Performance—Based Budgeting and the Value Engineer

A report on the VE role in building a brand new Saudi Arabian port city. See page 6.
V.E. in Construction Industry
by A. J. Dell'Isola, 1982, [Hard Cover] .................................
Presents a proven, organized approach to reduce cost of
ownership of construction projects — educational facilities,
hospitals, offices, apartments, laboratories. Applicable to
public works projects — roads, sewage treatment plants,
transportation systems, dams.

Techniques of VA & VE (2nd Edition)
by L. D. Miles, 1972 [Hard Cover] .................................
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.

Value Managment for Construction
by M. C. Macedo, Jr., P. V. Dobrow, J. J. O'Rourke, 1978
[Hard Cover] .................................................................
Provides a balanced compromise of the value management
concept to both practitioners and students. It is designed for
those involved with the planning, design, construction,
operation and financing of building projects — as well as
upper level graduates and those taking graduate and
professional courses.

Value Engineering
by A. E. Mudge, 1981 [Soft Cover] .................................
The VE Systematic Approach presented in three superbly
organized parts — an in depth examination of the theory and
fundamentals of VE, application of the Systematic Approach,
and the magnitude/wide scope of uses of the Systematic
Approach.

ORDER FORM ON BACK COVER
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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 nor disapproved by the Society. They are the expressions of the author[s]. All papers have been edited — frequently condensed — by the editor.

VALUE WORLD is published quarterly on approximately the 15th of March, June, September and December, and is distributed internationally.
Farewell to Our Beloved Founder and Friend

Lawrence D. Miles will be remembered all over the world, not just for wisdom and systematic techniques, but for his mastery of inspiring people.

Lawrence Delos Miles, the father of Value Engineering and first President of the Society of American Value Engineers, died Thursday, August 1, at his home, "Sedgefield," near Easton, Maryland. He was 81.

Services were held Saturday, August 10 at the Newnam Funeral Home in Easton.

The value analysis system which Mr. Miles developed while working for General Electric Company has spread around the world. His book, "Techniques of Value Analysis and Engineering," first published in 1961, has been printed in 12 languages.

Mr. Miles came by his concern for cost cutting naturally, growing up on a Nebraska farm. "We had to pinch pennies," he often remarked. He worked as a bank teller, teacher and high school principal before receiving his Electrical Engineering Degree from the University of Nebraska.

At General Electric, it bothered him that things cost so much. He spent most of his 32-year career there developing and teaching his Value Analysis System before retiring in 1964. GE awarded him the Coffin Award — its highest honor.

In addition, the U.S. Navy awarded Mr. Miles its Distinguished Public Service Award in recognition of the benefits of his system to the United States.

Since retirement, Mr. Miles has been a sought-after speaker and consultant both domestically and internationally. He was honored with awards from Germany, Brazil and Japan.

Lawrence D. Miles will be remembered all over the world, not just for his wisdom and systematic techniques, but for his mastery of inspiring people. A young value engineer recently commented, "In five minutes of talking to Larry, he would have you feeling so good about your accomplishments and your own capabilities, that you'd be eager to go do ten times as well. Today, we need more managers like Larry Miles."

At 81, Larry was happy, having the respect of men and women all over the world, and still in love. He and his wife, Eleanor, exemplified "Value in Life" for which the two were given a special award.

Mr. Miles is survived by his wife, Eleanor Miles; a son, Dennis D. Miles of San Francisco; a step-daughter, Jane Oggatharp of Montpelier, Vermont; a brother, R.C. Miles of Murrysville, Pennsylvania; and six grandchildren.

Individual memorial donations can be made to Talbot County Hospice Foundation, P.O. Box 480, Easton, MD 21601. Corporate donations may be made to The Value Foundation/Lawrence D. Miles Memorial Fund/1199 National Press Bldg./Washington, DC 20045.

The January/February/March, 1986 special issue of Value World will be dedicated to Lawrence D. Miles. As a SAVE member, you are encouraged to submit an article, paragraph or statement on how Mr. Miles inspired your life. Submissions should be sent directly to O.J. Vogl, Editor Value World, 4909 via el Sereno, Torrence, CA 90505.
Lawrence D. Miles
Memorial Issue of Value World
January/February/March, 1986

The next issue of Value World will be dedicated to the memory of Lawrence D. Miles, father of the Value Disciplines. You, his colleagues and friends, are urged to submit articles, paragraphs or statements about Larry Miles and his impact on your career, your business, and your life. Please submit material by November 15 directly to:

O. James Vogl, Editor
4909 via el Sereno
Torrance, CA 90505

SAVE is also accepting memorial advertising from Mr. Miles' many friends. No product advertising will be accepted for this memorial issue. Instead, Value World will accept memorial or testimonial messages ranging from 1/8 of a page to a full page. These may be black and white or color up to four-color process. Complete details on advertising in this special issue of Value World will be mailed to all members. For more information, contact the SAVE NBO at 312/346-3265.
You have been appointed to the position of Direction, Program Controls for one of the largest and most ambitious projects ever known...management services for planning, design, construction and operation of a totally new municipality. What would be your approach for the applications of Value Management/Value Engineering? Let me provide some background and constraints to help with the definition of the problem.

The city, Yanbu, Saudi Arabia, is on the shores of the Red Sea. It is connected by natural gas and crude oil pipelines to the rich fields across the Arabian Peninsula. Yanbu is to be a deep water port, a terminal with refineries as the primary industry...an immense infrastructure is required: roads, utilities and housing in an incremental and concurrent growth pattern.

At the time of your appointment, the program is making the transition from an oversized construction company to a municipality. There is a construction and operating contractor labor force of 27,000, and another 8,000 people composed of management and local commercial forces, businesses along with families. Up to this point, the services rendered to the rapidly growing population, commerce and industry have been almost fully subsidized by the agency of the Saudi Arabian government commissioned to build the city. The subsidy, along with the design, construction, procurement, operation and maintenance cost, is an immense and continuing outlay of funds.

With reorganization, directorates were created for typical governmental functions of both municipal and national agencies. For example, port operations, telecommunications, power generating and distribution are national responsibilities, while roads, housing and solid waste disposal are municipal. It became obvious to me, as the one who had been appointed to Program Control and then to Operations and Maintenance, that the transitions to national and municipal organizations and control would be more effective if a system for planning, programming and budgeting could be brought on line during the city's growth.

Up to the point where need for transition was identified, all the Operating and Maintenance (O&M) contracts were established and managed in the same way that those of design and construction were. That is, work tasks were weighed by percentage of estimated target value and spread over time for progress. To make the change, I determined that all O&M contracts could be characterized by measurable units. To illustrate, some of the measurable units for the various O&M contracts included:

- **Power Generation** - Megawatt Hours (MH) were computed for the contract period based on the average daily load and forecast load increases.
- **Water Reduction** - Cubic Meters (CM) were computed based on the average daily consumption and capabilities, [in thousands].
- **Cargo** - Metric Tons (MT) were computed for deliveries or shipments.
- **Solid Waste** - Cubic Meters were computed for landfill, Bags (Bg) were calculated for trash collection based on current and forecast housing, population and pick-up routing points.
- **Telecommunications** - Subscriber Months (SM), which was a computation of current and forecast hookups, as new areas and subscribers needs were to be met.
- **Supertanker Docking & Piloting** - Pilotage Acts (PA) were computed for all ship arrivals [tanker and cargo] to apportion costs of pilot fees, tug operations, line-handling etc., associated with each ship movement.
With these measurement units established, a major reporting system, using four columns, was initiated. The first major column heading contained the "Total Performance Budget," in measurable units, along with the corresponding total labor and material forecast costs. This permitted the calculation of a unit cost.

The second major column heading, "Earned Value," showed what had been provided or performed against the budgeted amount to date, along with the breakdown of costs for labor and material.

The third column was provided to indicate "Estimate-to-Complete" (ETC) — again in terms of units, with apportionment to labor and materials costs based on experience and forecast needs.

By now, readers will have identified that the fourth column would have to be "Estimate-at-Completion (EAC)" — a tabulation derived from the sum of the second and third columns.

At Yanbu, modern technology and processes were available; therefore, this Performance-Based-Budgeting system was automated easily and effectively. It has previously taken six cost engineers to report technical and cost progress for 26 O&M contracts; with this new automated reporting technique we needed only one. With a "no-cost" change, we required contractors to invoice and report to the new system.

Automation permitted almost immediate access to variances such as over-or-under-runs, late or early influences in either manpower, materials or both. Moreover, as experience was gained with the controls and the cost data, follow-on contracts were structured for performance and much more — competitive bidding.

One must realize that the contractors were, and will continue to be, international. Representation from any capable nation is invited by tender — and those who could provide qualified labor at the lowest man-day rates were destined to be successful. Therefore, in addition to the performance line displayed on the (four-column) control, additional lines for the indirects — such as overhead, field subsistence and housing, fee or profit — were also spread to be able to clearly separate direct from indirect costs, and yet permit them to be "rolled up" into the actual costs.

A modern residential community has risen at Yanbu. Solar collectors, air conditioning and aesthetically pleasing architecture characterize the new municipality.
Once the actual costs had visibility, it was possible to establish fees and rate schedules for municipal and national agency services. This was done to develop formulae for recovery of acquisition costs and to offset the O&M costs.

Performance-Based Budgeting provided insights and predictability of the cost, expenses and rate of return on investments for the city. When the city reaches its full population growth, estimated at approximately 150,000 people, the municipal and national agency fiscal controls will have been developed and on line with actual cost experience.

From the standpoint of Value Management, the data base created by such a system for life cycle cost analysis — for future projects in Saudi Arabia, or to adjust for different monies and locations — is an invaluable tool for planning, programming and design.

Formal VE procedures are currently in use in Saudi Arabia for a number of military projects that are being performed in close cooperation with the U.S. Army Corps of Engineers. There are indications that some dramatic savings have been achieved, as reported by a Saudi National at the International Conference in Sacramento. With potential for continued and even greater benefits through U.S. technology transfer and professional methods, the Saudi Arabian agencies are now positioned to formally and contractually adopt Value Engineering.

...the data base created by such a system for life cycle cost analysis...is an invaluable tool for planning, programming and design.

Container cranes at the new industrial port of Yanbu stand ready to handle import and export operations.
As the sun rises above the shoreline of the Red Sea at Yangu, a supertanker moves into position to begin loading.
Life Cycle Cost: Application to VE/VM

By Wg. Cdr. K. R. Krishnamurthy

Wg. Cdr. K. R. Krishnamurthy received his B of E degree in Electrical Engineering from the College of Engineering, Guindy in 1961 and M. Tech. in Industrial Engineering and Operations Research from IIT, Kharagpur in 1979. He has been in the Air Force since 1962. Some of the appointments held by him are Material Planning and Control Officer in a Production Depot, Assistant Director of Systems Evaluation and Deputy Director of VE. He was involved in system studies sponsored by the Air Force/Ministry of Finance. He attended a systems analysis program at the Ministry of Defence in 1982, a VE program at NITIE, Bombay in 1963 and the fifth INVEST national conference in 1984, where he presented a paper. He is the Director of VE for the Air Force.

This paper was presented at the 6th Indian Value Engineering Society (INVEST) Conference in April, 1985. It is reprinted here with permission of INVEST.

Introduction

Value Analysis can be defined as an organized functional approach to the elimination of unnecessary costs by studying the relationship between the function and cost without sacrificing performance, quality, reliability and maintainability. The crux of the discipline lies in the inter-relationship between the functional worth and costs.

We are all aware of the various phases of VA: Information phase, Functional phase, Creative phase, Analytical phase, Evaluation phase, Planning phase and the Execution phase. The method of evaluation of various alternatives which are developed and short-listed by the Decision Matrix Method is also widely known. However, the procedure is explained in brief in the next section to refresh your minds.

Decision – Matrix Method

Consider a situation where three alternatives A, B and C are listed in the Analytical phase. We need to evaluate them against certain attributes like Quality, Reliability, Cost, etc. Let us consider a hypothetical case of five attributes — P, Q, R, S & T — against which three alternatives are required to be evaluated.

The First Step is to compare the attributes pair-wise to arrive at the relative importance of each attribute. For example, the attribute P is compared with Q. If it is considered that attribute P is more important than Q in the overall evaluation, P is given an "I" mark and Q given an "O". (There are further refinements to the procedure where the marking is given on a 0, 1, 2, 3 scale, depending on the amount of importance of the concerned attribute.) The comparisons are made between every two attributes. One can easily see that there would be \( \binom{n}{2} \) comparisons, if \( n \) attributes are considered.

A typical Attribute Weight Co-efficient Matrix is shown in Table 1.

The next step is to compare each alternative with the other with respect to every attribute considered and giving the markings. For example, sample A is compared with sample B with respect to attribute P, and the points are given in the 0, 1, 2, 3 scale. The process is repeated for all pairs of alternates for all attributes. The

<table>
<thead>
<tr>
<th></th>
<th>P</th>
<th>Q</th>
<th>R</th>
<th>S</th>
<th>T</th>
<th>TOTAL</th>
<th>AWC (Attribute Weight Coefficient)</th>
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<td>4</td>
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<tr>
<td>Q</td>
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<tr>
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<td>-</td>
<td>1</td>
<td>1</td>
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<td>0</td>
<td>-</td>
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<td>0.067</td>
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<td>1</td>
<td>2</td>
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<td>0</td>
<td>-</td>
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<td></td>
<td></td>
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</table>
Sample Weight Co-efficient of each alternative with respect to a particular attribute is thus arrived at. Typical Sample Weight Co-efficient matrices of attributes P, Q, R, S & T are shown in Table 2.

The final step is to compute the aggregate weight of each alternative by multiplying each Attribute Weight Co-efficient by the corresponding Sample Weight Co-efficient and summing them up for each alternative as shown in Table 3. In our typical example, contender A wins the race with an aggregate weight of 0.559.

Consideration of Cost as an Attribute

The aim of VA is to reduce the costs for the same functional worth or increase the functional worth for the same cost or both, subject to the minimum laid down performance, quality, reliability and maintainability. We would have listed only those alternatives which meet the minimum laid down parameters, and hence the problem reduces to evaluating the functional worth against the cost. Most of the traditional VE studies relate to problems in product design. In such cases, the cost also can be considered as one of the attributes in the evaluation phase, and the first-ranking alternative could be selected. The cost considered is obviously the procurement or replacement cost of the component being considered.

With the introduction of certain alternate designs of the product/component being considered, certain processes could be eliminated, certain other processes modified, and certain other components eliminated. All these would result in the overall cost of the product being increased or decreased. All these increases/de-

Table 2 Sample Weight Co-efficient Matrices

<table>
<thead>
<tr>
<th></th>
<th>A</th>
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<th>C</th>
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<td>-</td>
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<tr>
<td>C</td>
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SWC Matrix w.r.t. P

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SWC Matrix w.r.t. Q

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SWC Matrix w.r.t. S

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<td>-</td>
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SWC Matrix w.r.t. T

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Table 3 Computation of Aggregate Weight

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<th>Alternate</th>
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<th>SWC</th>
<th>AWC XSWC</th>
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<td></td>
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<tr>
<td></td>
<td>R</td>
<td>0.400</td>
<td>0.80</td>
<td>0.320</td>
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<tr>
<td></td>
<td>S</td>
<td>0.067</td>
<td>0.25</td>
<td>0.017</td>
<td></td>
</tr>
<tr>
<td></td>
<td>T</td>
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<td>0</td>
<td>0</td>
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</tr>
<tr>
<td>B</td>
<td>P</td>
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<td>0.25</td>
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<td>0.253</td>
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<tr>
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<tr>
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<td>R</td>
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<td>0.20</td>
<td>0.080</td>
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<td>0.75</td>
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<td>T</td>
<td>0.200</td>
<td>0.83</td>
<td>0.166</td>
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</table>
creases were charged on the product/component being studied. The final cost of the product/component thus arrived at, was taken as an attribute in the Decision Matrix.

However, VA being a versatile tool, its use is not only limited to shop floor applications, but can also be extended to generating alternatives for Economy Analysis Decisions as between Manual/Semi-Automatic/Automatic Machines, Make-or-Buy decisions and the like. The VE tool need not be confined to industry alone, but can also be used in public institutions, public utility systems and social systems. In most of such cases, the financial implication is not confined to the replacement cost alone, but comprises many other costs/savings such as maintenance cost, operation cost, salvage price, etc. This is an area where consideration of the life cycle costs in VA/VE assumes a crucial importance. Let us now proceed to see how the life cycle costs are computed.

**Economic Life**

Before studying about life cycle costs, we should know what is meant by the term *life*. Life in this context is not the physical life of the equipment, but an economic life. The economic life of an equipment depends on any one of the following factors:

- (a) Sudden deterioration as in the case of electric bulbs.
- (b) Sudden obsolescence as in the case of military equipment when a vastly superior model emerges.
- (c) Gradual deterioration due to mounting annual maintenance and operating cost of the equipment until it is replaced, if not by a superior model, a new piece of the same model.
- (d) The combined effects of deterioration and obsolescence. The equipment may gradually deteriorate, resulting in increase in operational costs. In addition, due to continuous technological improvement, better models emerge in the market. In such cases, the economic life is governed by the combined effect of deterioration and obsolescence.
- (e) Combined effects of gradual deterioration and sudden obsolescence at a future date.

Estimating the economic life will have to be done judiciously after establishing to which of the types the equipment belongs, carrying out an economy analysis and calling upon people close to the system to make

---

### Table-4 Formulae for Discounting Cash Flows

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Factor</th>
<th>Shot Form</th>
<th>What it means</th>
<th>Formula</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Single Payment Compound Amount Factor</td>
<td>SPCAP</td>
<td>If the present cash flow is multiplied by this factor, the compounded amount after periods at <em>i</em> rate of return is obtained.</td>
<td><em>S</em> = <em>P</em>(1 + <em>i</em>)^n</td>
</tr>
<tr>
<td>2.</td>
<td>Single Payment Present Worth Factor</td>
<td>SPPWF</td>
<td>The present worth is obtained if a cash flow <em>S</em> after <em>n</em> periods is multiplied by this factor, the rate of return being <em>i</em>.</td>
<td><em>P</em> = <em>S</em> / (1 + <em>i</em>)^n</td>
</tr>
<tr>
<td>3.</td>
<td>Uniform Series Compound Amount Factor</td>
<td>uscaf</td>
<td>The total compounded amount after <em>n</em> time period is obtained if a uniform series of cash flow of <em>R</em> every period is multiplied by this factor, the rate of return being <em>i</em>.</td>
<td><em>S</em> = <em>R</em> <em>i</em>(1 + <em>i</em>)^n-1</td>
</tr>
<tr>
<td>4.</td>
<td>Sinking Fund Deposit Factor</td>
<td>sfdf</td>
<td>The uniform series cash flow is obtained if a sum <em>S</em> after <em>n</em> periods is multiplied by this factor, the rate of return being <em>i</em>.</td>
<td><em>R</em> = <em>S</em> <em>i</em>(1 + <em>i</em>)^n-1</td>
</tr>
<tr>
<td>5.</td>
<td>Capital Recovery Factor</td>
<td>crf</td>
<td>The uniform series cash flow over <em>n</em> periods is obtained if the present worth <em>P</em> is multiplied by this factor, the rate of return being <em>i</em>.</td>
<td><em>R</em> = <em>P</em> <em>i</em>(1 + <em>i</em>)^n-1</td>
</tr>
<tr>
<td>6.</td>
<td>Uniform series Present Worth Factor</td>
<td>uspWF</td>
<td>The present worth is obtained, if the uniform series cash flows over <em>n</em> periods is multiplied by this factor, the rate of return being <em>i</em>.</td>
<td><em>P</em> = <em>R</em> <em>i</em>(1 + <em>i</em>)^n-1</td>
</tr>
</tbody>
</table>
suitable forecasts. The economic lives of the alternatives considered in the VA analysis are first forecast.

The second step is to determine/estimate the following:

(a) Capital cost for procurement of the system.
(b) Annual operating/maintenance cost.
(c) Salvage amount.
(d) Minimum rate of return expected.

The first of these is a deterministic parameter. The second and third parameters can easily be estimated. The fourth is a top management decision for the complete organization.

The Life Cycle Cost of the equipment is the combined Cost/Revenue of research, development, production, operation, maintenance and salvage, suitably discounted to a particular time. The methodology for converting the cash flows at some instant to the cash flows at some other instant corresponding to a rate of return is given in Table 4. It needs to be emphasized here, that cash flows have two dimensions — money and time. They cannot be added or subtracted until they are all discounted to the same instant.

- **Problem**

Machine "A" costs Rs. 10,000/- with a salvage value of Rs. 4000/- at the end of six yrs. and an annual operating disbursement of Rs. 5000/- for the first three years and Rs. 6000/- for the last three years. Machine "B" costs Rs. 8000/- with a salvage value of Rs. 3000/- at the end of six years, with the annual operating disbursements of Rs. 5500 and Rs. 6500 for the first three years and last three years, respectively. The minimum expected rate of return is 15 percent.

Which is a more economical machine?

### Solution

Represent the cash flows in time scale.

<table>
<thead>
<tr>
<th></th>
<th>A</th>
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<td>0</td>
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<td>5500</td>
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<td>5500</td>
<td>6500</td>
<td>6500</td>
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</table>

**Annual Cost of A**

\[
\text{Crf} + (5000 \text{ uspwf} + 6000 \text{ uspwf} + 4000 \text{ sspwf}) + 15-6
\]

\[
= 10000 \times 0.26424 + (5000 \times 2.2832 + 6000 \times 2.2832 \times 0.65752) \times 0.26424 - 4000 \times 0.11424
\]

\[
= 2642.4 \times (11416.0 + 13699.2 \times 0.65752) \times 0.26424 - 45696
\]

\[
= 2642.4 + (11416.0 + 9007.5) \times 0.26424 - 456.96
\]

\[
= 2642.4 + 5396.71 - 456.96 = 7582.
\]

**Annual Cost of B**

\[
\text{crf} + (5500 \text{ uspwf} + 6500 \text{ uspwf} + 4000 \text{ sspwf}) + 15-6
\]

\[
= 8000 \times 0.26424 + (5500 \times 2.2832 + 6500 \times 2.2832 \times 0.65752) \times 0.26424 - 3000 \times 0.11424
\]

\[
= 2113.92 + (12557.6 + 14840.80 \times 0.65752) \times 0.26424 - 342.74
\]

\[
= 2113.92 + 5896.71 - 342.74 = 7668.
\]

So, A is better in spite of the higher procurement cost.
In some problems, the different alternatives considered may have different economic lives. The computation of life cycle costs in such cases is done by considering a span of years, which is the LCM (Least Common Multiple) of the different economic lives. The following problem will bring home the point.

**Problem**

There are two alternatives A and B. A costs Rs. 4500/- and has a salvage value of Rs. 500/- after four years, B costs Rs. 6500/- and has a salvage value of Rs. 500/- after six years. The annual operating costs of both the alternatives is Rs. 1000/- per year. Rate of Return (Minimum) expected is 15 percent. Which alternative is more economical?

**Solution**

Represent the cash flows in time scale over a span of 12 years, (which is the LCM of 4 & 6)

<table>
<thead>
<tr>
<th>A</th>
<th>4500</th>
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<tr>
<th>B</th>
<th>6500</th>
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</tbody>
</table>

**Annual cost of A** = \( \left\{ \frac{4500 + 4000}{15-4} SPPWf + \frac{4000}{15-8} SPPWf + \frac{-500}{15-12} SPPWf \right\} Crf + 1000 \\
= (4500 + 4000 \times 0.57175 + 4000 \times 0.3269 - 500 \times 0.18691) 0.18448 + 1000 \\
= (4500 + 2287.0 + 1307.60 - 93.455) 0.18448 + 1000 \\
= (8001.1) 0.18448 + 1000 = 1476 + 1000 = 2476 \\

**Annual costs of B** = \( \left\{ \frac{6500 + 6000}{15-6} SPPWf + \frac{6000}{15-12} SPPWf - \frac{-500}{15-12} SPPWf \right\} Crf + 1000 \\
= (6500 + 6000 \times 0.43233 - 500 \times 0.18691) 018448 + 1000 \\
= (6500 + 2593.98 - 93.46) 0.18448 + 1000 \\
= (9000.52) 0.18448 + 1000 - 1660.42 + 1000 = 2660 \\

Alternative A is more economical.

**Applicability of Life Cycle Costs in VA**

While evaluating the shortlisted alternatives in VA against various attributes, there is a common tendency among VE practitioners not to consider the life cycle cost, but to list various aspects of the life cycle costs as different attributes in the Decision Matrix Analysis. For example, in a VE study concerning provision of illumination in hangers, when different systems of lighting are being evaluated, one may be tempted to treat the life of the lamps and energy consumption as two different attributes in the Decision Matrix and consider only the installation cost of the lighting system as an independent attribute. This tendency is to be avoided. The difference in lives and energy consumption could easily be incorporated in the life cycle costs of the systems. Only those attributes which cannot be quantified in terms of life cycle costs should be included in the Decision Matrix. This approach not only increases the sensitivity of the analysis by excluding redundant attributes, but also makes the analysis more objective by resorting to quantitative comparisons wherever feasible, keeping the subjective assessments of attribute weights to the essential minimum.

**Consideration of Cost in the Decision Matrix**

We now proceed to examine how the aspect of cost (whether replacement cost or life cycle cost) should be treated in evaluating the short-listed alternatives in a VA analysis problem.

The normal approach among a majority of VE practitioners is to consider the cost also as one of the attributes along with other attributes being considered, compute the Attribute Weight Co-efficients, Sample Weight Co-efficients, Aggregate Weights and final ranking of alternatives based on the total aggregate weight. This procedure, however, suffers from two lacunae: firstly, the cost is not given the due importance it deserves and secondly, a subjective assessment over-
VA is basically concerned with the inter-relationship between functions and costs...

VA is basically concerned with the inter-relationship between functions and costs without, of course, sacrificing performance, quality, reliability and maintainability. We would have only listed those alternatives in which performance, quality, reliability and maintainability would not have been sacrificed. This means that we are concerned with only the functional worth vs. cost relationship while evaluating the listed alternatives.

Now consider a case where we are evaluating alternatives against five attributes in which cost also happens to be one. Five attributes would yield 10 paired comparisons. Out of 10 paired comparisons, there would be only four involving cost, and the remaining six comparisons would be among attributes relating to functional worth only. This approach tends to introduce a bias against the cost attribute. For example, in the hanger lighting system considered earlier, let the attributes considered be:

[a] Level of Illumination.
[b] Ability for colour resolution.
[c] Fatigue due to optical and psychological factors.
[d] Ease of maintenance.
[e] Cost. (This is obviously life cycle cost as we had already discussed. Hence associated attributes like energy consumption, life of luminaires, etc., are not included.)

Attributes (a) to (d) are concerned with functional worth only and attribute (e) alone is concerned with cost. Assuming, for instance, that the cost has been given a 1-0 superiority with respect to each of the other attributes, it would still get an AWC of only 0.4, whereas the functional worth attributes would get a sum of AWC's of 0.6 in spite of being inferior to the cost attribute. This bias will go on increasing when the number of attributes keeps on increasing. The ratio of AWC for Cost and Functional worth for 'n' total attributes can be calculated as follows:

(a) Total number of paired comparisons:
\[ nC2 = \frac{n(n-1)}{2} \]

(b) Total number of paired comparisons involving cost:
\[ (n-1) \]

(c) Total number of paired comparisons not involving cost:
\[ \frac{n(n-1)}{2} - (n-1) = (n-1) \left( \frac{n}{2} - 1 \right) \]

(d) Ratio of paired comparison involving cost and those not involving cost:
\[ \frac{(n-1)}{(n-1) (n/2-1)} = \frac{2}{(n-2)} \]

Thus the bias would be 2/3 if five attributes are considered, 0.5 if six attributes are considered, and 0.4 if seven attributes are considered.

It is further emphasized here that this bias is worked out in spite of assuming that cost enjoys weight superiority over all the other attributes. For a general case, where such an assumption is not valid, the bias would still be greater. It would be the ratio of number of paired comparisons involving cost versus the number of paired comparisons involving the various functional worth attributes. This would be:

\[ \frac{(n-1)}{(n-1) n} \frac{2}{2} n \]

Thus the bias would be 0.4, 0.33, 0.29 and 0.25 if a total of 5, 6, 7 or 8 attributes are considered, respectively. However, as per the definition of VA, there should not be any bias and the functional worth should be evaluated against the cost implying a one-to-one comparison.

The second lacuna in the decision matrix computation is in giving weight as [0,1] or as [0,1,2,3], which is only a subjective assessment. Take the case of four alternatives A, B, C & D costing Rs. 1000, 2000, 3000 and 4000. Even if they were to cost Rs. 1000, 2000, 3000 and 4000, the SWCs worked out on the [0,1] or [0,1,2,3] scale would be the same in both the cases. There is no way of denoting the exact amount by which one alternative is superior to another in respect to the cost attribute. This disadvantage is not only with respect to cost, but is equally applicable to any other attribute which is capable of being expressed in quantitative terms. In the hanger illumination problem that we discussed, if the level of illumination provided by three alternatives is 20 lux, 200 lux and 300 lux, we can only denote it by a better/worse comparison in a 0.1, 2, 3 scale by this method. The exact amount by which one alternative is better than another in respect of that particular attribute which is being considered cannot be denoted in this decision matrix method.

To obviate these shortcomings, I suggest the following refinements to the method.

[a] With respect to attributes which can be quantified [e.g. weight, cost, etc.], the SWC should be taken in direct proportion (or inverse proportion) to the quantitative parameter, depending on whether the maximum or minimum of the quantity is desired. Thus, if four alternatives, A, B, C & D, are considered, if less weight is a desirable attribute and the weights are 10 kg, 15 kg, 25 kg and 50 kg, the SWCs according to the traditional method and the ones according to my refinement are shown in Table 5. It may be seen that the objective SWC works out to 0.44, 0.29, 0.18 and 0.09, whereas the Decision Matrix...
Method discussed earlier would yield the SWCs of 0.6, 0.3, 0.1 and 0.

(b) In as much as VA is concerned with studying the inter-relationship of functional worth and costs, I advocate a Cost Benefit approach rather than assuming the cost as one of the attributes, since the latter method introduces bias against the cost. To simplify the point further, the AWCs, SWCs and Aggregate Weights of all the alternatives are computed, considering all attributes other than cost. Let the sum of the Aggregate Weights of three alternatives be $Y_1$, $Y_2$ and $Y_3$. Let the costs (or Life Cycle Costs as applicable) be $X_1$, $X_2$ and $X_3$, respectively. Calculate the Cost/Benefit ratio which is $X_1$, $X_2$ and $X_3$.

The contender with minimum cost benefit ratio is obviously the winner.

**Conclusion**

Most of the Technical papers presented in VA seminars pertain to case studies. Papers dealing with the aspects of methodology of VA are an exception. Further, I had occasion to go through some of the VE study reports which made me suspect that some of the VE practitioners at least, are not fully appreciating the time value of money. Though the Decision Matrix method is a wonderful tool to evaluate on the basis of attributes which cannot be quantified and which have to be subjectively assessed, I have perceived a tendency among some VE practitioners to extend this method to all aspects of evaluation including the ones which can be perfectly quantified. These were the factors which impelled me to present this paper.

If I have dealt with the aspect of evaluation to the exclusion of other phases in VA, it is only because the subject of the paper concerns only evaluation; it is not due to an attempt to attribute any over-riding importance to the evaluation phase of the Value Analysis Scheme.

Life Cycle Costing, Decision Matrix, and Cost Benefit Analysis are methods used to compare and evaluate the alternatives against functional worth and cost. However, the selected alternative may only represent the best of several poor candidates. VE may be used to develop additional worthy alternatives to consider before selecting the best choice. Whereas Life Cycle Costing emphasizes cost visability, VE seeks Value Optimization. The two disciplines are complimentary, because the former is required to achieve the latter. They are to be suitably integrated to achieve optimum results.

**Table-5** Computing SWC by Traditional Method and by Refinements

<table>
<thead>
<tr>
<th>Traditional Method</th>
<th>Refined Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>A B C D TOTAL SWC</td>
<td>A k/10 0.44</td>
</tr>
<tr>
<td>A 1 2 3 6 0.6</td>
<td>B k/15 0.29</td>
</tr>
<tr>
<td>B 0 1 2 3 0.3</td>
<td>C k/25 0.18</td>
</tr>
<tr>
<td>C 0 0 1 1 0.1</td>
<td>D k/50 0.09</td>
</tr>
<tr>
<td>D 0 0 0 0 0 0 0.0</td>
<td>Note: $k = \frac{150}{34} = 4.41$</td>
</tr>
</tbody>
</table>

Substituting this, the SWC will be

A $\frac{4.41}{10} = 0.44$
B $\frac{4.41}{15} = 0.29$
C $\frac{4.41}{25} = 0.18$
D $\frac{4.41}{50} = 0.09$
"What Price Esteem Value?"

By J. J. Kaufman, CVS

J. Jerry Kaufman, CVS, is a consultant on VE management with 25 years experience in the industry. He is a past president of SAVE and is National Director of the Certification Board.

Some people take their alcoholic beverages seriously, others could not care less, and still others like to "test" those so-called discriminating drinkers who take their alcoholic beverages seriously.

As an example, Coors beer (a popular brand name) has many dedicated followers that claim they can tell the difference between Coors and other beers blindfolded. The Coors Company states it only uses mountain water in its process. They will not ship their products to northeastern states because "the long trip would hurt the taste." Coors also rejects building breweries in that area because "the water isn't good enough."

What has all this to do with VE? Well, let's see how valid "Esteem Value" is when applied to this subject. Esteem value, you will recall, is defined as "the motivated desire to acquire, or possess, for nonfunctional reasons." Buying by brand name is esteem value. That is why companies spend a good portion of their earnings to project the proper marketing image. To lose one's name in the market place is to lose everything.

When my No. 1 daughter was in college majoring in marketing, she decided to test the effects of esteem value in brand names. She invited four friends to her room, and served four cans of Coors beer and four cans of the local brand. What her guests didn't know was that all of the cans contained the local beer.

As her guests drank, two gentlemen began making comparisons, describing the "excellence of flavor and smoothness" of Coors over the other brand.

The martini...is surrounded by purists whose fanaticism is equal to the difference in alcohol content between the martini...and the beer...

After awhile, my daughter told her guests that all the beer they were drinking was the local brew. To this day, the two who were making comparisons refuse to believe they were not drinking Coors. (Incidentally, Debbie received an "A" when she submitted her findings as a report.)

The martini, another popular but somewhat more potent drink, is surrounded by purists whose fanaticism is equal to the difference in alcohol content between the martini (40-45%) and the beer (10-12%). Although not a brand name, there is as much attention given to how to make a martini as what to put in it. A bartender's handbook will tell you that the martini has eight parts gin to one part dry vermouth. The ingredients are shaken with ice, and the cooled liquid served in a stemmed glass, with an olive. However, this doesn't begin to describe the quest by hundreds and thousands leaving work each evening for "the perfect dry martini."

Many purists claim the martini should be very dry (not less than 15 parts gin to one part dry vermouth), and the peel of a fresh lemon cut paper thin and twisted over the mixture. The lemon peel is then rubbed around the edge of the glass, and gently dropped into the drink, in place of the olive.

Not only are brands of gin and vermouth the subject of heated arguments, but also the proportions, temperature, and mixing methods. (Always stir gently, never shake.)

In an exclusive New York restaurant, a lady returned her martini because "it wasn't dry enough." The...
bartender, somewhat hurt, served the second martini without any vermouth. However, the lady still claimed her martini wasn’t dry enough.

One restaurant I know uses an atomizer to gently spray the vermouth over the gin after the glass has been filled. Another presents its customers with an eyedropper filled with vermouth so they can add their own proportion.

Of all the ways to make “the perfect dry martini,” my favorite recipe is:

Purchase climbing gear and climb to the top of the Matterhorn with a pickax, a glass, and a bottle of gin. Once there, chip some ice from the glacier, put it into the glass and pour in the gin. Then, pull yourself up to full height and call out across the Alps “V-E-R-M-O-U-T-H.” When the echo returns, the martini is ready.

For the same reasons, scotch and brandy also have brand-name following. No one can dispute the difference between “cheap” and “quality” scotch, but is the price proportional to the difference? A friend of mine keeps two kinds of scotch whiskey in his house — expensive and cheap. If a guest asks for plain scotch, he is served Chevas Regal or Johnny Walker. If he asks for “scotch and water” or “scotch and soda,” he gets the cheaper brand because, says my friend, “anyone who dilutes the scotch couldn’t tell the difference in quality anyway.”

One Value engineer went a step further. He had two bottles of Johnny Walker, but one was filled with a cheaper brand. The first drink his guests received was the expensive scotch. From then on he served from the second bottle. The rationale? “Well,” said the VE, “after the first drink, the taste buds are dulled and can’t distinguish between brands anyway, so why continue serving Johnny Walker?” When asked if this wasn’t deception, he said, “As my guests continue to drink, the enjoyment they experience is the same regardless of which brand is served. Therefore, why not add to their enjoyment by letting them believe they are drinking Johnny Walker? This,” he said, “is cost effective esteem value.”

If you think all of this is simply “an American characteristic,” I believe I was exposed to a Japanese version when I visited there two years ago. At dinner one evening, I asked my host what was the proper temperature for serving Saki. He said, “The serving temperature must be equal to the temperature of the inside wrist of a 21-year old geisha, as tested by applying two drops on her wrist.” When I asked what that temperature was in the event I didn’t have a geisha available, he only looked at me and smiled.
VE's Expanding Horizons

By S. S. Venkataramanan, CVS

Mr. S.S. Venkataramanan, CVS, has a first-class Honors Degree in Mechanical Engineering. He has contributed numerous articles and papers to SAVE publications and in SAVE conferences.

Slowly but surely, the impact of VE is growing around the world. The construction industry in the USA started VE applications in buildings, highways, water treatment, and sewage treatment plants during the mid-60s and early 70s. Probably the first building design to be value engineered in the USA was in 1964.

The international building industry started taking cognizance of the U.S. experience about 10 years later. The matter has since then been under active consideration by the International Council For Building Research Studies And Documentation (Counseil International Du Batiment Pour La Recherche L'Etude Et La Documentation) (CIB) since 1977. This organization has, as its members, nearly 300 building research institutions from more than 70 countries, and is headquartered at Rotterdam, Netherlands.

CIB commissioned one of its Working Commissions — No. W55 on Building Economics — to examine how VE techniques could be used by more countries and what role CIB could play in that process. This survey of VE activities in about a dozen countries was carried out in 1978-79. It was followed by a discussion at the 1980 symposium in Lausanne, Switzerland in 1981. Two SAVE members — Donald E. Parker of the USA and I — became members of W55 that year and concurrently also rapporteurs to the CIB on the subject of VE.

Since then, much publicity for VE and SAVE has been secured in the CIB forums during the several meetings of W55, followed by a major triennial Congress held in August, 1983 at Stockholm, Sweden. Papers were presented at this Congress by both rapporteurs above to an interested, though questioning audience. In a short, effective presentation, Donald Parker explained the benefits derived in the USA and methods of VE application to a joint meeting of two Working Commissions — W55 and W60 — at Copenhagen, Denmark just before the 1983 Congress. We continued these efforts at the 1984 Symposium of W55 in July at Ottawa, Canada and then the W55 meeting at Waterloo, Ontario, Canada the same month.

These efforts have created a greater awareness of VE potential among the CIB members and have paved the way for increased interest in VE on the part of major building organizations in several countries, including India. The Government of India has already held two orientation seminars; a five-day workshop on a live building project will be held soon in New Delhi. CIB has also authorized its vice-president, Mr. G.C. Mathur of India, to conduct a similar workshop for the building industry of developing countries who are members of the CIB in the Asia–Africa region. It is possible that CIB may hold a similar workshop in Europe and in other areas of the world so that the international building industries will recognize the potential of VE and start benefiting from it.

The most attractive prospect perhaps for SAVE will be to add to these efforts by joining the National Bureau of Standards in Washington, D.C., which will host the 1986 CIB Congress scheduled for September 21-26, 1986 at the Convention Center, Washington, D.C.
I suggest that SAVE, as well as its members, get in touch with the following individuals and take advantage of this conference to project VE in an effective manner:

Dr. James R. Clifton, Tel.: (301) 921-3458
C.I.B. 86 Program – Telex: Western Union
Committee Chairman, 89-8493 GARG, or
B 348 Building Research TRT 197-674 NBSUT
National Bureau of Standards,
Gaithersburg, MD 20899 USA.

Mr. Richard N. Wright
President of CIB,
c/o National Bureau
of Standards
Building 226, Room B 226,
Washington, DC 20234 USA.

Mr. Donald E. Parker, Tel.: (202) 296-4090
c/o Smith Hinchman &
Grylls Associates, Inc.,
Washington, DC 20036, USA.

Prof. Dr. Gyula Sebestyen, Tel: 010-110240
Secretary General Telex: 22530 bouwc nl
PO Box 20704, Weena 704,
3001 JA Rotterdam
Netherlands

Standardization and VE

SAVE members are perhaps already aware that some countries are ahead of even the USA and Japan in creating national standards for VE, embodying definitions, terminology and the Job Plan. These are:

West Germany – Din 69,910 (1973, Revised 1981)
Austria – ONORM A 6750 & A 6754 (1975)
Hungary – MI 8871 (1977)

Two years ago when the President of the International Standards Organization [ISO] and the President of the French National Standards Organization [AFNOR], were in India, they expressed an interest in publishing an International Standard for VE and suggested that the Director-General of the Indian Standards Institution [ISI] promote the idea. This was taken up in earnest by the ISI who wanted to first publish an Indian Standard. The draft for this has already been prepared by a committee of over 20 members (including me and some of the firms using VE in India). It is now under wide circulation for eliciting comments and criticism before finalization.

This indeed is an expanding horizon for SAVE and other VE societies all over the world. It is up to them to take up the matter with their national standards bodies, and develop standards for VE so that more and more organizations in their countries will become aware of VE.

VE in Eastern Europe

Many of us are already aware of VE activities in England, France, Italy, West Germany and perhaps other countries of Western Europe. Few, however, are aware of the progress made in Eastern Europe. It is understood that Rumania, Czechoslovakia, Poland and Hungary have been engaged in considerable VE work during the last 10 years. The USSR has recently started to take great interest.

Most noteworthy among all these countries is perhaps Hungary. This country has not only published a national standard as far back as 1977, but also has held a couple of major VE conferences in Budapest. The growth and development of VE is under the charge of the Hungarian Ministries of Finance and Industry. Production, construction, and consultancy organizations in Hungary have greatly increased their professional VE skills by continuous contact with the rest of the world, and through their own applications within Hungary. SAVE and VE have been recognized by many organizations. Several books on VE have been published, including a Hungarian translation of Larry Miles’ book.

Every sector of industry — light, heavy, building construction, and even administration and management systems — has adopted VE in a systematic way. In fact, in a manner worthy of emulation by several other countries including many of us in the so-called free world, 22 such companies participated in a fine VE exhibition from November 12 to 17 at the Sportcsarnok in Budapest. This event attracted great interest among the several hundred visitors who consisted mainly of managers, engineers and students. The Hungarian press interviewed leading foreign and local VE specialists at the exhibition, and published topical stories. There were also broadcasts on the radio.

To their advantage and credit, Hungarian experts have not slavishly followed whatever has been written or projected by others, but have modified VE in various ways and have even constructively criticized some of our techniques, such as the criteria weightage matrices, analysis matrices, etc. I would be happy, with some help from a translator, to make these criticisms available to English-speaking readers. If members of SAVE or VE practitioners know the Hungarian language, please contact me. You can perform a great service for the English-speaking VE community.

It is understood that Rumania, Czechoslovakia, Poland and Hungary have been engaged in considerable VE work during the last 10 years.
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Effective February 1, 1985
Suggestions For Strengthening VE's Use As a Procurement Reform

The following is an excerpt from a letter to the Office of Federal Procurement Policy by SAVE's Director of Federal Liaison, Hal Tufty, CVS.

"First of all, we do not wish to see every major systems and construction project subjected to a VE study. Many simple projects do not warrant a VE study, and requiring a study in those circumstances would produce an unnecessary economic and regulatory burden on the government and contractor. SAVE believes it is important to emphasize this point first so that VE is kept in perspective as an important resource to control procurement costs.

"When the Federal Acquisition Regulation (FAR) was published, Part 48 which covers VE was inexplicably weakened. Agency heads were given the authority to exempt themselves from the VE requirements of Part 48. SAVE believes that this is not sound procurement policy. VE is a discipline that asks questions about the cost, function, and worth of a product or process. Because of this truth, VE is bound to generate natural enemies who do not like having their original assumptions or costs questioned.

"For example, some designers object to Value Engineering Change Proposals (VECP's) because they see such efforts as an intrusion on their design judgment. Program managers sometimes object because of their commitment to a particular project regardless of the costs.

"Others sometimes oppose the use of VE largely because they do not understand the VE process, nor do they see how VE differs from other more traditional cost reduction techniques.

"What should be done to encourage the use of VE through changes in the FAR? First, SAVE believes that the provision now in FAR Part 48 allowing the agency head to exempt his agency from VE regulatory coverage should be deleted. This provision was one of the so-called 'executive changes' made by the FAR drafters after the FAR was first revised based on public comments previous to its final publication.

"SAVE would also like to see FAR Part 48 further revised to require federal agencies to establish dollar thresholds over which a VE study would be performed. For instance, the Environmental Protection Agency (EPA) requires that a VE study be performed on all

Priority and Attitude — VECP’s Biggest Obstacles

The following comments were extracted from a series of computer network messages on June 30, 1985:

The Inspector General is unhappy with the low rate of progress in the Value Engineering Program. Secretary Taft has asked for a briefing.

I think we all know that attitude is the basic problem — both in the Department of Defense and in industry. There are some "islands of good results," but overall the results fall far short of potential...

In the June issue of Value World, William H. Copperman addresses the issue of contractors using the requirements of Mil-Std-480 A to establish a priority of "URGENT" for VECPs. He states: "...the time it takes for processing is excessive...which in many cases wipes out the potential savings..."

These two messages, while entirely unrelated in their mode of distribution, are very much related with respect to the basic problem.

I endorse both concepts. It is an attitude problem. One of the symptoms is the levels of priority that are assigned to VECPs in the processing and disposition/implementation/negotiation cycles.

When a high priority is establish for VECPs, the attitudes will change...or is it the reverse? ▲

John D. Jackson, CVS
wastewater treatment construction projects with a con­struction value of $10 million or higher.

"SAVE [and the VE staff in EPA] believe that a $5 million threshold is more appropriate. But again, we believe that the agency should establish the mandatory use of VE based on individual agency experience. For projects having a value of less than $5 million, the agencies should strongly encourage the use of VE in circumstances where they think its use is appropriate.

"What about third-party VE Proposals? SAVE believes that H.R. 4209 [now P.L. 98-577] strongly encourages the use of VE through provisions in the law relating to the work of the competition advocates and Procure­ment Center Break-out Representatives. A close read­ing of the legislative language appears to allow the sub­mission of third-party VE proposals either to the Break­out representative or the contracting officer.

"If this is true, as we believe, SAVE recommends that FAR Part 48 should be revised to specify those circumstances in which third-party VE proposals will be accepted by the government. We would be pleased to work with your staff to draft appropriate regulatory guidance on third-party VE proposals.

"The importance of VE has not gone unrecognized by the Grace Commission or the President's Council on Management and Administration (CCMA). The Grace Commission's task force report on Federal Construc­tion Management suggested in construction issue number 19 that VE should be used more extensively in all federal construction and grant-funded construction programs.

"An Office of Management and Budget (OMB) spokes­man recently told us that this recommendation had been accepted by the President as part of his efforts to make use of many Grace Commission recommenda­tions to improve government management."

Hal Tufty, CVS

Industry Hitchhikes on a Good Idea

I've read with interest the articles that have been appearing in "Spelunker's Corner" on the Contractual Aspects of VE. The reason that I read these articles is because I know very little about CAVE and VECP's but recognize the importance of a manufacturer involving his suppliers in the VA Process. I have been hitchhiking on the good work the U.S. government agencies have done to devise and formalize the VECP System.

Perhaps you would be interested in a case study or two performed by private industry. In the first example, we were purchasing a complex product for distribution through our marketing channel from a manufacturer that had never heard of VA. In a short time he had attempted to raise the price several times. We could not tolerate a price increase, so we offered to train their employees in VA and help them reduce their manufactur­ing costs. The owner agreed and we conducted a three­day workshop on the product. The program was suc­cessful and the arrangement we made was this: the supplier kept all the savings and agreed not to raise the price for two years.

In the second case, we split the savings 50/50 with the supplier. In both examples the management of the supplier companies was delighted to have their employees trained in VA, because they could continue to use the education on other product lines they manufactured.

It is my opinion that private industry has not even scratched the surface of gain-sharing programs with their suppliers. When you consider that today's JIT systems dicate single-source purchasing against long­term contacts, the buyer and the value engineer need a technique to stimulate the supplier to come forth with cost improvement ideas. The VECP System seems to fill the bill nicely.

Richard G. Bradyhouse, CVS

It is my opinion that private industry has not even scratched the surface of gain-sharing programs with their suppliers.

"Spelunker's Corner"
Larry Miles, with Dusty Fowlkes on his left, conducts one of General Electric's first Value Analysis seminars.

Carl Chase, Gries Reproducer Corp., addresses the 1963 National Meeting in New York City.

Larry Miles, first President of SAVE, addressing the assemblage at the 1964 National Meeting in Los Angeles.

Larry Miles, with Dusty Fowlkes on his left, conducts one of General Electric's first Value Analysis seminars.

A Nostalgic Look At
It Was

Admiral Richard Mandlekorn tells his now famous story about removing bricks from a chimney to the Society at the 1964 National Meeting, as Ed Heller and the group double up with laughter.

Value Engineering

Carlos Fallon at his inimitable best at the Society’s National Meeting in Los Angeles in 1964.

Three VE pioneers enjoying the Ambassador Hotel’s poolside luncheon at the 1964 National Meeting. (Left to Right) Tony Tocco, 2nd SAVE president; Fred Sherwin, 3rd SAVE president; Richard Mandlekorn.
The Multi-Disciplinary Approach of Value Engineering

By D. K. S. N. Murthy

D. K. S. N. Murthy is a Senior Standardization Engineer in the Engineering Research Centre of TELCO, Jamshedpur. He completed his MSc. (Engg.) in production management from Ranchi University. He is a member of the Institute of Standards Engineers and Fluid Power Society of India and INVEST. He has been involved in many VE studies in his organization.

This paper was presented at the 6th Indian Value Engineering Society (INVEST) Conference April, 85 and is reprinted here with permission from INVEST.

VE — A Team Work of Various Disciplines

Value Engineering is defined as "Systematic Application of recognized techniques by a multi-disciplined team which identifies function of product or service, establishes worth for that function, and provides alternatives to accomplish the function reliably at lower overall cost through use of creative techniques." The first step in a VE job plan is to formulate a team of experts from Design, Industrial Engineering, Materials Management, Quality Control, Standardization, Production, Accounts, etc. The objective of drawing group members from different disciplines can be summarized as:

(a) To utilize the genus of various techniques already in use.
(b) To look at the different analytical features from different angles/view points.
(c) To evolve an implementable solution through involvement and commitment of the people concerned who are also responsible for implementation, thus minimizing the resistance to change.

Concepts Of Other Disciplines In VE:

The VE methodology has some of its concepts similar to those of work study, method study, reliability engineering, CPM, etc. For instance, one of the main objectives of VE is identification of meaningful and unnecessary costs. Unnecessary costs as defined by Miles are those which do not contribute either to quality, use, life or appearance of a product. These are hidden costs of zero value. They get embedded in the product in the same way as the undesirable additional work content to the basic work content in work measurement studies. The analogy of unnecessary costs in VE with additional work content in work measurement is more clear from the diagrammatic comparison given in Figure 1. Just as a designer would seek alternatives, VE makes an in-depth search for alternative designs, shapes, processes, etc. to accomplish the function once identified. It challenges every aspect of design requirement including, tolerances, finish, materials, heat treatment, etc. to be compatible with the functional requirements.

The building in of reliability parameters into the product is one of the major considerations of the designer, which is also given due emphasis in VE studies. The product with better maintainability and lowest life-cycle cost is considered to have the highest value.

One of the analytical questions used during VE study is "Can a standard item be used?" While conducting a VE study on a flanged castle nut, it was observed that due to provision of the flange of a diameter bigger than the width of a hexagonal portion, the manufacturing cost was three times that of a standard castle nut of the same size.

The hexagon was milled over a round bar. The functional analysis revealed that the flange was required to provide more bearing area than that obtained by a standard castle nut of that size. The comparison with features of standard castle nut propelled the basic idea of eliminating the round flange by increasing the width across the flat equal to the diameter of the flange, thereby simplifying the manufacturing process was simplified, i.e., the complete nut being of hexagonal shape, this is now machined from hexagonal bar, thereby eliminating the time consuming milling of hex-
agon. This saved the cost of the nut by 70 percent; fulfilling the desired function at a lower cost. This example highlights contribution of standardization in VE.

The critical path of basic function line in a FAST diagram (Functional Analysis System Technique) for functional analysis is similar to the critical path approach in CPM. The various phases — select, examine, develop and install — used in method study the use of six phases — of what, why, how, when, who, and where — are common with VE studies.

Thus, we see that VE is a right combination of ingredients of various proven techniques in the management process.

**VE Concepts In Other Disciplines:**

While VE as applied today is of comparatively recent innovation, its functional approach is subconsciously or unconsciously used by all in our jobs. In fact, the concepts of VE originated in the purchasing department.

Many instances can be cited where the functional approach in the areas of design, materials management, maintenance, scrap reduction, material utilization, standardization, etc. have resulted in remarkable improvement and savings.

While standardizing the rope for scrap loading buckets in a foundry, data were collected regarding the type of rope presently used, the standard types of ropes available, prices of such ropes, their functions, etc. It

was observed that a sisal rope, which was primarily intended for load lifting and was costlier than other ropes (sisal yarns are imported), was being used with huge annual consumption. In the particular application, on investigation as to why such costly rope is used and what its function is, it was observed that the rope was used to tie bottom lids of scrap loading bucket. When the buckets are brought to the opening of the melting furnace, the rope should catch fire, burn and allow the lids to open, making the scrap fall in the furnace.

When the function was identified, a hemp rope which was cheaper (not meant for load lifting) could be used and was standardized for the application, satisfying the desired function at lower cost.

The widths across flats of hexagonal drive fasteners have been recently standardized at ISO level; while standardizing the sizes, the basic consideration was their compatibility with functional requirements and material conservation. The width across flats was standardized, maintaining a logical ratio (=1) between the bearing area (the annular area) under the bolt heads and the tensile stress area of the screw thread. The bearing area under the bolt head determines the magnitude of the comprehensive stress on the bolted members relative to the clamping force applied by the fasteners. The tensile stress area of the screw thread governs the clamping force, which can be developed by tightening the fastener for any particular strength.

---

**FIGURE 1**

**ANALOGY OF BASIC WORK CONTENT IN WORK MEASUREMENT WITH MEANINGFUL COST IN VALUE ENGINEERING**

<table>
<thead>
<tr>
<th>Total Cost of Product</th>
<th>Total Cost of Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>WORK CONTENT ADDED due to less skill of operator.</td>
<td>UNNECESSARY COST added due to human factors like habits, attitudes, resistance to seek advice/consult.</td>
</tr>
<tr>
<td>WORK CONTENT ADDED due to shortcomings of management.</td>
<td>UNNECESSARY COST added due to lack of information on cost, state of technology, etc.</td>
</tr>
<tr>
<td>WORK CONTENT ADDED by inefficient methods of manufacturer.</td>
<td>UNNECESSARY COST added due to lack of ideas.</td>
</tr>
<tr>
<td>WORK CONTENT ADDED by defect in design or specialization of product.</td>
<td>UNNECESSARY COST added due to lack of time, i.e. product designed in hurry.</td>
</tr>
<tr>
<td>BASIC WORK CONTENT of product or operation.</td>
<td>MEANINGFUL COST OF PRODUCT contributing to value.</td>
</tr>
</tbody>
</table>

**OBJECTIVE OF WORK STUDY IS TO IDENTIFY ADDITIONAL WORK CONTENT & ELIMINATE OR MINIMIZE IT.**

**OBJECTIVE OF VALUE ENGINEERING IS TO IDENTIFY UN-NECESSARY COST AND ELIMINATE OR MINIMIZE IT.**
class of fastener. This functional approach used in standardization of widths across flats [unlike the earlier used rule of thumb Across Flat = 1.6 x thd. size] has resulted in reduction in widths of commonly used sizes of M10, M12, and M14, and from 17, 19 and 22 to 16, 18 and 21, respectively. This reduction has resulted in conservation of material since these are very commonly used commercial sizes. The material saving is over a few tons in the USA alone.

The above two examples illustrate the application of VE concept in standardization.

The Design-To-Cost concept is a discipline of making the designers responsible for performance coupled with cost. This concept advocates the function-cost approach at design stage and is an outcome of investigation on application stages of VE.

Similarly, the VE approach is used in many quality problems, make-and-buy decisions and other conventional cost reduction methods.

**Special Features Of VE As Compared To Other Disciplines**

Due to its multi-disciplinary, function-oriented team work the potential gains through VE are more enormous and much more expeditious than other conventional methods. With fast changing technology it is difficult for an individual to keep track of the advancement in various fields, store it and retrieve it when required. The team approach of VE helps in overcoming this difficulty, because the team members with their up-to-date knowledge in their fields pool up their resources towards a common goal. The team approach also inherits the advantages of Theory Y of Mac Gregor, which emphasizes the need for participation, recognition and motivation.

The above are some special features of VE attributed to the multi-disciplined approach apart from other commonly pronounced benefits like (a) cost prevention in addition to cost reduction, (b) the function cost relationship sometimes leading to an entirely different means of accomplishing the function, which is unconventional as compared to other cost reduction methods, (c) the dual effect of reducing cost and improving product utility and customer appeal, (d) reducing total cost of life cycle, (e) exploring technological advancements, and (f) utilization of creativity, etc.

**Conclusion**

VE and other disciplines are complementary functions with a common goal of aiming to achieve overall economy. However, VE with its multi-disciplinary approach provides much more analytical insight into the problem concerned, and hence is more versatile and result-oriented.

While the organized teamwork of VE should be used to obtain all its benefits, the VE philosophy — the function cost approach, the unconventional thinking, the adaptation of latest technology, etc. — should be practiced by every supervisor down the line. Every supervisor irrespective of the area where he works should be a trained value engineer, so that he can use its principles by surveying and probing his own activities and various jobs as a routine to achieve maximum benefits of this powerful technique.

---

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Design for Assembly and Value Analysis

A Combo That Can Help You Compete With the Toughest Competition in Town or Out of Town

By Richard Bradyhouse, CVS

Richard G. Bradyhouse, CVS, is Technical Manager of Producibility for Black and Decker Manufacturing Company. He has served SAVE as a National Director of Career Development and is a Past President of the Chesapeake Chapter.

In the late 70's and early 80's, there were numerous pilgrimages to Japan by U.S. businessmen and engineers to determine how the Japanese were landing products on our shores at significantly lower prices. Typically, these groups would return in a state of semi-shock and draft a presentation to their top management and Board of Directors.

Their assessment would usually follow along these lines:
1. Japanese attention to quality far surpasses our primary due to Demings SQC and the dedication of the Quality Circle Teams.
2. Their JIT inventory system is astounding in its ability to keep a factory running with almost no inventory of parts.
3. Their thorough flow manufacturing layouts eliminate much of the materials handling required in manufacturing.

They would then sum up their findings with the great pronouncement:
We're ahead in technology!
Our designs are as good as theirs!
We're losing the battle on the factory floor!
Engineering then takes time out to congratulate itself while wondering how manufacturing let things get away from them.

Manufacturing, on the other hand, was too busy to take time out because they were feverishly writing capital appropriation requests for no set-up machining centers — automatic guided vehicles and robots — wondering why the rules of the game had been changed.

As I look back on this scenario, it wasn't really true that U.S. designs were just as good. In some respects, U.S. designs were superior and the Asians were busy copying them. In other respects, however, there were subtle design differences in Japanese products on which U.S. manufacturers should have gone to school.

I went on one of these so-called study missions to Japan and saw first hand that there were definite differences in the assembly approach.
1. There was extensive use of pick-and-place units.
2. Parts were inserted from above.
3. There were few re-orientates on the line.
4. Parts were designed for easy insertion.
5. In some cases, entire products were assembled without being touched by human hands.

Today, five years later, there are relatively few design centers that have taken more than a cursory look at DFA (Design for Assembly).

I recently visited a builder of advanced automation machinery who had three pieces of machinery on his
This scenario is particularly sad because in cases like this huge capital outlays are only producing modest labor savings while the capital absorption is pumping up the overhead rate.

This scenario is particularly sad because in cases like this huge capital outlays are only producing modest labor savings while the capital absorption is pumping up the overhead rate.

This scenario is particularly sad because in cases like this huge capital outlays are only producing modest labor savings while the capital absorption is pumping up the overhead rate.

What we all need to do is convince ourselves that it is worthwhile to "design it right the first time." Having made this commitment, we need to allocate the first two or three days of the development phase to a DFA/VA study. In the studies I have conducted, we combined VA techniques with the DFA system and produced a hybrid technique that yields much better results than either system could have produced on its own.

To elaborate briefly on how this is done:

<table>
<thead>
<tr>
<th>Step</th>
<th>Method</th>
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</thead>
<tbody>
<tr>
<td>1. Determine function of all parts in the assembly.</td>
<td>VA</td>
</tr>
<tr>
<td>2. Determine time and cost to assemble these parts.</td>
<td>DFA</td>
</tr>
<tr>
<td>3. Challenge if part is unique or if its function can be combined with another part in the system.</td>
<td>DFA</td>
</tr>
<tr>
<td>4. Determine if alternate design approaches would eliminate the need for a separate part.</td>
<td>VA</td>
</tr>
<tr>
<td>5. Assure that the remaining parts in the design are configured to go together easily.</td>
<td>DFA</td>
</tr>
</tbody>
</table>

The Baltimore Sun newspaper obituary for Larry Miles, the developer of VA, quoted him as being saddened because his work is more accepted outside the U.S. "We have so many people who could make good products," he said in an interview, "and doggone it, we have the ability to design and manufacture better products. It's sad that such good methods are available and close, but not being used while factories are being closed and people are being put out of work."

Japan gets the credit for JIT and for applying all of the above. When will we? The clock is running.
A recent Sunday morning found me laboring the prospect of whether to remain in bed watching the movie, “One Eyed Jacks,” or arise, get out and listen to a preacher’s sermon. One choice seemed more appealing. Guess which one?

However, Goodness, in the form of my angelic wife, prevailed, and we attended the morning services.

Glad we did.

There I picked up a most sterling piece of logic, much to the credit of a five-year-old youngster. Our pastor works very hard to change a traditional one-way communication into a two-way dialogue, especially with younger children. On this Sunday he grouped the children in a circle for a short exchange during the Worship Hour.

He related his childhood frog-catching days and reminisced in particular about one giant bullfrog who croaked like a frog. To which one child immediately responded “Of course it croaked like a frog; it was a frog.”

Who could argue with such sweet, simple logic as that?

I believe there are many interesting similarities between Sunday morning experiences and VE, in regard to preaching.

First, there are and must be preachers or advocates in both professions to sustain continued growth. Someone must stimulate the masses; someone must bring the word.

Second, some preachers are obviously more articulate communicators and consequently more effective than others. Often, good message content is useless and lost because of ineffective communicators.

Third, there are the well-intentioned, but ill-informed. VE was mistaken for good old fashioned cost reduction; and presented as such.

VE was mistaken for plain old sharp buying skills; and presented as such.

VE was mistaken for cheapening the product, and labeled as such.

Therefore, if the profession is to retain its identity and purpose we must become sharper, more precise and articulate in presenting the VE Story.

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It is reasonable to assume that VE has not reached its full potential in many arenas because certain interests who croaked VE terms, just weren’t frogs.

Therefore, if the profession is to retain its identity and purpose we must become sharper, more precise and articulate in presenting the VE Story.

Any good preachers out there?

If not, we might as well watch “One Eyed Jacks.”

Value World, October–November–December 1987
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