A Strategic Plan for Value Engineering in DoD

The Reduction of Total Ownership Cost (R-TOC) Initiative is a key component of the Department’s efforts to transform the way in which systems are developed, acquired, operated and supported. R-TOC seeks to control the ever-increasing costs of DoD systems while improving readiness. The principles of Value Engineering (VE) and Lean Enterprise Value are important elements of R-TOC. DoD has documented more than $27 billion in Value Engineering savings in the past 20 years, $2.5 billion in FY02 alone. With this proven record of success, it is imperative that we continue to exploit the discipline inherent in the VE methodology and techniques, within the government and in partnership with industry, to help improve quality, better manage program risk, and reduce cost across the Defense Department.

This document establishes a number of stretch goals and objectives for the Value Engineering program. In terms of cost savings, we should strive to achieve annual cost savings and avoidance of 1.5 percent of total obligation authority by FY06.

Everyone’s active support is essential for furthering these efforts. We have to transform how we behave by seeking innovative ways to improve warfighting capability at lower cost. While some significant results have been achieved, we must continue to improve and thereby accelerate the benefits of transformation.

Michael W. Wynne
Acting Under Secretary of Defense
Acquisition, Technology and Logistics

Introduction

The Department of Defense’s (DoD’s) Value Engineering (VE) program reduces cost, increases quality, and improves mission capabilities across the entire spectrum of DoD systems, processes, and organizations. It employs a simple, flexible and structured set of tools, techniques and procedures that challenge the status quo by promoting innovation and creativity. Furthermore, it incentivizes government participants and their industry counterparts to increase their joint value proposition in achieving best value solutions as part of a successful business relationship.

The Under Secretary of Defense for Acquisition, Technology and Logistics (USD(AT&L)) has established goals and metrics to transform how the entire AT&L enterprise executes its mission. Pursuing these goals helps achieve the ultimate outcome: providing the warfighter with the means for mission success. VE, as one of the disciplines of Systems Engineering and as a component of the Reduction in Total Ownership Cost (R-TOC) initiative, plays a part.

The first AT&L goal is “acquisition excellence with integrity.” A number of the metrics within this goal focus on reducing operating and support (O&S) costs for defense systems. The DoD Value Engineering community has established its own goal within the context of this broader enterprise goal. Broadly stated, VE Goal 1 is to improve the value proposition for defense systems. Within the context of Value Engineering, this means that programs should take a methodical approach to examining the functions being performed and identify and implement ways to improve them.

An “industrial base strengthened” is also an AT&L goal. The purpose of this goal is to ensure that the industrial base (both prime contractors and their supply chains) will be in a viable position to meet defense needs rapidly and efficiently. The VE Goal 2 contribution is to help align industry and government value propositions in defense systems. VE efforts provide value to the government by reducing program costs while increasing capability. VE simultaneously generates value to industry by allowing shared savings to increase profit margins.

Another AT&L goal is a “motivated, agile workforce.” Workforce training in key skills is one of the metrics used to evaluate success. VE Goal 3 pursues this AT&L priority by making efforts to increase Value Engineering expertise. Education and training will become elements of an intensive outreach effort to communicate the opportunities Value Engineering provides and how to take advantage of those opportunities.

The three Value Engineering goals are interrelated. Goal 1 promotes the widespread usage of the VE methodology, both within the government and across government-industry business relationships. Goal 2 attempts to overcome several barriers that inhibit the implementation of the improvements generated from using the VE methodology. Specifically, pursuit of this second goal provides a source of engineering and other resources to expedite technical review and technical approval of proposals generated by industry and expedites the administrative approval process. Finally, Goal 3 deals with the outreach process needed to inform government and industry program managers (PMs) and their staffs on how to take advantage of those opportunities.

Goal 1: Improve the Value Proposition for Defense Systems

A program’s value proposition includes lowering cost, reducing cycle time, improving readiness, and increasing warfighting capability. Improving this value proposition across the board is a complex endeavor. It starts with an understanding of the value for all customers and stakeholders. It then considers all processes that affect the delivery of this value and seeks both to eliminate waste (non-value added activity) and to create additional value. Special attention is paid to the interfaces between processes, where the greatest opportunities for improvement are often found. Consequently, the effort is not limited to business process reengineering. Tradeoffs are conducted so that not only is the job done right; but also they ensure that the right job is done. When exercised among functions that are not controlled contractually, the outcome of the Value Engineering process is often a Value Engineering Proposal (VEP).
This goal can be accomplished through broad and rigorous application of the Value Engineering methodology by all program managers. The VE methodology (sometimes called the VE job plan) is a systematic process to find ways to enhance the value proposition. It is virtually identical to the process used by the Lean Enterprise Initiative to enhance lean enterprise value. Basic steps of the methodology are:

- Frame the problem; obtain top management support
- Establish partnerships among the system developer, system supporter, user, PM, etc.
- Reach a consistent understanding of the system or process
- Analyze required functions (map the enterprise value stream)
- Determine resources (e.g., costs, cycle time) currently consumed for those functions
- Conduct function and resource trade-offs
- Identify value mismatches and seek innovative solutions
- Implement solutions.

Senior leadership conducts VE workshops to improve the enterprise value proposition.

The methodology is often applied in the context of a Value Engineering workshop (or kaizen event) designed to build continuous improvement and conducted by a trained facilitator. Such workshops act as a catalyst for change. When held outside the context of the office, they help break the cycle of patterned behaviors. They bring together professionals who may have rarely had an opportunity to meet collectively and participate in such a comprehensive analysis of the process.

Thirty Pilot Programs have been established to reduce FY05 O&S cost by 20 percent. Additional special interest programs may also be named. To demonstrate their effectiveness, VE workshops will be offered to several of these programs. As results are developed, other R-TOC programs and all major defense acquisition programs will be encouraged to utilize a similar approach.

**Goal 2: Align Industry and Government Value Propositions in Defense Systems**

The objective for Goal 1 targeted the government’s value proposition. However, the government and its industry partners (both prime contractors and their supply chains) are dependent on each other for the creation of value and success. Based on partnering, communication, trust, and mutual understanding of the acquisition business case, incentive strategies can be applied that demonstrate to the contractor that its objectives can best be met by successfully meeting the government’s objectives. In reality, effective incentive strategies may include multiple concepts; however, industry’s value proposition is almost always improved by achieving an adequate return on investment.

There are both direct and indirect advantages to industry for submitting Value Engineering Change Proposals (VECPs) that change its contract with the government. Of course, the most obvious advantage is the fact that the contractor receives a substantial share of the cost savings that accrue from the implementation of VECPs. In addition, development costs are reimbursed on approved VECPs and they may provide usable technology on other product lines. Perhaps even more important than the financial reward of shared savings on successful Shared Value Proposition VECPs, an active VE program also improves a contractor’s competitiveness and helps establish a reputation as a cost-conscious producer. Several contractors have been selected as outstanding VE contractors and have been recipients of the Department of Defense’s VE Achievement Awards. Consequently, use of VECPs aligns industry and government value propositions for defense systems.

Despite the above advantages, VECP usage has been quite small in recent years because of several fundamental problems. PMs are sometimes reluctant to divert their limited engineering resources to the task of technical evaluation of contractor-initiated VECPs. This leads to lengthy processing times and potentially unhappy customers from an industry perspective. In fact, the entire VECP approval process can be difficult and cumbersome.

To mitigate this situation, the DoD is in the process of establishing a flexible source of funding for projects that reduce the life cycle cost of defense systems. This would provide start-up funds for engineering and other efforts needed to implement such initiatives. In addition, an effort will be made to obtain Department-wide visibility of all submitted VECPs to obtain insight into the VECP process and provide assistance, if necessary, for timely execution.
Goal 3: Increase Value Engineering Expertise

All VE customers and stakeholders must improve their knowledge about what to do, how to do it, and the attainable benefits. An increase in Value Engineering expertise is therefore an important enabler for Goals 1 and 2. There must be continuous education and training of the AT&L workforce to ensure that there is access to the necessary expertise. The rationale for the strategy, goals, and metrics will be disseminated through all acquisition courses and other mechanisms. Industry will be encouraged to include the strategy and goals in training it provides its workers. A VE community of practice (CoP) will be brought together to share and to learn from one another face-to-face and virtually. This community will be bound by a common goal and purpose that is supported by a desire to share experiences, insights, and best practices. Activities in pursuit of this goal include:

- The VE community must engage in continuous process improvement. There will be organized interaction among VE customers and stakeholders through workshops and other similar fora to obtain a better understanding of VE barriers and to identify corrective actions.
- VE workshops will be conducted and results studied to identify and promulgate lessons learned on the types of activities, programs, and processes that can derive the greatest benefit.
- Defense Acquisition University (DAU) coursework will be reviewed annually to ensure that the VE content is adequate and up-to-date. New continuous learning modules will be created to guide people through the VE methodology and the VECP process from both an industry and government perspective. Illustrative case studies will also be developed.
- The VE CoP will become the basis for a knowledge management approach to Value Engineering. Knowledge management is being intentional about the use of intellectual assets to improve organizational performance through increased efficiency, effectiveness, and innovation. It is aimed at linking knowledge seekers with knowledge sources (both written and experiential). Initially the CoP will be primarily focused on VECPs in support of Goal 2; it will help navigate the VECP process, provide assistance and answers to technical questions, and serve as a voluntary mechanism for obtaining VECP visibility. Eventually, the CoP will help industry and government better understand and use the VE methodology. PMs will also be able to obtain an appreciation of the benefits other PMs have realized.
- There will be a broad outreach campaign. VE successes will be highlighted in a broad range of publications to expose the benefits and opportunities to wide audiences ranging from contracting officers to industry and government program managers. Similarly, VE community participation in conferences and seminars will be used to gain further exposure.
- VE awards will be presented in annual ceremonies recognizing outstanding achievement in both government and industry. Such leadership recognition will encourage people to increase VE usage.

Implementation

The Systems Engineering Directorate in Defense Systems will review and provide guidance on vital systems engineering-related matters within DoD. It will interface with senior leadership throughout the Department to provide a cross-functionally integrated focal point to address issues spanning the acquisition life cycle from operational requirements generation to fielding, operations and support, and retirement. The VE program will assume an important position on the Directorate’s agenda.

The following stretch objectives are indicative of goal achievement:

- Net government savings and cost avoidance resulting from VE should be at least 1.5 percent of total obligation authority by FY06.
- Ninety percent of VECPs received should be fully processed (either approved and awarded, or rejected) within 180 days by FY06.
- At least 500 people will have completed DAU offered VE continuous learning module by FY06.
- A VE knowledge management community of practice will have at least 250 members by FY06.

The Directorate will monitor the goals and objectives articulated in this document as well as the activities being undertaken to achieve them. Meeting these goals depends on the cooperation, support and leadership of the systems engineering principals in DoD. They must work to ensure that VE is appropriately considered within program offices, especially major defense acquisition programs. In addition, these principals must work to remove barriers that inhibit VE applications. Finally, they also must ensure that trained expertise is available to enable program offices to capitalize upon VE opportunities.

Value Engineering has been used effectively for more than 50 years in countries and companies throughout the world. Following the concepts depicted in this strategy will lead to continued growth and value creation as part of the Department’s overall transformational efforts.
Value Analysis at the Service of Company Management

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Abstract

The turn of the century has brought its share of good and bad news. Given the events of the past two years, senior managers are concerned about their companies' capacity to adapt to a world that is evolving at lightning speed. This situation has created many opportunities to optimize company operations.

Today, heads of companies are increasingly on the lookout for new ways to ensure the survival of their companies in the short term and to provide sustained growth in the long term. In this article, I explore different avenues by which value management may help achieve these goals and propose that company directors adopt a management culture based on creating value for their company, its clients, and its employees. A series of examples illustrate the multiple uses of value analysis tools in company management policy.

Introduction

The quality of a company's management has a great influence on its profitability. Managers have access to a panoply of tools to help them in their drive for increased efficiency and profitability, including benchmarking, re-engineering, partnering, process simplification, and "design to cost." When presented in a sort of "cookbook" approach, however, these tools sometimes produce results that are below expectations: the "recipe" is not applicable to the company's working environment, employees do not buy in to the principles espoused by the method, or the results are disappointing when compared to the effort expended to implement the "recipe."

The principles of value analysis open up new horizons to managers. The theory toward which we are evolving, value management (VM), can be applied to a wide variety of fields, leading to an improvement in the value of work carried out in the company.

The success of this method is based on the fact that it delivers results by focusing action on functions that are essential to the company's survival and growth. In this respect, it fits well with the tools mentioned above. When benchmarking has been completed, VM takes over as a method for introducing change. When re-engineering has been accomplished, VM shows how to go about instituting change. Some VM tools can even be used to carry out re-engineering!

Value management can be defined, first and foremost, as a management style. It provides a framework for executive decisions made to create value for clients, shareholders, and partners. VM is based on a search for optimal solutions, and it rationalizes choices through the use of indicators. As it is based on teamwork, it develops a sense of collective success among both people and organizations. It is a system that encompasses:

- Management style
- The internal and the external environments in which the company operates
- Positive human dynamics
- The efficient use of appropriate tools and methods

Fields of Application

As noted by Lewis and Zimmerman, "The application of VM is a universal application. It can be applied to manufactured items, new product development, systems, factories, capital projects, organisational structures or other areas where functions need to be applied."

Lewis and Zimmerman continue, "Expected benefits of value management are:

- Reduced time to market
- Reduced product and operating costs
- Use resources more effectively (productivity)
- Compete successfully in global market
- Increased employee involvement
- Exceed customer needs"

The definition of the company is formulated via the identification of the mission, vision, and values of the business unit. The mission is the company's reason for being (final product) to which all other functions (main, secondary, or constraints) are attached to allow the company to achieve its mandate. The vision colours the actions taken to achieve the final results, while the company's values supply a framework for decision making and management of human and material resources.

Using the functions identified during the company definition process, the value manager takes the operating model as a key element in carrying out the operational analysis. Operations can be observed and their performance diagnosed objectively on a function-by-function basis.

Development of operational processes gives a clear picture of activities and the sequence of events to be carried out to fulfill company functions. It clearly defines the roles and responsibilities of each team member in achieving the anticipated results.

Results measurement is defined by the measurement criteria and level of expectation concerning the anticipated results with regard to each of the functions to be met.

Value analysis methods highlight the essential aspects of these four elements. Functional analysis may be used to advantage in defining the company's mission and specifying its activities. The

1 Brun and Constantineau, Le management par la valeur
2 Zimmerman and Lewis, FSAVE, What a CEO Needs to Know
questions “How?” and “Why?” applied to the relationships between activities allow functions to be classified and lead to a schematic representation of operations in the form of a “Customer FAST” model. With the superimposition of employee roles and responsibilities onto the operating model, the organizational structure can be defined.

Once developed, FAST is a powerful tool for analyzing a company’s operating methods. Using the model to correlate functions, resources, and results leads to a diagnosis of the value of the means that are used to deliver results (solutions). When the value of some solutions is questioned, various creative techniques such as brainstorming may be used to generate new methods of working.

Following the creative phase is an evaluation of the ideas generated. This evaluation is based on a range of criteria aimed at assessing the measured value of the idea, such as satisfaction of a need and the resources required to implement and maintain the idea. Each exercise ends with the creation of a structured action plan aimed at integrating the results into the company’s current operations. The plan is developed in such a way that the integration progress can be easily monitored.

Some Practical Examples

Defining a Company

Many works dealing with company management place a great deal of emphasis on the importance of marshalling resources around the performance of the business unit. Some even go so far as to say that this is an essential ingredient for ensuring the long-term survival of companies. In this regard, company managers have a double responsibility: they must both attract and retain the best talent available. One of the best tools for mobilizing resources is to create, with the people involved, an image of the company with which they can identify. The VM approach does exactly that.

Creating a company profile involves identifying the mission, the vision, and the values that the company intends to adhere to throughout its activities.

The whole reason for forming the company—why it exists, its end purpose—is embedded in its mission statement, which is unique and remains unchanged for as long as the company exists. The mission statement is a determining factor in creating the company profile. It must be simple, unifying, and understood by those involved at all levels. Finally, it should be short and contain an active verb linked to appropriate nouns.

People familiar with value analysis will naturally use functional analysis techniques to draw up a mission statement, calling upon co-workers at all levels to help write it. Teamwork is the order of the day, and members are carefully chosen to represent the various employee groups that contribute to the company’s final product. Special attention is paid to employees who are known to have an influence in their workplace.

Divergence techniques are used to avoid falling into the habit of accepting the first idea that is put forward. An examination of the environment in which the company operates is extremely useful in this respect. It highlights the various agents influenced by, or having an influence on, the company. It allows the team to share different views and cement a common understanding of why the company was created. This approach guarantees that the team members will buy in to the mission statement and support it when dealing with other colleagues.

The following table provides some examples of how this method may be applied in some specific fields.

<table>
<thead>
<tr>
<th>Type of company</th>
<th>Mission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper manufacturer</td>
<td>Enhance the value of forest products</td>
</tr>
<tr>
<td>Maker of residential ventilation products</td>
<td>Purify the air</td>
</tr>
<tr>
<td>Public Curator</td>
<td>Protect individuals who are incapable of functioning autonomously</td>
</tr>
<tr>
<td>Regional economic development council</td>
<td>Attract foreign investment</td>
</tr>
<tr>
<td>Municipal engineering department</td>
<td>Provide urban infrastructure</td>
</tr>
</tbody>
</table>

The vision is the second important element in defining a company profile with which people can identify. It is aligned with the mission and vision provides an intermediary objective that is both concrete and measurable over the medium term (five to fifteen years). Unlike the mission, the vision may be modified periodically to take into account changes in social and economic parameters that affect the company’s business environment.

Ideally, the vision must be bold so as to stimulate employees to reach for a higher level of performance. The examples from the above table are used again in the following table.

<table>
<thead>
<tr>
<th>Type of Company</th>
<th>Vision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper manufacturer</td>
<td>Produce the best newprint in the world</td>
</tr>
<tr>
<td>Maker of residential ventilation products</td>
<td>Be recognized by the medical profession as reducing respiratory illnesses</td>
</tr>
<tr>
<td>Public Curator</td>
<td>Become a Canadian benchmark</td>
</tr>
<tr>
<td>Regional economic development council</td>
<td>Be one of the five top performers in Canada</td>
</tr>
<tr>
<td>Municipal engineering department</td>
<td>Satisfaction rate for services provided = 85%</td>
</tr>
</tbody>
</table>

A company run by value managers must adopt yardsticks to provide a framework for decision making. Having a small number of core values ensures cohesion, clarity, and credibility in daily activities within the company by providing a reference point to

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4 Collins and Porras, *Built to Last*; Collins, *From Good to Great*
which all employees, whatever their level in the company, may always refer when making, or trying to understand, a business decision.

The team that has developed the mission statement will also produce the company’s vision and values. Once again, it will work in a workshop environment and produce a group result that, once adopted by consensus, will be circulated throughout the company.

**Strategic Planning**

An annual exercise used increasingly by companies of all sizes, strategic planning allows people to step back from their everyday tasks, analyze company performance, and identify “strategic” actions that should be taken in the pursuit of company goals. A typical value analysis work plan can easily be integrated into strategic planning.

1. Plan the working sessions
2. Gather information
3. Functional analysis
4. Identify solutions
5. Evaluate scenarios
6. Develop solutions
7. Introduce chosen solution

Because of the short amount of time available to participants, planning the working sessions and information gathering is carried out beforehand during individual meetings. A four-part questionnaire is used to build a bank of basic information that will be used as an introduction to the strategic planning workshop.

1. The Company
   - Environment
   - Mission
   - Vision
   - Values

2. Operations
   - Services provided
   - Products made
   - Customers
   - The role of the company
   - Operational costs

3. Management
   - Distribution of work
   - Strengths
   - Weaknesses
   - Job satisfaction

4. Performance
   - Current performance criteria
   - Ideal performance criteria
   - Results obtained

The workshop lasts one or two days, and its main goal is to allow senior management to share impressions about the company’s past and future. The use of value analysis principles to guide the workshop means that goal by providing a systematic, organized framework for presenting ideas. Thus, the first section of the questionnaire is used to situate the company in its current environment. It updates the mission statement and leads to an evaluation of the accuracy of the vision and the relevance of the values promoted within the company.

Functional analysis may be used to great advantage in the strategic planning process. If the mission is considered to represent the company’s ultimate purpose, the information gathered in the second section of the questionnaire is used to provide a model of company operations around this mission. Participants are asked to validate the first draft of a model developed beforehand by the session leader. They concentrate specifically on expressing the model’s first-level functions that represent the strategies currently in use.

Once the model is approved, participants are asked to analyze the value of the above-mentioned strategies. To do this, allocated resources (costs) and results obtained (performance) are attributed to each strategic branch. The information gathered in sections three and four of the questionnaire provides material for discussion.

Functions whose means (solutions) create little value are identified and a brainstorming session follows to find different ways of working. The ideas are sorted and then evaluated against objective criteria that meet everyone’s expectations. The ideas that are accepted will be included in an action plan for integrating them into company operations.

**Diagnosing Operations**

How can you tell what is going well and what isn’t in a company? Here again, there are books and articles galore on this subject.

Often, the financial results are viewed as the only indicator by which company performance need be evaluated. I beg to differ! The fact that a company makes an operating profit and generates a healthy return for its shareholders is not a guarantee that it is healthy. On the contrary, this may be a sign of “killing the goose that lays the golden egg.”

Carrying out an in-depth value analysis of company operations can certainly lead to forming a more reliable and comprehensive diagnosis. In such a case, the steps mentioned above are reworked, confirming the company’s mission and developing a functional model based on an examination of the environment. However, the model will be more extensive than the one used in the strategic planning session because participants will wish to cover all aspects of operations to develop an informed opinion concerning their company. The model may well incorporate many third-level functions (operations), and even some fourth-level functions (activities) if their integration into the model allows participants to have a better overall understanding of the company.

To carry out this exercise, 10 to 20 managers are invited to take part in an operational diagnosis workshop. Depending on the availability of the participants, some of the preparatory work concerning the decision tree can be carried out beforehand. In all cases, the content is validated and the diagnosis made in the workshop. This encourages a rich exchange of views and ensures a high level of acceptance of the results.

An analysis of the operating budget by function, coupled with identification of the results obtained for these functions, guides participants in the diagnosis process. Some functions will not have sufficient resources to allow them to achieve the expected results. Others will have too many! Some will have no results that can be identified with the company’s mission. Finally, some functions may be added to the base model because of their impact on the company’s survival.

The following example deals with a firm of management consultants. If the company administration had looked no further than the financial results in evaluating the performance of their com-
Example: Functional model of a "staff" business unit

<table>
<thead>
<tr>
<th>Mission</th>
<th>Strategy</th>
<th>Management</th>
<th>Operation</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Survey the economic situation</td>
<td>Consult various reports and studies</td>
<td>MANAGE INFORMATION AND KNOWLEDGE</td>
<td>Draw up company and corporation profiles</td>
<td>MANAGE AND FOLLOW UP ON AGENTS</td>
</tr>
<tr>
<td>2. Supply economic intelligence</td>
<td>Supervise studies</td>
<td>MANAGE INFORMATION AND KNOWLEDGE</td>
<td>Schedule and monitor high-calibre missions</td>
<td>MEET WITH SENIOR MANAGEMENT OF INTERNATIONAL COMPANIES</td>
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<tr>
<td></td>
<td>Manage information and knowledge</td>
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<td></td>
<td>DEVELOP IDEAS AND PRESENTATION TOOLS</td>
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<tr>
<td></td>
<td>Manage and follow up on agents</td>
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<td></td>
<td>PREPARE SECTOR PLANS</td>
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<td></td>
<td>Meet with senior management of international companies</td>
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<td>SUPPORT THE ACHIEVEMENT OF INVESTMENT PROJECTS</td>
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<td></td>
<td>Develop ideas and presentation tools</td>
<td></td>
<td></td>
<td>RECOMMEND AND FINE-TUNE PROJECTS</td>
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<tr>
<td></td>
<td>Prepare sector plans</td>
<td></td>
<td></td>
<td>CARRY OUT BENCHMARKING</td>
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<td>3. Advise sectors</td>
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<tr>
<td>4. Draw up company action plan</td>
<td>Draw up an operating plan</td>
<td>Draw up a development plan</td>
<td>Co-ordinate with other organizations</td>
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<tr>
<td></td>
<td></td>
<td>Support the drawing up of a vision plan and a positioning plan</td>
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<tr>
<td>5. Analyze results</td>
<td>Measure results</td>
<td>Explain the results</td>
<td>Produce reports</td>
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<tr>
<td>6. Manage the business unit</td>
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<td>MANAGE HUMAN RESOURCES</td>
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<td></td>
<td>MANAGE MATERIAL RESOURCES</td>
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<td></td>
<td>MANAGE FINANCIAL RESOURCES</td>
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</tbody>
</table>
Example: Diagnosis of a Management Consultant Company

<table>
<thead>
<tr>
<th>Mission</th>
<th>Strategy</th>
<th>Management</th>
<th>Operation</th>
<th>Activities</th>
<th>Resources</th>
<th>Results</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Position the company</td>
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</tr>
<tr>
<td>1.1 Expand the clientele</td>
<td></td>
<td>Identify target</td>
<td>Make lists</td>
<td>$210,000</td>
<td>One new client</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2 Meet</td>
<td></td>
<td></td>
<td>Set meetings</td>
<td></td>
<td>$2,000</td>
<td></td>
<td></td>
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<tr>
<td>1.3 Process</td>
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<td>2. Provide resources</td>
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<tr>
<td>2.1 Build a team</td>
<td></td>
<td>Recruit new resources</td>
<td>Learn about</td>
<td>$2,000</td>
<td>2 new councillors</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2 Develop</td>
<td></td>
<td></td>
<td>Analyse</td>
<td></td>
<td>2 new candidates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3 Inter</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Provide tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1 Obtain methods</td>
<td></td>
<td>Add</td>
<td></td>
<td>$25,000</td>
<td>2 new applications</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2 Tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Supply a service</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1 Negotiate agreements</td>
<td></td>
<td>Sell our services</td>
<td>Draft offers</td>
<td>$50,000</td>
<td>30 new mandates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.2 Supply</td>
<td></td>
<td></td>
<td>Submit</td>
<td></td>
<td>$1,000,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.3 Carry out mandates</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Manage the company</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1 Administration</td>
<td></td>
<td>Accounts receivable</td>
<td></td>
<td>$50,000</td>
<td>Gross profit 15%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2 Orientation</td>
<td></td>
<td>Accounts payable</td>
<td></td>
<td>$5,000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.3 Evaluation</td>
<td></td>
<td>Organise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Total:</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

company, they probably would not have discussed the development of expertise—in which the company was not investing enough. Would they have clearly diagnosed (more than individual awareness) the difficulties they were having in keeping their staff interested in their work? Would they have identified the weakness of their investment in business development?

The development of an operational diagnosis from an operating model brings all the pieces of the puzzle together and gives a global view of the situation. It rapidly pinpoints the organization's weak spots and allows managers to concentrate on the elements that are priorities for improvement. The method used leads naturally to identification of new ways of working. In this regard, the workshop leader must be especially vigilant at the diagnostic stage. He or she must ensure that the participants concentrate on analyzing the situation and resist the trap of immediately identifying solutions. The value analysis work plan must be respected completely if full value is to be gained from the exercise.

A creativity session aimed at identifying paths for improvement follows the diagnostic stage. Ideas are evaluated against pre-established criteria, and those that will be integrated into company operations are selected. Necessary resources are allocated and performance objectives are confirmed for the short (one year) and medium (2–5 years) terms, as appropriate. The relationship between operations and company strategies may also be identified.

The workshop completes its tasks by drawing up an action plan. The diagnosis performed on the basis of an operating model provides an overall view of the projects to be accomplished and sets priorities based on increasing the value for all stakeholders. This approach is in line with the views of Robert G Cooper, co-founder of PDI, who maintains, "Without a big picture view of projects in the pipeline, project workers may think Go/No-go decisions are random."

### Drawing up the Operational Process

Operational diagnosis sometimes reveals a blatant lack of an operating framework in the business process. We complain that employees work badly, but we don’t tell them what to do, when, and how. The development of a process responds clearly to these three questions and is an integral part of the culture change seen in many companies. Today, the most energized and energizing companies base their development on the "Project, Process, Resources" model. Value management embraces this company concept and integrates all the aspects into a management concept called From

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5 Product Development Institute, Ancaster, Ontario, Canada
6 Foti, *Priority Decisions*, p. 28
7 Customers, shareholders and employees
Mission to Working Directives. From the mission flows the operating model, which in turn leads to the work process, giving rise to procedures, which in turn produce working directives.

The results of the operational diagnosis allows managers to address those processes whose impact on operations will have the greatest value. Development and introduction of these processes are prioritized in descending order according to the value created for the company.

The functional analysis is the main process development tool. It is used to question the relevance (value) of functions and produce a logical, efficient sequence. The success of this exercise will be directly proportional to the rate of involvement of the people responsible for the development of process applications.

Management Indicators

The last link in the company’s value chain is performance measurement. A list of indicators should be drawn up, together with the expected results. The list should be developed in a logical manner, and some basic questions have to be answered before putting pen to paper. The following three questions should form a basis for group discussion to begin the process:

- Must we measure?
- Why measure?
- What should be measured?

At first glance, the answer to the first question (Must we measure?) might seem too obvious. It takes on quite a different aspect when it is put to a management team gathered in a workshop setting. Ideas differ greatly as to the usefulness of the exercise when compared to the effort it requires. Some see measurement as a threat, others think only of an increase in administrative costs, and still others see an opportunity for continuous improvement.

Once the decision to measure is made, managers then have to think of why to measure: for improvement, for comparison purposes, to report to shareholders, for employee remuneration, or for any other good reason in a given situation. The question “What should be measured?” is aimed at pinpointing the facets of the organization whose evolution should be monitored. Is it the financial picture, how closely procedures are followed, employee performance, or some other aspect that reflects company culture?

Only when satisfactory answers have been found to these three questions can the list of indicators be drawn up. Depending on the

From Mission to Working Instructions

<table>
<thead>
<tr>
<th>Mission</th>
<th>Operating Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Survey the economic situation</td>
<td>Consult various reports and studies</td>
</tr>
<tr>
<td>2. Supply economic intelligence</td>
<td>Suppose studies</td>
</tr>
<tr>
<td>3. Advise sectors</td>
<td>Manage information and knowledge</td>
</tr>
<tr>
<td>4. Draw up company action plan</td>
<td>Manage and follow-up on agents</td>
</tr>
<tr>
<td>5. Analyze results</td>
<td>Meet with senior management of international companies</td>
</tr>
<tr>
<td>6. Manage the business unit</td>
<td>Develop ideas and presentation tools</td>
</tr>
</tbody>
</table>

Process

Trigger → Action → Conclusion

Who? What? How?

Chef: 1. Validate... Check if...
Councilor: 2. Supervise... Begin the follow-up...
Analyst: 3. Calculate... Assign the file...

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company’s nature and vocation, measurement indicators may be chosen for activities, or results indicators, or both. The number of indicators will be limited so as to target the best ways to take the company’s “pulse” in each of the fields under scrutiny.

The make-up of the indicators is directly linked to the audience to which it is addressed. It is easy to understand that indicators of interest to the board of directors differ from those required by the manager of the IT department. However, the indicators used by the latter must be linked to those presented to the former; they must constitute a sub-group of those used by a higher level. In practice, each of the company’s departments and sections should have its own indicators, allowing it to measure the contribution that its resources make to the overall benefit of the company as measured by the high-level indicators.

The operating model provides an ideal tool for developing indicators at all levels. First, it shows all the company’s activities. Second, its very structure allows the indicators to follow the organizational hierarchy (final results, strategies, management, and operations). Finally, it may be coupled with a matrix of roles and responsibilities to help choose which indicators to offer to the various sections of the company. These three characteristics ensure coherent action.

Conclusion

This article demonstrates, through the use of examples, that value analysis can make a constructive contribution to the manager’s work.

Used judiciously, in selected applications aimed at giving a human face to the company, measuring performance, identifying causes of under-performance, correcting weak situations, or simply prioritizing actions, value analysis delivers astonishing results in terms of both tangible outcomes and mobilization of resources.

At the macro level, the integral use of value analysis to define and review the working methods of a company “from mission to working instructions” reflects a company culture using value management, a management style that delivers value to all parties concerned: clients, shareholders, and employees.

Bibliography


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Is “Drink Beer” a Function?

Dr. Roy Woodhead, J.J. Kaufman, M.A. Berawi

Abstract

This paper is a work in progress report that attempts to explain underlying theories of Function Analysis practice and the use of such theories in a VE study. It explains the relationship between real world implemented solutions and the class of abstract processes such implementations belong to. It is these abstract classes of solution-process that are what we call functions. The ability to position a particular implementation within a generic and abstract class of implementable solutions we call functions allows us to consider alternatives that could perform the same work but with added benefit. The paper concludes that ‘Drink Beer’ is not a function as it is a particular real world solution-process and goes on to explain why such an approach limits the possible solution space that could unlock innovation.

Introduction

Have you ever looked at someone else’s FAST diagram and thought to yourself, “Those are not functions they are solutions or outcomes”? On review of old FAST diagrams we can even criticise our own work. Of course we always have the explanation of, “It does not really matter because it’s about stimulating creativity that counts”. But what if that is not an acceptable position? As we seek to move VE into new fields of work, the need to provide internal consistency within our theories becomes even more important, especially if such models steer a Research and Development (R&D) programme (Woodhead & McCuish, 2002). That we can recognise weaknesses in our own work is a mark of our own learning and advancement in terms of our ability to model the relationships between ‘a thing’, ‘what it does’ and ‘what value is achieved when it is performed’. The ‘way’ something is performed or done is a reflection of a previously recognised problem that has been solved with the particular method being examined; we will call these “Solution-processes” to emphasise the fact that they exist in a real way as opposed to a conceptual way. This line of enquiry means that we see far more embedded knowledge associated with naming functions than the simple rule of ‘active verb and measurable noun’ suggests. The challenge is to articulate theories that describes this and then set about developing rigorous proofs in the form of doctoral research (See Woodhead & Downs, 2001; Kelly, Male and Graham, 2004). As such this work-in-progress report brings you into the investigation and your feedback is encouraged.

As universities and industry forge closer Technology Transfer programmes (Lambert, 2003) the role VE can play will become increasingly important. However, for VE to play a more active role in R&D projects then the underpinning constructs upon which FAST is built needs to be more ‘objectively’ reliable so as to conform with the rigour science and academe demand before funding. Under such demands we need to be able to not only say “XYZ” is not a function but also prove it irrefutably. This paper draws from ongoing doctoral research and presents some explanations that will lead to such an outcome.

Going back to the beginning

In the early period of Value Engineering the use of Function Analysis was what set it apart from other ‘problem solving methodologies’ (Kaufman, 1990, 1999). Crum (1971) stated that:

The ‘oxygen’ of Value Engineering is the determination of functions and function-dominated thinking.

This ‘oxygen’ flowed from the seminal work of one man, Larry Miles. Miles (1972) stated:

The heart of the situation is “the customer wants a function.” He wants something done. He wants someone, perhaps himself, pleased. He wants something enclosed, held, moved, separated, cleaned, heated, cooled, or whatever under certain conditions and within certain limits; and/or he wants a shape, a color, an aroma, a texture, a sound, a “precious” (costly) material, or whatever to bring pleasure to himself or others he wishes to please. That is all he wants. That is all he cares about.

Thus the language of function is the language of the heart of the problem. The customer wants only two and only two types of functions in varying degrees in different products or services. Use functions and Aesthetic functions serve his needs. Use functions entail some action that he wants performed, and aesthetic functions please him or someone he wants to have pleased.

He then continued under the heading “Identify, Clarify and Name Functions” to explain his concept of a “Function.”

State the function in exact sentences. Examine the sentences. Is that exactly what it does for the customer? Is that exactly what the customer wants to do? Is that exactly what the customer believes he’s paying for?

Improve and clarify the sentences until they say exactly what the function really is. Describe what the function does and name it with a verb and a noun, for example, support contact, enclose housing, control current, radiate heat, etc.

His narrative went on to explain the difficulties that arise with this naming convention:

While the naming of functions may appear simple, the exact opposite is the rule. In fact, naming them articulately is so difficult and requires such precision in thinking that real care must be taken to prevent the abandonment of the task before it is accomplished.

The problem is that the verb-noun construct itself lacked unambiguous rules that formed an inclusive and exclusive mechanism to refute alleged functions such as ‘Open Door’, ‘Increase Profits’ and ‘Drink Beer’. Furthermore, in many situations customers are either committees or the technological capability is be-
yond their current understanding and so their views are difficult to determine.

Miles did attempt clarification and suggested that the verbs and nouns should reflect measurability:

To provide more benefits, functions are named whenever possible using a verb and noun that have measurable parameters. For example support timer may also be defined as support weight, and interrupt circuit may be defined as interrupt current. This approach, in many cases, allows and promotes measurement of the appropriate cost for a specified function in more specific terms.

Here is our first clue. Those things that can be named in measurable ways must exist in such a way that they can be measured. Furthermore, if they exist in a concrete way then they must also be solution-processes unless the measurability refers not to a thing but the units we use to assess a thing. Rereading Miles we note the measurable noun, such as weight or current, is a term associated with recognised units of measurement. In practice this source of ambiguity is often overcome by the subsequent intention to use named functions to generate alternative solutions; the practitioner’s experience thus provides a corrective bias when considering whether alleged functions such as ‘Drink Beer’ are really functions or not. The inexperienced practitioner may be unable to grasp the crucial nuance being discussed because the underlying rules associated with such a means to distinguish, what is and is not, a function remain tacit.

What is perhaps the most significant implication of Miles’ explanation is the need for ‘intense concentration’. In the time constrained episodes of VE workshops the pressure to move through an agenda often curtails contemplative time needed to thoroughly and confidently identify and name a function. If the only reason we use Function Analysis and FAST is to stimulate a latent creativity in teams then such techniques are considered in the same way other creative techniques. Within this perspective the underlying theory is that the team is creative and would have got to the same insights and outcomes with other techniques. That is, Function Analysis and FAST don’t really have any merit other than providing a co-ordinating script for the team members. We demote this view on the grounds that for us a proper Function Analysis or FAST corresponds to an understanding of how something works. The way something works is the way it performs its functionality and so without making that explicit then at best teams will tinker and at worst they will cause the system, product, project or organisation to fail. For us the underlying theory is, “Cross functional teams should figure out how something should work before trying to fix it.” The creativity of insight is in the naming of functions. The creativity of alternative ideas follows this stage. Both types of creativity must not be confused.

Function Analysis and FAST in University-Industry collaborations offer the prospect of new approaches to the use of a VE designed not in terms of how many days it takes but in terms of the quality of outcomes it achieves. In a R&D context the ‘proof of concept’ is an outcome related to functionality and this has priority to schedule decisions; if it has to work before it can be sold then it has to work and if this means that the VE effort takes more than five days then so be it!

Temporary assumption

Before moving into our ‘work-in-progress’ explanation let us detail a temporary assumption that will later be removed. That is, we now imply a temporary arrangement to make our explanation easier.

For the purpose of the next section let us say that there is a one-to-one mapping between a ‘thing’ and a ‘function’. So for example, a car’s tyre will be seen to have a single function and so to does every other component in a system of components that comprise a thing we call a car.

If a system has n components then it has n functions under this assumption. We will later remove this assumption to show the underlying richness of functional thinking linked to technological innovation.

What we actually do when naming a function

Let us articulate the means by which we name and then use a function:

1. We understand how a system with n components or elements is recognised as creating value; for example a Formula 1 racing car.
2. We undertake some form of analysis in which we select a “thing,” a particular component for example, from within the system under examination; for example the tyres on the car’s wheels.
3. We then observe the ‘thing’ in isolation from the system by giving it priority in our thinking (e.g. talking about a rear tyre without talking about every other part of the car)
4. We understand the purpose of the thing in relation to the system; for example, why do we need such a wide car tyre?
5. We next identify what work, or function, it does in order to achieve its purpose which in turn enables the system within which it resides to deliver value.
6. We then name this work in the form of an active verb and a measurable noun that to us is a function; for example, transmit torque.
7. Having named the function we then generate alternative ways of doing the work the current thing does. For example, what other solutions could be used such as slicks (i.e. tyres with no tread on them)?
8. We then evaluate whether any of the alternative solutions enable better value at the system level. If one does then it is substituted for the previous solution and so a tyre with a lot of treads cut into it is replaced with a tyre with no treads.

What we have done is look at a solution-process in the real world and then move it to a generic representation in a conceptual world that allows us to swap things around in order to get better results. From this we can see that a function can be performed by other solution-processes and so the function must be a class or set
of solution-processes itself; in the same way X is an abstract concept as used in algebra. Let us look more closely at this before moving towards general rules that will assist us when naming and using functions in a VE study.

**Functions are abstract solution-processes**

Figure one shows how we as humans build knowledge. A phenomenon is observed and then understood as a process that is later used in a practical setting to achieve progress. The key word not used in the last sentence is ‘Technology’ and that is what functional thinking and VE set out to improve; from roads and buildings, cars, planes and computers to projects, teams and organisations.

Let us assume then that for some reason we are unhappy with solution-process ‘A’ and so we first of all name it as a function such as “Transmit Torque”. What we have done is not name the solution-process “Transmit Torque” but have named a generic set of solution-processes in the form of a verb-noun function. Solution-process ‘A’ is but one potential candidate to perform the function from within a possible-solution space as shown in figure three:

Let us see a system as a series of solution-processes. These could be mechanical solution-processes such as how an internal combustion engine works. Similarly they could be cognitive solution-processes such as how our brains recognise sour milk. This distinction is very important for when Miles asks for intense concentration I argue he is asking us to do one of two things:

i. Understand how we think something does or should work; this is about intentionality and so leads to intentional functions that managers and engineers use to anticipate what they want to happen.

ii. Understand how a thing works in accordance with laws such as physical laws and chemical laws; this is an etiological explanation where etiology is an explanation of the causal relationships that have led to the thing’s current state. These etiological functions are what scientists and engineers contemplate when they seek to observe and then influence nature.

Our current views of ‘Use’ functions can be seen to flow from both these statements and in a future publication it is our intention to develop means to distinguish between them. However ‘Aesthetic’ functions are more often than not intentional especially if they originate in designed artefacts.

Let us describe a system as figure two shows. It is a context that has solution-processes within it. It could be a fair ground ride, a car, an organisation or even a virus. The important thing is to recognise the context as the ‘thing’ which contains solution-processes; the difference between ‘thing’ and ‘solution-process’ becomes a product of where ‘we’ set our scope lines in the VE study. Because of our previous assumption we also state that each solution-process corresponds to a single function.

---

**Figure 1. The knowledge domains used during innovation.**

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---

**Table 1. Analysis of total value established by substituting solution-processes.**

<table>
<thead>
<tr>
<th>Possible Solution-Process Combinations</th>
<th>CAPEX (PV)</th>
<th>OPEX (PV)</th>
<th>Revenue Impact (PV)</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>X → Y → A → Z</td>
<td>$10</td>
<td>$5</td>
<td>$10</td>
<td>$5</td>
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<tr>
<td>X → Y → B → Z</td>
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<td>X → Y → C → Z</td>
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</tr>
<tr>
<td>X → Y → D → Z</td>
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<td>$15</td>
<td>$5</td>
<td>$30</td>
</tr>
<tr>
<td>X → Y → E → Z</td>
<td>$25</td>
<td>$5</td>
<td>$10</td>
<td>$20</td>
</tr>
</tbody>
</table>

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By moving from a materialistic solution in the form of a process to an abstract class of solution-processes, in the form of a conceptual function, we are enabled to consider alternative combinations as shown in the following table:

---

**Figure 2. Solution-processes within a system**

Let us assume then that for some reason we are unhappy with solution-process ‘A’ and so we first of all name it as a function such as “Transmit Torque”. What we have done is not name the solution-process “Transmit Torque” but have named a generic set of solution-processes in the form of a verb-noun function. Solution-process ‘A’ is but one potential candidate to perform the function from within a possible-solution space as shown in figure three:

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**Figure 3. Alternative solution-processes capable of performing the function Transmit Torque.**

To understand our argument linked to table one it is important that we briefly explain the concept of customer that determines value. In the case of a product the customer is a person who exchanges money to own such a product and the goal for the manufacturer is to offer a product that is ‘perceived’ as better than that which rivals offer. As such the psychological functioning within the customer’s mind is the intentioned aim of the designers seeking to emphasise worth. In the context of an organisation we must look to the economic functioning that companies are embedded within. If the purpose of the firm is to enable progress within the rational of Adam Smith’s “Invisible Hand” then we can see wealth creation as a reflection of a potentially positive contribution to technological progress. As such, the firm serves society even if its managers cannot see such an interconnected functional role and assume they are free thinkers as they decide the best way in which to succeed from within an economically conditioned set of choices and the rationality of “self-interest.”
Money and economic value are thus the means through which a firm's managers anticipate materialistic progress from within a complex arrangement of intentional functions. It is for this reason the Interstate Highways of the USA have more cars than horses on them.

As can be seen in Table 1, the methodology that underpins VE practice not only enables us to bring higher levels of creativity to bear on the systems we seek to improve but also provides us with a means to compare value, not just at the single component level as is the focus of cost cutting, but from the perspective of the whole system. What is more, it shows how a narrow focus of short-term cost reduction targeted on a single component would have led to solution-process B being selected which does not yield most value to the organisation. Solution-process 'C' costs more in terms of Capex but yields the best value when compared against other permutations considered at the macro level.

**The normative nature of functions and the way they are performed**

If a function is an abstract class of solution-processes then the first thing to recognise is that they are a way of 'knowing' which allows ingenuity to take place. When we consider human genes we see them as packets of instructions or information that then influences how other molecules arrange themselves into a purposive system we casually call 'life'. Having an instruction manual does not in of itself lead to an outcome. There has to be a solution-process where the instructions are translated into actions. One way to view this is to consider the difference between information and knowledge both of which need the correct environment with appropriate resources to make the translation process possible. Therefore, to separate functions from solution-processes is simply a mode of thinking for in reality they are intricately bound. This realisation allows us to see our use of functions in the context of knowledge management where VE practitioners meld scientific knowledge with engineering and management know-how.

That a function is thus a mode of knowing forces us to examine how we use them to leverage innovation (i.e. functions in the context of VE and innovation are epistemological). From within this perspective we can think of them as dynamic logic symbols in the way we think of X in "If X then Y" (e.g. causal-etiological views of function drawn from nature) or "In order to X we must Z" (e.g. intentional views of function such as when a designer plans some product feature that she hopes will entice customers to exchange money). Now we realise that in our world the only question we can ask of a function, which is simply a class of solution-processual solutions, is "Is it performed well?"

If we consider an example then our explanation becomes clearer. Imagine that we are working in a VE study looking at whether or not we should purchase a particular car model for a fleet of company cars. The cars will be used all over the USA which means we expect cold mountainous regions to have different demands on the car than say flat desert regions. One ambition is to keep operating costs down and so we focus on one function involved with the engine which is "Consume Fuel." In some hypothetical research we 'supposedly' carried out let's say we found that 'car model type A' led to a distribution as shown in figure four:

![Figure 4. Miles per gallon for sample of cars tested](image)

When the salesman tells us that on average we will get 45 Miles per gallon we now 'know', as opposed to assume, this statement to be incorrect and that the actual mean is closer to 30 Miles per gallon. What is more, because the actual performance is disvaluable in terms of what we were led to believe we can now see this underperformance as a 'problem' as enabled by reference to the functional norm. If other factors mean that the underperformance of this particular function is compensated by the over performance of other functions then we might think of ways in which we can alter the actual mean through some kind of additive to the fuel. In this scenario, where we seek to move the functional norm, we are pursuing an 'opportunity'.

The distinction between 'problem' and 'opportunity' becomes very useful when functions are used in critical situations such as an organisation facing insolvency. In such scenarios the manager can now consider how best to deploy scarce resources so that the immediate problems are solved before any search for opportunity begins. It may also be that functions seen to have problems are handed over to managers to deal with, whilst functions with the prospect of opportunity are sent out to the R&D department to find out how best to capture and protect some competitive advantage.

**Removing our previous assumption.**

In order to explain our insights so far we have held the assumption that there is a one-to-one correspondence between a single component and a single function. This allowed us to explain that once we have identified the function of a particular component, then we can simply search for a direct swap. It is now time to remove this assumption and realise why function modelling is the oxygen of Value Engineering.

If we have three components in a system then we will probably identify three functions and in doing so get a glimpse of the original designer's knowledge of the system. Why did the designer have three components? Because that was then seen to be the best way of performing at least three functions. However, innovative engineers can often design a multi-functional component that performs the work of many components. This attraction to 'do more with less' is what often leads engineers to elegant solutions. In the previous section we considered a single make of car and the range of fuel consumption was between 15 and 45 miles per gallon depending on the type of terrain the car traversed. By using a common unit of say $/mile, we can consider alternative solutions, such as rotary engines, diesel engines, fuel cells and so on, and as we do...
so widen the possible-solution space; that is we widen the range of potential solutions (See figure five).

Figure 5. Hypothetical national average cost of fuel per mile

If we only looked at this single function with a view to selecting the best technology then we might make the wrong decision (see similar mistake associated with cost-cutting and table 1). In the UK the government wants to encourage environmentally friendly technologies and it might be that tax relief advantages offset the apparent cost of a particular technology. Similarly, the cost of installing, operating and maintaining something like a Fuel Cell technology may bring a host of problems that at the company level would make such a selection unfavourable. The point being made here is that not only does the elicitation of functions widen the possible-solution space, but it also allows the implementation of technology to be considered inside a bigger picture and in so doing helps organisations move closer to elegant solutions.

Conclusion

By making the realisation that a function is an abstract class of solution-processes we can now distinguish between a real world solution-process and an abstract one. The title of this paper asks whether “Drink Beer” is a function and now we can quite clearly say it is not because it is a real world solution-process. What is more, we can see that by naming a solution-process as a function we limit the width of the possible-solution space and so limit the ability to get even closer to an ideal or elegant solution.

References


Acknowledgements

The authors would like to acknowledge, and thank, the insights shared freely by Professor Dan A. Seni, of Quebec University At Montreal, Canada.

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Choosing by Advantages is an integrated decision making system developed by Jim Suhr while he was working for the US Department of Agriculture Forestry Service. Since leaving the Forestry Service, Jim and his wife Margaret have continued to develop and promote CBA though their Institute for Decision Making Innovations, Inc.

Central to CBA is what Jim calls the “Fundamental Rule of Sound Decision Making.” This rule states that, “Decisions must be made on the importance of advantages.” An advantage is the difference between the attributes of competing alternatives. Importance is the value placed on that advantage based on the purpose and circumstances of the decision, the needs and preferences of the stakeholders, the magnitude of the advantage, and the magnitudes of the attributes from which the advantage was derived.

When I looked at the outcome of a VE effort, it occurred to me that the most likely reason for the rejection of one of a team’s recommendations could be summarized in a single sentence:

The decision-makers were not convinced that the advantages of adopting the proposed alternative outweighed the advantages of not doing so.

Therefore, a system that stresses the relative importance of the advantages of competing alternatives should attack this problem in a direct, straightforward manner. Referring back to the “Fundamental Rule” stated above, the CBA system certainly seems to be aligned with this premise. It directs the team’s efforts through a logical sequence from alternatives to attributes, to advantages, to importance, and culminating at relative importance. Following this logical sequence promises the opportunity for an effective and efficient process.

Aside from the prospect of improving the team’s effectiveness and efficiency, I also believed that CBA could make a significant improvement in the decision-makers’ understanding of the team’s recommendations. When laid out using one of the CBA methods tailored to different situations, the attributes of each alternative are plain to see, as are the advantages offered by the differences between the attributes of the alternatives in question and the importance assigned to each advantage. Thus, the decision-maker can readily see the whole rationale for the recommendation laid out in front of her.

Figure 1a shows the presentation of the hypothetical findings of a study team using CBA. Two options, Alternatives A and B, are being compared using three factors: capacity, access, and safety. It is immediately clear from this presentation that the team studying these alternatives felt that:

- Alternative A would offer a disadvantage in capacity, while Alternative B would offer advantages in safety;  
- Alternative A's advantage in capacity is the most important of the three advantages;  
- Alternative A's advantage in capacity would be slightly more important than Alternative B's advantage in safety;  
- Both of these advantages would be significantly more important than Alternative B's advantage in access;  
- Overall, based on the total importance of the advantages for each alternative, the alternatives are almost comparable, with Alternative B being slightly preferred.

CBA Methods and Modifications That Were Used in the Workshop

Two of the CBA methods were used in the workshop. The first was the “Tabular Method.” This method, which displays attributes, advantages, and the importance of the advantages for two or more alternatives, was used in the Information, Development, Decision, and Presentation Phases. The second was the “Two-list Method,” which only shows the advantages of two alternatives. This method was used during the Evaluation Phase. Figures 1a and 2a show the CBA formats for these two methods.

I felt that the format for each could be improved for use in VE. In particular, I thought each would require too much explanation for the limited time available during a VE workshop. While it might not be possible to make them self-explanatory, it appeared that their graphics could be redesigned to make them more visually appealing.

Figure 1: The CBA Tabular Method

<table>
<thead>
<tr>
<th>Factors</th>
<th>Alternative A</th>
<th>Alternative B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>1000 vpd</td>
<td>800 vpd</td>
</tr>
<tr>
<td>Access</td>
<td>Good</td>
<td>Very Good</td>
</tr>
<tr>
<td>Safety</td>
<td>Fair</td>
<td>Excellent</td>
</tr>
<tr>
<td>Total Importance</td>
<td>130</td>
<td>140</td>
</tr>
</tbody>
</table>

a. Original Format

b. Modified Format
intuitive. Being a big fan of graphic artist and philosopher Edward Tufte, I also hoped to use some of his concepts to reduce the amount of "non-data ink."92

Reviewing the material from Jim’s three-day Sound Decision-making Course, I decided to use the balance scale metaphor that Jim uses effectively to demonstrate CBA concepts. The resulting variations of the Tabular and Two-list Methods are shown in Figures 1b and 2b, respectively.

Both variations capture several key elements of CBA in their graphic presentations. These elements include:

- Factors are listed above the scale’s fulcrum, indicating they are neutral and have no effect on the scale’s balance;
- All information about competing alternatives is placed on either side of the fulcrum;
- In the Tabular Method, attributes are shown to the far left and right, “off the scale” and indicating that they also have no effect on its balance;
- Advantages are clearly “on the scale,” reinforcing that they are the elements that are being “weighted;”
- Advantages are shown on the side of the scale that they should “weigh down;”
- The placement of the advantage, indicated not only by the placement of the text but also by a small dot under the text, indicates the amount of leverage it has on the decision; and,
- The small scales near the bottom of each remind the team to strive to understand how the scale would tip under the relative “weight” of the advantages.

There is one more important distinction between the standard CBA Tabular Method format and the modified format. In the CBA Tabular Method, a number is assigned to each advantage indicating its relative importance. These numbers are then summed to produce an indication of the total importance of the advantages of an alternative, which is compared to the sum for competing alternatives.

I decided not to make any such attempt to sum arithmetically the relative importance of the alternatives. Instead, I relied on the scale metaphor and the team’s visual perception of the “weight” of the competing alternatives. The major reason for not using the calculation was the limited time available during the workshop for training in the CBA method. I believe the scale metaphor was well received and contributed to both the success of the workshop and each team member’s satisfaction with their corporate effort.

The Use of CBA in Specific Phases of the VE Workshop

CBA methods were used in the Information, Evaluation, Development, Decision, and Presentation Phases.

Information Phase. First, the Tabular Method was used near the end of the Information Phase. It was first used, as shown in Figure 3a, to summarize the advantages presented by the proposed design in comparison with the existing condition. As would likely happen in most cases, this indicated that the scale would tip decisively toward the proposed design. However, it also illustrated the relative importance of each advantage offered by the proposed design, as well any advantages posed by the existing condition (as expected, indicating the impacts of implementing the proposed design). This use of the Tabular Method strengthened the team’s understanding of the “purpose and need” of the project. It also provided me with an opportunity to acquaint them with CBA concepts and to lead them through the Tabular Method in preparation for their use of it later when working individually and in small groups.

Before moving on, this method was repeated a second time. In this case, we compared the proposed design with what I called a “realistic ideal design.” The purpose of this exercise, shown in Figure 4b, was to help the team identify advantages that might be obtainable by changing the proposed design.

The use of these two applications of the Tabular Method provided an excellent transition to the Function Analysis Phase that followed. The impacts of the proposed design and the potential opportunities identified in the “realistic ideal design” led directly into development of a “FAST diagram based upon issues of concern.”93

Evaluation Phase. The second use of a CBA method, this time the Two-list Method, was during the Evaluation Phase. After the discarding of “thought-provoker” and nonsense ideas, as well as the designation of appropriate ideas as “notes to designer,” each of the remaining ideas generated by the team was evaluated by one team member, usually the originator or key proponent of the idea. An example is shown in Figure 4. As can be seen, each idea was evaluated in terms of both non-cost and cost advantages. Based on these evaluations, a letter between “A” and “E,” and a number between “1” and “5” was assigned to each idea to indicate the balance of the comparison of non-cost and cost considerations, respectively. After all ideas were evaluated, the team members pre-

<table>
<thead>
<tr>
<th>Alternative A</th>
<th>Alternative B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Higher Capacity</strong></td>
<td>130</td>
</tr>
<tr>
<td>Better Access</td>
<td>40</td>
</tr>
<tr>
<td>Much Better Safety</td>
<td>100</td>
</tr>
<tr>
<td>Total Importance</td>
<td><strong>130</strong></td>
</tr>
<tr>
<td>Total Importance</td>
<td><strong>140</strong></td>
</tr>
</tbody>
</table>

a. Original Format

![Figure 2: The CBA Two-list Method](image-url)
### EXISTING CONDITION

<table>
<thead>
<tr>
<th>ATTRIBUTE</th>
<th>VERY IMPORTANT</th>
<th>SOMEWHAT IMPORTANT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 lanes ea. dir</td>
<td></td>
<td></td>
</tr>
<tr>
<td>None on br. 4' inside rdwy.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-complying bridge rail</td>
<td></td>
<td></td>
</tr>
<tr>
<td>k = 85 55 mph</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4% Width restriction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low - lots of maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10' outside shoulder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>No detour to boat ramp</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Possible area of improvement, but not much potential for significant improvement in value

### PROPOSED DESIGN

<table>
<thead>
<tr>
<th>ATTRIBUTE</th>
<th>VERY IMPORTANT</th>
<th>SOMEWHAT IMPORTANT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility/ Capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety - Shoulders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety - Bridge Rail</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety - Sight Dist.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety - Long. Slope</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reliability of Throughput</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintainability</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic Disrupt. During Const.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access to West Side</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Possible area of improvement for proposed design

### FACTOR

<table>
<thead>
<tr>
<th>VERY IMPORTANT</th>
<th>SOMEWHAT IMPORTANT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 more lane</td>
<td></td>
</tr>
<tr>
<td>Wider shoulders</td>
<td></td>
</tr>
<tr>
<td>Safer rail</td>
<td></td>
</tr>
<tr>
<td>Better sight dist.</td>
<td></td>
</tr>
<tr>
<td>Platter slopes</td>
<td></td>
</tr>
<tr>
<td>Much more room</td>
<td></td>
</tr>
<tr>
<td>Ample room</td>
<td></td>
</tr>
<tr>
<td>Better maintenance</td>
<td></td>
</tr>
</tbody>
</table>

### COSTS

- Moderate to high maintenance, High user & safety costs

### PROPOSED DESIGN vs. Proposed Design

- No roadway shoulder
- 4-mile detour from IH 10 east.
- 1.307 ac. impacted

### REALISTIC IDEAL DESIGN

- Up to 10' shldr. inside & out
- More direct access
- <1.307 ac. impacted

### COSTS

- $24 million construction, high user costs during const.

### a. Existing Conditions vs. Proposed Design

### b. Proposed Design vs. Realistic Ideal Design

### Figure 3: Information Phase Analysis

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sent each analysis to the assembled team, which added comments and developed a consensus on the rating of the idea in terms of both non-cost and cost advantages.

As each idea was reviewed and consensus reached on the ratings, the number of each idea was plotted on a matrix as shown in Figure 5. This matrix indicated if ideas were good, marginal, or poor candidates for improvement and aided in the selection of ideas for further development.

We found an unexpected benefit in the use of the Two-list Method during the Evaluation Phase. As it began the Development Phase, team realized that it had already analyzed and discussed each idea in a similar, though more abbreviated format. Thus, the analysis of each prospect had already been framed with respect to the issues involved and the attributes that would need to be developed. Based on my experience with previous workshops, I felt that this accelerated progress during the Development Phase considerably.

Development Phase. A CBA method again involved the Tabular Method, this time during the Development Phase. Individuals
and small groups evaluated each prospect using the same format that was used during the Information Phase. The format used was the same as that shown in Figure 3 (without the boxed callouts shown on Figure 3 to illustrate the significance of the positioning of the various advantages).

Decision Phase. Another change related to the integration of CBA was the insertion of a distinct Decision Phase. During this phase, the team reassembled after evaluating the prospects and used the format shown in Figure 3 to review the attributes and advantages that had been developed during the Development Phase. They discussed each prospect and modified attributes, advantages, and the importance of each advantage before reaching a consensus to recommend or reject each prospect. In doing so, the team often revealed subtle advantages that had been overlooked during the individual or small group analyses.

Presentation Phase. The Presentation Phase continued the emphasis of advantages and their relative importance, again using the format shown in Figure 3. In developing the presentation, I urged the team to build the best case for each both the current design and the team’s recommendation, stressing the need to provide decision-makers with high fidelity information that was as objective and factual as possible.

Conclusion

I found Choosing by Advantages to be a useful system that can be incorporated effectively into the value engineering process. It provides a clear and easily understood logical path that proceeds sequentially from alternatives to attributes, to advantages, to the importance of advantages, and culminating in sound recommendations. Through the transparency of the CBA formats, the team’s reasoning is open for all to see. Whether they agree with the recommendations or not, I believe decision-makers will gain greater confidence in the VE process when its results are presented in this manner.

I think this application of CBA also demonstrates the often-overlooked possibilities offered by the improvement of graphics and visual media. Like a good engineering or architectural project, good graphics are designed based upon established principles, practiced with a constant emphasis on improvement.

Finally, analogy and metaphor can and should be exploited to maximum advantage. As shown, the combination of a simple analogy and clear, effective graphics can be a powerful combination.

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Gary R. Myers, PE, CVS, is president of Epsilon Engineering, Inc., Houston, Texas.
Index by Article

AASHTO Value Engineering Award. Value World 26 (2): 5 (Fall 2003).


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Index by Author


Wilson, David C. Improved Road Safety Is No Accident. Value World 26 (1): 14-16 (Spring 2003).
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