SOCIETY OF JAPANESE VALUE ENGINEERING

GUIDEBOOK FOR VE ACTIVITIES
= A BASIC VE MANUAL =

English translation of “VE KATSUDO-NO-TEBIKI”

Originally published in August 1971 (Japanese Version)
Translated in 1981 (English Version)

CONTENTS

WHAT IS VE?

Today's rapid technological progress and fiercely competitive business environment mean that rationalizing the enterprise and improving its profitability have never been so vital. Every organization naturally tries to maintain its profitability – the source of growth and prosperity for the organization – through efforts in each of its departments: research and development, engineering, manufacturing, purchasing, finance, sales personnel management, etc. However, achieving greater profitability and maintaining the stability and growth of an enterprise requires that resources already available within the business – know-how, experience, personnel, capital, materials, and equipment – be utilized more effectively.

In recent years, Value Engineering (VE), which has been introduced and expanded in certain industrial establishments, has been attracting major attention as a new method of achieving reduction in costs, which in turn result in greater profitability for the company.

VE is defined as:

> *A systematic approach to analyzing functional requirements of products or services[*] for the purpose of achieving the essential functions at the lowest total cost.*

In short, VE is a system that a company can employ in an organized manner, to improve the value of its products or services, and thereby ultimately achieve a reduction in costs.

Until now, different industrial establishments have tried various methods of cost reduction. Yet, it appears that there are still many unexplored aspects to cost reduction. Value Engineering (VE) is a novel approach to cost reduction. A number of companies have achieved significant results through effective application of this system.

In order to increase the profitability of companies through VE, one must first gain an accurate understanding of the discipline. It is also critical that specialists in each field support VE and master its techniques. With a significant number of people in the company understanding and practicing VE in an organized manner, the VE system can become a formidable tool for achieving higher profitability.

Ideally, VE will be learned and appreciated by not only top management personnel but also those in different departments, at various levels and in interrelated companies. This, we believe, would enable the system to be employed in an even more progressive manner.

[*] Services to which VE can be applied include: software items, such as organization, formal procedures, filling-out of forms, actual operations, processes and setting-out specifications, that go hand-in-hand with manufacturing products; and "service" facilities, such as government organizations, hospital treatment, etc.

A BRIEF HISTORY OF VE

The event that triggered the development of VE was the “Asbestos Affair”, which occurred in 1947 at the General Electric Company, in the U.S. World War II had just ended, and asbestos, then the commonly specified flooring material for warehouses, was in short supply. Through some specialist suppliers General Electric discovered that a substitute was available at a lower cost. However, Fire Control Regulations, which prescribed the use of asbestos in the flooring, prohibited use of the substitute material.

The incident benefited General Electric in the long run, as it prompted study of the functions of various products. A task force led by Mr. Lawrence D. Miles was organized to find the best method of improving the value of any given product. The group was given five years and a budget of 3 million dollars. The system they developed is what we now know as Value Engineering (VE), or Value Analysis (VA).

VE was first introduced to Japan in 1955. However, it did not catch on immediately, and it was not until 1960 that industry began utilizing the system. In February 1960, Mr. S. F. Heinrich of the National Association of Purchasing Agents visited Japan for the purpose of conducting Purchase Engineering Seminars at various locations throughout the country. It was at these seminars that ideas on the implementation of Value Engineering for purchasing management were introduced.

In December 1960, the SANNO Institute of Business Administration introduced the Value Analysis Planning Course (VAP). As early as 1957, SANNO had begun conducting the Creative Thinking Course (CTC), a training program that incorporated many of the underlying principles of VE concepts. In May 1969, SANNO pioneered Japan’s first in-company VE training courses, in the form of VE Workshop Seminars. These seminars could be regarded as the real genesis of the development of VE in Japan.

The timing of the introduction of VE to Japanese industry couldn’t have been much better. The Japanese economy was moving toward recession, due to excessive capital investment

that resulted from tremendous economic growth. Simultaneously, the International trade policy was liberalized, opening up greater export opportunities for Japanese manufacturers. In order to be competitive both locally and abroad, industry was forced to cut costs. The advantages of VE over other cost-cutting methods became apparent, and the system was implemented by the automobile and heavy electrical equipment industries.

Successful cost reductions in these industries paved the way for others to adopt VE. In 1963, the system was adopted by shipbuilders, railroad and heavy vehicle manufacturers, and electrical and communications machinery makers. By 1964, the system had extended to basic machinery industries. From 1965, it spread from the fabrication industries to process industries, then to metal, fiber, food, chemical, and steel industries. In recent years, the system has also been taken up by architectural and construction companies.

Improvements in VE theory and practice led to functional studies such as definition and evaluation of product functions being carried out more thoroughly from 1966. In addition, job planning, one of an important series of steps in the VE process, was established, giving VE a solid structure and foundation within many companies. As a result, the focus of VE activities has shifted from materials procurement and purchase departments to planning and engineering department. The role of VE as an approach to business management is now widely acknowledged. VE is becoming even more broadly accepted as a system for value assurance of products and services.

Today, VE is yielding excellent results as a method of cost reduction. In addition, it has been reported to be effective at the research and development and design stages. VE has been applied not only to hardware but also to processes, office routines, and methods of organization – the so-called “software”.

THE VE WAY

1. CONSUMER-ORIENTED THINKING

The term ***value*** in Value Analysis or Value Engineering pertains to the judgment of the customer or consumer regarding the product. Therefore, in VE, improvement of the value of the product is approached from the viewpoint of the customer. Generally, ***analysis*** means breaking-down an object into smaller parts. But, in VE the purpose of analysis is to detect problems, if any, and to solve them. More concisely VE is a method of trying to solve problems related to the value of the product or service, from the consumer's point of view.

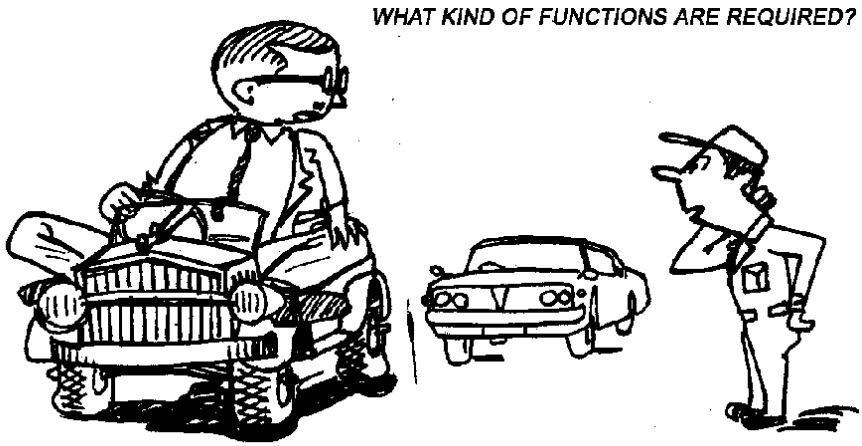
Normally, when a customer makes a purchase he/she does not merely buy the product at "face value". The purchase decision is made only after the customer is satisfied as to the function or utility of the product. The customer, therefore, pays money for the "package of functions" that the product offers. Thus, the customer may consider that the product is of little ***value*** when, after using it, he/she finds that:

it does not live up to expectations,

it is complicated to operate and/or maintain, or

it fails or malfunctions too frequently.

The point at which VE can enter and tackle the problems can be determined by examining customers' value judgments of a product and the type of functions they expect. In other words, if there is a dissonance between the functions possessed by the product and the functions expected of the product by customers, then there is a problem that could be addressed by VE. Only after customers' expectations are fed back to the design section and the necessary corrections are made can a product of high value (worthy of being purchased) be produced.



2. FUNCTION-ORIENTED APPROACH

A commercial business can increase its profitability by 3 possible methods:

(1) Raise the price of the product.

(2) Increase sales of the product.

(3) Bring down the cost of the product.

However: It is not easy to raise the price because of intense competition. There are limits to reducing the cost of the product through increased mass production and accelerated sales.

Therefore: The only remaining method is to lower the cost of production.

Traditionally, cost reduction has been carried out by analyzing the cost structure of the product, and trying to reduce costs in each production component (see Fig. 1). However, one cannot expect to achieve substantial cost reduction by such methods. The cost of materials is generally increasing and the cost of processing (labor) is also showing an inevitable upward trend, due to inflation and scarcity of new entrants to the workforce. Overheads also involve materials and labor – again, little opportunity for cost-cutting.

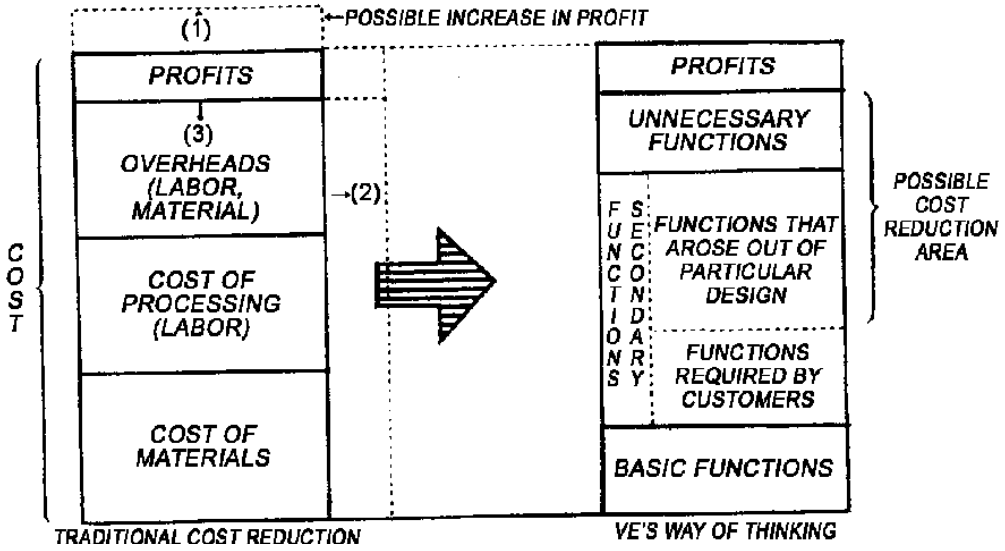


Fig. 1: FUNCTION-ORIENTED APPROACH

In contrast to the *product-oriented* approach, VE approaches the problem in a *function-oriented* manner. In VE, the cost of the product is divided in two: cost related to the *basic function* of the product; and cost related to the *secondary functions*, or those that support the essential function. Secondary functions are those required by consumers and those arising out of the particular design employed to provide the essential function. In addition to these there are certain *unnecessary* (superfluous) *functions*. These are often present because of excessively complex design specifications, unreasonably high demands on performance (e.g., conveniences which are not absolutely essential), excessive safety measures resulting from insufficient technical examination, etc., or due to

the whims of the designer.

By taking this function-oriented approach, VE first eliminates these unnecessary functions. Then, by making appropriate modifications to the design (including changes in materials, manufacturing methods, transportation, testing methods, etc.), costs related to secondary functions can be reduced. In VE, the steps involved in studying functions are primarily: defining the functions, developing the functional configuration model, and evaluating the functions. Herein lies the distinctive quality of VE.

3. TEAM DESIGNING

In general, the responsibilities placed on the designer of a product or service (or system) are based on the following priorities:

(1) Performance (function)
(2) Delivery schedule
(3) Reliability, safety, ease of operation, etc.
(4) Reasonable cost

The factor of prime importance in the designer's task is to provide the expected functions within an appointed delivery deadline, in a reliable manner. In addition, he/she is expected to make the product as affordable as possible. Therefore, this issue of cost is always regarded as being of only second or third importance. Normally, neither academic education nor workplace training can equip a designer with sufficient knowledge concerning costing. Information on cost management is not generally available. In many cases, it is unreasonable to expect the designer to also shoulder the burden of cost management, given the time constraints imposed by delivery deadlines.

It is said that a thorough evaluation of the design idea, materials to be used, and methods of processing is needed to arrive at a good design. Let us suppose that to achieve a certain performance (function) there are 3 possible design ideas, and that for each of these ideas 3 different combinations of materials can be used. Let us also suppose that 3 different processing methods are possible with each of the above material combinations. This means there are 27 possible designs. In theory, with all these possible permutations technical feasibility studies (whether the desired function can be achieved or not) and cost comparisons have to be carried out for each, so that the optimum design idea can be selected (see Fig. 2).

In practice, however, this method of selection is difficult to carry out, due to the limited number of designers involved and the limited time available for design work.

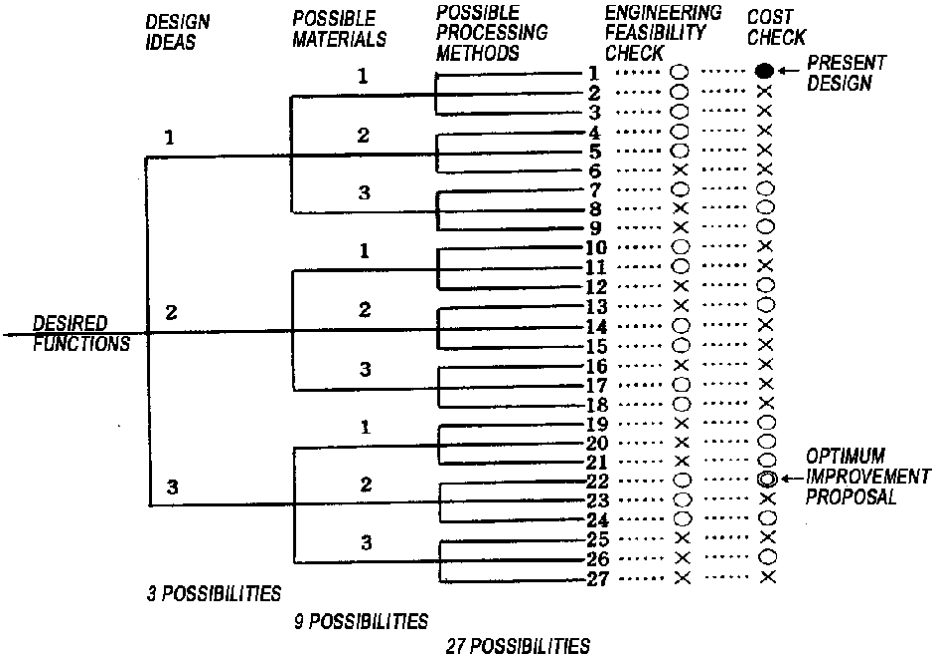
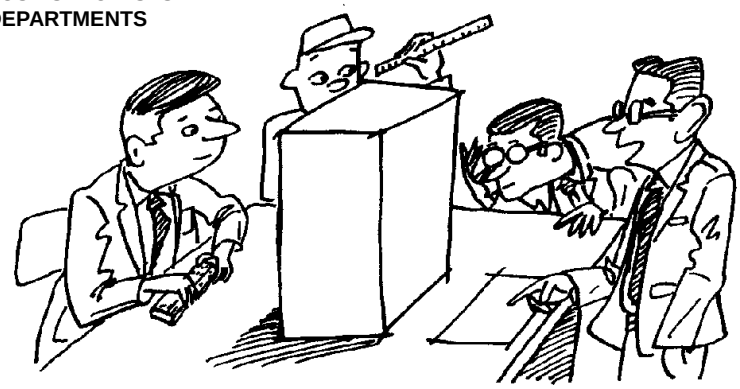


Fig. 2: DESIGN CONCEPT AND ALTERNATIVES

Value Engineering can be called a system in which a group of people assists designers from the viewpoints of both cost and function. A characteristic of VE is the assistance of specialists from various fields – e.g., experts on machine tools, processing; experts on layouts, transportation, factory management (IE Specialists); specialists in materials and supply sources (purchasing), cost specialists, consumer specialists (sales specialists); etc. – for better design outcomes. In VE, this type of activity is called team designing.

In team designing, the organization's intellectual resources, including its knowledge and experience, are assembled for a concentrated application of this new cost-cutting method. Making this work effectively requires the elimination of sectionalism, well-coordinated time scheduling (so that the various specialists can get together), and the creation of a positive atmosphere in which people can concentrate on cost-cutting.

INVOLVE AND ENTHUSE SPECILISTS FROM DIFFERENT DEPARTMENTS



Industrial establishments are always seeking to improve management in order to maintain their growth and development. To this end, various management techniques have evolved over the years. For a brief look at this evolution, let's review some of the historical developments:

As shown in Fig. 3, IE (Industrial Engineering), the main objective of which is improvement of working conditions and adjustment of working hours, was developed around 1911. IE evolved out of the particular industrial need of the time, maintenance of stable and efficient production brought about by the development of specialized techniques and increased productivity. Around 1924, due to the need for maintenance of consistency in mass-produced products, the statistically oriented Quality Control (QC) system was introduced. Then, VE was developed around 1947 as a new method of bringing down costs through re-evaluation of materials used, methods of processing, and design. In summary, it can be said that these management practices arose in response to specific historical conditions.

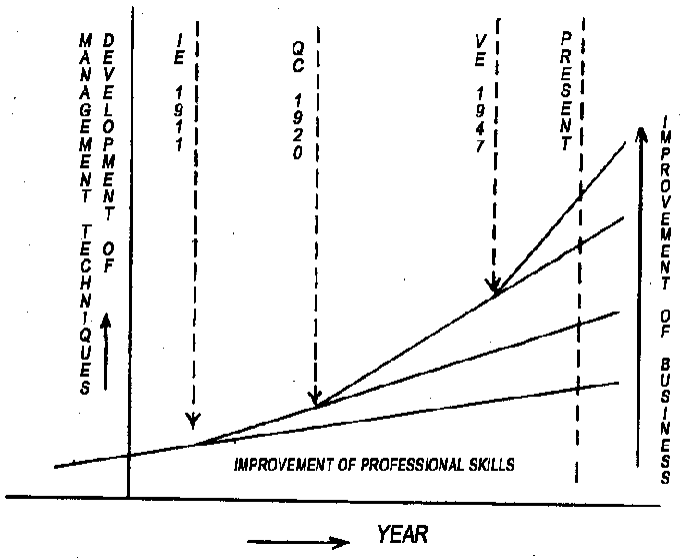


Fig. 3: EVOLUTION OF MANAGEMENT TECHNIQUES

We can observe that each company, depending on the type of product, and the structure and quality of management, has a distinct history in its introduction of new management techniques. This has been true for VE, too. Even though companies may share the same need for VE, their motives for introducing it and their history of other management techniques already introduced may differ. When introducing any management technique, one has to take into account this background; otherwise the approaches cannot be fully integrated into the organization.

In this chapter we shall discuss the generally accepted method of introducing VE into an

organization. However, it is important that the introduction be carried out in a fashion most appropriate to the company concerned.

(1) CONDITIONS FAVORABLE FOR INTRODUCTION OF VE

In order for an organization to survive in a climate of intense competition, it may become necessary to lower the cost of products or services (or improve their value). As a rule, the extent to which there is a need for product cost reduction is an important factor in deciding whether to introduce VE. In the background of many companies that have employed VE there has been a compelling requirement to reduce costs, due to liberalization of import policies and a subsequent increase in competition.

Key factors in introducing VE into a business, and in establishing and maintaining the system within the company, are the enthusiasm of the promoter and strong support from top management. Without exception, in companies that have enjoyed remarkable benefits from the introduction of VE we can recognize the enthusiasm and faith in VE of the promoter, and the understanding and support of top management.

ENLIST THE UNDERSTANDING AND ACTIVE SUPPORT OF TOP MANAGEMENT

It is said that the characteristics of VE are organized effort and team designing. In this spirit, then, the promoter's enthusiasm and the management's support are essential factors in systematically applying the experience and knowledge of specialists selected from various sections of the company.

(2) WHY INTRODUCE VE?

In Japan, VE had its beginnings primarily in the fields of materials procurement and purchasing. The first industrial establishments to introduce VE were the automobile and heavy electrical industries. In these industries, the major contributor to costs is materials, and VE was effective in reducing these costs. Although a number of other western management approaches were introduced to post-war Japan, VE was found to be the most effective for materials procurement and purchasing departments. Today, however, there is

a growing understanding that the real objective of VE is *functional analysis*. An increasing number of design changes are prompted by application of VE. Implementation of such modifications by design engineering sections is helping to broaden appreciation of VE's potential for greater applicability in this field.

A survey was conducted among companies in which VE has been actively implemented. They were asked how they initially came to know about VE. The responses are shown in Table 1.

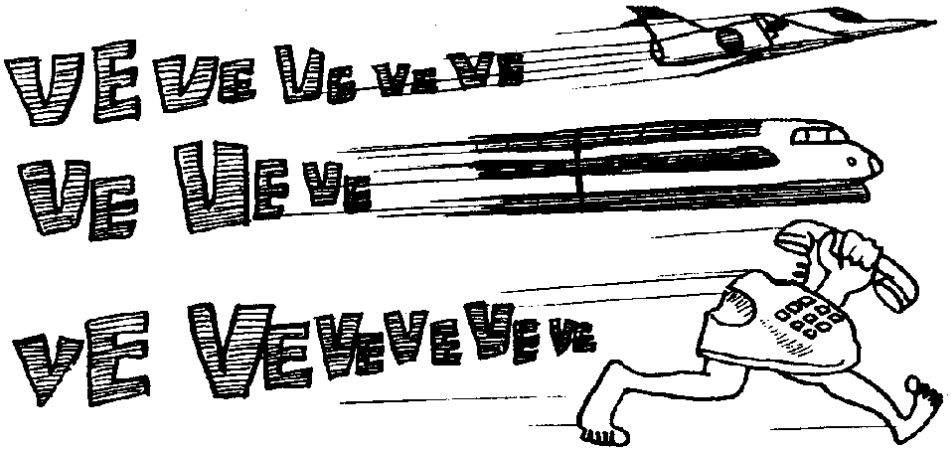
1	SEMINARS, SHORT COURSES	56.6%
2	LITERATURE (JAPANESE)	41.1%
3	INFLUENCE FROM OTHER FIRMS, OTHER PEOPLE	21.5%
4	LITERATURE (OVERSEAS)	15.9%
5	RESEARCH GROUP	6.5%
6	OBSERVATION (OVERSEAS)	3.7%
7	OTHER	2.8%

Table 1: HOW DID YOU LEARN ABOUT VE?

Recently, more companies have been introduced to VE by way of prime-subcontractor relationships, recommendations by parent companies, etc. Consequently, an increasing number of companies have actively adopted VE.

With expectations of intensified competition between companies, and the continuing slide toward recession, many manufacturers will be forced to cut costs. Therefore, we foresee an increasingly important role for VE in any type of business that seeks to improve the quality of its management.

VE IS BEGINNING TO POWER ALL KINDS OF COMPANIES AND INDUSTRIES



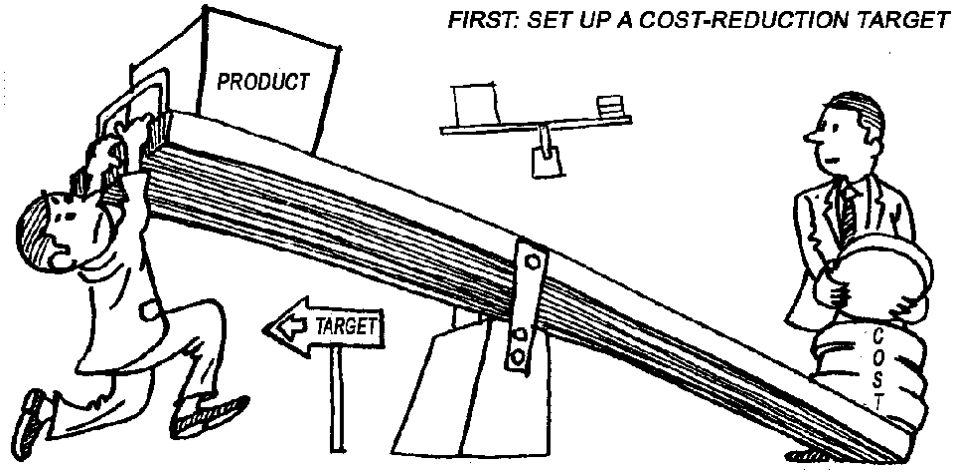
(3) HOW TO INTRODUCE VE

In this section we discuss the standard procedures for introducing VE, working on the assumption that individual organizations will devise methodologies that are most appropriate for their particular circumstances.

1) Confirming the need for VE

The need for VE has to be confirmed before it is introduced into a company or department. In other words, one has to know, in practice, how strong the demand is for a

reduction in costs or an improvement in value. Generally speaking, no company would pass up a chance to reduce their product costs. However, the extent to which cost-cutting is needed, and in which product line, is often not clear.



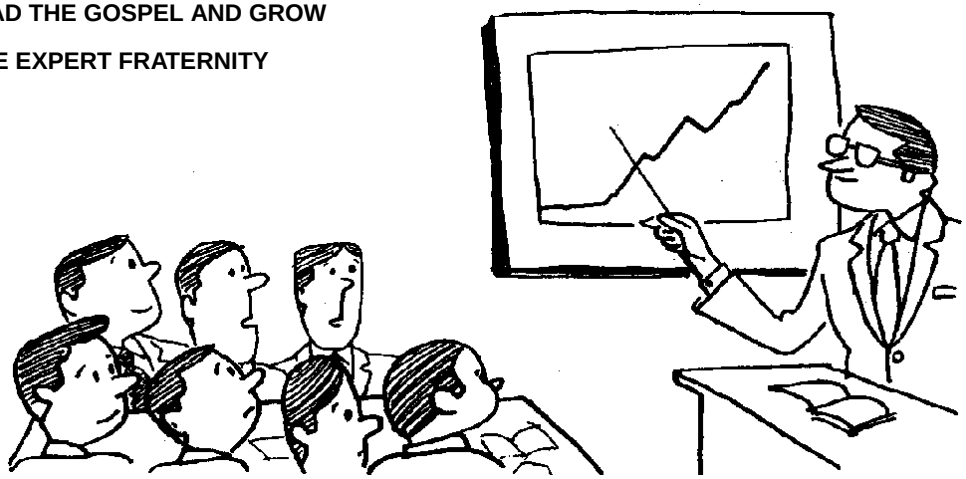
Today, some businesses practice so-called “management by objectives”. Implementing VE in these companies is likely to be easier, because cost-cutting targets have already been defined. Therefore, instead of adopting the generalized “let’s reduce costs as much as possible” approach, setting specific cost reduction targets helps to confirm the need for VE.

2) Studying VE

Before initiating VE one has to know what value engineering is – its methodology, its uniqueness, how to organize it, and how to put it into practice. This stage may be termed a period of study, or an “incubation” period. To acquire knowledge about VE, people in the company who are interested in the subject can attend seminars, schools, research group meetings, etc., or read relevant literature. If top management understands and supports the concept, VE workshops may be conducted within the company. In fact, there has been a recent increase in the number of companies adopting the internal workshop approach.

SPREAD THE GOSPEL AND GROW

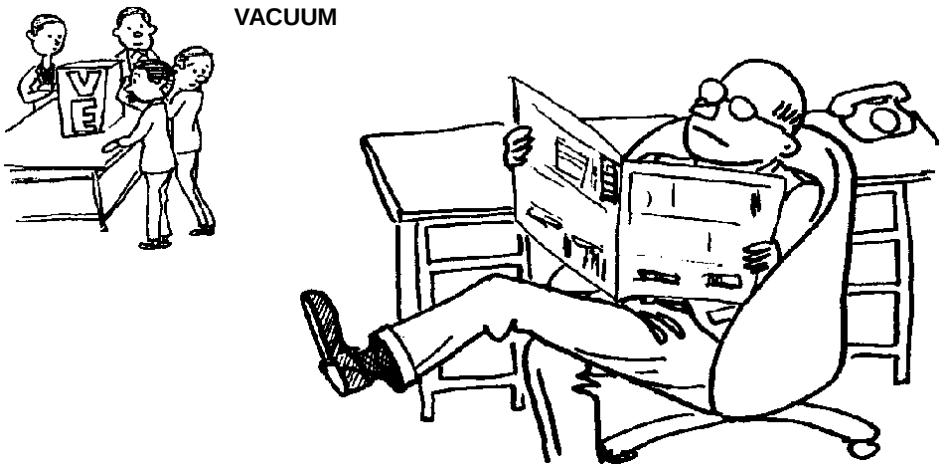
THE VE EXPERT FRATERNITY



3) Educating top management about VE

It is said that a systematic approach is essential for VE. If VE is implemented on a small scale, involving only a department within the company, or just a few people, no significant results can be expected. The positive support and understanding of top management, who can mobilize the entire organization, is vital. The promoter should take this into account, as well as identifying a suitable top management supporter, and the most appropriate point at which to enlist that person's support. In light of all these considerations, promoters should start persuading top management by showing, if possible, an example (preferably within the company itself) of cost reduction. In those companies that have successfully implemented VE we can be sure of finding top management people who demonstrate a good understanding of and sympathy toward VE.

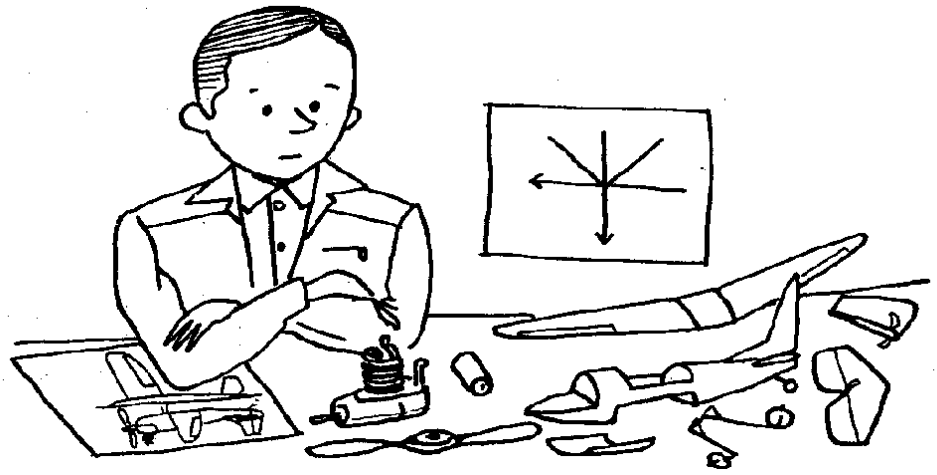
VE PROFESSIONALS CAN'T ACHIEVE THEIR GOALS IN A VACUUM



4) Test application of VE

The best way to communicate the effectiveness of VE to company officers is said to be a real-life demonstration of cost reduction on one of the company's products, using VE. There have been many instances of practical cost-cutting achieved by VE during such test applications. These have served as convincing arguments to top management, who usually proceed to implement VE on a larger scale, throughout the company.

IMPORTANT! SELECT ONE OF THE COMPANY'S OWN PRODUCTS FOR A CASE STUDY



At this early stage of VE trialing, however, an organized approach may be difficult, and cost data may not be available. An important aspect of giving VE a trial run, therefore, is selecting a suitable product to which it can be applied. As a rule, it is preferable to test VE on a product with some of the following characteristics:

a) Easy to analyze
b) Likely to respond positively to VE application
c) Easily measured in terms of cost reduction (monetary value) effect
d) Capable of showing positive results in a relatively short time
e) More likely to demonstrate a significant degree of cost saving (monetary value)

5) Setting up a VE promotion section

It may be necessary to establish a separate department or group of people to promote VE. The role of this department or section would be:

a) Propagation of VE within the company
b) Establishing a VE plan and implementation path
c) Identification and training of specialists
d) Creating channels of cooperation between different departments
e) Collection and analysis of data

Some companies establish a special committee with responsibility for carrying out the above functions. However, committees can have some disadvantages:

a) Responsibilities are not clearly delineated
b) It is difficult to actually carry out data analysis
c) Over time the committee may become routine-bound, or even stagnant

For those reasons, most companies are setting up exclusive VE departments or groups.

6) Training of VE specialists (Value Engineers)

Specialists who fully understand VE, and who can undertake analyses according to VE

methodology are needed for effective implementation of the system. These specialists would not be members of the abovementioned VE promotion department. Rather, they would be specialist engineers in various aspects of the production cycle – research and development, engineering, manufacturing, industrial engineering, purchasing, testing, quality control, cost estimation, maintenance, and sales. They need to be trained to master the techniques of VE and become Value Engineers. The following methods can be used to train value engineers:

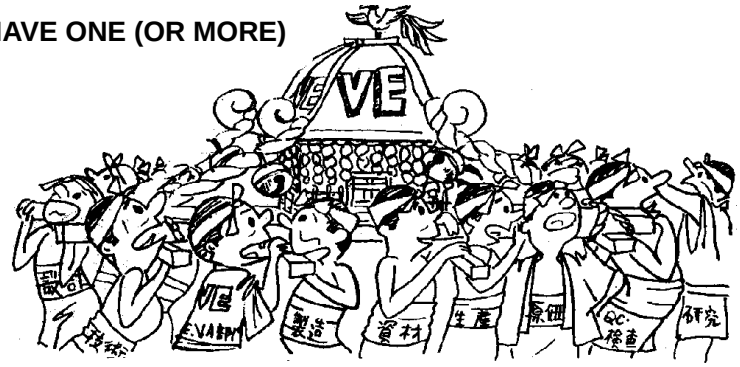
a) Training and research sessions conducted within the company
b) Sending personnel for external training
c) Holding internal VE workshops and seminars
d) Exchanging personnel with the VE promotion department for OJT

1	DESIGNING/ENGINEERING	18.3%
2	VE/VA	17.2%
3	MANUFACTURING/PRODUCTION	12.0%
4	MATERIALS/PURCHASING	10.7%
5	INDUSTRIAL ENGINEERING	8.5%
6	COST/COST ESTIMATION	6.5%
7	QC/TESTING	6.1%
8	RESEARCH & DEVELOPMENT	4.1%
9	SALES/OPERATIONS	3.9%
10	OTHER	12.7%

Table 2: DEPTS. VErs WORK IN

Today, in companies with a well-established VE system, trained value engineers are placed in various departments, as listed in Table 2. When necessary, they are assembled as a task force to undertake VE work.

QUALIFIED VE SPECIALSTS: EVERY DEPARTMENT SHOULD HAVE ONE (OR MORE)

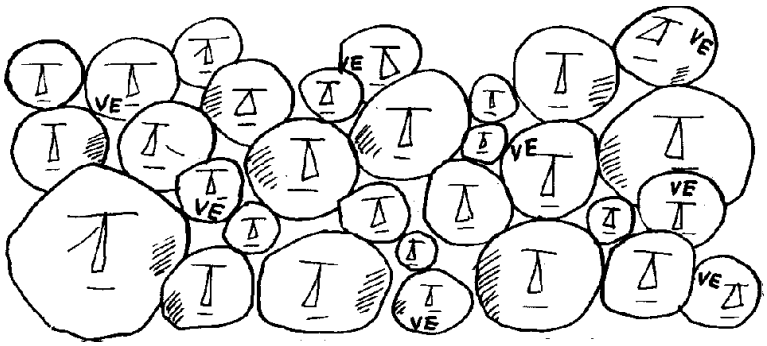


7) Workshop seminars

These days, more and more companies are holding workshop seminars in the initial stages of VE, for such purposes as test-implementing VE, constructing a model case of cost-cutting on one of the company's products, and training of value engineers. In such seminars, a task force comprising specialist engineers is organized and assigned the task of improving the value of one of the company's products. While learning VE techniques, these people will prepare a Value Engineering Change Proposal (VECP), and then discuss it. Thus, a model case for VE is constructed. The characteristics of such workshop seminars are listed below:

a) Participants learn VE methods and techniques.
b) VE's effectiveness in cost-cutting is proved or demonstrated.
c) Better communication develops between participants, and consequently between the departments they represent.
d) Individuals with the attributes to become value engineers are identified.
e) The VECP prepared during the workshop seminar has practical utility not only toward immediate cost reductions, but also as data for future analyses.

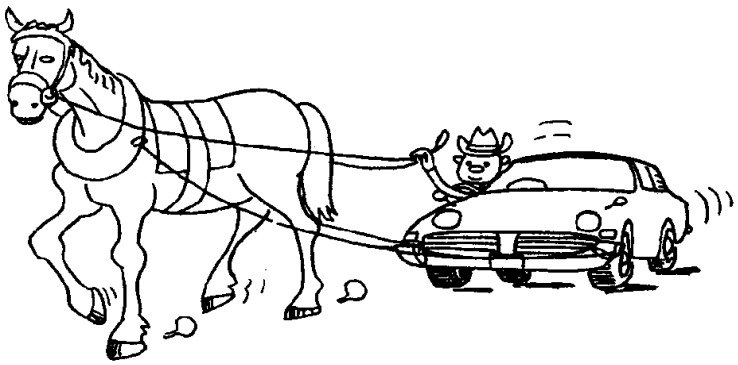
VE GET-TOGETHERS FOSTER INTER-DEPARTMENTAL COMMUNICATION AND HELP IDENTIFY POTENTIAL VALUE ENGINEERS.



8) Precautions to observe when implementing VE

The effectiveness of VE in cost reduction has been broadly evident in many companies. However, there have been cases in which desirable results have not been achieved, despite the application of VE. Reasons for these disappointments vary – the nature of the business, the type of product, no real justification for using VE, etc. However, in most cases where results fall short of expectations, the following factors are responsible for hampering effective introduction and development of VE.

1. Insufficient knowledge about VE. In some cases, due to a flawed understanding of VE, there is insufficient functional analysis and organized activity, and a reluctance or inability to adopt new attitudes toward cost-cutting. Consequently the expected results are not achieved.



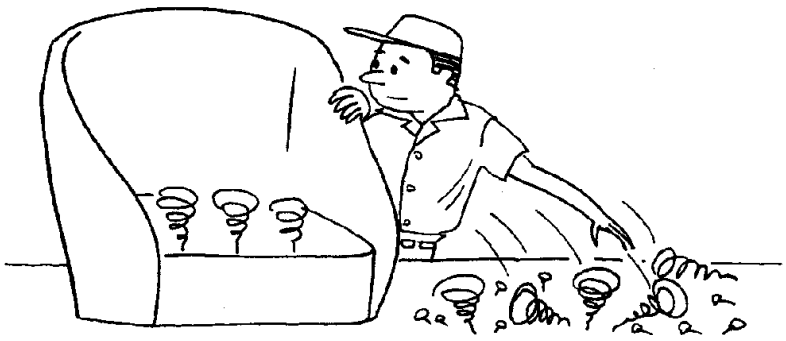
THE REASON WHY VE IS NOT SUFFICIENTLY EFFECTIVE...

2. Halting the process at the trial stage; VE degenerating into just another formalistic

practice. Even among companies that were early adopters of VE, there have been examples of the system having been abandoned because its full benefits could not be gained. In such cases, the following can be observed: Responsibilities were not clearly delineated; no clear-cut procedures had been followed in advancing the change proposal, test implementation of VE, and demonstration of its effectiveness; there was no actual implementation and follow-up; or, in other words, the company fell prey to sectionalism and VE ended up as just another formalistic practice.

3. Cost-cutting targets not defined. Most companies introduce VE with the objective of reducing costs. In some cases, however, the targets are either not clearly defined or are too ambitious. Sometimes, even if there is a desire for cost reduction and clear targets exist, the cost reduction potential is not carefully analyzed, or properly exploited.
4. Lack of organized approach. A characteristic of VE is organized effort – team designing. However, if some departments do not fully understand this concept, analytical activity may be undertaken only by the VE promotion department. In companies where VE tasks are assigned to only a section of the staff, overall organized activity is not developed. Thus, not only is the desired outcome aborted but VE itself may gradually wither and die.
5. Lack of function-oriented approach. True, VE is, in effect, functional analysis. In some companies, because of pressure to achieve an immediate effect or improvement, or because knowledge of proper functional analysis is lacking, VE activity occurs as sudden spurts of ideas and techniques. In this type of approach, economizing on materials often becomes the focus, so value engineering sometimes gets tagged "stingy VE". In such cases, VE activity cannot develop properly, and eventually it may even become difficult to realize the essential functions of the product. Sometimes a change proposal can become the very reason for customer complaints about a product. Some companies have discontinued their VE programs as a result of such consumer dissatisfaction.

OVEREMPHASIS ON ECONOMIZING MATERIALS ALONE...



6. Analysis is not properly carried out. There is a correct sequence of steps in

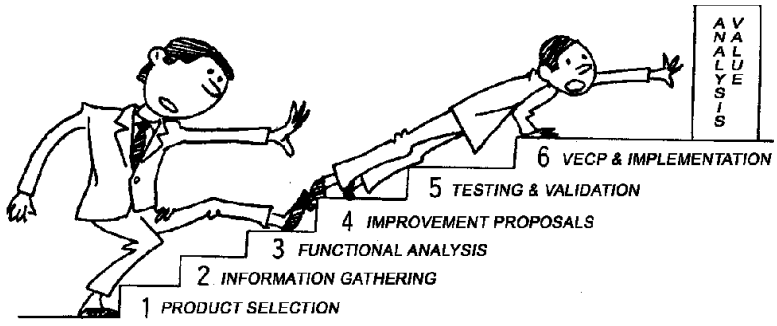
manufacturing a product. If one of these steps is skipped or eliminated the product could be defective. Similarly, VE must be implemented in a proper sequence of steps in order to achieve cost reduction. If this sequence is not followed, the VE process will be defective. Among companies in which VE was not successful, there are a number that did not follow the proper job plan, or deviated from the path.

7. Poor understanding of the process for implementing a VE change proposal. Even though an excellent change proposal for reducing the cost (improving the value) of a product may have been prepared, such ideas will never see the light of day if the department or section which should adopt the proposal does not have a proper conception of VE, or is not emotionally inclined to accept it. The greater the delay in implementing the change proposal, the less effective it will be.
8. Lack of information, particularly regarding costs. A lack of information about costing and technology has been strongly felt in many companies where VE has been attempted. If the estimation of costs in the change proposal is faulty, there will be a significant difference between the actual and the estimated effects. In extreme cases, information about costs is so lacking that estimates cannot be included in the change proposal. Such conditions are often instrumental in retarding VE activity.

We have listed above some of the factors to which particular attention should be paid when introducing VE. There are, of course, many other factors pertaining to individual companies, which might hamper the implementation of VE. One way to overcome such obstacles is gaining the understanding and support of top management, usually as a result of the unstinting efforts of value engineers.

HOW TO IMPLEMENT VE

The appropriate approach for implementing VE in a company will vary according to such factors as type of product, manufacturing system, structure of the business, extent of the need for VE, and quality of management. In short, there is no fixed pattern. One has to decide on a method of implementation that is suited to the particular company and product, and then ensure strict adherence to this methodology. That said, if “authentic VE” is the objective, then the implementation methodology should reflect the characteristics of authentic VE. In other words, crucial steps that are intrinsic to genuine value engineering implementation should not be skipped or omitted.



In this chapter we explain the key steps involved in implementation of VE in a company.

(1) VE JOB PLAN

VE is a system wherein an attempt is made to solve problems relating to the value of a product or service. For this purpose, the value has to be measured, and a product or service with low value needs to be identified. The formula for measuring value in VE is:

$$V = \frac{F}{C} \qquad (\text{VALUE} = \frac{\text{FUNCTION}}{\text{COST}})$$

Therefore, for any solutions relating to problems with value (V), measurement and analysis of function (F) and cost (C) are necessary. In VE, the measurement and analysis are carried out in the following order:

1. What is it? 2. What does it do?	Definition of Function
3. What is its cost? 4. What is its value?	Evaluation of Function
5. Is there a substitute having the same function? 6. What is the cost of that substitute? 7. Does it satisfy the requirements?	Development of Alternatives

If we compare the above steps with the standard process in solving a problem, the definition of function corresponds to stating and clarifying the problem, the evaluation of

function corresponds to setting up evaluation criteria for solution ideas, and the development of alternatives corresponds to solving the problem. These steps, therefore, are essential stages in problem solving through the use of VE.

This sequence of steps in VE activity is called an implementation plan or a *job plan*. Usually, a job plan consists of the following 6 steps:

1. Selection of the product to be analyzed
2. Gathering of information
3. Functional analysis (definition and evaluation of function)
4. Development of improvement proposals (creativity, evaluation and refinement)
5. Testing and validation
6. Submission of change proposal and implementation

When such a job plan is represented in greater detail, it would be as shown in Fig. 4. This diagram, of course, represents a generalized job plan. In particular companies the classifications may be different and steps may have different names.

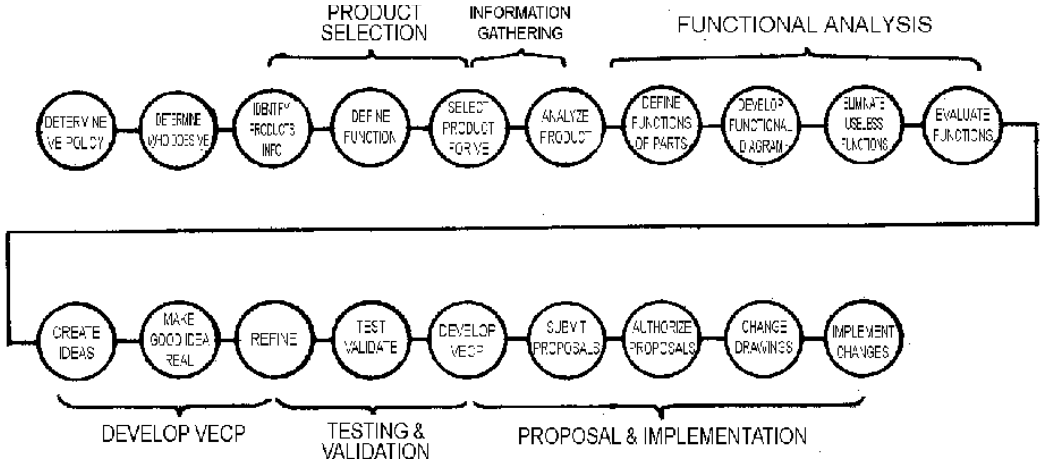


Fig. 4: EXAMPLE OF JOB PLAN

(2) WHAT IS FUNCTIONAL ANALYSIS?

The basic role of VE is the elimination of unnecessary functions by examining the relationship between the essential functions and cost, examining all possible methods of achieving the necessary function, and selecting the optimum method as the basis of the change proposal. In short, the purpose of VE is to find answers to the following five questions regarding function:

1. What is it?
2. What does it do?
3. What is its cost?
4. Is there anything else which can provide the same function?

5. What is the cost of that substitute?

The essential function(s) must be defined, and then the steps required for achieving that function at minimum cost must be followed. This procedure consists of the following 3 steps:

1) Definition of Function. A product is analyzed to determine what functions it possesses and what functions are required of it. If the product is found to have functions that are not required, these may be designated as unnecessary functions and the product may be considered to be over-designed. To eliminate such excess or overlap in functions it is helpful to first have a clear conception of the product's functions. This is achieved by expressing the functions simply in terms of a verb and a noun: e.g., ruler -> measure (verb) distance (noun)

2) Evaluation of Function. Determining the value of a function in monetary terms constitutes evaluation of a function. Usually, the total cost of the product is more than 10 to 20 times the assessed value of its functions. Through function evaluation, one can determine the extent of potential cost reduction, and thereby set goals for cost-cutting. This is one of the steps unique to VE. Proper training of personnel and an accumulation of techniques are necessary for proper function evaluation.

3) Development of Alternatives. In this step, many possible ways of achieving the required functions are considered through brainstorming; making lists of advantages, desired objectives and disadvantages, etc. Thus, using all available creative techniques, efforts are concentrated on developing a number of possible proposals. At this stage teamwork is, again, crucial.

(3) STAGE AT WHICH VE IS TO BE APPLIED

VE has to be implemented continuously in order for it to cope with technological innovations and competition. However, the question arises: At what stage in the development and manufacturing of a product should VE be applied?

The lifecycle of a product starts with research and development, and then proceeds through growth, maturation, and aging, until its eventual obsolescence. Competition is most intense at the growth stage, and it is at this stage that cost-cutting is most needed. However, if VE is applied as early in the cycle as possible, the product will be even more competitive. Of course, this would call for greater effort.

Today, more and more companies are applying VE to greater effect at the stages of research and development, and engineering. This is called "First Look" VE. At this early stage, functional analysis and cost estimation are very difficult; therefore solid experience in the practice of VE is needed before attempting to apply VE at this point.

In addition to cost reduction in products, VE can be used in software – manufacturing

procedures, administrative procedures, and organizational matters. See Fig. 5.

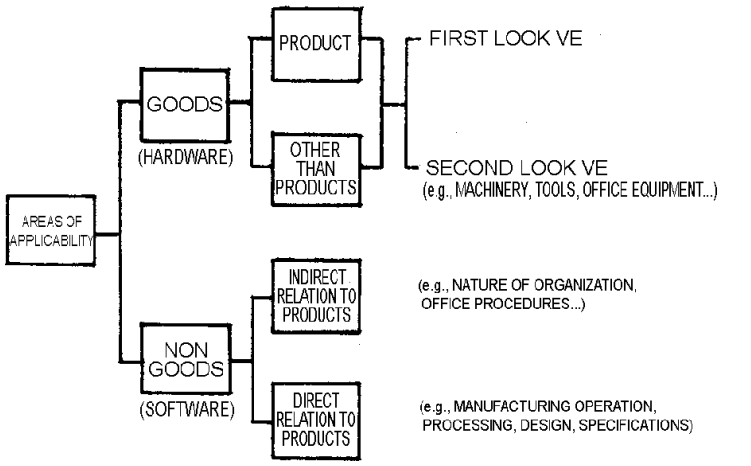


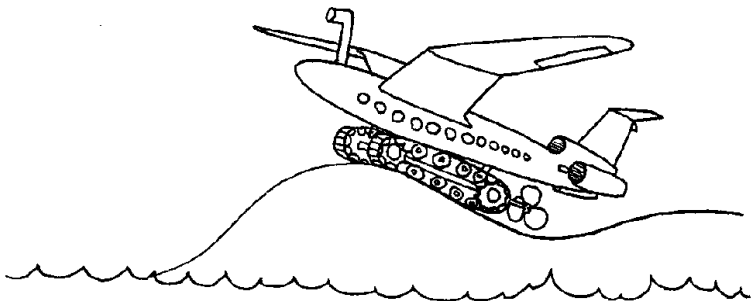
Fig. 5: AREAS OF VE APPLICATION IN MANUFACTURING COMPANIES

(4) PRODUCT SELECTION

It is important to choose carefully the product to which VE will be applied, because the nature of the product will greatly influence the results achieved. Unless a product with significant unnecessary costs or low value is chosen, the efforts expended will not reap their just rewards.

It is generally recommended to select a product with low value or high cost. However, it would be useful to keep in mind the following points when making the selection:

UNREALISTIC PERFORMANCE EXPECTATIONS? VE CAN HELP!



Design aspects

1. A product that was designed in a hurry.
2. A product in which an unreasonably high level of technology is required.
3. A product with complex functions.

Sales aspects

4. A product for which there is a customer demand for VE.
5. A product whose sales the company desires to expand.

6. A product that has attracted too many customer complaints.

Manufacturing aspects

7. A product with a high manufacturing cost.
8. A product with a high deficiency rate.

Ease of application aspects

9. A product about which information can be easily gathered.
10. A product to that lends itself naturally to application of VE

If an appropriate product with the above characteristics is selected, VE can produce remarkable results.

(5) ORGANIZATION OF A TASK FORCE

Numerous methods are available for reducing costs of products and services. For instance: management by objectives, establishment of a QC circle, implementation of a ZD movement, or elimination of superfluous departments. Any of these cost-cutting exercises could either involve the whole company, or be practiced at department level. In the case of the design department, cost-cutting could be achieved by making changes in the design, or by carrying out design engineering management. In the production department, cost reduction could be realized through changes in the design of tools used, the method of operation, or by improving conveyance and layout. In the purchase department, lower costs could be achieved by locating cheaper raw materials that conform to the specifications, or by identifying a more price-competitive supplier. However, if large-scale cost reduction is to be achieved, the knowledge and experience of one or two departments are inadequate. Unless the knowledge and experience of various departments are collectively brought to bear on the problem, large-scale cost-cutting cannot be achieved. For this purpose, the company should take the initiative at top management level, set up a team of specialists from different departments, and allow them to concentrate on the job of reducing the costs of selected products. In VE, team designing is often practiced by such a group of specialists – a *task force*.

The following points should be clearly delineated when organizing a task force:

1. Names and designations of members
2. Project to be assigned
3. Background against which the project was selected
4. Objectives set for task force
5. Period for which task force would remain in effect
6. Appointment of team leader

7. Time and place of first meeting
8. Firm agenda for the first meeting

There are two ways of organizing a task force. One is to assign to it all tasks – product selection, functional analysis, preparation of a change proposal, submission of the proposal and implementation – i.e., the entire job plan. The second method is to assign to the task force only those tasks from functional analysis to submission of the proposal.

The lifespan of the task force would depend on the tasks assigned to it. For instance, it could vary from a minimum of 3 to 4 days to as long as 1 to 3 months, involving up to two hours commitment per day. The number of members can range from 4 or 5 to 10 or more. At the very least, representatives of the 4 critical departments - design (engineering), production, purchasing, and VE (cost analysis) - should be included in the task force. The other members can be selected according to the type of work involved.

THE TASK OF THE VE PROMOTION SECTION

Once a job plan is in existence, some tasks relating to the promotion and management of VE will emerge. This creates a need to assign a section exclusively for this work. In companies where an exclusive unit implements VE, there is a VE promotion section, department, or committee, which is tasked with controlling and supporting all work related to that VE implementation.

(1) COORDINATION, EVALUATION, TRAINING, AND CONSULTATION

The work of the VE unit can be broadly classified into the following tasks: coordination, evaluation, training, and consultation.

Coordination. The planning and regulation of VE activity. This includes coordinating the VE-related work of different departments – collecting, recording, and applying the relevant data, promoting better teamwork, etc.

Evaluation. Examining the product to determine its potential for cost reduction, studying results obtained by other value engineers, and applying them to the case at hand, etc.

Training. Particularly in the initial stage, the primary function of the VE promotion unit will be to teach VE to specialists in different departments, so that they can qualify as value engineers. If, through the training process, the value consciousness company personnel can be raised, this will lead to better teamwork and, ultimately, better results.

Consultation. The staff of the VE promotion unit should be available as internal consultants on any aspect of VE. Because personnel belonging to regular departments must also attend to their own responsibilities, the promoters of VE must actively support VE by using their broad knowledge and valuable experience.

The above type of work is known as *VE management* or *VE service*. According to a recent survey, the work of promotion units typically comprised the elements shown in Fig. 6.

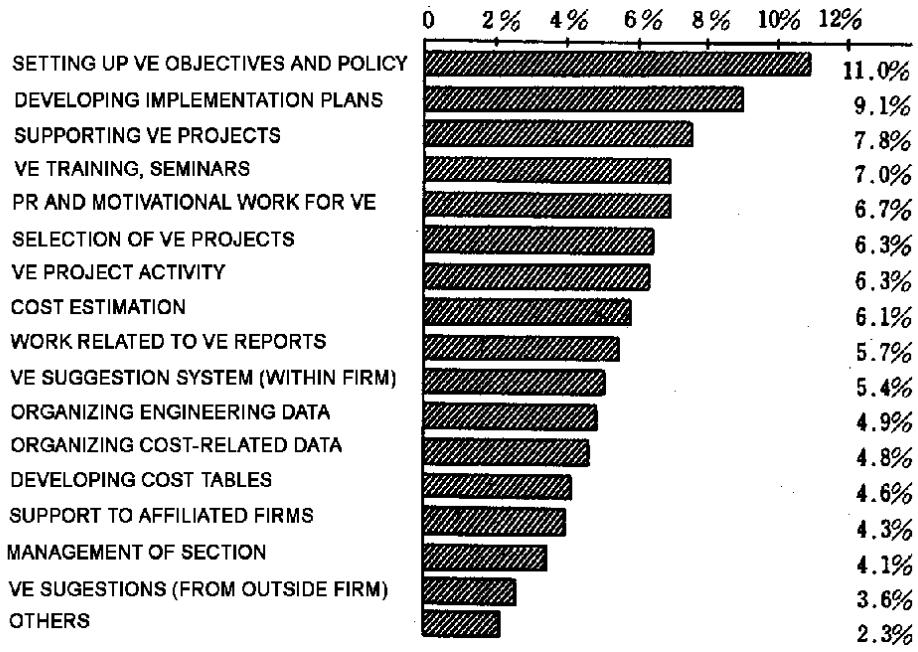


Fig. 6: TYPES OF WORK IN VE PROMOTION UNITS

(2) OTHER VE-RELATED ACTIVITIES

The primary function of VE activity is the pursuit of significant cost reductions by organizing a task force comprising specialists from different departments. However, there are additional VE-related activities to be carried out.

1) Cost surveys and parts surveys

Normally, a low-value product (one having a high cost relative to its function) is selected for application of VE. This generates a requirement for detailed surveys of the cost of the product and its components, the manufacturing process and essential equipment.

Also, when the costs of products or parts having similar functions are compared, some items carrying a very high cost may be exposed. Such unexpected high-cost factors can facilitate selection of the product to which VE will be applied. This kind of survey is very useful at the time of initiating VE.

2) VE meetings

If the project taken up is not so large in scale as to justify a task force, VE can be carried out just as effectively by one person. But, there is still the likelihood that individuals involved in the project will get together for informal discussions regarding VE. Such meetings are particularly useful when:

- the adopted project already has clear-cut objectives, and it is only new ideas that are sought, or

- when cooperation is sought from an affiliated company.

Such meetings generally take place monthly, and sometimes double as training sessions.

3) Utilizing a VE suggestions system

Many companies employ a “suggestions system” for improving management, and in some cases VE-related suggestions are included in those systems. In other cases, a separate VE-related suggestions system is organized in order to solicit ideas from employees.

A successful suggestions system should incorporate the following:

a) Suggestions should be considered promptly; a quick decision should be made as to the acceptance or rejection of every suggestion.
b) The person submitting a suggestion that is accepted should be rewarded in some way.

We can observe organizations where this VE suggestion system is an active component of VE activity, and other organizations where this aspect is managed by task forces.

Naturally, the content of suggestions received is of utmost importance in a suggestions system. Providing an appropriate atmosphere and suitable motivation is also important. In ideal situations, the suggestions system promotes awareness of VE within the company, and contributes to the health and longevity of the system.

4) Design review meetings

It may not be easy to introduce VE in plants where products are custom-made. However, there are still certain repetitive steps involved in the case of items that are not mass-produced. Here, VE activity can be undertaken in the form of a design review meeting. The first step is to select some new products that have any of the following characteristics:

- ordered in relatively large quantities
- involves a highly repetitive manufacturing process
- expensive to produce
- has a rather long production leadtime

Then, a design review meeting is held with designers and value engineers, for the purpose of inspecting the design before it is accepted. Through such meetings, significant results can be achieved without taking up a great deal of time (a couple of days or so). This procedure, when included as part of the design process, is sometimes called a *value review*.

Design reviews are a useful means of training designers in VE. A team of designers who have undergone VE orientation training is organized, and each month’s designs are

audited from a VE perspective. A specific theme (e.g., “tolerance”) is agreed on at the beginning of each month; then, in the team meeting, held later in the month, the designs are examined with special emphasis on the nominated theme. If the review reveals some undesirable aspect, the design is returned to the engineer for correction. This method allows VE audit results to be recorded and compiled, even in the case of custom-made products. These records could be useful as reference materials for future design work.

5) Preparation of cost tables

As VE activity gathers momentum in a company, it may reveal shortcomings in availability of information, particularly with regard to costs. Therefore, cost tables need to be prepared, in order to facilitate cost estimating and comparison. A cost table can be one of four types, depending on its intended use: purchasing, fabrication, designing for production, or designing for function. These can be further divided into sub-types, such as lists of unit costs, tables from which manufacturing costs can be estimated through the use of designs, tables used for selection of materials, method of production, and function. The advantage sought in using cost tables is quick cost estimates and quick cost comparisons. Therefore, cost tables that are simple in structure, and can be read easily are, preferable.

Cost tables are not properly prepared in many companies. As VE becomes active, the preparation of cost tables becomes a major responsibility of the VE promotion unit.

6) VE case study meetings and VS meetings

The best way to help individuals appreciate the benefits of VE is to show them examples of VE cost reduction in products made by their own companies. Such case studies are particularly useful particularly when trying to persuade affiliate companies to adopt VE. Some companies that actively practice VE periodically compile cases of successful VE implementation and publicize them both internally and externally. Several companies hold annual VE conferences at which such case studies are reported. Alternatively, in order to impress parent company engineers, case studies of successful VE activities in affiliate companies are compiled and reported at so-called Value Sales (VS) meetings.

7) Function explanation meetings

In a group of affiliate companies, one such company may produce only a single component or carry out partial processing of a part. In such cases, employees may not be fully aware of the part’s function or even its location in the finished product. Because a part’s function needs to be clearly understood for more effective VE activity, explaining the end-product functions of parts to their manufacturers, or taking them on tours to the final assembly plant can be quite useful.

8) VE newsletters

Almost invariably, VE newsletters are published by companies that actively practice VE. The chief aims are promoting the extension of VE into fresh applications in other departments, PR, and staff motivation. These newsletters usually feature:

a) Introduction to VE theory and practice
b) News about engineering and materials innovations
c) VE activities within the company and in other organizations
d) VE training and its benefits
e) Reports on cost reduction through the use of VE
f) The fate of VE-related suggestions from employees

Points to bear in mind when producing a newsletter include:

a) A simple format is preferable and a single issue need not contain a large number of items (often, a single B5 or B4* is sufficient).
b) It is better to issue smaller newsletters more frequently.
c) It need not be very expensive to produce.
d) It is better to distribute the newsletters to as many people as possible (including relevant staff members at affiliate companies).
e) It is preferable to keep the VE newsletter independent of other company publications (including it as part of the company house journal does not achieve the same impact).

* B5 paper size = 18.15 x 25.7 cm; B4 paper size = 25.7 x 36.3 cm

EFFECTIVENESS OF VE

Cost reductions on a scale never previously seen have been achieved in companies where VE has been actively implemented. The effectiveness of VE, in terms of money saved per case per year, ranges from several tens of thousands to several hundreds of millions of yen.

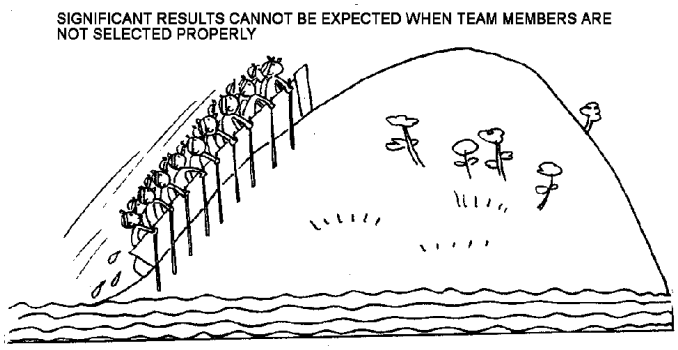
The greater the benefit/cost ratio obtained by VE activity, the greater should be the budget earmarked for such activity. Current experience suggests the following values for possible cost reductions through VE.

$$\text{PERCENT COST REDUCTION} = \frac{\text{PRESENT COST} - \text{COST AFTER IMPROVEMENT}}{\text{PRESENT COST}} = 30 \text{ TO } 70\ \%$$

$$\text{BENEFIT/COST RATIO} = \frac{\text{ANNUAL NET SAVINGS DUE TO VE}}{\text{COST OF VE OPERATIONS}} = 10 \text{ TO } 20 \text{ TIMES}$$

The above values are generally regarded as standards against which VE achievements can be compared. However, such effectiveness cannot be expected if the product selection or the selection of implementation team members is not carried out properly. These selections are important factors in the success of VE.

When we look at the results obtained from training in workshop seminars conducted by the SANNO Institute of Business Administration in certain companies, we can see that the annual net amount saved by one team (average membership, 8.8 people) was 19.83 million yen; the percentage cost reduction achieved in the part selected for VE analysis, 34.9%; and the benefit/cost ratio, 32 times. When these values are converted to annual net savings per member per hour of work, it amounts to about 20,000 yen. In other words, a single value engineer working for just one hour can produce a net/annual saving of about 20,000 yen.



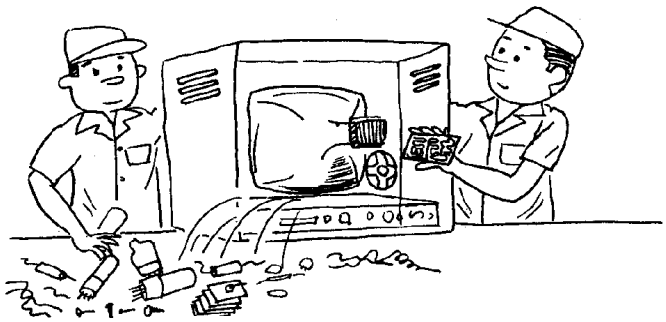
The cost-cutting capability of ordinary workers in a company, as demonstrated by the results of suggestion systems, etc., is about 5%. This value rises to about 10-15% in the case of trained engineers (Industrial Engineers). The sum of these capabilities is the total

capacity of the company to reduce costs. Therefore, such companies with a poor cost-cutting record would benefit greatly from employment of value engineers, whose cost-cutting capability is estimated to be more than 30%.

The VE change proposal prepared as a result of VE activity includes suggestions for improvements in designing, engineering materials and processing methods. Change proposals are usually prepared when VE analysis is carried out by a team of three or more. A proposal will be one of three types:

1. Able to be implemented immediately.
2. Requires some technical investigation.
3. Cannot be implemented at this point, but is expected to have potential for implementation following technical improvements.

With these proposals, difficulty of implementation and effectiveness in cost reduction is inversely proportional. For instance, in the first type of proposal, the effect of implementing it would not be very marked but the proposal is easy to implement. Conversely, the third type of proposal is difficult to implement but a significant effect can be expected.



...BUT DOESN'T COST-CUTTING COMPROMISE PRODUCT PERFORMANCE?

Some people seem to feel that VE might reduce product performance. This perception grows out of a misunderstanding of VE activity. If the functional analysis is properly carried out, so that the required function can be assured, VE activity will never degrade the performance (function) of a product. In general, the relationship between performance and cost is as illustrated in Fig. 7. Many products are capable of having their performance improved hand-in-hand with a reduction in manufacturing cost. In other words, the majority of products fall into the shaded area of the graph: VE does not reduce the performance of a product. In fact, in many cases, VE actually improves performance.

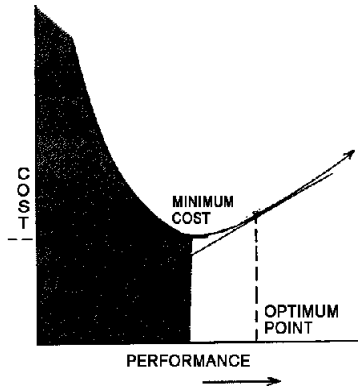


Fig. 7: RELATIONSHIP BETWEEN PERFORMANCE AND COST