MR L D MILES
with compliments
OPK

PROCESS PLANT & EQUIPMENT — COST ESTIMATION

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"Reduce the price ...... (this) forces the costs down ...... to force the highest point of efficiency"

"Vital few vs the trivial many"

"......A cynic knows the price of everything, and the value of nothing"

Potential of human mind is far from fully utilised.

Two heads are better than one.

These statements seem axiomatic and were first stated/known for a long time — the first one in 1923 by Henry Ford (Page 4), second implied by Pareto in 1896 and essence found (27) in the Old Testament! Put together, these statements, add up to Value Analysis (VA) "discovered" in late forties as a result of war-time necessity! Ford's statement in effect amounts to the current design-to-cost concept of VA. And yet even today the normal sequence is design, then cost and last selling price, only to find that there is no buyer!

Necessity **is** the mother of invention. During World War II, certain critical materials were reserved for defence, and manufacturers were forced to look for substitutes. Man's ingenuity rose to the occasion and suitable substitutes were found/created.

With the war over and the supply of previously critical materials resumed, users reverted to the original materials. The substitutes were discarded without a second thought; that is, by most users except General Electric.

GE's Vice-President (Purchase), H. L. Erlicher noticed that, in many cases the substitute was less expensive and/or more reliable than the original material. So why discard the substitute? He went a step further. Why not use this process voluntarily to get better value? A GE purchasing agent, L. D. Miles, and a team of 3 were assigned this task in 1947. Their analysis for better value, i.e., achieve the function at lowest cost, led to founding of a new discipline, Value Analysis (VA), through which GE saved $ 200m (29) in 17 years. The U.S. Navy adopted it, and termed it, Value Engineering (VE) and in the first year of its application, a saving (6) of over $ 18m was obtained. The Air Force started using it in 1955 and the Army in 1956. In 1959, VE got a further boost by the new Secretary of Defence, Robert McNamara, formerly of the Ford Motor company, resulting in $ 14B savings (6) in the first 5 years. Is it any wonder then that after a 5 year gestation period, 1947-52, VE emerged as a mature and sophisticated tool of management (14)? Media as diverse as Wall Street Journal and Readers Digest have carried articles on this new Science (or Art?)

The author owes his "initiation" into VE to Mr. R. H. Kempter and Mr. R. H. Rossman of Washington DC during their visit to India in March 1977 arranged by Mr. N. H. Atthreya.

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Reprint of **Chap. 13. Value Engineering** from Chemical Weekly, June 7, 1977. Serialisation started on April 5. This work contains **Cost-capacity Nomograms for U.S.A. (1976) with conversion factors for Britain, France, India, Italy, Japan & West Germany.** 250 pages.

How does VE differ from other cost-reduction techniques. **First,** the latter "clips costs" whereas VE "blasts costs" (2). **Second,** it is a disciplined and organized approach which takes nothing for granted. **Third,** its utility lies in team-work and **Fourth** the stress is on **function,** without sacrificing quality. It peels the "cost onion" (13) and identifies un-necessary cost. Under its powerful influence, the cost pyramid "tumbles down".

VE is an attitude of mind and a way of thinking (25). VE is for the champion (23)! The difference between a winner and runner-up is small, but what a difference! A champion/winner always needs a coach — a Guru! This is the Value Analyst/Engineer. He must combine (16, 28) youthful imagination with mature judgement (Fig. 13.1) and sound techno-

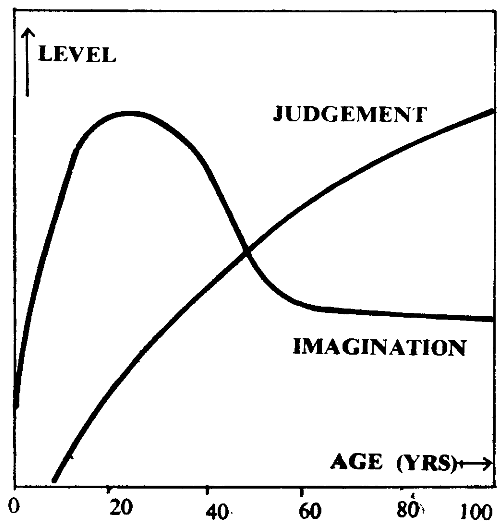

Fig. 13.1 Imagination — Judgement — Age

logy (20). He must have knowledge, initiative, imagination and creativity (19). He must be a psychologist, engineer and salesman, yet he must have the ability (9) to see the problems through the eyes of the management. He must be able to lead a multi-disciplinary team, with members from design, production, estimating, purchasing and sales or marketing departments. He must be an innovator (25), NOT inventor.

Does such a super-being exist? Certainly, yes — in every organisation. But it requires the ability to pick a "needle out of a haystack"!

To top it all, the Value Analyst must be humble. Miles, credited by most authors as the father of this discipline, hardly mentions his **own** role in his classic work (23) on the subject. He has set the example. Let's follow it!

DEFINITION

Miles and Associates used the term VA to analyse the cost of a product/item vis-a-vis its function. It is a sytematic analysis starting from scratch and without taking anything for granted. And this is where it differs from the conventional cost reduction techniques. Emphasis is on function rather than on product and then one "brain-storms" in a team to see what else could perform the function. Main criterion is **value,** NOT cost. Cost is determined by what an item **is** whereas value is determined by what it **does** (5). Value is relative (19) and somewhat subjective. It is related to utility and cost but can be measured (30) only by the user.

The person performing VA is called the Analyst. When the U.S. Navy adopted this technique, they "coined" VE since they used engineers. Later the term was broadened to Value Managment (VM). Some authors have tried to differentiate between these terms (29) thus :

VA = Cost correction for an existing **product — remedial** (6)
VE = Cost avoidance in case of a new product — preventive (6)
VM = Applied to total operation of the company.

Although there is some rationale in the above definitions, they are not completely exclusive and, in essence, they are synonymous. In the present text we will uniformly use the term VE to cover the above and other related functions.

As mentioned earlier, VE is **function-oriented** in contrast to other similar techniques, such as work study and method study which are **method-oriented**. VE analyzes not cost **but** value. VE is interdisciplinary and all embracing (16). A typical VE team comprises :

Designer
Estimator
Producer
Purchaser
Salesman
Value Engineer (Co-ordinator)

One member from each function is sufficient, although it is advisable to rotate membership in order to generate fresh ideas. Value engineer is normally the Chairman or the co-ordinator of the committee. He may be a specialist in any branch, although for process plant, engineering knowledge may be desirable. In addition, he should have had a fair exposure to other disciplines and also an extensive training in VE. Other members should also be exposed to the subject through a short orientation course to establish the right "wave-length" for the entire team. This could be conducted either by the value engineer himself or by an outside consultant. Value Engineer must be a fairly senior person reporting to the top management, whose involvement is essential, for the VE process to be effective.

Value is subjective and relative and hence not easy to define. Maximum value implies providing function at minimum cost. Mathematically, it has been expressed as (28) :

$$\text{Value} = \frac{\text{Quality} + \text{Reliability} + \text{Service}}{\text{Price } (= \text{Cost} + \text{Profit})} \qquad \textbf{Eqn. (13.1)}$$

This doesn't help much since it is difficult to quantify the numerator. However, it is obvious that if cost goes up, value goes down unless the numerator also increases at least proportionately.

VE maintains, if not enhances quality. Quality engineering (QE) and VE are, in fact, 2 sides of the same coin (31). VE provides basic function at lowest cost **without affecting quality.** QE aims at improving quality **without increasing cost** (21, 22).

VE IN A NUTSHELL

It has already been stated that VE uses a functional approach. In a nutshell it asks 6 simple questions :

TABLE 13.1 : QUESTIONS UNDER VE

WHAT :	**is** it?
	does it **do**?
	is it **worth**?
	does it **cost**?
	else will work?
	does **that** cost?

In VE, as in other disciplines, a clear definition of the problem is most essential (2, 23).

"A problem, once defined, would be simple" — Charles Kettering.

"A problem solvably stated is half solved".

A guide for choosing the right problem/product, in order to get best results (5, 13).

"Choose next year's winner — NOT last year's loser"

"Go for the best sellers"

The emphasis is quite rightly on the future (33) :

"I am interested in the future because that is where I intend to live"
— Charles Kettering.

Questions in Table 13.1 are answered in a logical sequence :

TABLE 13.2 : SEQUENCE FOR ANSWERS

A. Collect Information	
What : **is** it?	— Gather facts
does it **do**?	— Determine function
is it **worth**?	— Evaluate function
does it **cost**?	— Evaluate cost/worth
B. Speculation	
What **else** will work?	— Brainstorming
	— Eliminate
	— Simplify
C. Analyze	
what does **that** cost?	— List pros & cons
	— Assign value to each
	— Select best ideas
D. Planning	
Alternate solutions	— Analyze **specifics**
	— Assess feasibility & savings
E. Report & Implement	
	— Prepare report & proposal
	— Discuss with management
	— Translate ideas into action
	— Schedule & funding. Monitor to completion.

VE complements, **NOT** substitutes, good management and other skills (15). The basic philosophy of VE can be stated simply : There is a better way to do it, find it (18). In fact, the attempt is even to improve on the "best"!.

for how is one to know that the "best" has been achieved, since, this is somewhat subjective? The technique outlined above can be summarised as (17) :

Blast — Create — Refine

or (5) : Prepare — Incubate — Illuminate & Verify.

Success of VE assumes not only top management support but actual involvement (1). Mere lip service (2) is not enough. In the reporting/presenting proposal stage, the management should be told clearly (12) :

WHAT : is the cost
is the benefit
is the risk

Candidly, first show the "rainbow", then indicate how to get it ! This is why the Value Engineer has to be a salesman too!

In an interesting exercise (11), a customer, a salesman and a designer were asked to list the functions of a product in order of priorities. Needless to say that the three answers were different. Here again the ingenuity and psychological training of the Value Engineer plays the very important role of a "psychologist" to arrive at an agreed order of priorities.

VE is the greatest cost-saving technique! It applies not only to the engineering field, where it first originated, but also to services, management control information and capital projects (16). To be most effective VE must be a continuing exercise. Fig. 13.2 shows (33) the relationship of

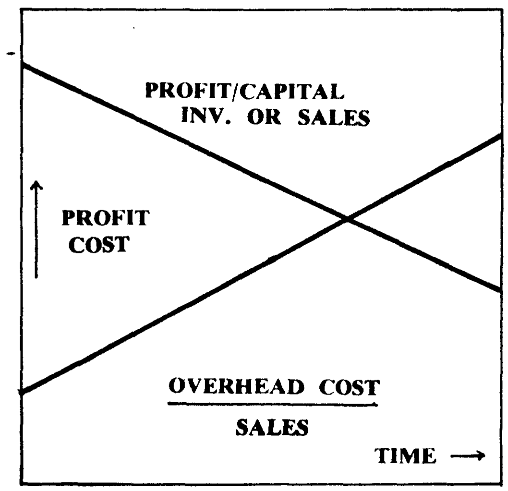

Fig. 13.2 Cost — Profit — Time Relationship

cost and profit with time for a typical project. It is clear that profit decreases and cost increases with time. If left to themselves, this could lead to a situation which may soon become irretrievable. Hence, it is essential that the VE exercise is not just "one-off" but a continuing one. It must become an attitude of mind leading to continuous monitoring.

To be most effective, decisions on VE proposals should be prompt, for delay in approval can lead to considerable reduction (14) in savings (Fig. 13.3). Savings through VE of course must take into account the cost (14) of change (Fig. 13.4) suggested by VE.

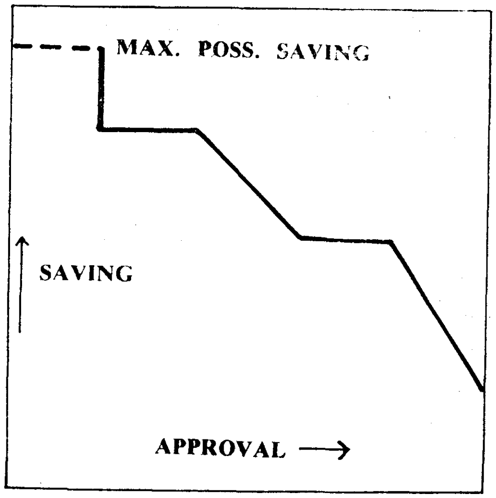

Fig. 13.3. Delayed Approval — Saving

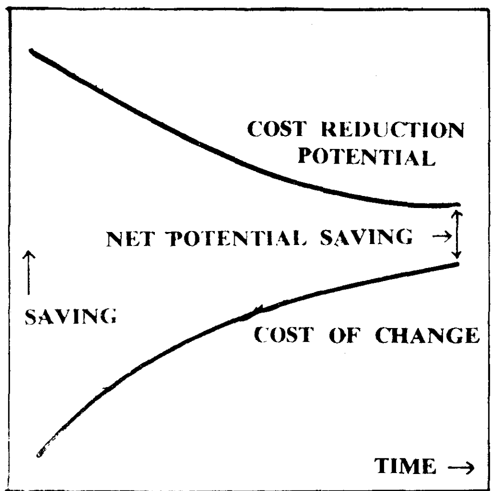

Fig. 13.4. Saving Through VE

The advantages of VE, in brief, are :

A proven method

Needs are met

Function is served

"Chunks" of un-necessary cost are "Blasted away"

Difficult areas are simplified

Cost saving can be diverted to areas for which new sanction is not possible.

VITAL FEW & TRIVIAL MANY

A complete process plant consists of thousands of items. So also an automobile or an aircraft. Application of VE to each and every component would be a laborious and unending job. Fortunately, a well known principle enunciated by an Italian-born Swiss economist, Vilfredo Pareto, in 1896 comes to our rescue. In studying income distribution (3), Pareto found that a few people had most of the money. This has been erroneously

(16A) termed as Pareto's Law. Numerous people, over the centuries, have observed this phenomenon in their local sphere/activity.

Unfortunately, the law which was later found to have a much wider application, lay buried, until rediscovered (27) for industrial situations in recent years. Thereafter it came to be known as the famous 80 : 20 rule stating, in effect, that relatively few causes are responsible (29) for most of the effects (Fig. 13.5). More recently this has been reduced to the terse statement (16A) :

"Vital few vs the trivial many"

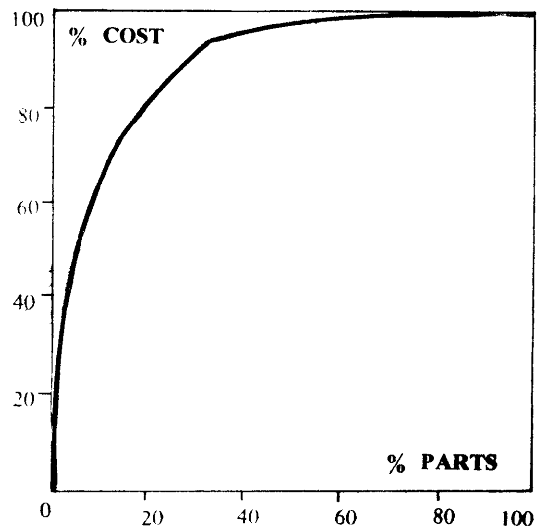

Fig. 13.5. Vital Few — Trivial Many

In any situation, therefore, such as a process plant, it is sufficient to concentrate on the vital few items. This same principle led to the most commonly used A-B-C analysis in purchasing.

Table 13.3 lists some typical applications of this principle to indicate its very wide and general use :

TABLE 13.3 : "VITAL FEW"

Few (normally 20%)		Most (normally 80%)
Employees	contribute to	Absenteeism
Products	contribute to	Sales (Profits)
Items	contribute to	Expenditure
Suppliers	contribute to	Problems
Employees	contribute to	Sales
Tasks	take up	Time

The list, in fact, is unending. But it is a pity that such a general and powerful tool remained hidden and un-utilised in industry for several decades! But this has several parallels in history, science and engineering. It will be an interesting research to find how long certain inventions/discoveries were delayed as a result of such lapses. This may happen even more now — with the "knowledge explosion" and the seemingly intractable problem of "information retrieval".

An attempt has been made (27) to translate this law into modern management language.

$$\text{Priority Index} = \frac{\$\text{ Value} \times \text{Probability of success}}{\text{Time to recover money} \times \$\text{ Investment}} \times 100. \quad \text{Eqn. (13.2)}$$

As expected, low probability of success is (29) associated (Fig. 13.6) with potentially high savings and vice-versa.

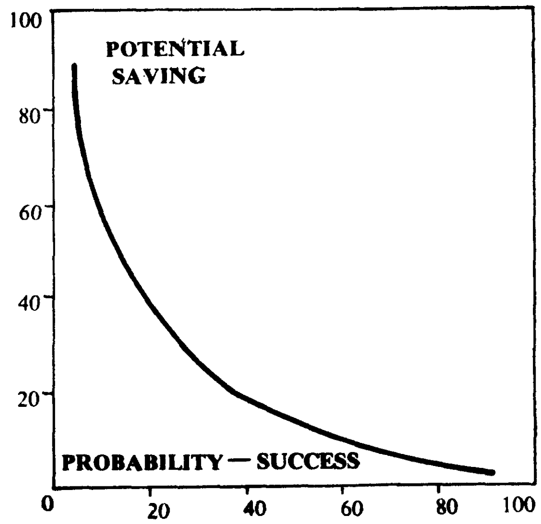

Fig. 13.6. Savings — Success Relationship

The cost of a product typically comprises (15) :

TABLE 13.4 : COMPONENTS OF PRODUCT COST

Materials, including bought out	40%
Direct Labour	10%
Overheads including administration charges	45%
Profit	5%
	100%

It is interesting to note that in the conventional cost reduction programmes very little effort is directed to the major cost components. Purchasing normally is a low level function (24) and in some cases no more than a Post Office (29). Likewise, very little attention has been paid to economising on overhead in a methodical and scientific manner. Whenever a company finds itself in a "profit squeeze", costs are cut across the board in a panic e.g., in case of overhead charges, such insignificant items as library budget and phone calls may be drastically cut without realising that these may actually lead to negative results!

Here again VE can provide a most useful guide for a creative search to "blast cost" not just "cut corners" in the sense of "penny wise pound foolish". And this approach should be coupled with "vital few" rule, so as to concentrate effort in areas which will yield maximum results e.g., a 5% saving in purchasing or overhead charges can lead to a 20% increase in profit, whereas a similar saving in labour component may be hardly worth the trouble and effort.

Likewise, VE could be very effective in tackling the "paper explosion" e.g., at the U.S. Government Federal Agency and New York Stock Exchange. The quantity of paper accumulated **every year** at the Agency is astronomical, needing 0.2m filing clerks and 25m ft^3 of filing space (30). The Stock Exchange was swamped with so much paper that they had to stop trading one day a week and later resorted to a shorter working day!

FAST (Function Analysis System Technique)

It is a diagram revealing the inter-relationships of all the known essential functions. The diagram looks similar to PERT, Programme Evaluation Review Technique, but with a basic difference. FAST is **function-oriented** whereas PERT is **time-oriented** (18). FAST represents, pictorically, the relationship of the functions a product was designed to do, not what we would like it to do. This is accomplished by using the verb-noun functions arranged logically along the following lines :

1. Indicate scope of the problem.
2. Draw critical path of the basic and required secondary function(s). Other secondary functions lie below or above the critical path.
3. To test proper arrangement of functions, ask "how" and "why" by using a verb-noun combination, i.e., logic diagramming.
4. The functions on the critical path are basic and must be performed. Other functions are subordinate and are not essential.

FAST diagram is a powerful VE technique which :

a. clearly shows how functions are inter-related.
b. tests the validity of the function.
c. helps understand the problem.

As applied to process plant, FAST diagramming can be used both for individual items of equipment as well as for the complete plant. Perhaps the former would be more meaningful.

PARAMETRIC COST ESTIMATING (PCE)

PCE relates cost to certain parameters/characteristics of a product or system, and is based on historical data. The parameter obviously depends on the industry and the product. For example, in the steel industry, it could be man-hours per ton, in effect a measure of productivity. The same yardstick could be used for fabrication of process equipment, provided accurate historical data are available. Other parameters for process plant and/or equipment could be :

Physical : e.g., area, volume, weight, capacity.
Performance : e.g., heat duty, hp, kva.

The cost data in App. H & I are shown as a function of physical and performance parameters depending on type of equipment/plant.

PCE is particularly important in early design, when preliminary characteristics are established and one needs to know the probable cost. The cost refers to a specific base year, corresponding to the historical data used. As the design proceeds, the cost can be firmed up. The cost can be up-dated through the use of an inflation index (Chap. 8 & App. F). The cost should also be corrected for "learning effect" and technological advances, although the relevant correction factors are not easily available.

Documentation is the most important part of PCE and it serves as a valuable reference during pre- and post-design stages. It is also quite useful during the feasibility stage. The extent of the documentation depends on the extent of historical data available.

It is heartening to know that process plant and equipment industry has been using PCE without calling it so. The cost-capacity and cost-performance relationships presented in App. H & I are, in effect, examples of PCE.

DESIGN-TO-COST

This seems to be the crux of VE and concept of Henry Ford who, perhaps, anticipated VE by quarter of a century. The industrial world may have lost much by not paying sufficient attention to Ford's far-reaching statement. The same is also true of the observation leading to the profound statement, "vital few vs trivial many."

The conventional approach is to design an item, then cost it and finally fix the selling price. Is it any wonder that many ventures based on this traditional method have failed? The selling price may be such that the customer does not consider the item "good value". The Ford and VE approach is the reverse. Start with a price the market can bear; work backward to the cost, and, thereafter, to design. This is the design-to-cost concept. A very pragmatic and realistic approach. In this concept, the cost to produce (based on selling price) is established prior to design, and the design is required to develop the item so that it can be produced at, or under, the pre-established cost target.

Ford, as quoted (Page 4) in the "Definitions — Wise & Otherwise" starts with the premise that cost is not fixed, in fact, the real cost is seldom known ! The selling price having been fixed on the basis of the market, forces the cost down, and then the design is geared to meet the cost. This is not only common sense, but makes good business sense, judging by the phenomenal success of the Ford "Model T."

Is'nt it strange that Henry Ford's philosophy of 1923, re-stated and termed VE 25 years later, has yet not achieved the acceptance it deserves? How many organisations in India and elsewhere, outside perhaps Japan and the U.S.A. really practise VE, i.e. pay more than just "lip service"? The New Brittanica Encyclopaedia (1974) devotes only $\frac{1}{4}$ page to VE and that too under the heading "Research & Development — Industrial"! This is probably another indicator that VE is not widely practised.

The life cycle cost of a product or facility, also called "total cost of ownership", is made up of a number of factors or cost elements. The acquisition cost includes the cost of design and development, and the cost of manufacture (including profit) and/or construction. The cost of operation and maintenance, in many cases, far exceeds the acquisition cost of a product or facility. In some cases, the cost of disposal can add a great burden to the owner, as in the case of nuclear waste materials.

The total cost of ownership is determined during the development of the user's criteria and standards, and in the design and development process. Thus, the user and the designer have the major impact in the **creation** of life cycle costs.

In the real world, these cost creators have been short-changed in their educational process and, unfortunately, have little (if any) knowledge of the cost impacts of their specifications and designs. Thus, we find many products and buildings that are so costly after design that they far exceed their budgets or economic "selling prices".

The creation of life cycle costs of a product, time-wise and cost-wise, is illustrated in Fig. 13.7.

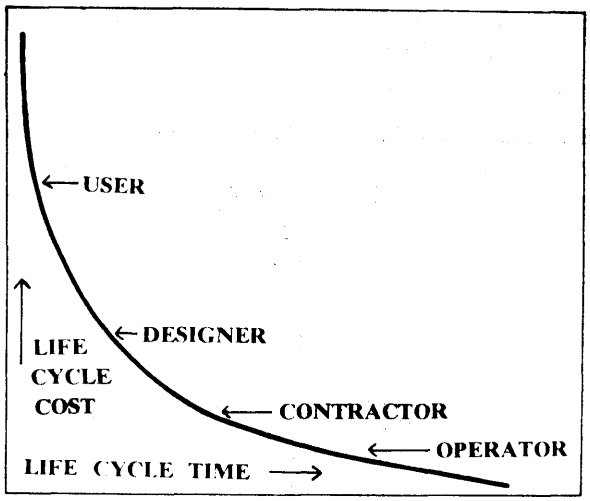

Fig. 13.7. Typical Cost Pattern

Using the VE techniques early in design can drastically reduce the cost of the final product. A good VE Team will challenge the user's criteria, and eliminate those standards and specifications which do nothing to improve performance, but merely add to final cost. A second (and perhaps third) look by a VE team during the design process will provide less expensive alternative approaches to original design concepts. Additionally, efforts aimed at reduction in operations and maintenance costs will always produce good results.

However, because of the lack of experience in the use of these techniques, the usual process for obtaining a new product follows the path indicated below.

At the beginning the user sets a standard so high that cost is phenomenal. The designer takes a pragmatic view of the whole issue and arrives at a design with hopefully moderate cost, but still much higher than would lead to a selling price which the market can bear. The Engineer/Contractor team, using the VE concept, can reduce the cost and, during production maintenance, a fresh VE exercise can effect additional savings. This process is logical, leading to the lowest cost for acceptable quality. It is, however, only a substitute for the full use of VE during the design process.

APPLICATIONS TO PROCESS PLANT

VE technique has been used recently for building industry and construction of process plant including oil refineries (16). Construction industry, although one of the largest in terms of value, is one of the most conservative. The codes are obsolete, there being no change in 25-30 years (23). Although design/engineering constitutes only 5% of a construction contract, the decisions made at this stage affect the total project cost considerably, and it is worth offering an incentive for better and more economical design. Application of VE to construction, through a formalised documentation system (4) can pay rich dividends. VE is invaluable for decision making (20) on major capital projects, including process plants.

The VE concept has been applied (7, 10) to a 1000 ton/day ammonia plant, location : Rotterdam, Time : Nov. 1972. Against a formal enquiry, 3 bids were received. These were fairly competitive and selection was, therefore, not easy. A VE consultant was engaged to facilitate the decision. The analysis established a correlation between the investment cost and hydrogen content of the feedstock :

TABLE 13.5: AMMONIA PLANT — INVESTMENT COST

Feedstock	% H_2 by weight	$ m Erected Cost
Lignite	5	40
Fuel Oil	12.5	31
Naphtha	15	23
Natural gas	25	23

The price of feedstock varies inversely with hydrogen content resulting in near equalization of the production cost. VE went a step further and analysed the possibility of using pure nitrogen instead of air in the synthesis step. This suggestion arose from the fact that in an oxygen plant, nearly pure nitrogen is normally vented to the atmosphere and is therefore available practically free of charge. Adopting this suggestion led to a saving of $ 4m, in investment cost of a natural gas based plant. The production cost in both cases was found to be similar. However, the saving of $ 4m in capital cost was found quite attractive and in the present situation of high interest rate and scarce capital, it could prove decisive.

Another recent application (8) of VE relates to the new mechanical vapour recompression (MVR) system vs the traditional multiple effect evaporator (MEE). Evaporation requires considerable energy, so any means of conserving it is to be welcomed. In case of MEE with 4 effects, the approximate energy required is : 1000/4 = 250 Btu/lb. evaporation. Also, there is the additional energy required for pumping substantial quantities of cooling water, 3 — 6 gals per lb. of evaporation. MVR is a modern concept whereby the first stage vapour is mechanically compressed and used as heating medium in the same stage. The vapour is thus condensed in the evaporator itself and no external condenser is required. The energy requirement is of the order of 30 Btu/lb. evaporated. Due to low overall temperature difference in MVR, surface area is larger and therefore capital cost higher. However, the operational economy of MVR is so high that the extra capital cost is recovered within the first year of operation. For thick viscous solutions, MEE is much more economical than MVR because of the higher temperature difference and therefore, better heat transfer.

Application of VE in this case pointed to combining the two competing systems, MVR for the initial stage and MEE for the final stage. Such a combination appears complex but seems most economical.

One of the biggest problems faced by process plant contractors is to ensure delivery of individual items/equipment in accordance with the construction schedule. A major contractor has a large staff of expeditors who constantly visit (24) their suppliers and also the sub-suppliers in order to expedite, and also to get the correct status at any point of time. In spite of this, delays of 6 months and more in delivery of major equipment are quite common. Such delays are expensive.

If the project time and therefore cost is not carefully controlled, the project may soon become unviable even before it takes off! In Table 12.18 several specific cases, where actual time and cost exceeded the estimate by a factor of 2 or more have been cited. A typical case of cost over-run in the development of a new product is shown (18) below :

TABLE 13.6 : NEW PRODUCT DEVELOPMENT — COST — $ 000

	Years					
	0	1	2	3	4	
Development cost — Estimated	50	70	92	104	108	
Spent	0	12	64	97	108	
Production cost — Estimated	1.4	2.2	2.9	3.7	4.0	(Best Bid 4.2)

Thus the over-run in development cost exceeds 100% and that on production cost by 300%. This is frightening, to say the least. The over-run is due to a combination of :

poor estimate
high inflation
time over-run, and
poor, perhaps no(!), control on cost

Application of VE at the start and during development could have prevented such a "run-away" situation.

The cost-time curve has a minima (Fig. 9.4, Page 106) corresponding to the normal completion time and minimum cost. If, however, for some reasons the project is to be finished in "crashtime", then the cost is considerably higher (26).

Fig. 13.8 shows (23) for a typical project the possible cost reduction due to application of VE and the corresponding cost of change, both as a function of time. It also indicates that VE application during construction has a direct bearing throughout the span of the project, from concept to completion.

BENEFITS — INCENTIVES

General Electric, the first to introduce this concept claimed to have saved $ 200m (29) in 17 years through the application of VE. The U.S. Navy Bureau of Ships saved $ 18m (6) in the very first year of adopting VE. When the concept was accepted and used widely in the Department of Defence, through the initiative of the new secretary, Robert McNamara, the savings in the first 5 years of the programme amounted to $ 14B (2, 15, 16).

With such colossal savings, VE spread like a tidal wave in U.S.A. and its ripples reached Europe in 1960. Dunlop in U.K. were one of the first companies in U.K. to take up VE. Two of Miles Associates left GEC in 1958 to form Value Analysis Inc. in U.S.A. and in 1962 Value Engineering Ltd., U.K.

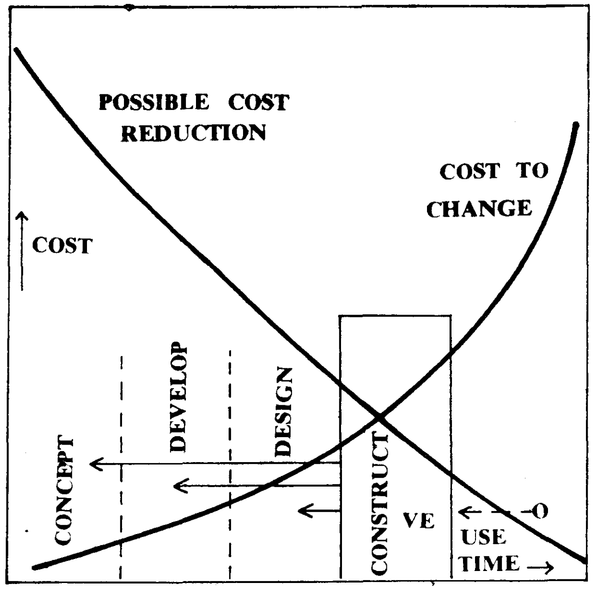

Fig. 13.8. Process Plant Project Execution

A survey of several firms using VE indicated savings of the following order (30) :

TABLE 13.7 : SAVINGS THROUGH VE

Product	**Savings, %**
Consumer	26 — 28
Light Engineering	29 — 32
Heavy Engineering (including capital equipment)	30 — 34

Thus for process plant, one can expect savings of the order of 30% which is quite substantial. For 7 specific case studies ranging from Dunlopillow mattress to sewage tank diffuser, savings ranging from 26% to 69% have been reported (29). As one would expect, high potential savings are associated with low probability of success and vice-versa (Fig. 13.6).

The savings are seldom less than 5%, frequently 10-20% and sometimes over 30% (19, 23).

The acid test, of course, is to calculate the ratio of savings to the cost incurred in effecting these savings. This will vary considerably from case-to-case but as a rough guide :

$$\frac{\text{Savings}}{(\text{Cost of VE} + \text{Cost of Change})} \simeq$$

1-10, normally, **minimum** 3-4 (3) but could be much higher (32). The savings for a mass produced item are obviously higher (15) than for a jobbing item.

(Eqn. 13.3)

Bulk of these savings are on account of material and/or method of manufacture. There is considerable potential, so far largely untapped, in cutting overhead costs, contributing upto 40% of the product cost. As mentioned earlier, a company, may, in a panic situation, cut telephone bill and library budget without realising that these may lead to negative results! Only a disciplined and methodical application of VE can help.

The savings indicated above are the direct and measured one. In addition, there are indirect and intangible savings/benefits — which, if they could be quantified, may exceed the direct savings. VE can improve the entire climate and attitude in an organisation. Being essentially a team effort, it leads to better :

Communications	Human relations and
Understanding	Co-operation.

These are more vital and, although difficult to measure, they are bound to improve the balance sheet of the company. And these benefits are only a by-product!

How to encourage suppliers to use VE? Here purchasing department has an important role to play. Suppliers can be asked formally or informally to use VE and given the incentive of either more business or final order without competitive tendering (1). A formal incentive clause (2) is desirable, especially for major contracts. In general, fixed price contracts offer maximum potential for VE both for savings as also for incentives. The scope is much less (14) for cost-plus contracts. The savings could be shared with the contractor in the proportion of 10 : 90 for a cost-plus contract to 50 : 50 or even 75 : 25 for a lump-sum contract. Such attractive incentives make use of VE by a contractor almost imperative.

BEWARE

VE is NOT an answer to all problems. It cannot be! The programme was perhaps oversold (29) in Britain in the earlier stages. Some VE programmes have failed (3) because of :

Overselling; Insufficient top management involvement; Wrong emphasis — on price rather than value and Novelty wearing off

In addition, there are, in every organisation, "doubting Thomases" to say (13) :

Our work is different; It wont work; We've tried it before; We are doing well, why change? and Union won't accept it

The list is almost endless! According to Kettering (29) whenever a new idea is proposed, 999 out of 1000 people will give the proposer all the reasons why the idea wo'nt work! In sharp contrast, the creative approach is, "Lets find at **least** one good reason why it **can** be done."

CONCLUSION

VE is not a panacea to all ills. Nor is it a cost reduction technique in the normal sense. Normal techniques "clip costs" whereas VE "blasts costs". VE is for champions!

It is a disciplined and organized team-work approach to analyze the **function** of an item/product through a brainstorming session to determine various alternatives to meet that function. The alternatives are then examined for cost to see which provides the best **value**. Emphasis is on function and value, rather than on the item and its cost.

In case of a new product, VE introduces the creative concept of "design-to-cost" instead of the conventional "cost-the-design", the cost being derived from the price at which a product can be sold. Applications of VE to process plant industry to reduce and control cost are described.

As often in history, many a valuable concept goes unnoticed either by default or by virtue of their being too far ahead of their time. The industrial world has lost much due to such lapses.

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