PAPERS FOR VALUE WORLD

A new system for Value World papers is in effect. Papers will no longer be acceptable in hard copy, but must be on a disc as described below.

PREPARATION OF DISC

All papers will be submitted on a disc using an IBM compatible computer or word processor. Both density discs (low and high) as well as both sized discs (3.5" and 5.25") are acceptable. The preferred word processing program is Word Perfect 5.0 or 5.1. However the following are acceptable if you cannot use WP5.1:

ASCI  Navy DCA  Word Star 3.3  Multi Mate
Advantage II  Spreadsheet DIF  Microsoft Word 4.0

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Before you have your paper scanned be sure that you use only 8.5" x 11" paper. If your paper is not that size, make the typing 6.5" x 9" - trim the length to 11".

BIOGRAPHY

Please write a short (about 120 words) biography of yourself in the third person: Include a BLACK & WHITE photograph.
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EDITORIAL POLICY: To provide informative, timely and interesting communications pertaining to Value Engineering / Value Analysis and related disciplines. VALUE WORLD enables contributors to express themselves professionally in advancing the art. VALUE WORLD is dedicated to the establishment of a mutual bond among those seeking to better the quality of working life and establish a communications network through which participants can interact for mutual benefit.

The views expressed in VALUE WORLD are neither approved or disapproved by the Society. They are the expressions of the author(s).

All papers have been edited — frequently condensed — by the editor.
Implementing, Maintaining, and Continuously Improving a Value Engineering Program in a State Transportation Agency

by Ken Roberts

Ken Roberts is with the Florida Department of Transportation, Office of Value Engineering. Ken has been with the FDOT for 28 years serving in various capacities. His experience involves highway and bridge construction, Maintenance Engineer for the Jacksonville urban area and District Bridge Engineer. Ken has been involved in VE for 5 years conducting VE training and program management. During the past year he served as President of the North Florida Chapter of SAVE.

There are many areas of a state agency value engineering (VE) program that differ from what I will term the “classical” VE approach. In a governmental agency, such as the Florida Department of Transportation, the product produced is unique each time. There are no two projects that will be exactly alike or even require the utilization of the same processes to produce the desired results.

Repetition does occur in developing plans and specifications for transportation projects. However, the repetition is in the processes that are used by project managers and designers. It is important, then, to provide a means to develop the processes for maximum effectiveness and to train project managers so that maximum efficiency is achieved in the process utilization.

Another area of significant impact is that of a constantly changing work environment. This change may be generated by any of a number of factors including the political atmosphere, management turnover, policy changes, changing annual budgets, and technology. Requirements by outside agents, such as state and federal environmental regulators and local special interest groups, present an even greater impact due to a lack of control over the overall project schedule and project requirements.

Another area of significant impact is that of subjective decision making. We, as engineers, who deal with facts and numbers, are trained that engineering is a “finite science,” and therefore, we should be making fact-based decisions. In reality, because many project activities and selection design criteria can work within acceptable ranges, decisions may become subjective and thus personal. In doing so, VE recommendations are taken more personally rather than as an engineering aid or tool that

Our experience has shown that the initial introduction of a VE program in a governmental atmosphere is best accomplished in a low profile area of the agency. Decisions in these areas are generally painless and result in little adverse action. Also, in many instances, ownership is not a factor. Once credibility has been achieved through positive results and the benefits of the tools and techniques of VE are recognized by project managers, the program may be advanced to more adventurous transportation elements.

Another critical factor to understand in the development of transportation projects is that of subjective decision making. We, as engineers, who deal with facts and numbers, are trained that engineering is a “finite science,” and therefore, we should be making fact-based decisions. In reality, because many project activities and selection design criteria can work within acceptable ranges, decisions may become subjective and thus personal. In doing so, VE recommendations are taken more personally rather than as an engineering aid or tool that
the project manager uses to produce the best possible product.

Finally, in this effort to provide insight into the atmosphere surrounding VE involved in a state agency, I will describe what is probably the most dramatic impact that inhibits the full utilization of VE. Presently, overwhelming emphasis is placed on meeting production schedules, project time tables, letting dates, cash commitment targets, and the overall delivery of transportation projects contained in the annual work program. It is recognized that the primary mission of the agency is to complete the critical transportation program. It is recognized that the primary mission of the agency is to complete the critical transportation program. Presently, I will describe what is probably the most dramatic impact that inhibits the full utilization of VE. Presently, overwhelming emphasis is placed on meeting production schedules, project time tables, letting dates, cash commitment targets, and the overall delivery of transportation projects contained in the annual work program. It is recognized that the primary mission of the agency is to complete the critical transportation improvements so noted. The potential failure to exhaust state budgets in areas where massive local need exists creates pressures where the focus is to meet production schedules and insure that all available dollars have been committed. VE activities, as in Florida, may generate cost avoidances in excess of 50 million dollars per year. This may involve re-programming and bringing forward projects in the development process at an advanced pace, thereby adding to the production pressure.

The evolution of a VE program must involve the establishing of VE as an integral part of the project development. Many organizations have made the mistake of setting the VE function as a separate entity thereby becoming alien or cult to the normal process and to the project personnel.

The Florida Department of Transportation's VE Program has evolved through the years encountering all of the roadblocks and impacts indicated above. Today, VE is an integral part of the project development. The Department's ten full time value engineers are generally looked upon as sources of information and provide tools and techniques to aid the project manager. VE is considered another functional area such as drainage design, structure design, right-of-way acquisition, etc. The achievement of Florida Department of Transportation's VE Program is based on many factors of which the most important has been the strong support of senior management. A significant fact is that, since the program began in 1976, the agency head has changed six times. Continuous support by each of the agency heads has been maintained.

Second only to the strong commitment by top management, the Florida DOT program has achieved success through the development and implementation of seven key elements. They are:

1. VE Policy
2. Organization
3. Training
4. VE Procedure
5. Use of VE Consultants
6. VE Change Proposals (VECPs)
7. Recognition

POLICY - For any program to be implemented, it must first have an authority or obligatory requirement that places responsibility on a department, work, unit or position. Program continuation and success is dependent upon three items. They are: 1) assigned responsibility; 2) delegated authority consistent with the assigned responsibility; and, 3) accountability.

A state VE program's success will depend on how successful you are in the planning phase of program development. The first step in the planning phase, assuming top management has already committed to establishing a VE program, is to develop and publish a policy statement.

Policy statements should be originated by the highest level of authority in a state transportation agency. In many states policy statements are only issued by the agency head. In states where there is an established transportation commission, policy statements may be issued by them.

ORGANIZATION - Following the lead of a policy statement issued by the agency head, the next action is to assign program responsibility in the central office. The State VE Administrator position should report to a high level manager such as the chief engineer. The VE Administrator must be able to communicate freely and effectively across organizational lines with VE teams, designers, project engineers, and maintenance personnel as well as managers and outsiders.

The State VE Administrator must plan, develop and establish VE procedures, management orientations and employee training. He must also set objectives and measures of effectiveness, and design monitoring systems to measure program success.

TRAINING - The next element of an efficient and successful VE program lies in the ability of the VE Administrator to establish and maintain a multi-disciplined pool of experienced employees trained in the tools and techniques of VE. Varying degrees of orientation and training should be made available to upper and middle managers. The more management understands the principles of VE, the more confidence they will have in a VE study producing well thought out alternatives.

Considerable emphasis should be placed on the selection and development of VE team leaders. The team leader should be the “best of the best.” Our experience has shown that the quality of a VE team study is usually a direct reflection of the leadership ability of the team leader.

VE PROCEDURE - Specific procedures must be established to define how the VE program will function for the benefit of the Department's employees and for design and VE consultants that become involved in the Department's VE activities. Several areas have been identified as important factors that should be included in any operating procedure. Criteria should be developed for the following:

1. Project Selection
2. Annual VE Work Plan
3. VE Team Structure and Qualifications
4. VE Study Process
5. VE Report Format
6. Implementation Process
7. Measures of Effectiveness and Reporting
8. Consultant Use
CONSULTANTS - Agencies may elect to involve consultant services in the VE program. Criteria should be adopted outlining the method and manner of consultant utilization. Mature transportation VE programs use consultants in several ways. VE consultants may provide training and team leader services. Design consultants may be required to provide the VE team support with engineering services and possibly serve as team members.

VECPS - A fundamental part of any transportation VE program should involve the primary supplier, the construction contractor. VE change proposals submitted by the contractor should be considered as a continuation of the VE concepts, principles, and techniques applied at the construction stage of a project. Appropriate processing and evaluation criteria are essential to maintain credibility from the contractor's point of view. The Value Engineer should be the champion of VECPs and make every effort to insure impartial considerations of all proposals.

RECOGNITION - The recognition and awards program provides added recognition and incentive for work performed and tangible evidence of participation in the VE process. A recognition program should be designed to provide incentive at various levels.

They may be district, unit, team or individual awards. In this manner top management, mid-managers and individuals may be motivated to perform in and support VE.

The Florida Department of Transportation has employed all of these program concepts. The benefits are much more than can be identified here or indicated by mere numbers. However, in a society where success is measured by statistical analysis, the following represents the success of our program during the last three years.

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<th>RECOMMENDED SAVINGS</th>
<th>IMPLEMENTED SAVINGS</th>
<th>NUMBER OF STUDIES</th>
<th>NUMBER OF REC.</th>
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<td>287</td>
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It is our belief these are satisfactory achievements. Outstanding is our goal.

International Conference Photo Album

Larry Zimmerman presents O.J. Vogl an award of Merit for his work as Editor of SAVE's professional journals.

Keynote speaker at the opening of the International Conference, June 1, 1992: Philip C. Gregory, Senior Vice President, Functional Operations, LTV Missiles & Electronic Group.
The Replacement of the Lacey V. Murrow Floating Bridge

by William F. Ventry, PE, CVS

Bill Ventry is president of William F. Ventry, P.E., CVS, which specializes in VE and Transportation Consulting. He has over 25 years of experience in transportation and has been involved in VE since 1979.

He has held positions from design squad leader to chief engineer of the Florida Department of Transportation. He, at one time, served as the Department’s Chief Value Engineer and is credited with developing the Department’s program into one of the nation’s best.

He has served on many American Association of State Highway and Transportation Officials (AASHTO) committees and task forces, including the Standing Committee on Highways. He was a member of the VE task force and was instrumental in both the writing and approval of the “AASHTO Value Engineering Guidelines.” He also served on the Chief Highway Engineers Committee.

When I was asked to provide an article on one of the unique Transportation projects on which I have performed Value Engineering (VE) Studies, one that comes to mind is "The Replacement of the Lacey V. Murrow Floating Bridge."

On July 2, 1940, the Lacey V. Murrow floating bridge opened. It was the first concrete floating bridge in the world and was considered an engineering milestone. It later became part of the Interstate 90 corridor, connecting Mercer Island and Seattle, Washington.

In 1987, the floating bridge was placed on the National Register of Historic Places. In July of 1990, the bridge celebrated it’s 50th birthday.

In 1989, a new parallel I-90 floating bridge was opened, immediately adjacent to the old bridge. The old bridge was shut down to traffic and a contractor began rehabilitating the Lacey V. Murrow Bridge.

On November 25, 1990, about 1/3 of the 8,583 foot floating bridge sank during one of the worst storms to strike western Washington in years. Of the 26 floating concrete pontoons, 9 sank approximately 200 feet to the bottom of Lake Washington. The remaining 17 pontoons were floated away from the new I-90 bridge and anchored along the shoreline until a decision could be made concerning their reuse.

Within two weeks of the sinking, a VE Team was assembled by the Washington Department of Transportation, to do a VE Study of the replacement of the floating bridge. For the VE study, the VE team consisted of the following individuals and expertise:

Bill Ventry, Team Leader
William F. Ventry, PE, CVS
Bob LaFraugh, Scheduling
Wiss, Janney, Elster Associates
Jerry Weigel, Bridge Construction
Washington Dept. of Transportation
Ying Fay Chan, Bridge Design
Washington Dept. of Transportation
Harold Peterfeso, Environmental
Washington Dept. of Transportation
Don Hoffman, Design
Washington Dept. of Transportation
Richard Kay, Design
Federal Highway Administration
Gary Kasza, Bridge Construction
Federal Highway Administration

The team was provided a meeting room in proximity to the project site. On December 10, 1992, the team was provided an initial briefing and set about gathering information, including a site visit to inspect the remaining floating pontoons.

During the investigation phase the team identified the following areas of focus.

Condition of the Remaining Pontoons:

Pontoons B, A-1 and A-2 were beached as a unit. Pontoons F, C, G-1, and L-1 were anchored as a unit.
on the water side of B, A-1 and A-2. Pontoons X, Y, Z, E, D, G-2 and L-2, which were not originally torn from their anchorage system, had since been relocated to a temporary anchorage at the South end of the lake. The teams observations indicated that there were a variety of torsion and stress cracks in the old bridge's pontoons.

**Condition of the Existing Approach Structures:**

The existing approach structures were not floating pontoons but were fixed bridges with a conventional foundation. The East approach had already been widened during the rehabilitation work and appears to have survived the sinking reasonably well. The West approach had not yet been widened and the team questioned the condition of the foundation because of the transition span failure during the sinking.

**Graving Dock Availability:**

The team identified two graving dock sites that had previously been used for casting concrete bridge pontoons. They are the Port of Tacoma and the Everett Navy Homeporting site. The team determined that both sites were available although procedural, environmental, and permit issues would have to be satisfied. There were also two contractor sites available, one in Seattle and one in Tacoma. The team identified the need to have a number of sites available for a fast track schedule.

**Construction Cost:**

The team focus of cost reviews was the life cycle cost of using the salvageable old pontoons versus constructing new ones.

**Design Sequencing:**

Since the Washington Department of Transportation wanted to begin replacing the bridge as soon as possible, the team investigated all possibilities for design. The techniques identified by the team were 1) Design/Build contracts, 2) Consultant Design, 3) Washington DOT Design and 4) a combination of Consultant/Washington DOT Design.

**Construction Sequencing:**

The team investigated areas which would allow the replacement to pursue fast track opportunities. The primary critical path resource identified by the team was the availability of graving dock sites and the ability to cycle construction of new groups of pontoons and rehabilitate old groups of pontoons through those sites. The team also investigated the possibility of using precast versus cast-in-place for time and money savings. Innovative contract procedures, such as bidding generalized documents, bidding two stage contracts, bidding multiple contracts and design/build were investigated by the team.

**Maintenance:**

The maintenance requirements for all possible alternatives were investigated, with the team focusing on the maintenance cost implications of various combinations of the use of the old pontoons with some new ones versus constructing all new pontoons.

One of the major considerations for the team was the condition of the remaining pontoons. The team ultimately concluded that due to the tremendous stresses that had been exerted on the old pontoons during the sinking, of the 17 still floating, only 6 were salvageable.

The other major consideration was the construction schedule. What was the feasibility of maximum use of available graving docks and how quick could the design and construction be accomplished?

In the speculation phase, numerous alternatives were formulated, that ranged from double decking the new I-90 floating bridge to salvaging the sunken pontoons and rehabilitating them along with others still floating.

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Damage to Pontoon L-1 caused by falling West Transition span
During the Evaluation phase, two potential feasible alternatives emerged. They were:

**Alternative No. 1**

Use the existing approaches that were being rehabilitated, construct 20 new pontoons to current Federal Highway Administration standards.

**Alternative No. 2**

Again, use the existing approaches, rehabilitate the 6 old pontoons that were salvageable, and construct 15 new pontoons.

As you can see, this sets up a "classic" life cycle cost analysis. The team concluded that Alternative No. 1 was the most feasible and cost-effective from a life cycle cost perspective. New pontoons would have significantly lower maintenance costs. Additionally, new pontoons would be built to last 75 years, whereas, the useable old pontoons would have an estimated lifespan of only 30 years.

Even if the old pontoons were used, they would have to be dry docked and extensively rehabilitated.

Any time saved by using the old pontoons would essentially be consumed by the time they would have to be Dry docked.

As for scheduling possibilities, the team developed a VE schedule using two graving docks, and concluded that a new bridge could potentially be in place by late summer, 1993, "without jeopardizing quality of design or construction." The completion date was arrived at by considering how long it might take to resolve outstanding environmental and permitting issues, the availability and capacity of the graving docks, the design process requirements and the construction process itself.

On December 14, 1990, the team made the recommendation to the top management of the Washington Department of Transportation, that they use the existing approaches that were being rehabilitated and construct 20 new concrete floating pontoons.

The recommendations of the team were accepted and today the new pontoons are under construction with a completion date set for August, 1993.
The Direction and Growth of Value Management — A Strategy for the 90s

J. Jerry Kaufman, BS, CVS, FSAVE is founder and president of J.J. Kaufman Associates, Inc., a Value Management Services Firm. He holds engineering degrees from the Academy of Aeronautics and Johns Hopkins University. Formerly the corporate director of Value Programs and internal consultant for Cooper Industries, Mr. Kaufman was responsible for developing and successfully implementing VE in the strategic business units and divisions of the corporation. Mr. Kaufman is Past President of SAVE, Past Chairman of the CVS Certification Board, and Trustees Chairman of the L.D. Miles Foundation.

A Backward Glance

There is a tendency among industrial management in the United States to grasp one initiative at a time as the answer to meeting business objectives. The decade of the 60s saw a myriad of cost reduction programs as the initiative to improve our competitive position, but productivity suffered. In the 70s industry turned to productivity improvement as the answer, and quality took a back seat. The 80s and into the 90s will be known as the time for quality awareness. Is this the answer that industrial managers are looking for?

VE versus the single initiatives

Many management initiatives sprang forth and peaked over the last 40 years, then faded in popularity. A small sampling of these programs include; Management by Objectives, Kepner Trego problem analysis, Management Grid Analysis, Participatory Management, Customer Awareness, Design to Cost, Life Cycle Cost, Work Simplification, and many more.

A matter of survival

During the same period Value Engineering (VE) continued its low visibility, but persistent survival path. How does VE differ from these initiatives? What are the elements that account for its continued survival? What can we do to accelerate the growth of VE? True, VE's growth domestically has been stagnant, but it has grown steadily in the European and Asian communities. Considering that VE lacks an identity, organizational roots, and formal recognition by the academic community, its continued existence is somewhat of a mystery.

Even the simplest questions like; “What is a Value Engineer?” “What does a Value Engineer do?” and “What would you put into a professional job description to define a VE’s position in a company?” - will provoke a heated debate among VE practitioners.

One reason for the survival of VE could be because it is a methodology, not a single initiative. History has proven that single initiatives by themselves, directed at improving business, will not work.

What makes a business successful

Competition and business success is not based on any single issue. It is a combination of factors that include the harmonious integration of timing, cost effectiveness, quality and productivity, with dedicated and trained people, led by skilled and creative managers, that makes a business successful. In other words, it takes a disciplined approach, an operating methodology and a work ethic supported by a committed management to make it happen.

Our Current Status

The common perception of VE is that it is a management “tool” to affect cost reduction. As such, VE has been closely associated with the reduction of direct costs (i.e.: material and labor) of hardware products. In the United States this perception is encouraged by the Department of Defense (DoD) and other Federal Government VE programs directed at “after the fact” cost reduction.

A preoccupation with cost reduction

Federal Government Contractors are encouraged to participate through the submission of VECPs (Value Engineering Change Proposals) that provide for up to a 50 percent share of the contract savings with the Government, for approved and successfully implemented
VECPs. Non-defense industries have generally followed DoD's example and placed VE in organizational positions to reduce product cost. Over the last 10 years there have been some strides in the US to move VE into the non-hardware side of business with successful examples cited in; Design to cost, overhead reduction, savings in paper flow, and reductions in scrap and rework, to name a few; but the perception of VE as a hardware associated cost reduction activity still persists.

The VE movement off-shore

In Asia and Europe, VE is accelerating and expanding into the management culture of businesses representing a large variety of markets, products, services and government. Japan formally adopted VE in 1966, and according to the Society for Japanese Value Engineering, credits much of its success in industry to their emphasis on quality and VE. Korea's consumer products industry is aggressively pursuing VE, and Taiwan is making effective use of VE in their government capital improvement programs.

In Europe, common market countries have created a congress as a forum for their individual VE societies, to discuss advancing the concept and applications of VE, and to resolve issues of mutual interest and concern.

Globally, VE is entering a new phase driven by the changing business environment. The unit cost of a product is no longer the dominant business expense it was 20, or even 10 years ago. Manufacturing technology has reduced direct labor's contribution to standard cost to less then 20 percent, compared to 80 or more percent of material cost. The emphasis today and into the future is focused on the cost of doing business, time to market, quality products and after market services.

The Future Challenge

As a methodology VE is well prepared to meet the future challenges; but are the practitioners who use the methodology?

To move the Value methodology into an accelerated growth direction, we first must change our thinking from "engineering" or "analyzing value," to "managing value," and focus on all of the elements that make a business successful. In this regard the term "Value Management" (VM) may be more appropriate in describing the Value methodology.

Value Management, the methodology

VM is not a single initiative, or even multiple initiatives. VM is a methodology that embraces those initiatives and management skills that make a business successful. The word VALUE, is a marketing term, not an engineering or production term. Only the customer can determine the value of products and services offered in the marketplace, and in a free market economy, only the customer can make a business successful.

The application of VM begins with a needs analysis to understand what functions the market wants and is willing to pay for, then moves to align a company to profitably satisfy those market requirements.

Some characteristics of the VM methodology include:

- VM is guided by a methodical disciplined approach consisting of specific steps that move the study issue from definition to implementation.
- VM requires an interdisciplinary "team" dedicated to the resolution of the study issue and committed to the successful implementation of approved resolutions.
- The application of Function Analysis allows multi-disciplined team members to communicate with each other as the Function Analysis System Technique (FAST) isolates root problems, or clearly addresses new opportunities.
- VM focuses on the business plan, its commitments and objectives, rather than seeking targets of opportunity.
- A major element to the success of VM projects is the effective use of VM trained facilitators in guiding the teams through the VM methodology.
- As a methodology, VM can be used to resolve any dilemma where a choice of functional approaches is a viable option and the objective is to improve value, in whatever units value is measured.

This does not suggest abandoning cost reduction as a result of VM. It does however, look at cost reduction as a way, among alternatives, to solve a problem or capture an opportunity rather than making cost reduction the prime objective and central issue of the VM study. Cost reduction is not an objective. It is a means selected to achieve an objective.

Putting cost reduction in proper context, VM studies should seek to achieve the best cost-to-price ratio rather than concentrating only on cost reduction. This allows for examining how functions can be improved or added to support a price increase while evaluating how business expenses can be reduced. The result is improved profit margins, sales and market share.

Opportunities for VM

Other viable opportunities for VM include, but are not limited to the following:

- Time to Market
  Advancing technology has significantly reduced the window of opportunity for new product introductions. A three-year product development phase from concept to market, considered normal a decade ago, has shrunk to nine months or less. Missing the marketing window could result in a major loss of market share and sales.

  VM Task Teams, using Function Analysis System Technique (FAST) to improve the product development process, can help reduce time to market while protecting the quality and integrity of the product.

- Improved Process Time
  Reducing process time, be it the processing of information or the product manufacturing process,
including inventory turns, is aimed at improving the time value of money. Reducing the return on investment cycle will significantly improve the financial condition of the company.

A VM study using FAST will isolate those functions necessary to achieve the objectives of the process under study, and eliminate activities that do not support required functions, while improving process quality.

- **Organization Effectiveness**
  The functional line organization that describes most industrial companies was conceived and developed during the industrial revolution. It was structured as specialized compartments designed to handle and analyze the complexity of information needed to run a business. Computer technology has since given business the opportunity to retrieve and process information quickly and efficiently, without having to filter information through many layers of management. Today's successful companies are made up of small entrepreneurial based teams, led by managers who can manage people, as well as process information effectively.

  The interdisciplinary VM task team, and its supporting methodology are well suited as a culture for entrepreneurial objectives.

- **Value Added vs. Non-Value Added**
  Each process in a company should be analyzed to determine its contribution to bottom line performance. Recent productivity studied in the U.S. indicated that as much as 95 percent of the expenses to conduct business in an industrial environment can be classified as non-value added. On the factory floor relating to raw and finished goods inventory, tool change, machine set-up, material travel, floor space, rejection and rework, are all considered non-value added. A more balanced value added to non-value expense ratio will improve the cost of doing business.

  The FAST modeling process can quickly isolate non-value added functions and activities, and the creative processes in VM can help achieve a more cost effective process.

- **Product Information**
  To compete effectively requires a company to produce a continuous flow of new ideas for products, services and processes. Consumer products are especially sensitive to product changes that involve the innovative application of functions and features to meet customer expectations.

  VM is not only sensitive to those factors that drive economic value, but perceived value is also carefully considered in evaluating the potential success of the “whole” product.

- **Productivity Improvement**
  Productivity Improvement can be described as an organized effort to achieve business goals expressed as the ratio of invested resources (input) to improve the effective utilization of those resources (output).

  The dynamics of VM, where function (output) is analyzed with respect to the cost to achieve those functions (input), is a compatible methodology in achieving productivity improvement goals.

**A Challenge to Value Managers**

Because VM cuts across all functional lines of an organization it is a most effective training ground for future executive managers, as well as a successful business methodology.

If VM is to reach its full potential, Value Practitioners must become better trained, educated and more proficient in the effective use of the methodology. A professional image of VM must be created based on its effective use as a resource to executive management rather than a cost reduction activity to be tolerated during good times.

In summary, the expectations of VM demand that practitioners act, think and become better managers. ▲
Joining the Visiting Team

by R.B. Sperling, CVS; W. Lenzer, PE, CVS, FSAVE, & D. Hamilton, PE, CVS

William E. Lenzer, PE, CVS, FSAVE, is president and founder of VEI, Inc., Dallas, Texas. He has worked in the consulting engineering business exclusively since 1963 and is a registered professional engineer in 34 states. Bill served on the SAVE Board of Directors from 1978 through 1986; he is a past president of SAVE.

David A. Hamilton, PE, CVS, manages all VE effort for U.S. Cost Inc., Atlanta, Georgia. He has presented numerous VE training workshops and VE presentations for the Georgia Institute of Technology, Naval Facilities Engineering Command, New York City Transit Authority, Metropolitan Atlanta Rapid Transit Authority, and the Florida Department of Transportation.

Please see page 19 for R.B. Sperling biography.


Introduction

As an extension of the Selection and Use of VA/VE Professionals, this paper suggests that by becoming a member of the VE team, the value manager can enhance the performance of the study itself, and even improve the level of implementation.

Not all VE teams operate within a congenial environment when they travel to a client’s site to perform a study. VE consultants sometimes experience isolation and lack of communication, and are presented with the added challenge of finding out virtually all needed information, and must contact the client and the design team with no assistance from the host organization. It would seem that, in some cases, consultants are programmed for failure by making it unnecessarily difficult for them to do their work.

In contrast to this almost adversarial approach to VE, there is a positive, supportive style of coordinating VE studies. By “joining” the VE team the value manager can help in numerous ways. These support activities can be divided into three phases: pre-study, in-study, and post-study.

Pre-Study Support

There are two key items during the Pre-Study phase that the value manager can help with to improve VE studies done by visiting teams: project documentation and study facilities.

Project Documentation

It is essential that the VE team has access to the fullest design package possible. Sending the plans, specifications and current cost estimate to the team at least a week in advance of the study is advised. Augmenting the design package with design criteria, studies and other background is desirable. It is better to make too much data available (overfeed the team) than to deny vital data (starve the team).

Study Facilities

There are personal needs which the value manager can help satisfy to enhance the team’s working environment. Herzberg calls these “hygiene factors” in the work place which have the power to dissatisfy and demotivate the worker when present in unsatisfactory forms. Thus, care in setting up the VE team’s work environment (meeting room, telephone, photocopy/FAX) can contribute to a satisfied, more productive team.
There are personal needs which the value manager can help satisfy to enhance the team's working environment.

**In-Study Report**

The main thrust of team assistance by the value manager is during the study itself: by providing a site tour, making technical data available and giving management support.

**Site Tour**

Orienting the VE team to the physical location of the study project is extremely important. What they can learn from a visit to the site (where practical) can transcend the printed project documents. To deny the team access to the job site keeps potentially valuable data from being accessed. Ideas are generated by “kicking the dirt.”

**Technical Support**

The most important boost the value manager can give the visiting team is to be a channel of information. There is ample opportunity for the value manager to help the team by identifying items needed and either supplying them directly or pointing out how to get them. A critical resource is the people who have been involved with the project to date and possess knowledge not necessarily documented anywhere. Giving the VE team access to these people is an extremely valuable service which improves the knowledge of the team members.

**The most important boost the value manager can give the visiting team is to be a channel of information.**

**Management Support**

The value manager needs to spend adequate time (at least 50%) with the VE team. Welcoming them on Day 1 and thanking them on Day 5 is not sufficient contact. Daily contact (Days 2, 3 and 4 also) is essential; being available to answer questions is especially important at the front end of the study. Also, key questions can arise throughout the study, some of which need timely answers to avoid delaying the work of the team. Giving encouragement to the team is highly recommended. To paraphrase a key principle in The One Minute Manager:<sup>1</sup> *help the VE team reach its full potential; catch it doing something right.* By reinforcing good performance the team senses a positive rapport which encourages extra effort.

**Post-Study Report**

When the work of developing the VEPs is complete, “selling” the results begins with the verbal briefing and the formal report. The value manager can support both of these critical activities.

**Presentation Support**

The Presentation Phase communicates the VE team’s results on an immediate basis. While the formal report becomes the documentation for the study, often it is the presentation that carries the message. Therefore, it is important that the value manager make the tools (proper audience, room and equipment) available to the team to assure the best possible presentation.

**Implementation Support**

Because the value manager has spent considerable time with the VE team during the study, he can answer questions arising during implementation discussions by the design team. Supporting the project manager during this implementation work is essential to ensure complete follow-through of the VE study.

**Consultant Experience**

Two VE consultants (Consultant “A” and Consultant “B”), who experience varying styles of value managers as they do VE studies for many different clients, report on the specific effects of strong support from the value manager.

**Local vs. Remote Studies**

Consultant “A” has client “Al” who does VE studies at local sites as well as remote sites. For the local studies, the value manager is only a part-time participant; whereas, for the remote studies he is with the VE team full time.

VE consultants are rated by this client on the basis of savings generated by the studies. The consultant with the highest rating performed 80% of the remote studies over a multi-year period. From the consultant point of view it is more desirable to do remote studies for this client because the value manager is involved full time, the implemented savings are better and the consultant rating is higher.

**Improving Implementation**

A VE consultant team needs a value manager to act as a champion in-house, to assist the team in fact-finding, and to be a liaison with the client’s staff. An important additional function is to provide an interface with the owner, user and designer at the presentation. This assistance is instrumental in helping sell the results of the study.

The value manager can assist in selling the VE proposals if he:

- has a technical knowledge in one or more disciplines
- practices good human relations within the client organization
- has established credibility
- has a professional approach.

Furthermore, implementation meetings scheduled by the value manager, whether the VE team is present or
not, are a key to ensuring high rates of implementation, based on experience with many clients.

**Increasing Return on Investment**

For consultant “B,” the R.O.I. (Return on Investment) of construction VE studies is normally 20:1. When the ROI is greater than this norm, a comparison of client styles reveals that a strong value manager can positively influence the ROI.

For example Client “B1” who has multiple VE consultants, rarely conducts site visits and only involves the consultant in half of the implementation meetings, typically accepts 40% of the VE proposals, but only 20% of the dollar savings.

In contrast, Client “B2,” who always conducts site visits and provides ample information through a heavily-involved value manager, accepts 40% of the VE proposals but 45% to 50% of the dollar savings (more than double Client “B1.”)

In another case, Client “B3” had VE performed on one major project. There was a site visit, but no involvement in implementation; the value manager was not aggressive. Only 20% of the VE proposals were accepted.

Finally, Client “B4,” who had a very active value manager from the senior management level, had two large projects where 54% and 71% of VE proposals were accepted, and 51% to 80% of dollar savings were accepted.

Highest VE savings for Consultant “B” occur when:
- there is an active value manager (preferably a senior person)
- regular site visits are part of the study
- studies are conducted at the client’s office
- the value manager is involved in implementation
- VE is conducted early (10% to 30% design).

**Summary**

None of the suggested functions by the value manager is unique. However, when they are freely given, the visiting team is more likely to be comfortable and productive in its work. The value manager who is aggressive and who encourages an “open” process will obtain the maximum results from VE consultants. Consultant experience points to higher implementation rates where the value manager “joins” the visiting team. And with higher implementation rates the acceptance of VE by project managers will grow from the negative: “What will VE do to my project?;” to the positive: “What can VE do for my project;”

**References**

A Knowledge-Based System for Value Engineering

by Khalid A. Taher, Ph.D.

Khalid A. Taher is an assistant professor at King Saud University in Riyadh, Saudi Arabia. He has a Ph.D. in Civil Engineering and conducted leading research in Value Engineering. He has participated in a number of VE studies and seminars. His present research concentrates on the use of Artificial Intelligence and the Database technologies to enhance the effectiveness of VE studies. He is an associate member of the American Society of Civil Engineers and a member of SAVE.

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Introduction

Value Engineering (VE) or Value Analysis (VA) has been used by many organizations since the early 1950s. Its true potential, however, is realized only when time is spent identifying functions then developing creative alternatives to replace them at lower cost. Creativity in a VE study comes basically from experience of team members and the synergy effect of the brainstorming process conducted by the members.

VE studies have always been a team task and always been limited, due to their cost, to bigger projects. The application of a VE study by individuals is difficult due to the amount of work involved and the absence of experience and interaction with others.

An engineer, using VE, can find out the client’s real needs of the structure. He/she can also try to provide alternative designs to satisfy those needs, at the lowest cost possible. But when the experience in a particular design area is missing, the role of the individual in using VE becomes largely crippled. It takes an intelligent system to substitute for this factor in a VE study.

This paper presents a new tool for VE. This tool employs “Knowledge-Based Systems” (KBS) to substitute for the experience in a particular area when VE is applied by an individual who does not have it. KBS provide tools for computer use in acquiring and structuring knowledge and expertise in fields where conventional algorithmic programming cannot apply. A Knowledge-Based system, called “ValuExpert,” was developed to demonstrate the use of KBS in the creativity phase of VE. ValuExpert was used as a proof of concept and a research tool to investigate the issues outlined.

Knowledge-Based Systems

There are different computerized systems to support VE studies. The effectiveness of the existing systems, for the most part, fall short in assisting properly in the creativity phase of VE.

The limitations of the existing computerized VE tools can be overcome, to a certain degree, with a different type of computer program referred to as KBS. According to Barr:

“Knowledge-Based Systems are mostly strongly characterized by their use of large bodies of domain knowledge, facts and procedures gleaned from human experts that have proved useful for solving typical problems in their domain.”

Therefore, what makes KBS different from other large computer programs written to aid problem solving is their ability to formalize and represent knowledge within a specific domain. Typically, this kind of knowledge cannot be represented through a large database or well-defined procedures. In practice, if the knowledge needed for a task is stable, numerical, and can be easily aggregated then conventional programming will be the best way to solve problems in that domain.

What makes KBS different from other large computer programs written to aid problem solving is their ability to formalize and represent knowledge within a specific domain.
In the VE studies the creativity phase is primarily cognitive, requiring reasoning at multiple levels of abstraction. The use of KBs to aid in this process of VE could be highly beneficial.

ValuExpert attempts to provide (in a one-person VE study) for the lost richness of different members' experience. Experiences from previous VE studies are stored in a special database (experience-base) in ValuExpert and used to provide alternative ways to satisfy required function.

The Domain of ValuExpert

ValuExpert was implemented in a domain of school roofing systems. Roofing systems constitute a manageable, yet rich part of the building components, that were suitable to demonstrate the value of such a tool. This work uses information from VE studies conducted over a period of six years on school buildings in Washington state. This information, plus experience provided by an authority in the field (a domain expert), provided the knowledge that ValuExpert uses.

The Design of ValuExpert

Figure 1 illustrates the components of ValuExpert. The system is designed to criticize a proposed roofing system design, and offer alternatives to all or parts of the proposed system that can satisfy the required functions at a lower initial, or life cycle costs. After the information phase is conducted, the user describes the design he/she has to the system through a number of interactive menus (Figure 2). ValuExpert evaluates the proposed design, and provides alternatives and suggestions to enhance its value. The system uses for this process what the user believes to be the Basic and Secondary functions/criteria of the element under study (Figure 3).

The Design of ValuExpert

![Diagram of ValuExpert components](image)

The system maintains a database of experiences that relate to well-defined areas of potential problems (e.g. Figure 4). The system offers an interactive interface for the user to update the experience-base with new ideas (Figure 5). Such ideas are used by the system to suggest alternative ways to satisfy function or criteria required by the design. Based on that process, the system reconstructs the lists of Basic and Secondary criteria for the roofing system so as to reflect the user's needs in a better way.

A roofing system should satisfy a set of selection criteria that are defined by the surrounding conditions and by the user's specific needs. The degree at which a given design satisfies each element in the selection criteria should be consistent with the criterion's relative weight of importance. A problem is said to exist when at least one of these requirements is violated. ValuExpert identifies three types of potential problems that could exist in a design and, accordingly, can affect its value. These are, the Basic-criteria related problems, the Secondary-criteria related problems and the Compatibility problems.

Compatibility problems refer to the unsuitability of using one type of a system component with another, such as concrete substrate with built-up roofing. Problems could exist when non-compatible systems are selected or when better compatibility is not used.

Basic criteria problems are criteria that should be satisfied for the design to comply with a specific code or to perform its Basic function. Basic criteria cannot be changed or removed without impacting the technical feasibility of the design.

Secondary criteria problems are those criteria that facilitate serving a specified secondary function(s) such as carrying mechanical equipment by the roof. They also include criteria that, if exist and are not satisfied (completely or relative to their weight of importance), might impact the cost of the system (initial or life cycle cost) such as accounting for the aspect of “congested site” in the selection of a roofing system. When Secondary function(s) can be served by a different, less expensive method, its corresponding criteria in the list of secondary criteria for a secondary design aspect could be removed or selected with the appropriate weight of importance depending on the existing situation.

ValuExpert uses a roofing matrix (RM) that contains different characteristics of 20 representative roofing systems (covers most of the systems commonly used for schools). The domain expert has provided the knowledge that describes the different systems' characteristics in terms of a consistent score of five levels (5 being superior, and 1 inferior). These scores describe the performance of each system in every given feature in a relative manner. Some of those criteria were identified as Basic criteria others as Secondary. The program provides the user with the list of the Basic criteria and has him/her select the applicable ones. The program then evaluates the systems in the "RM" against the set of the selected Basic criteria. All the systems with scores lower than a threshold (4, or better than average) in any of the applicable Basic criteria would be flagged for being not suitable and discarded from the solution space.

For the Secondary criteria, the system verifies with the user their existence and their relative degree of importance for the present situation. The program then tries to relax the search constraints by searching for alternative ways to serve some of the selected functions, and accordingly, remove the criteria that are required for them.

The process of reducing search criteria from the list of the common Secondary ones, is not a direct process.
For the Secondary criteria, the system verifies with the user their existence and their relative degree of importance for the present situation.

It involves searching the experience-base for previous solutions to criteria or function problems if any should exist. To illustrate this point, let us assume that the system has queried the user for the degree of complexity of the proposed design, as a Secondary criterion, and let us assume that the design calls for a complex shaped roof. Since such a criterion would have a negative impact on the cost of the selected system, and might be removed without affecting the Basic function of the roofing system. It represents a problem. A search is conducted in the experience-base for previous solutions to a similar problem. The user is then presented with the cases that deal with the problem of complex design, if any, one at a time. He/she is asked to verify the applicability of the conditions that would allow their solution to work. If no case is found applicable, the system adds this criterion to the list of search criteria.

Based on the above discussion, it can be noticed, that the process of problem identification and the search for alternative design (solution), is mainly based on a process of removing the unnecessary criteria, if any, and reconstructing a new list of search criteria with
This solution calls for: relocate mechanical equipment into the ground, and use a
no traffic roofing system. Figure solno001

conditions required for the proposed idea
no technical restrictions

conditions selected as possible to satisfy (select from above)
room available on the ground for the mechanical system

Figure 4

This solution calls for: relocate mechanical equipment into the ground, and use a
no traffic roofing system. Figure solno001

conditions required for the proposed idea
no technical restrictions

conditions selected as possible to satisfy (select from above)

Figure 4

relative weights that reflect the user's needs. This list
should help select an alternative component or design
that can better satisfy the user required lower initial, or
life cycle costs.

The search process evaluates the compatibility of
the proposed alternatives to the existing deck and
insulation systems. It provides, as well, a list of the
most compatible systems (deck and insulation) for each
alternative presented.

ValuExpert uses a five-step process, to handle the
search.

First, using a satisfying technique, the solution space
is reduced to one that satisfies all the essential criteria.

Second, a list of secondary criteria is constructed out of
the confirmed (by the user) secondary criteria. This step
includes the search in experiences for a solution to a
potential problematic Secondary function or criterion.

Third, the system requires the user to assign a weight
to each element of the list of Secondary criteria (the
sum of all weights should add up to 100%).

Fourth, the system calculates a score for each possible
solution (alternative), based on its degree of satisfaction
to the selected list of criteria.

Fifth, the system uses one of the user's main-
emphasis criteria (initial cost or life cycle cost) to
adjust the previous score. Finally, an ordered list of
alternatives (based on suitability score), is presented
to the user.

Adjusted score for initial cost = Qualitative score/initial cost score (1) Adjusted score for L.C cost = Qualitative score/L.C cost score (2).

In the final report, the program also presents the user
with an evaluation for the present design through a set
of suitability scores. These scores are calculated based
on the same criteria and weights used in the process of searching for the alternatives. The present design's evaluation includes a criticism for violating any Basic criteria, if any.

In case the alternative systems assume the use of a solution from the experience-base to a criteria problem, the final report will include that. The approach, outlined above, has proven to offer a good degree of flexibility for the search process. It allows the user to assign different weights to different search criteria, and interactively, test their effect on the selection process. Such flexibility can enhance the process of dealing with the uncertainty in the design, and, accordingly, lead to increase the value of the design.

**Conclusion**

ValuExpert has demonstrated promising results that strongly suggest the use of KBS technology in VE. KBS can help make the VE technique more widely spread by providing a tool to ease conduct of its most essential and most difficult phase, the creativity phase.

An individual (or even a team) with little experience in some area of the design being value engineered can find a specialized KBS most helpful.

An intelligent assistant can provide such a support at a considerable low cost. It is expected that this tool will increase the profitability of VE studies and help spread VE use in smaller projects by increasing the ratio of savings to cost of study.

**References**


A Project Performance Review Based on the VE Job Plan

by Roger B. Sperling, CVS

Roger B. Sperling, CVS, is VE Site Coordinator and Associate Division Leader for Plant Engineering at Lawrence Livermore National Laboratory. He has a BS in Engineering from UCLA. Mr. Sperling is responsible for coordination of all Laboratory VE activities. He conducts in-house VE studies and monitors studies made by VE consultants. Roger is President of the San Francisco Bay Area Chapter of SAVE.

Introduction

A final — and often overlooked — procedure in the design and construction of facilities is the project review, or “post mortem,” which attempts to analyze the problems encountered during the project and identify lessons learned.

One way to perform such a project review is in the manner of a detective: a staff person is assigned to open closet doors, find the skeletons and study them. Often this becomes a series of one-on-one interviews with the project team members and takes the appearance of an investigation with mostly negative connotations. Fears and apprehensions surround the persons involved; the term “post mortem” translates into “lynching” or “witch hunt” in their minds. The whole exercise can degenerate into blame-placing with real personal concerns about its effect on individual performance appraisals and even salary raises.

Another way is to conduct a Project Performance Review (PPR), a group-centered activity using a systematic plan and a trained facilitator. Instead of the investigative approach, the PPR involves the project team working together to explore the positive and negative aspects of a completed project. Team members are treated as equals and all ideas are recorded. Conclusions, both lessons learned and suggested changes in the design/construction process, are reached by consensus. The facilitator leads the team through a positively-framed process which contributes to team learning and team building.

The PPR Team

The success of a PPR depends largely on who is chosen to be on the team. Selecting the team members should be done in consultation with the facilitator who understands the PPR process. The team can be composed of managers and supervisors but should include lead staff persons who are familiar with the details of the project. While each project is different and the selection of people is unique to the project, the size should always be about six to eight.

The success of a PPR depends largely on who is chosen to be on the team.

The client should be included to receive first hand input on client satisfaction. This will ensure that the correct focus is developed for the PPR and that the client understands the process used. This will help get the buy-in on the lessons learned and any suggested solutions.

The PPR Process

The PPR process is based on the Value Engineering (VE) Job Plan. Table 1 compares the VE Job Plan and the PPR Agenda.

| Table 1 |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| VE Job Plan PPR Agenda | Information Phase | Creative Phase | Analysis Phase | Development Phase | Presentation Phase |
| List Purposes of PPR | List “What Did We Do Right?” (Brainstorming) | Rank Issues/Problems | List Lessons Learned | Develop Suggested Solutions | Prepare Report |
| Function Phase | Functions of Project | Presentation to Management | Report Phase | Implementation Phase |
| Determine Primary/Secondary | | | | | |
The VE Job Plan is designed to engage a team of design professionals in systematically analyzing project documents to improve function and reduce unnecessary costs. The PPR Agenda follows the same steps because of the inherent ability of the process to tap into the creative abilities of the team and solve problems collectively using the synergism of group interaction. Each step of the PPR Agenda is explained below.

**List Purposes of PPR/Visit Job Site**

These two activities serve to build a common understanding of the project and to document the reasons for the PPR, as in the VE Job Plan's Information Phase. A project may have had schedule, or budget or execution problems which need exploring; these key issues are usually listed, along with more abstract reasons, such as “understand job” or “list learned lessons.” The site visit is next; it puts everyone on a “level playing field.” It is possible that some persons have never visited the job site; as they see the completed project they, along with the facilitator, gain direct knowledge of the conditions which faced the designers and contractors.

**Determine Primary/Secondary Functions**

Using function analysis (as in the VE Function Phase), the facilitator asks the team to describe the functions of the project using the verb/noun convention. Responses can include “house staff” as well as “satisfy client.” The team then discusses which are primary, which are secondary, and even which are required secondary functions. This clarifies the scope of the project and can reveal changes that occurred during the life of the project that affected performance. For example, the project may have been schedule-driven at its inception, but over time became budget-driven, reversing primary and secondary functions.

Using function analysis (as in the VE Function Phase), the facilitator asks the team to describe the functions of the project using the verb/noun convention.

**What Did We Do Right?**

Operating in the brainstorming mode (the Creative Phase) the team responds to the “What did we do right?” question. It can be hard for the team at first to think of positive aspects of a project, especially one that has a reputation for being a problem job. However, it is not unusual for many items to be listed including: “good teamwork,” “ordered right material” and “met schedule.” Focusing on the “good” aspects of the project turns the tables on the normal post mortem process. The team knows that they still have to deal with the negatives, but they get a boost from acknowledging that in any job there are successes to be celebrated. Focusing only on the failures actually distorts the evaluation, creating a descending spiral of negativism. The PPR process builds team confidence that both the good and the bad can be verbalized and dealt with in a non-threatening environment.

**What Could We Do Better?**

Continuing in the brainstorming mode (the Creative Phase) the team is asked to list the problems or issues associated with the project, but couching them as responses to the question “What could we do better?” Rather than listing negatively-phrased items such as “cost estimate incomplete” they are worded as positive aspirations for improvement, such as “improve cost estimate.” Team members can acknowledge that an error was made but simultaneously make a suggestion for improvement. It becomes easier to express the problems surrounding a project when said in an upbeat way. While it is not an exuberant brainstorming session it does contribute to a continuing sense of team building.

**Rank Issues/Problems**

The next step ranks the issues/problems listed in response to the two questions (Evaluation Phase). Evaluation is done of the positive “what we did right” responses to identify key successes in the project. Then the team begins working with the problem areas, the “what we could do better” items.

The facilitator provides ranking criteria to the team, such as “Impact on Job” (0-5 points) and “Ability to Change” (0-5 points). Table 2 details these criteria; the first evaluates the past, while the second looks to future improvements. The team is asked to rank each item against these two criteria by assigning two scores which are added for a total ranking score. For example, “improve cost estimate” might have a moderate impact on the job (4 points) and be easily improved (5 points) for a total of 9 points. As each item is considered the ranking process become more sophisticated because the team develops its own methodology; sometimes the first-ranked items are revisited to adjust numbers for consistency.

<table>
<thead>
<tr>
<th>Impact/Ability on Job to Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAST</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>5 (High)</td>
</tr>
<tr>
<td>4 (Significant)</td>
</tr>
<tr>
<td>3 (Moderate)</td>
</tr>
<tr>
<td>2 (Some)</td>
</tr>
<tr>
<td>1 (Little)</td>
</tr>
<tr>
<td>0 (None)</td>
</tr>
</tbody>
</table>

This analysis of the issues/problems can be the most significant event of the PPR. Now discussion and consensus building take place. This is when understanding of the various viewpoints of the job grows. This is when managers begin to hear what the problems of the team members were; how design criteria were obscure or non-existent at the start of the job; the impact of the difficulties in obtaining material and manpower.
Lessons Learned/Suggested Solutions

The ranked issues/problems provide the team with data which allow them to synthesize their findings into lessons learned and to develop suggested solutions for consideration by management (Development Phase). Still working with the whole team, the facilitator helps them gather together the highly-ranked issues into groups which define a lesson learned on the project. An example lesson learned is “Take more time at the start of project to define scope, schedule and budget.”

This activity could end the PPR. However, if time is available, the process can continue with the team brainstorming solutions to the lesson learned and refine their thinking into specific proposals, such as “formalize the kickoff meeting process with a check list of items to be discussed.” Such proposals can be presented to management to improve the design/construction process.

The PPR Team can proceed to develop recommended solutions to process problems, but the proper group to carry out this work is a Quality Improvement team which can carefully work on generic problems. Some members of the PPR team can be assigned to the quality team to communicate project-specific knowledge.

Presentation to Management

A presentation to management and the client gives the team and facilitator the opportunity to summarize the PPR effort and make recommendations which can improve the management of future projects (Presentation Phase). Such a meeting can be beneficial if only the lessons learned are presented; however, it is important to spend some time explaining the PPR process so that everyone understands the steps taken to reach the lessons learned.

Prepare Report

The facilitator collects the work sheets from the PPR sessions and reduces them to report pages, forming a record of the team effort (Report Phase). This report is distributed to management and the client and is retained in the project file. Team members also receive copies as documentation of their joint effort and as a ready reference to lessons learned.

Adopt Suggested Solutions

The final PPR step is the implementation of team findings (Implementation Phase). This can be the hardest step to accomplish. Getting Management to implement specific proposals for process improvement may take persistent effort. But if a pattern of activities is revealed by a series of PPRs, such as “consistently poor project definition,” then the recommendations of PPR teams to “change the project initiation process” may become easier to implement. Also, the lessons learned may be taken to heart by the PPR team members and as the process is used more and more there can become an internalization of the desire to improve the way business is done.

Getting management to implement specific proposals for process improvement may take persistent effort.

Schedule and Cost

The PPR process requires a minimum of one-half of a team-day to complete; the maximum time depends on the size of the project and the number of team members. Limiting the team size is, in part, necessary to reduce the time needed to process all the ideas that are recorded. A small $100,000 construction project may require only the minimum time, unless complex issues are raised that the client wishes to work with the team. A $1,000,000 project may only take a full team-day if the issues raised are typical of design and construction work; however, special concerns can extend the time. As projects become larger more time may be needed.

The cost of the PPR can be considered a normal project cost, as are other project close-out activities such as, as-built drawings. If this cost is not accounted for in the initial project budget, overhead funds may be needed to support it.

Recommendation

The VE Job Plan is a fundamentally sound creative group process and has applications in other activities. One of them is the Project Performance Review. Instead of the often negative fact-finding approach to project evaluations which can threaten the team members, the group-centered approach can be a positive experience for the team and actually foster the objectives of the project review: to learn from each project and improve the way business is conducted while maintaining the dignity of and respect for those involved. PPR team members report positive feelings about the PPR process because it casts an objective light on the project and focuses on the performance of the process, not on the performance of individuals. Anyone wanting to encourage open communications with employees about the reasons for successful and unsuccessful projects should try the PPR process.
Applying Function Analysis to Understand and Reduce Purchase Costs

by R. Daryel Anderson, PE, CVS & Charles J. Teague

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Daryel has focused the value process at Allison on meeting design-to-cost targets of new and derivative engines. He has led numerous successful VE studies with supplier teams to better understand cost drivers and identify unneeded functions. He is Vice President, Professional Development of SAVE, President of the Central Indiana Chapter of SAVE, and is Chairman of the General Motors Value Management Committee.

Charles Teague is a Materials Development Engineer at Allison Gas Turbine Division, General Motors Corp. He has a BSMATE from Virginia Polytechnic Institute and State University and an MBA from the University of Indianapolis.

Charles is responsible for the selection of materials and processes used in the Allison components of the T800-HLTEC engine. Charles has participated in several VE Workshops focusing on design-to-cost targets for the T800 engine. His practical understanding of gas turbine principles, engine/airframe interaction, and experience with the quality system used in the aerospace industry has been an important contribution to these workshops.

Introduction

One of the primary users of new materials and processes has been the aerospace industry. The need for reduced weight, increased stiffness, reduced corrosion, and increased fatigue resistance for both applications has led to the development and application of polymer, metal, intermetallic, and ceramic matrix materials. Because the need for more versatile, multifunction weapon systems is increasing, the pace for making advances in material development and application is accelerating.

In the 1980s, Allison, through its aggressive pursuit of gas turbine engine programs for the next generation vertical takeoff and landing aircraft (VTOL), was awarded contracts for the Army T800 engine (for the RAH Comanche helicopter) and the Navy’s T406 engine (for the V-22 Osprey). At Allison, the growth of these engines is a continuing process of development and application of new technologies to increase engine reliability and durability while keeping costs down.

Introducing new technologies, especially new material and fabrication techniques, is an expensive process. The acquisition cost for new technologies is initially high and required production quantities are usually not sufficient enough to show potential savings. Because of this, projected cost goals for engine production and intended aircraft application are required. For military applications, this means that design-to-cost goals must be established and achieved to convince life cycle planners of the value of the new technologies. Value Engineering (VE) methodology is an important means of understanding engine component and systems costs. VE methodology uses techniques such as function analysis to aid in defining unnecessary costs, propose solutions, or assist in defining alternative strategies for material development or for the component fabrication.

Value Engineering: A Team Approach

VE is a function-oriented team approach for improving the value of a product, component, or manufacturing process. The VE approach used at Allison provides a forum in which suppliers and their subcontractors can identify the design and manufacturing processes that contribute to high
acquisition costs and try to eliminate these costs. Also this approach can be used, if necessary, to define technology development programs that could reduce acquisition costs. In addition, this team approach provides communications between the supplier and customer to clarify any concerns about the component or process.

Allison's VE method is a multitask process emphasizing a component's cost on a per function basis. This cost is determined in three major steps: design-to-cost evaluation, pre-VE workshop orientation for the suppliers, and the VE workshop (Figure 1). This process also provides a supplier and/or customer interface that can eventually help each participant understand the other's concerns about the component.

For the initial design-to-cost evaluation, Allison uses an extensive computer database containing material and fabrication costs for individual components in the T800 and T406 engine programs. This database reflects current costs for fabricated components from both the Allison manufacturing facility and current suppliers. The data are tracked and compared with established cost goal values for each program. (The specific cost procedure is shown in Figure 3.) Any significant deviation from these goals alerts Allison management that a VE study may be required.

The Value Engineering Workshop

After management has approved a VE study, the first step is to identify those components that need to be studied. Subsequently, a VE workshop orientation is conducted with the supplier and the supplier's subcontractors at their facilities. An important part of this preworkshop is to define the basic features of the component or system to be studied and the process to be used to fabricate the component. Allison uses its design-to-cost values as a basis for this initial discussion and VE study. The goal of the orientation session is to assign cost values to the features, later to be allocated to the basic, supporting, and design objective functions for the component in the VE workshop. Finally, the Allison value specialist prepares for the VE workshop. This preparation involves coordinating the VE team, which includes Allison specialists, the supplier, and the supplier's subcontractors. Representatives from purchasing, manufacturing, quality, and engineering departments participate in a three-day VE workshop.

The VE workshop begins with a review of the engine program, design and manufacturing criteria, and quality issues for all participants. The VE team then writes a statement of the study objectives. The team members perform function definition, evaluate, and propose alternatives for the key features of the component. The part cost data developed in the preworkshop are allocated to the features and form a baseline cost to be used throughout the workshop. The basic, supporting, and design objective functions are defined. Then a function analysis system technique (FAST) diagram is prepared to establish the critical path and supporting functions. Costs of critical path
functions are assigned and compared with supporting and design objective function costs. A value index (VI) is calculated by dividing the total cost by the combined critical path cost. Diagramming in this manner helps the team define functions and costs.

In the creativity session of the workshop, participants brainstorm functions that account for 80% of the component cost and include any performance areas that need strengthening. The ideas taken from the brainstorming session are reviewed by the team, common ideas are pooled and restated, and then the ideas are graded against a predetermined set of criteria. Ultimately, the ideas are ranked for final selection and prepared as a proposal for implementation.

The proposal phase of the study is used to describe the proposed change, document assumptions for technical feasibility, and show cost savings. Workshop participants prepare proposal forms to give management personnel at the conclusion of the workshop. Once management approval has been given, the designated team member is responsible for implementing the proposal. A second VE team may be needed to define the implementation plan and process to be followed.

The Value of Function Analysis

Often in the concept and design phases, the component's compliance with general requirements and user expectation is not cost effective. It is generally assumed that as a component matures, increased funding will be made to address alternatives for production process approval. Concurrently, the manufacturer of a component is unaware of the required functions and therefore cannot participate in identifying alternatives that could lower manufacturing costs. In other words, normal business practices provide little opportunity for the subcontractor and the customer to discuss requirements. Including the supplier as a team member in the VE study helps to clarify requirements from the beginning. In function analysis, the team selects brainstorming topics that address areas for opportunity in cost improvement, customer concerns, producibility, and fault correction. This gives the supplier the opportunity to contribute ideas that might not have been considered.

Specific Case Evaluation

The basic functions of a component or process in a gas turbine engine are to deliver power to a gearbox, propeller, or fan by ingesting air, mixing fuel, converting energy, and extracting power. Design objective functions include the customer's expectation for reliability, maintainability, performance, and weight. In modern gas turbine engines the design objective functions are responsible for a significant portion of component costs. This is particularly true for the T800 and T406 engines for which life cycle costs are a contractual requirement. This is illustrated by a FAST diagram for a major component in the T800 engine.

The air/oil cooler shown in Figure 3, for example, is a procured component. The required function of the air/oil cooler is to cool the engine oil before it is returned.
This information was used during the creativity phase to brainstorm ideas for those features/functions that contained the majority of the costs. The planning phase proposal for cost savings indicated that acquisition costs could be reduced by 33% if the proposal was implemented. The use of a FAST diagram for the air/oil cooler helped the VE team identify costs associated with each function. The FAST diagram clearly defines areas of opportunity for cost improvement without changing the fundamental properties.

Conclusion

Function analysis, including FAST diagramming, translates the structure of any product or process into words. The ultimate objective is to shift the viewpoint of the VE team member from a set position to a flexible one, allowing alternate ideas or concepts consideration.

The use of function analysis, applied in a VE study, in the concept and design phase is effective in determining the requirements, defining basic and supporting functions, and allowing acceptable alternatives for cost reduction. Function analysis also allows the subcontractor to communicate with the engineering personnel responsible for the initial design. This lets the subcontractor participate in evaluating alternatives to the supporting and design objective functions for the part.

The results of the VE study formulate a strategy that is then set in motion by the VE team. The impact of proposal implementation can be identified through design-to-cost tracking to determine if the objectives were met.

References

A Comment on 'Those Graphs': Potential VE Savings During a Construction Project

by Stuart MacPherson

Stuart MacPherson is a researcher at Heriot-Watt University, Edinburgh, Scotland. He is investigating techniques for evaluating alternative Heating, Ventilating and Air Conditioning (HVAC) system designs for office buildings as part of an on-going research project into VE in construction. A professional engineer, Stuart holds a BS in physics, an MS in engineering and an MBA from Heriot-Watt University. He has several years experience in the HVAC industry, and prior to re-entering academic life was a consulting engineer.

The notion that the greatest opportunity to influence the value of a project occurs at the earliest stages of planning is now accepted wisdom.

Nowhere is this more true than in the construction industry. With a few exceptions, such as repetitive house building, the products of the construction industry are one-off customized buildings. It is not possible for the retrospective analysis of the components of a completed one-off building to yield any (capital) savings on that particular building, nor is the reduction in cost of a few components at the advanced stages of design likely to make a significant impact on the (capital or life cycle) cost of the project as a whole.

This general rule is often illustrated by one of the graphs shown in figure 1. Figure 1(a) appeared in the General Services Administration handbook which formed the basis for the wider incorporation of VE into US Government construction contracts (GSA, 1972) and has since been used by other writers on VE (for example Macedo et al., 1978 and O'Brien, 1976). The illustration in figure 1(b) appeared in Dell'Isola (1972) and has also found its way into much wider use.

Although some allowances must be made for their obvious simplicity, these illustrations are nevertheless incorrect. The cost reduction potential due to a change in design does not alter over time. To show it reducing as in these illustrations is to confuse the idea of 'cost...
reduction' with 'savings.' More properly considered, potential cost reduction is a constant equal to the difference between the cost of the original design and the altered design. Furthermore, the cost to implement changes in design can rapidly overtake the potential cost reduction, therefore the graph in figure 1(a) should not exhibit the asymptotic behavior shown. A more rigorous approach to illustrating the relationship between cost-effective design alterations and time would be that shown in figure 2.

The potential cost reduction (which may be capital or life-cycle) is indicated by the horizontal line, while the cost to change follows the familiar sigmoid curve which indicates the funds already sunk in the original design (i.e. abortive work) plus the cost of altering to the new design. The net potential saving to be obtained by adopting a design change is therefore the difference between the potential cost reduction and the cost to change as indicated by the arrows. The breakeven point is where the cost to change equals the potential cost reduction, and it is no longer possible for this design change to yield any net saving.

Generally speaking, large potential cost reductions will be associated with relatively major design changes such as building size or plan shape, etc. Such changes become extremely costly to make as design progresses, and very quickly the cost to change overtakes the potential cost reduction. Consequently, the breakeven point for such a major change occurs early in the design.

Conversely, small potential cost reductions are normally associated with minor design changes such as choice of finishes. These changes do not entail such large amounts of abortive design work and can often be made after construction has begun.

Intermediate design changes have potential cost reductions and breakeven points which lie between these two extremes (see broken lines) and the locus of these breakeven points will form a curve as shown by the shaded line.

Some design changes will be incompatible in that they form a set of alternatives, only one of which can actually be implemented. Other changes may be compatible however, and capable of being implemented in combination, although the magnitude of the cost reduction potential and the cost to change of each may, in combination, be different from the individual figures based on the original design. For example, if the building size is reduced, then it is still possible to change the finishes, but the cost reduction in doing so will be less than it was based on the original design. Hence the aggregate net savings from a combination of changes may be different from the simple addition of the individual net savings based on the original design.

Accepting this problem of interdependence, it is possible to see that at any instant a figure for total net savings from a combination of compatible design changes will exist. If plotted against time on a graph it will produce a curve of the form shown in figure 3, which is a more correct representation of how total net potential savings on a project vary with time.

This graph assumes that we are dealing only with cost reducing VE; that is improving value by
maintaining function but reducing cost. It is however reasonable to suppose that the potential for improvement in value by the more general criterion of maximizing the relation between function and cost also follows a similar rule.

References
PUBLICATIONS

BOOKS:

"Techniques of VA & VE (3rd Edition)" by L.D. Miles. This book, authored by the originator of Value Analysis and Engineering Technology, shows management and professional people specific steps to disciplined thinking, giving them 25-50 percent more efficiency—both in the quality and quantity of their mental work.

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"Innovative Change, 101 Case Histories Value Engineering" by A.E. Mudge. This book describes 101 Case Histories resulting from the application of the value engineering methodology to both hardware and software, system, procedural and organizational projects. The case histories have been drawn from the worldwide applications of Value Engineering's systematic approach to both commercial and military projects.

COST Non-Member $38.00 Member $33.00

"Value Control Design Guide" by Value Analysis, Inc. This 400 page "Guide" classifies and compares 60 different manufacturing processes used to produce individual parts made from either metallic or plastic materials. In addition to general design information and a detailed explanation of each process, there is a relative cost comparison for producing any quantity of parts, as well as tooling, labor and material waste cost comparisons.

COST Non-Member $110.00 Member $90.00

VIDEOTAPES

"Principles of Value Analysis/Value Engineering" The Miles Value Foundation, in cooperation with the Society of American Value Engineers and North Carolina State University, produced this 35 minute presentation to introduce you to the concepts and benefits of Value Analysis.

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"Keeping the Competitive Edge with Value Analysis" by Robert Brethen, President and Chief Executive Officer, Philips Industries, Inc. Mr. Brethen tells an exciting story about how his company has applied the tools of VA to achieve dramatic results in product enhancement, market share growth, cost reduction, and profit improvement. Philips Industries received the society's highest award—Excellence in Value Engineering for 1988.

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"Manufacturing: A Competitive Weapon" by Al Mattaliano, Staff Vice President, Manufacturing, Hughes Aircraft Company. Mr. Mattaliano describes a revolution in manufacturing technology that is occurring at Hughes. The concepts and practices of just-in-time, expert systems, cycle time management, automated work instruction, flexible manufacturing, and computer aided design and manufacturing, integration are illustrated through example from the several manufacturing plants. The role of VE in this environment is identified.

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