment is formally conducted and reported out for Major Defense Acquisition Programs as part of Milestones B and C of the DoD Acquisition Life Cycle[1]. The purpose of the assessment is to demonstrate that the program is executable in terms of funding and manpower. This requirement, on the surface, appears to be more about management of the program's execution than the inherent affordability of the system. However, embedded in this

[1] Defense Acquisition Guidebook, Table 3 Regulatory Requirements Applicable to All Acquisition Programs Retrieved July 20, 2012, from https://acc.dau.mil/CommunityBrowser.aspx?id=332546

regulatory view is the need to apply affordability analysis with its associated techniques, such as Value Engineering, to assist in the assessment of the program's affordability? The application of Value Engineering within this context is to identify and quantify the greatest functionality for the least cost or expense. Figure 5 shows the temporal application of Value Engineering in relation to key Systems Engineering Technical Reviews and the required Affordability Assessments. It is the author's contention that Value Engineering in support of affordability analysis is achieved through applying VE techniques to processes / products associated with each of the key technical reviews. So how the concept of affordability used is and what roll does Value Engineering play in the analysis of a program's affordability?

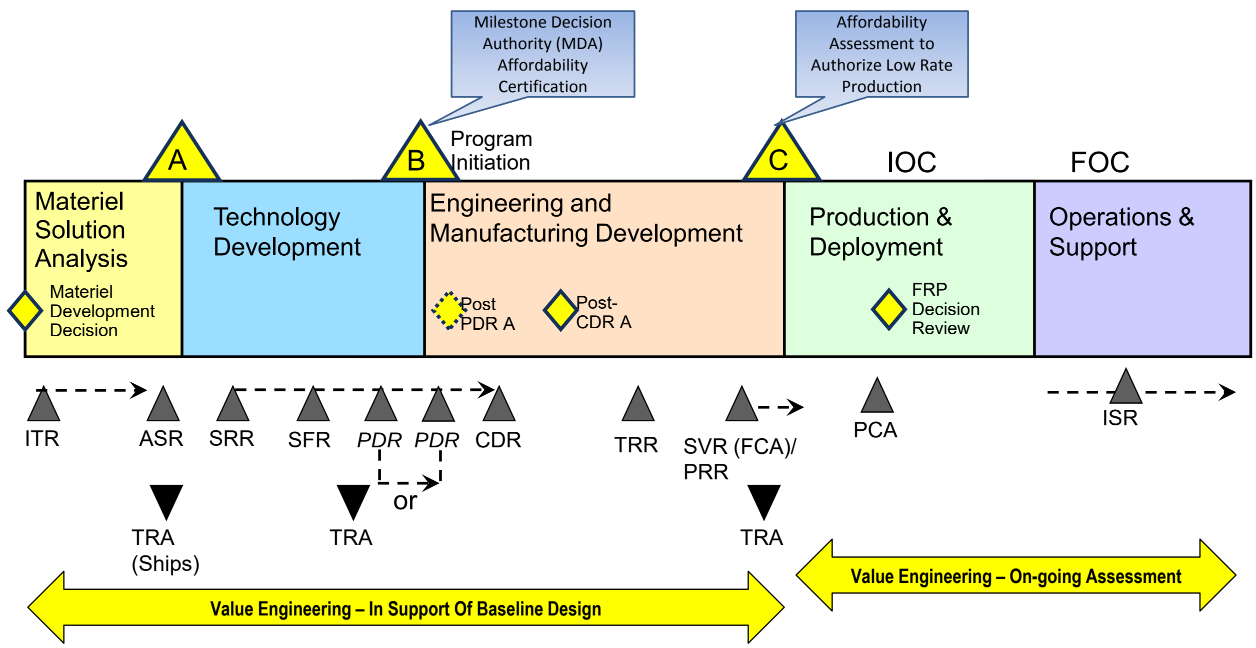

Figure 5 VE Relation To Systems Engineering Technical Reviews[2]

Although Value Engineering is applicable at any point in the life cycle, the earlier VE can be applied to a program the greater is the potential for cost savings. Value Engineering supports two of five major affordability areas of interest; the setting of design goals, and understanding systems requirements versus systems affordability. The setting of design goals may be

[2] Reviews

Initial Technical Review (ITR)
Alternative Systems Review (ASR)
Systems Requirements Review (SRR)
System Functional Review (SFR)
Preliminary Design Review (PDR)
Critical Design Review (CDR)
Post-PDR Assessment (Post-PDRA)
Post-CDR Assessment (PCDRA)
Test Readiness Review (TRR)
System Verification Review (SVR)
Functional Configuration Audit (FCA)
Production Readiness Review (PDR)
Operational Test Readiness Review (OTRR)
Physical Configuration Audit (PCA)
Technology Readiness Assessment (TRA)
In-Service Review (ISR)

accomplished at the top level of the system, as part of an architecture study, or evaluation of subsystems. The application of Value Engineering techniques to requirements analysis can be in the form of supporting the performance of economic analysis, or establishing Total Ownership Costs, Cost As Independent Variable Analysis, Design To Life Cycle Cost or Design To Cost program. How and when Value Engineering is applied is dictated by the Technical Review being supported.

Value Engineering Short Primer

Value Engineering is an organized/systematic approach that analyzes the functions of systems, equipment, facilities, services, and supplies to ensure they achieve their essential functions at the lowest life-cycle cost consistent with required performance, reliability, quality, and safety. (Engineering, 2011)[3] Value Engineering is a product development discipline-approach-methodology that is nestled into a few industrial pockets years ago and, aside from some automotive or precision machine design pockets where it persists, it seems to have gone unnoticed or long forgotten by many businesses. Below is a brief glance at the practice of Value Engineering and what it has to offer designers.

The primary focus of Value Engineering is assuring that the greatest functionality is provided for the least cost or expense, to maximize value[4]. Value Engineering is defined as a systematic process of review and analysis of a project, during the concept and design phases, by a multidiscipline team of persons not involved in the project that is conducted to provide recommendations for:

1. Attaining the needed functions safely, reliably, efficiently, and at the lowest overall cost;
2. Improving the value and quality of the project
3. Reducing the time to complete the project. (Administration, 2012)

Like many techniques or methodologies, it consists of a problem solving approach or “job plan” and a set of tools and skills. In this way, it is very similar to Design for Six Sigma or Lean

[3] The original definition that the OSD handbook uses is from Jay Mandelbaum and Danny L. Reed, *Value Engineering Handbook*, IDA Paper P-4144 (Alexandria, VA: Institute for Defense Analyses, September 2006) The IDA paper was the first major update of this material. The OSD document is an expanded version of that paper.

[4] The authors defined value as a ratio or relationship of cost to function. How is that measured and are there certain norms or nominal values we should seek? There needs to be a component of functional value measurement. Value measurement is closely aligned to decision analysis. It is the means by which the analyst makes a differentiation between criteria used to make a decision. What decision process does the analyst conducting Value Engineering use to make these value decisions? I don’t think we explain function to value relationship well in the paper. I am more familiar with Multi Criteria Analysis, an evaluation process in which value elicitation is associated with the concept of incorporating analyst / stakeholder’s preferences via the application of weights to decision criteria. The weighting is the quantification of the relative importance of one decision criteria versus another for use in making judgments regarding benefit. Weights are applied to decision criteria to execute tradeoffs between multiple objectives, and to incorporate subjective judgment. This is less true in Value Engineering. The function being analyzed becomes the measure of value. But this is an elusive concept. Who is to say if the function is worthwhile or not and to what degree. What means of value judgment of function to cost is to be used? Value Engineering will assist in helping set boundaries around this question.

Product Development since we learn and implement Value Engineering the same way we learn other methodologies and programs.

Generally, Value Engineering is broken into 3 "studies" that organize the overall "job plan" or problem-solving approach. They are as follows.

- Pre-Study: collecting customer information, defining scope, and assembling a team and resources
- Value Study: the problem solving step, including product design
- Post-Study: the execution and post-implementation data review activities

The Value Study steps as shown in Figure 6 are where the real engineering and problem solving activities take place. It follows a problem solving approach expressed as follows.

- Orientation Phase: prepare for the value analysis by refining the problem statement organizing for the conduct of the analysis
- Information Phase: gathering data to understand the problem and aid in design
- Function Analysis Phase: understand the necessary or desired functions and the worth or importance of each
- Creative Phase: generate ideas to address each function and solve the problem(s)
- Evaluation Phase: rank and assess the ideas and select the most promising solutions
- Development Phase: design and develop and test the product or solution
- Presentation Phase: get buy-in and approval to execute the solution (preferred to as the "Decision Point")
- Implementation: monitor the approval process and implementation plan. The eight steps of the Value Study basically describe any product design and development process.

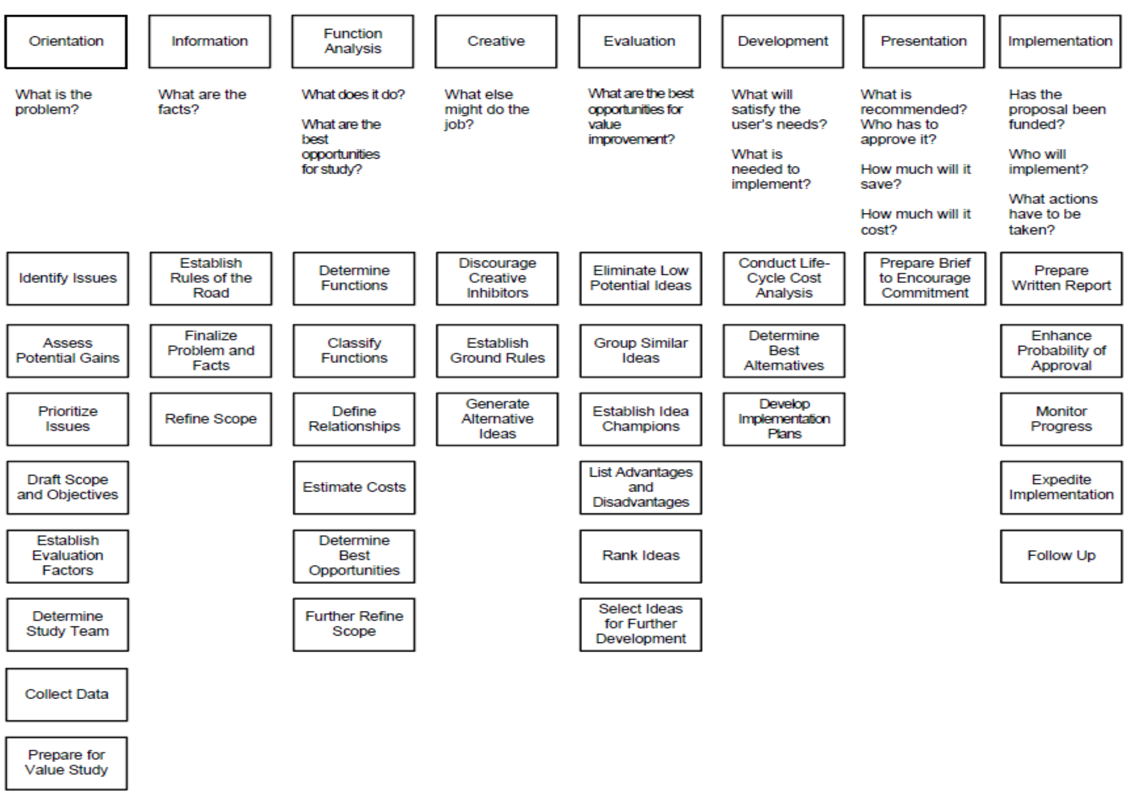

Figure 6 VE Job Plan Phases (Engineering, 2011)

Together with the Pre- and Post-Study steps the job plan basically describes most "Phase Gate" or "Stage Gate" product development processes. Generally these eight phases are conducted in a workshop venue specifically to include the "Stakeholders" in the process. Figure 6 depicts the eight steps with the associated major question each step is designed to answer. Below each question is a list of task / activities that need to be performed during each step.

At the heart and soul of the Value Engineering methodology is *Function Analysis*. Simply put, Function Analysis is a discipline of identifying the functions your product or solution needs to have in order to meet customer expectations. Once the functions are understood, the practitioners seek to enable those functions in the least costly way possible, with a special focus on long-term manufacturability.

The primary tool for mapping out the functions and understanding their importance is the FAST Diagram (Function Analysis System Technique) depicted below in Figure 7. It is a versatile and simple method of laying out the functions and features of a product. Fundamentally, it challenges the practitioner to identify elements of the design addressing why something is necessary or present from one direction, and how something is accomplished from the other direction. For every "how" there is a "why" and for every "why" there is at least one "how." Looking for alternatives and options for how a "why" can be accomplished is what drives the creative

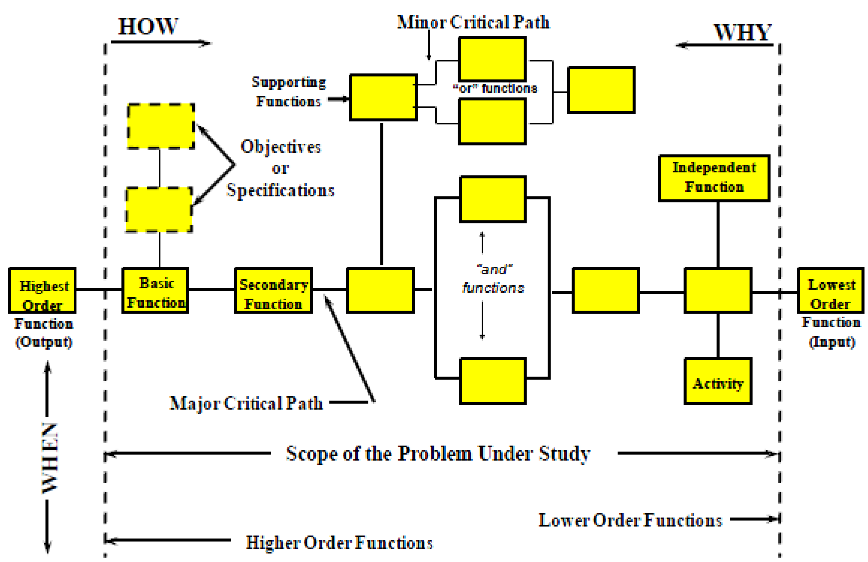

Figure 7 FAST Diagram Examples (Engineering, 2011)

problem-solving process.

As mentioned above, the whole method is based on solid, universal, objective, timeless principles. As a result, though many of the training materials and examples describe mechanical or electro-mechanical design applications, the approach and the tools work equally well for electronics design and software development. Using the FAST Diagram tool to lie out and communicate plans for cultural, behavioral change initiatives and training plans is preferred. It's great to be able to quickly explain how we are going to improve something and why it's important with an easy diagram.

Ironically, and unfortunately, Value Engineering is often employed to re-design existing products. It is seen as a methodology for removing cost from legacy designs without sacrificing performance. In truth, it is a very effective methodology for such, but to limit it's employ to that challenge is to realize only a fraction of its potential. Once tooling investments and supply contracts are established, it's difficult to take cost out of a product. Value engineering focuses on maximizing the function-cost balance from the very inception of the product concept and in this way shows its true potential to maximize a business' profit and customer satisfaction. In this way it shares a fundamental, universal principle with Design for Six Sigma, Lean Product Development, and many other product development methods. It's always better to design it right the first time, than it is to fix it after production starts.

Application of Value Engineering

Affordability considerations enter during the Materiel Solution Analysis phase in the form of Analysis of Alternatives (AoA) prior to there ever being a program (see Figure 5). AoAs are "initiated to examine potential materiel solutions with the goal of identifying the most promising option" (DAG, 3.3.1). Later when the Requests for Information are released the potential contractors become involved. The contractors conduct trade studies throughout the competitive stages of the acquisition and the selected contractor continues the trade studies throughout the program. The use of Value Engineering during the AoAs and trade studies is the key to specifying, defining and developing an affordable system.

To fully reap the benefits, Value Engineering should be applied even earlier than the AoAs. In JCIDS, the Identification of Capability Requirements (Enclosure A, paragraph 3 which occur prior to the AoAs. The Capabilities Based Assessment (CBA), can be viewed as a Value Study. The CBA consists of the following:

- Identifying the mission or problem to be assessed;
- Incorporate prior CBAs and studies;
- Determine the level of analytical rigor required;
- Perform an operational assessment to: identify capability requirements and any associated gaps and redundancies; and operational risks associated with each gap.
- Determine if a non-material approach can wholly or partially mitigate the gaps;
- Assess general approaches for materiel capability solutions.
- Make recommendations.

These steps correspond reasonably well to the steps associated with a Value Study. Hence, the Value Study tools and processes, in particular FAST, may be applicable during the CBA.

The AoA is a trade study with the approach being fully documented in the Defense Acquisition Guide (Engineering, 2011). DoD trade studies are documented in the System Engineering Fundamentals January 2001 Defense Acquisition University Press Fort Belvoir, Virginia 22060-5565 and further amplified by each contractor. Thus by incorporating the CBA, the various

affordability contexts [pgt-3] are included from the Baseline/Portfolio level, through the System-of-Systems to the System/Program Increment all the way down the cost trades for an individual component.
This leaves open two questions: 1) How can the Value Engineering tools and techniques be applied to incorporate affordability into the decision process; and 2) More importantly, how is the “value” of a system or system of systems determined and defined.

Value engineering allows for the evaluation of functions of a system within the architecture of the system. Value Engineering starts with a current product, extracts the functions of that product, determines a number of potential alternative architectures that perform those functions, examines the architectures for associated functions, appropriateness, feasibility and affordability, and then chooses the "best" architecture. So how does Value engineering fit into the systems engineering process. What are the data and execution interfaces? What are key data exchanges both input and output?

System Engineering as depicted in Figure 8 is used to determine the nature of candidate architectures to achieve a desired level of performance. The attributes associated with candidate architectures include the design of the architecture, description and measurement of features and functions, and how the system will be put together (integrated) and how well it performs in an operational context. Whereas, Value Engineering establishes the value of cost to functions in order to determine the most appropriate architecture at the least cost.

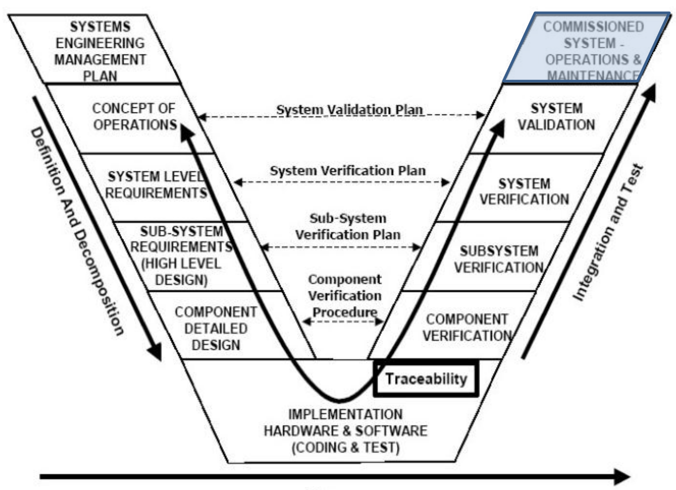

Figure 8 Traditional System Engineering V Diagram

Systems Engineering and Value Engineering, although appearing to be process like, are more akin to a way of thinking or a framework for exploring and understanding designs and their implications in terms of value, performance, and achievability. The traditional Systems Engineering V of Figure 8 is gear toward achieving a system architecture which meets the specifications as developed on the left hand side of the “V”. This approach then attempts to validate the design by integration and test up the right hand side of the “V”. This view or approach is somewhat static in that once architecture is set the engineering process is geared toward validating the baseline. The process does little to project beyond IOC how the design might change based on new requirements or repurposing of the system. Nor does it do a good job of anticipating total ownership costs. The eight steps and the associated questions are linked to activities that are easily mistaken for a sequential flow they should not be seen as such. In Figure 6 we express the relationship of the Value Engineering within the DoD System Acquisition phases as have two “major thrusts”. From Pre-Milestone A to Milestone C the thrust focused on identification and validation of a baseline design. In Post Milestone C we think of Value Engineering as providing information about the evolution of the system over time to expose potential changes in purpose or desired capabilities. This post Milestone C activity is represented by the blue area in Figure 9 of traditional Systems Engineering “V”. Figure 9 is another way of viewing and understanding the bi-modal nature of system adaptation cycle. Value Engineering supports both the design phase and the operational phase in order to provide a continuous evaluation of a systems worth.

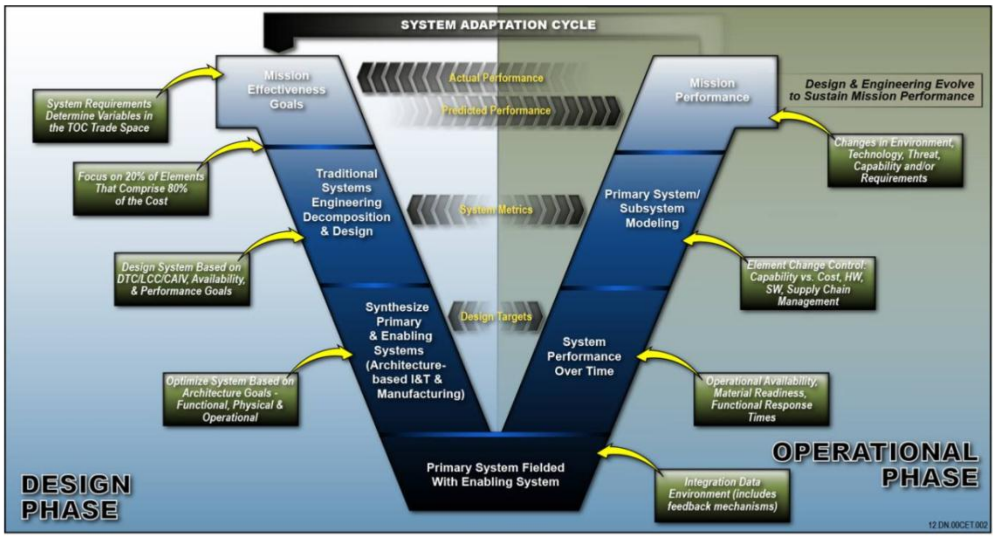

Figure 9 System Adaptation Cycle

Starting a Value Engineering study, you always ask for the specifications, and if available, evidences of trade off exercises. Is the logic consistent, correct and accurate? Are decisions apparently made on sound bases? Or are there inconsistencies in specifications, trade off matrices, the reasoning, is there sloppy thinking, incorrect conclusions, or decisions made without taking costs in account? This step can be assisted by the function logic diagram.

The analyses in Value Engineering sometimes are started with a list of the systems or subsystems, after which within the group alternatives are sought (without explicit function analysis). Sometimes it starts with a brainstorm on the functions that should be fulfilled by the system, after which alternatives solutions can be investigated. During this brainstorming phase, as much as possible solutions are mentioned. The valuation of the ideas is postponed until later. When there are many systems or functions, costs are allocated to systems or to functions. Allocating costs to functions is something we have not seen yet in se documents or processes. After that the most expensive functions and the functions that have unexpected high costs, are chosen to brainstorm for better alternatives, causing lower costs or better performance on more functions (increasing value). VE studies are carried out in short periods of time. It takes a VE-team in which stakeholders and designers work on the same spot at the same time, face to face until values (drafts, costs, and performances) are defined and agreed. After that the VE team is dismantled and ideas, a report, a cost calculation and action list remain. This is where the SE process continues again re- aligning specs and designs where applicable to the new insights.

System Vs Client

By definition of affordability and value, the client determines if he is satisfied and the level of satisfaction cannot be determined directly by any attribute of the system under consideration. The usefulness of a system only achieves meaning because the decision maker (client) views it as valuable. Within that decision process a lot of human interaction takes place, which is not necessarily rational and includes a lot of bias and mistakes. VE is more of a soft systems approach. Value Engineering allows the analyst to collect and quantify the decision marker's (client) value system being applied to judgments regarding the functions, quality, effectiveness, and affordability of the system solution. The methodical collection of decision maker values can be assisted by using decision support frameworks, such as the Analytical Hierarchy Process, Multi-criteria Fuzzy Decision-making, Multi-objective Mathematical Programming, and other techniques to collect and apply decision maker value weights to decision criteria. These criteria in turn are used to judge the value of the systems effectiveness and affordability.

Trading Functions Vs Cost

Essentially Value Engineering allows the system engineer to execute a function to cost calculus within a decision maker's value context and value system. The value solicitation and analysis that is the result of the Value Engineering process will affect functional priorities (what is in and what can be left out). The VE steps are designed to provide the user with instant feedback in regards to the best value. Using the VE process the analyst can address several fundamental questions which in turn shape the design effort in a way that results in a compliant and cost-effective system. The questions that VE can help answer include:

- Is the logic and reason clear why to invest?
- Are the specs logical in term of quantity and do they specify what the client values mostly?
- Is the project on budget, and where are the large cost drivers? Are those costs logical and acceptable? Should the design change?
- Are specs and the design aligned with the business objectives in a clear and understandable way?
- Do costs and functions have a good story? approval to execute the solution (preferred to as the "Decision Point")
- Are project values (including costs en system functions/ performances) regularly checked during design sessions, or e.g. gate reviews?
- Do the requirements cover all system aspects that cover clients' satisfaction?
- Are the main risks and issues related to the system performances? (do we know what can go wrong and its impact on the system performance)?
- Were the consultants or designers able to deliberate with the principal? Did the principal invest the time to answer all those questions that arose? How many decisions are made without a (small or large) discussion?

Where VE and SE do meet

Value Engineering methodically documents the decision process by which the design and evaluation of the system solution is executed. It formally sets forth the functions and their relationship to cost. It also allows the engineer to determine how well and at what cost does a particular design alternative meets the requirements as set forth by the stakeholders. It allows for a function-to-cost-to-affordability calculus to assist the decision maker in managing the development and ultimate performance of the system he / she is developing. With both VE and SE in the end systems are the same, the function representation will certainly differ, the SE-documentation describes the system in great detail, the VE documentation summarizes the key elements. Both function descriptions can be drawn in a FAST/requirement matrix to see whether the designed system complies to both, or that the function description should be adjusted. VE maps costs to objects and functions, which is not general practice within SE. VE is a short intervention in a longer lasting project processes. We can plot in the V-model, with short VE-interventions. VE provides the tools to do that; SE provides the tools and methods to secure the outcomes.

Where VE and SE in differ

Value Engineering does not cover topics like configuration management or requirement engineering. Ongoing process during project life cycle; it is a short term intervention.
SE provides systematic approaches to describe the design of a system, and keeps it consistent in time (years). VE provides short interventions for valuation of the design and redesign.
SE does not ask: do we do the right investment while SE answers the question: what does meet the requirement (hoping that the specs meet the needs).
Some questions to the co-authors:
1. Does SE distinguish functions and its requirements (which can be looked at as 'metadata from functions')? Is there a way to model functions in SE?
2. VE does have the FAST-model to order functions (that's just a way to do it; are there more in SE?).
3 How do system engineers check the completeness of their specs, which logical methods are there? Take the lighter: how does a system engineer come the insight that the spark wheel might be replaced by a piezo button? Is he systematically triggered to think that over?

Summary

So, with so many programs and methods out there, how do we know if Value Engineering is the one we should incorporate, and why should we choose it over Design for Six Sigma, or Lean Product Development? If you even suspect that your products could improve the function-cost balance, then you will do yourself a service to explore Value Engineering. If you are already integrating or executing DFSS or Lean Product Development methods, Value Engineering and these other methods are not mutually exclusive. In fact they are very complementary.

DFSS focuses on eliminating variation in product quality and performance. Lean Product Development focuses on eliminating wasted time and resources in product development and product production. Value Engineering focuses on maximizing product performance while minimizing manufacturing cost. They are all similar in outlook, but battle different enemies. But, because they all share the same fundamental ideas such as a step-by-step problem-solving approach, and good principles, they can be integrated together rather easily.

This is cost-quality tension at the heart of robust engineering principles –

1. Cost – Cost is what level of resources are applied to achieve functions within a product in order for it to perform at an acceptable level for their intended use. These include all cost associated with Total Ownership Cost (TOC); Design to cost, DTC (cost to design), UPC; Unit production Cost (cost to produce), and Life Cycle Cost (cost to support). What is significant here is that the measurement of cost is holistic and accounts for a product‘s complete life cycle, and the cost of the functional performance attributes of a system over time.

2. Quality – Quality is measured as variance of target function over time, (on-target engineering). As a measurement function in robust design, it really is not measureable separate from cost (quality loss costs). Any deviation of functional targets is considered a loss of quality. Hence one must quantify functional attributes of a system against stakeholder needs and iterate those ―requirements‖ to a set of ―measurable‖ parameters.

Significant work has been done to devise a very nice and practical integration of DFSS and Value Engineering practices and tools into our business' existing "Phase Gate" product development process. It's really quite easy to do when the practices are understood. If your business does not have a strong Six Sigma or Lean understanding, then Value Engineering can be a very practical way to drastically improve your product development methods without needing to first learn or increase your understanding in other business and production improvement methods. It will require a significant amount of leadership and behavioral change to successfully implement, regardless of how many methods or programs your business may or may not already practice.

Finally, Lean Product Development and Design for Six Sigma both find less of a foothold in high-end electronics design and software development. In both of these disciplines, variation is generally minimal and production in the realm of software development is little more complicated than making photocopies of a pencil drawing (relatively speaking). The enemies, variation and waste, are just not as damaging. However, the pursuit of maximum function for minimal cost is still just as important.

Value Engineering is an excellent balancing agent for Axiomatic Design practices, which are similarly applicable for mechanical, electronic, and software challenges. Where Axiomatic Design, in its pursuit of maximizing functional performance, tends to drive higher design complexity, Value Engineering practices and skills, which drive creative processes around satisfying functional needs with simpler or less costly options, can counter-balance Axiomatic Design's tendency to overcomplicate.

If your products or solutions might leave room for more functional performance or a little less cost in achieving functional performance, then Value Engineering might be a discipline worth time and energy to integrate. It can be incorporated as an element of your existing product development practice, or it can be made the backbone methodology by which you operate. It is also very complementary to Design for Six Sigma and Lean Product Development, if those are already in place.

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