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VALUE ENGINEERING: AN EXECUTIVE OVERVIEW

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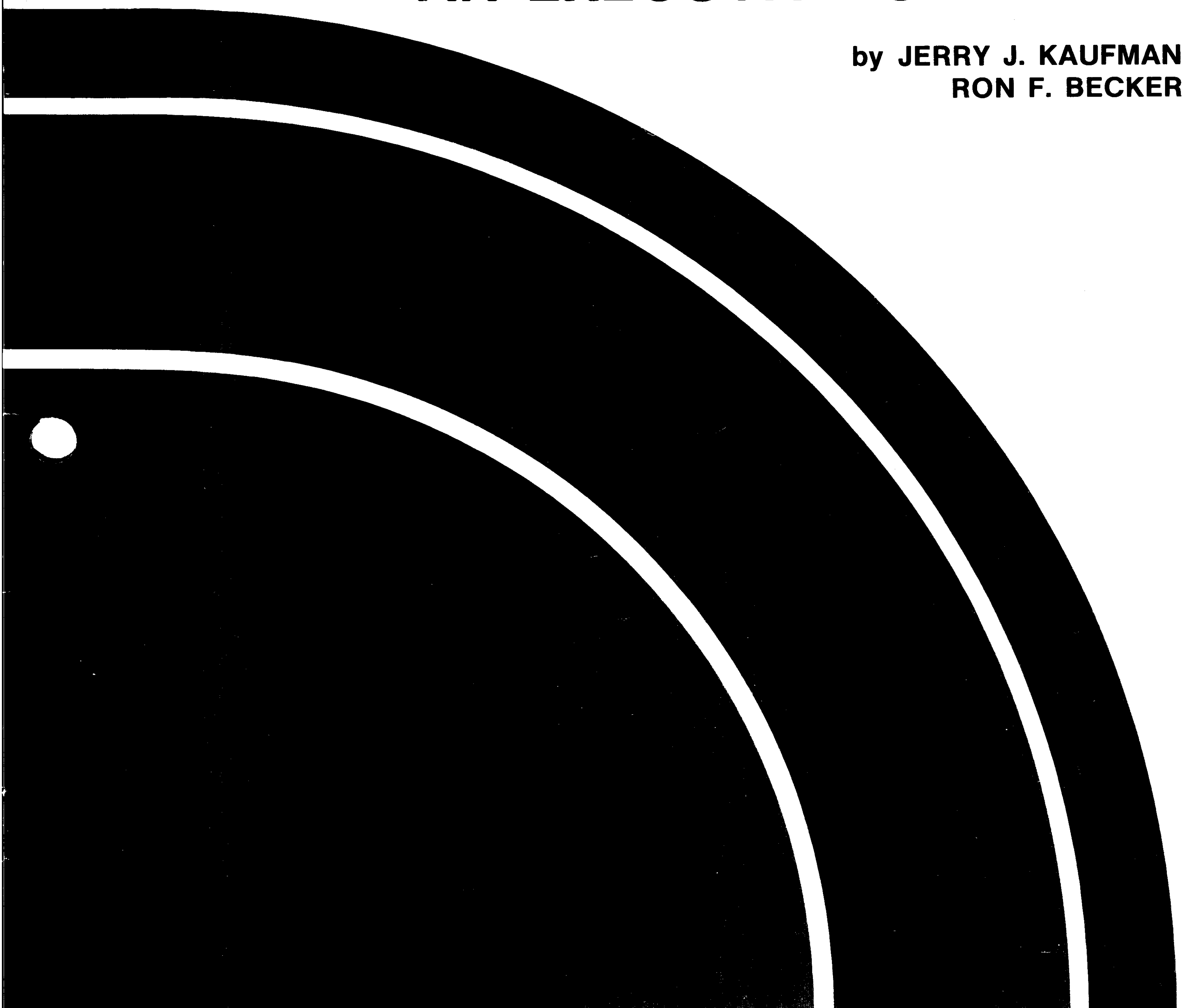

COOPER INDUSTRIES

VALUE PROGRAMS

VALUE PROGRAMS
AN EXECUTIVE OVERVIEW

INTRODUCTION

The need for Value Programs is more obvious when product costs are in trouble than when things are going good. Good by what standard, the competition? Without our changing anything, we could go from good to poor by the competition changing the base line. Are we truly responsive to the customer's needs or do we have features he pays for but doesn't need or needs features we don't furnish? Have we investigated a range of alternative ways to satisfy the market needs and selected the one that is the least costly or are we producing 'pet' ideas? Do we know what our products and product features cost or are they buried in a lump-sum total? If there is room for improvement, it is better for us to find it before the competition does.

Value Engineering has a fundamental difference from the more traditional approaches to design, cost reduction, industrial engineering, and production engineering. The key difference is that Value Engineering is a deliberate effort to identify and select the lowest cost method, from many alternative methods, to satisfy the proper functional needs. A single idea that is generated resulting in a lower cost to meet a design requirement is not Value Engineering. Although the idea probably represents better value, there was no attempt to determine whether the idea represents the *best* value from a selection of alternatives or whether the design requirement being satisfied represents the real problem. It is within this context that Value Engineering adds another dimension to good engineering.

Value Engineering utilizes a fundamental methodology and, as such, is applicable to a broad range of disciplines. Value Engineering has been applied to systems, equipment, facilities, procedures, methods, software, and support services. A value engineer is a specialist in the principles and applications of the value engineering methodology. The technical aspects of the problem under study are generally provided by those knowledgeable in the specific disciplines involved. The value engineer requires a high degree of interaction with others.

The benefits to be realized in having a Value Program are: the contributions to the goals of the profit plan; the development and building of teams to problem solve; the ability to apply creative thinking in daily job performance.

VALUE ENGINEERING DEFINED

Value Engineering is defined as:

an organized effort directed at analyzing the functions of goods or services to achieve those necessary functions and essential characteristics in the most profitable manner.

The key items in this definition are:

an organized effort . . . — Value Engineering utilizes a methodology that was developed for problem-solving over 30 years ago.

. . . analyzing and achieving necessary functions . . . a deliberate effort to identify what is being furnished and what the market needs, as opposed to perceived wants. The element interfaces engineering and marketing to define the priority requirements from the point of view of the customer, and includes the target selling price.

. . . and essential characteristics . . . in addition to achieving the product functions, other requirements must be satisfied such as reliability, maintainability and quality.

. . . in the most profitable manner . . . the cost is determined by generating and evaluating a range of alternatives including new concepts, reconfiguration, eliminating or combining items, and process or procedure changes. This also considers the operation and maintenance of the product over its normal life expectancy — the cost of ownership. These elements interface engineering with manufacturing.

The end results must satisfy the intended business purpose such as timeliness of development compatibility with other product lines, resources, market share, growth and after market. The disciplines of marketing, engineering and manufacturing, as well as other supporting disciplines, working together maintain a focus on the requirements, design and cost, as seen from the customers' sense of value.

THE VALUE ENGINEERING METHODOLOGY

The methodology, or procedure, used in Value Engineering parallels the procedure developed for problem solving, as illustrated in Figure 1.

These procedures utilize the principle of divergent thinking in the initial steps to expand the scope of thinking on the problem and for the generation of potential solutions. The later stages utilize the principles of convergent thinking to focus on the selection of a solution. Techniques are utilized to encourage the application of these principles. Some of the techniques used by trained value engineers are:

Divergent
- Brainstorming
- Function Analysis System Technique (FAST)
- Matrix
- Morphological

Convergent
- Rank and Weight
- Gut Feel Index (GFI)
- Numerical Function Evaluation

The techniques and the procedures used in Value Engineering are adaptable to new and existing products, complex assemblies and simple components, hardware and software projects.

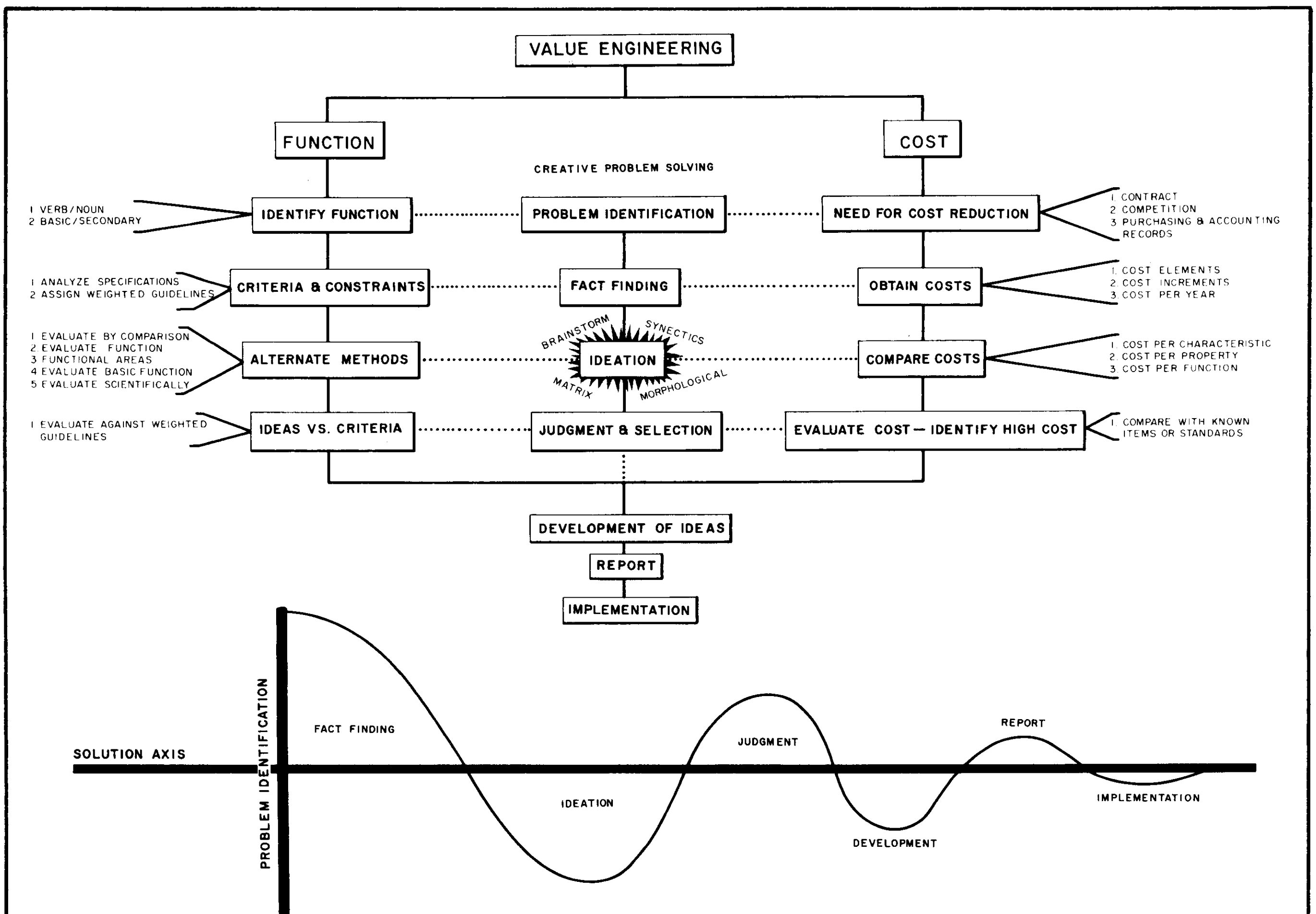

Figure 1

VALUE IS THE RELATIONSHIP OF FUNCTION TO COST

The objective in Value Engineering is to achieve the required function of a product, process, or service at the lowest cost of ownership. If the efforts of a value engineering study do not result in providing a useful solution to a problem, then the results of the efforts are of little value. Also, if the efforts provide a useful solution but costs more than the user is willing to pay, then again the results of the efforts are of little value. The value, then, can be improved by increasing the relationship of the usefulness of the solution to the cost of the product, process, or service, and is expressed by the relationship; *value equals function divided by cost.*

The usefulness of a solution will vary from person to person depending on the need and desire for ownership. Whether a solution is useful in relation to the cost is a value judgment by an individual, or a collective judgment by a group of persons, based on the prevailing circumstances at the time. In order to be *worth* something to the user, the item must satisfy some functional need or desire. In some cases the user defines the problem or provides the requirements that the solution must satisfy, such as designing to customer specifications. In other cases the users' needs are not defined by the user but are interpreted by a market research, such as when an item is developed for the consumer market. In either case, the value engineer is concerned with identifying the least cost method of providing the required function. If a currently available item exceeds the cost of another identified method of providing the same function, then the currently available item does not represent the greatest value.

From the above relationship, it can be seen that value can be increased by favorably influencing function and/or cost. The following illustrates the various combinations of influencing value; some are favorable, some are unfavorable. See Figure 2.

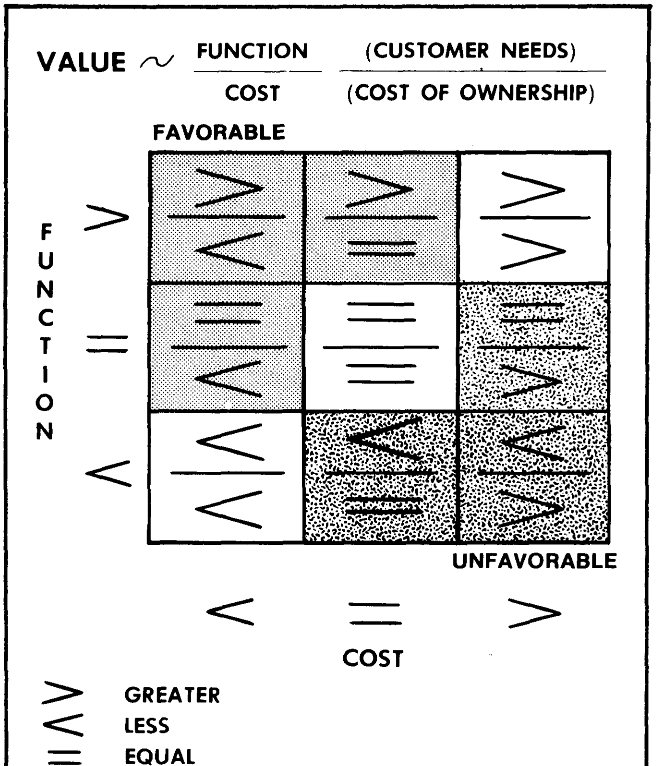

Figure 2

The most desirable relationship is to provide greater functions at less cost. (upper left box)

The cost, as used in this relationship, is the cost of ownership and includes not only the selling price but also the subsequent costs to the customer in operating and maintaining the item. It should be recognized that operation and maintenance costs can be significant over a period of time and must be considered in the value relationship when appropriate.

However, to simplify this discussion, the operational costs will be ignored and only the selling price, or acquisition cost, will be used to explain Value Disciplines.

THE CUSTOMER DETERMINES REQUIREMENTS

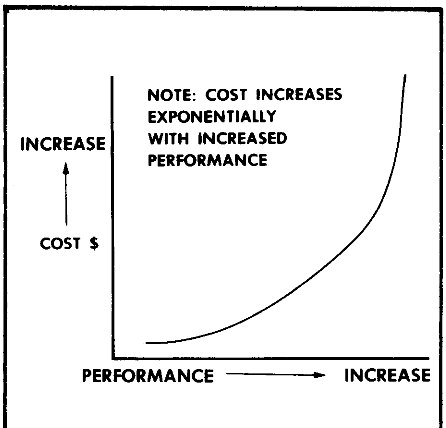

Figure 3

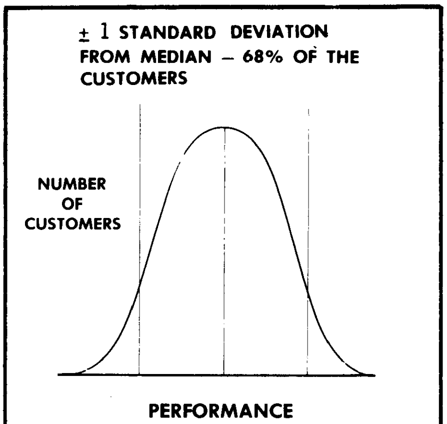

Figure 4

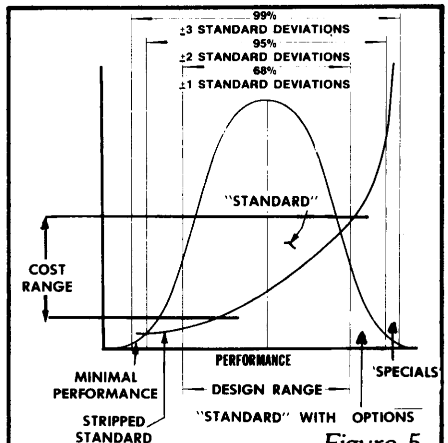

Figure 5

From the majority of customers comprising a market segment, the requirements for a 'standard' product offering can be determined. A single customer, or a small group of customers, determines the requirements for a 'special' product. It is not always easy to distinguish between the standard and special or to separate the needs from wants and translate these into product specifications. Marketing has the mission to anticipate, interpret, analyze, evaluate and predict these needs, as well as determine the market in terms of size, growth, share and timely opportunity.

In a Value Engineering study, Marketing is an indispensable member of the team to help maintain a focus on the value of the product offering as determined by the market segment being addressed. This focus is important when considering the relationship of performance to cost as shown in Figure 3.

The determination between a 'standard' product and a 'special' product is not always a definitive line. There is generally a transition between the standard and the special. If a survey were conducted to identify the needs of the universe of customers, the normal distribution would follow a bell curve as shown in Figure 4.

This curve indicates that statistically 68% of the customers will be clustered around the mean performance requirements.

Superimposing these two curves will indicate the importance of identifying customer requirements as in Figure 5.

By maintaining an awareness of these relationships, the value engineering team designs to the requirements of the market segment being addressed for a target price that those customers are willing to accept. If the market segment is for 'specials', then the cost is not as critical a factor as for the 'standard' product line where extreme performance, and associated high costs, should be avoided. Standard products tend to be more price sensitive than specials. The transition from standard to special can often be made by offering standard options that the customer may select. The value team addresses the problem of determining the requirements for a standard product and what to include as option — all other performances become specials.

COST AS A DESIGN REQUIREMENT DESIGN-TO-COST

Market data defining customer requirements includes an estimate of the purchase price that is acceptable to the customers for the performance required. Referring to the value relationship of function to cost, the cost data used is the cost of ownership and, for the purposes of this discussion, is the same as selling price as earlier stated. In the development of a new product or the re-design of an existing product, the resulting design must be producible at a cost that will permit selling at the target price. In Design-To-Cost (DTC), this target cost is a design requirement just as any other requirement of the design. A target production cost is established from a target selling price.

The selling price is established in support of the mid and long term sales plan, and includes cost elements that are not directly influenced by the design — profit, taxes, corporate expenses, market and selling expenses. The cost elements that are directly influenced by a design are the inventory costs consisting of direct labor, burden and direct material. All cost elements are in some way effected by the design but inventory cost is immediately visible to the designer for assessing the economic consequences of his design decision. The cost elements used in this discussion are those that make up inventory costs. A simplified version of the cost elements are displayed in Figure 6.

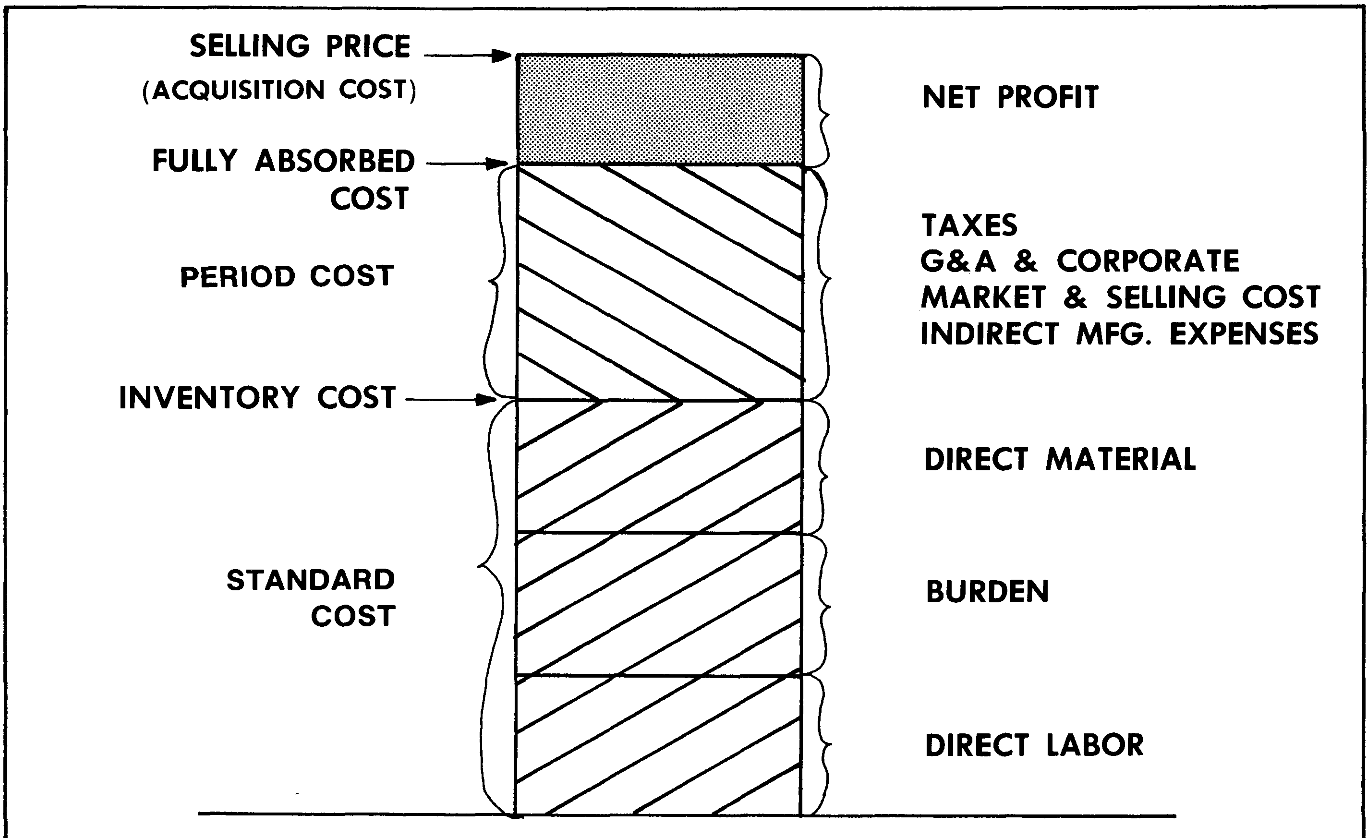

Figure 6

In the divisional profit plans, the inventory cost as a percent of sales is one of the specified goals. Using this data as a Cost-to-Price Ratio (CPR), a target inventory cost can be established as a percent or ratio of the target selling price. (Example — Target selling price is $1,000, target CPR is .55.)

$$\text{Target Cost} = \text{Selling Price} \times \text{CPR}$$

$$= \$1{,}000 \times .55$$

$$= \$550$$

Just as various performance criteria become design requirements, cost is also considered as a design requirement in Value Engineering. Product cost is significantly influenced by the designer's approach to achieve the required functions. Traditionally, engineers design to the upper end of the performance requirements. Then it is up to Marketing and Sales to live with the resulting cost and price to move the product. In Value Engineering, where cost is a visible design requirement, the cost and performance are subject to trade-off considerations. Should the Value Engineering effort result in not meeting the cost or performance targets, options can be considered along with the effect on sales: the performance could be met at a higher cost; the cost could be met if the performance requirements were reduced; or a lesser adjustment could be made to both. Another important option is to discontinue the development if the cost or performance

MORTALITY OF NEW PRODUCT IDEAS
(By Stage of Evolution ● 51 Companies)

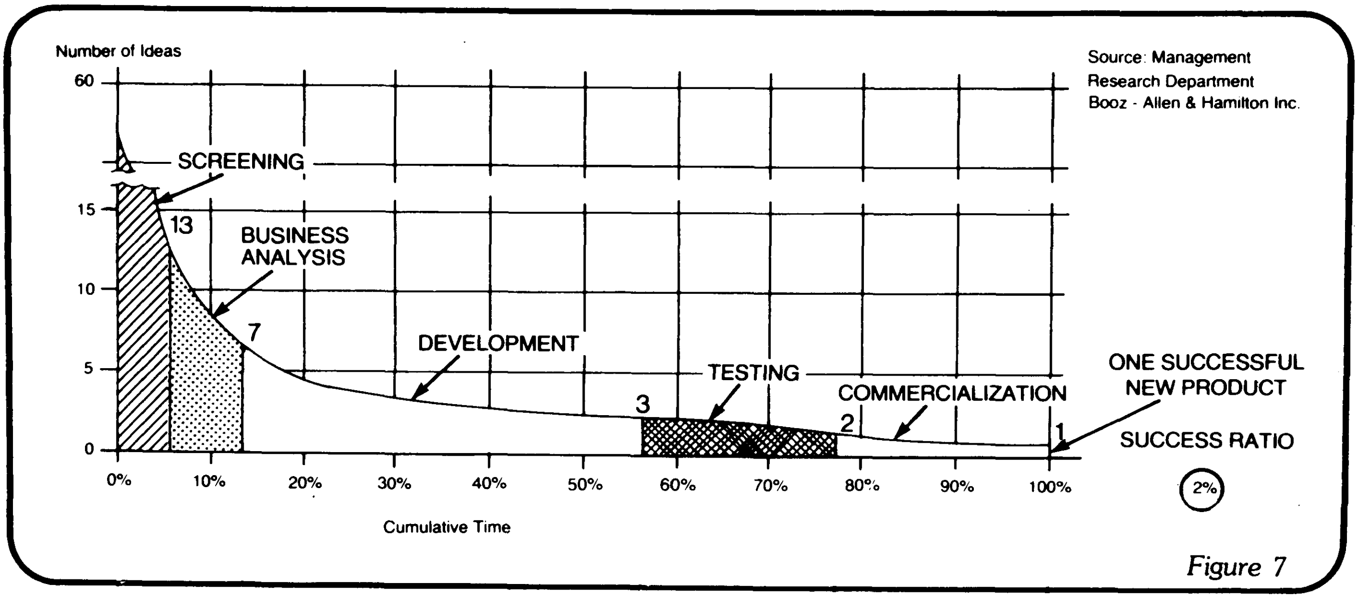

Figure 7

cannot be met. Having early visibility of high estimated production cost permits discontinuing the project or re-evaluating the requirements before significant 'sunk' costs are committed. A late discovery of not meeting the target cost results either in a higher loss of expended funds or, worse, a painful decision to continue the project because too much has been expended to discontinue now, with an unfounded hope of recovering some of the investment later on.

Figure 7 is a curve showing the typical mortality rate of new product development. The utilization of the concepts of Value Programs can influence this curve beneficially in two manners. The success ratio can be increased above the 2% level by a greater responsiveness to the needs of the customer or, the cost of the unsuccessful products can be reduced by early detection of costs greater than the CPR can support.

The trade-off options, illustrated in Figure 8, shown that the target cost and the target performance have a theoretical tolerance range. The target point on the cost/performance curve can 'float' within the tolerance zone and still be acceptable. However, this tolerance must be realistic and established when cost and performance targets are made and not arbitrarily established to justify results.

Generally a Value Engineering effort will result in meeting both cost and performance requirements. Meeting a cost target is just as much a challenge as meeting the performance target. An awareness of the impact that design decisions have on the cost and a cost

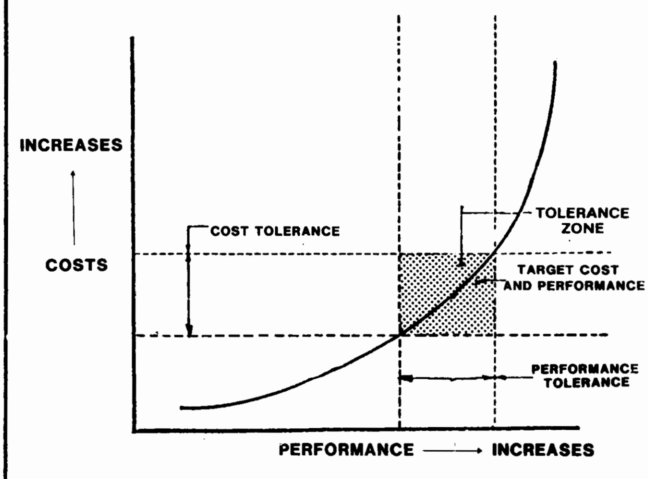

Figure 8

target to work toward encourages that extra effort to meet the design-to-cost target.

The estimated cost of a design is made by Manufacturing and, in effect, is a commitment by Manufacturing that the design can be produced for that cost.

Just as the Value Engineering team works with Marketing to define cost and performance requirements for the market segment, Manufacturing is part of the team to assure the design reflects the lowest cost manufacturing methods. In the early phases of the design where many concepts are being considered, detailed cost estimates are not required. Generally relative costs or parametric cost guides are sufficient to screen concepts — one design is judged by Engineering to be greater or lesser cost than another during the iterative phase of design development. Only after the concepts have been reduced to several competitive candidates is a detailed cost estimate performed by Manufacturing — sufficient to indicate whether the cost target might be met.

VALUE ENGINEERING IS A MULTIDISCIPLINARY EFFORT

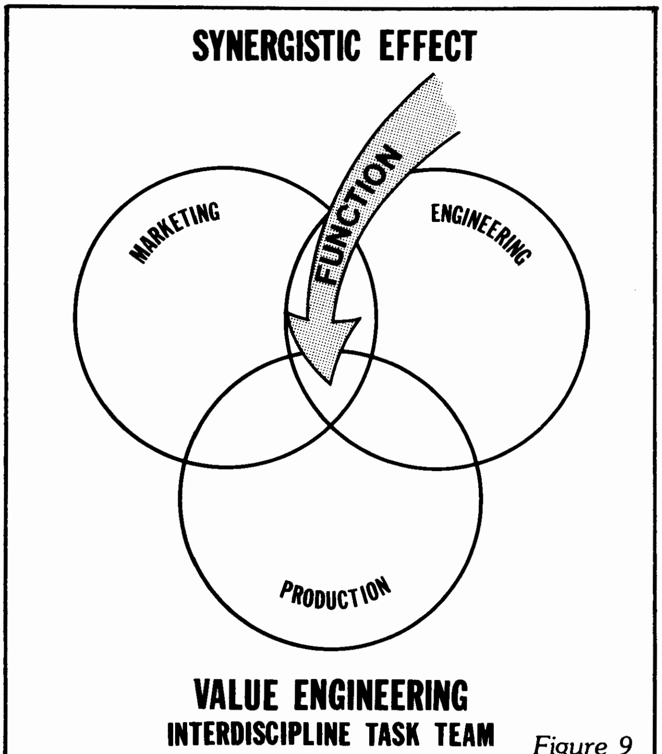

Figure 9

As previously described, Value Engineering utilizes Marketing to define the customer requirements (including price), Engineering to define the product, and Manufacturing to define the production process within the cost target. Other expert resources are used to further fine tune the product: Purchasing, Sales, Finance, Quality Control. The participation of these disciplines improves the communication and understanding of the input requirements and the output of the product. As each discipline considers the product through their technical filter working as a team, problems are

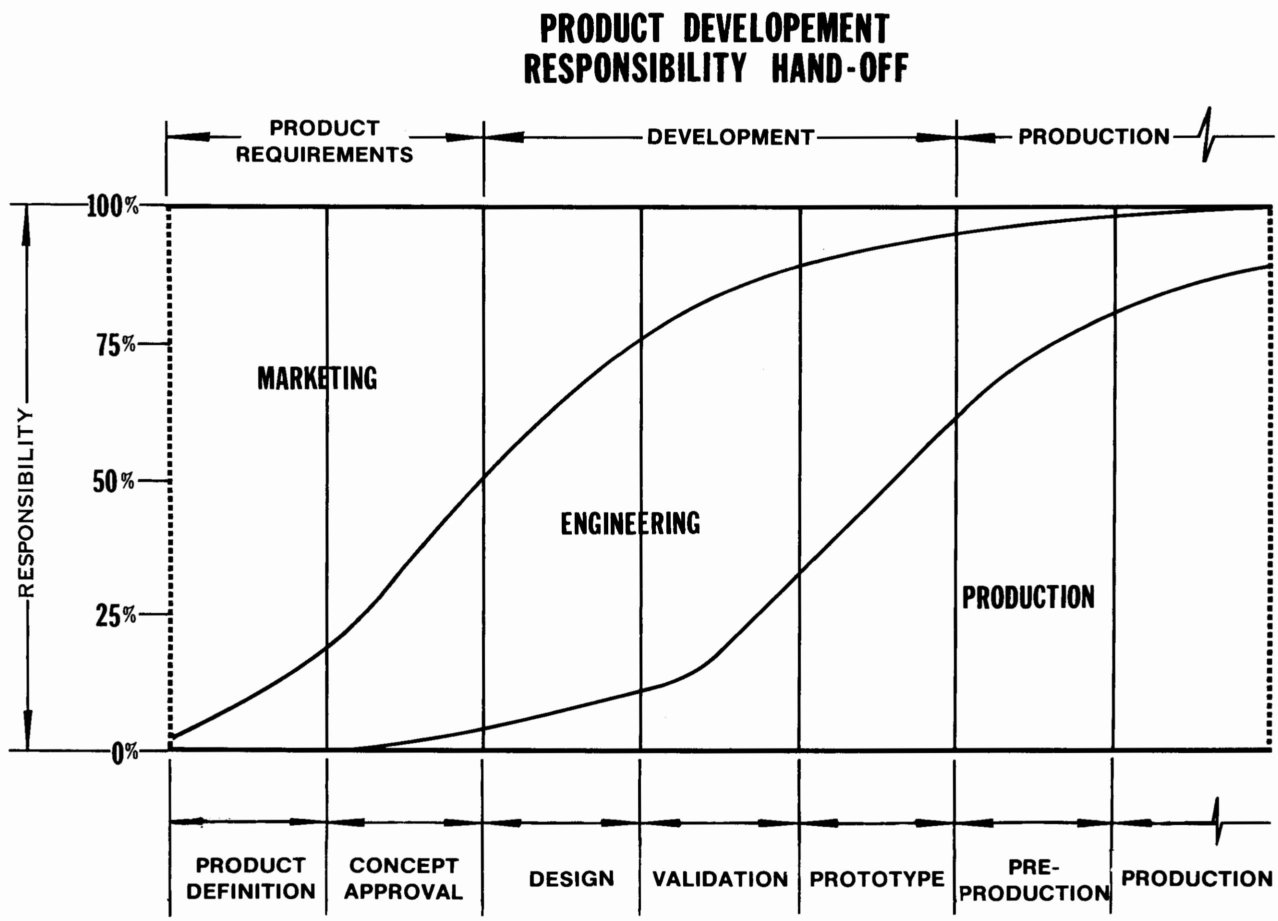

Figure 10

surfaced and resolved. Working independently, the resolution of one discipline becomes the problem of another discipline. The involvement of key disciplines has a synergistic effect such that the results of the team working together is greater than the sum of the results by working independently. See Figure 9.

The multidisciplinary team also permits an orderly transition of responsibility during the evolution of the product. Figure 10 illustrates how the responsibility for product development is transferred with a multidisciplinary team.

It should be noted that these disciplines are involved before and after the responsibility changes hands. Product development requires a constant feedback to assure all decisions remain on track and in focus. The Value Engineer team leader assures that the team remains focused and coordinated throughout the effort.

POTENTIAL SAVINGS FROM VALUE ENGINEERING EFFORT

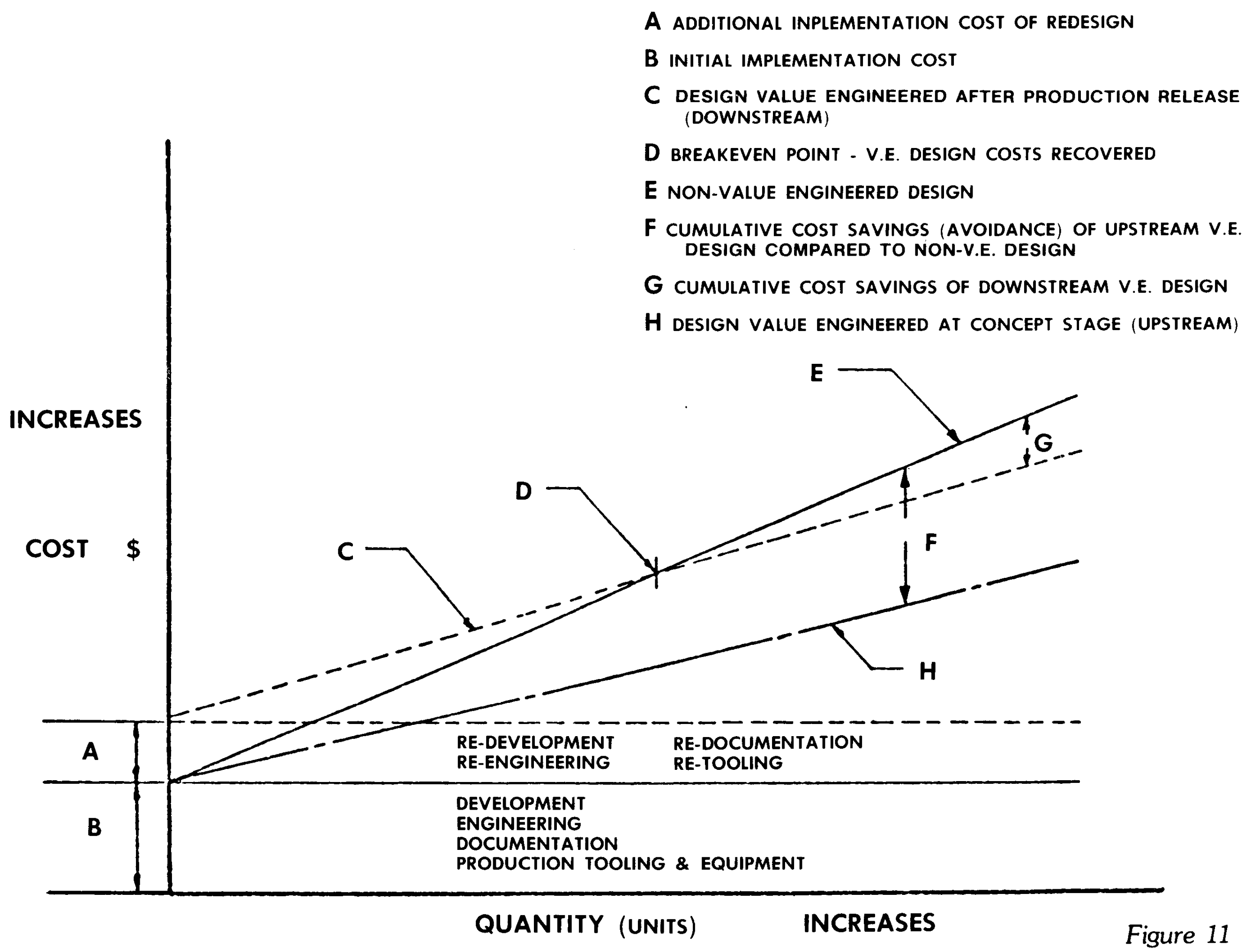

Figure 11

VALUE ENGINEERING OF NEW AND EXISTING PRODUCTS

The techniques used in Value Engineering involve a search and evaluation of alternative ways to meet the required performance at the lowest cost. The alternatives available for consideration are greater in a new product (upstream value engineering) than for an existing product (downstream value engineering). Existing products will generally have design constraints imposed such as the changed items must interface with non-changed items. Existing products will generally have cost constraints such as scraping or modifying existing inventory, existing documentation, existing tools and fixtures, and existing sales literature.

New product development not only has fewer constraints on the Value Engineering effort, but also assures that the cost benefits occur in the initial production. The break even point for the return on the investment of a value engineered new product is generally far more favorable than the break even point of a non-value engineered product placed into production and then value engineered later. This relationship is displayed in the potential saving curve. See Figure 11.

Although there is a better pay back for value engineering new products, the value engineered cost reduction of existing products must not be ignored. These products have an existing market, the product cost and performance problems are visible and the customer requirements are better defined. Cost reduction of existing products requires constant attention to keep up to date with the changing needs of the market, and to utilize the advances in design and manufacturing technology.

There is a tendency to expend more value engineering effort on cost reduction projects than on new products because the *before* and *after* cost differences are easier to quantify. The fact that cost 'savings', or cost avoidances, cannot be quantified for new products should not cause a reduction in these efforts. The emphasis for Value Engineering should address the market and profit plan and not the availability of cost accounting data.

DETERMINING CANDIDATE PRODUCTS FOR VALUE ENGINEERING

In order to achieve the greatest return for the value engineering effort it is necessary to determine which existing products would offer the greatest potential for a value engineering study (Value Opportunity Potential — VOP). The VOP is determined by multiplying the annual sales by the difference between the current CPR (Cost-to-Price Ratio) and the target CPR. This method considers the difference between actual and target cost and the magnitude of the sales.

A further analysis is performed, using the data available in the business plan, to determine which products are in a growing or declining market; what our share of that market is; and what the forecast of that market is. Utilizing the results of the Boston Consulting Group on product portfolio management (CASH COW, STAR, WILDCAT, DOG), the percent market growth (decline) and the ratio of our sales to that of the largest competitor is plotted on a four quadrant grid. See Figure 12.

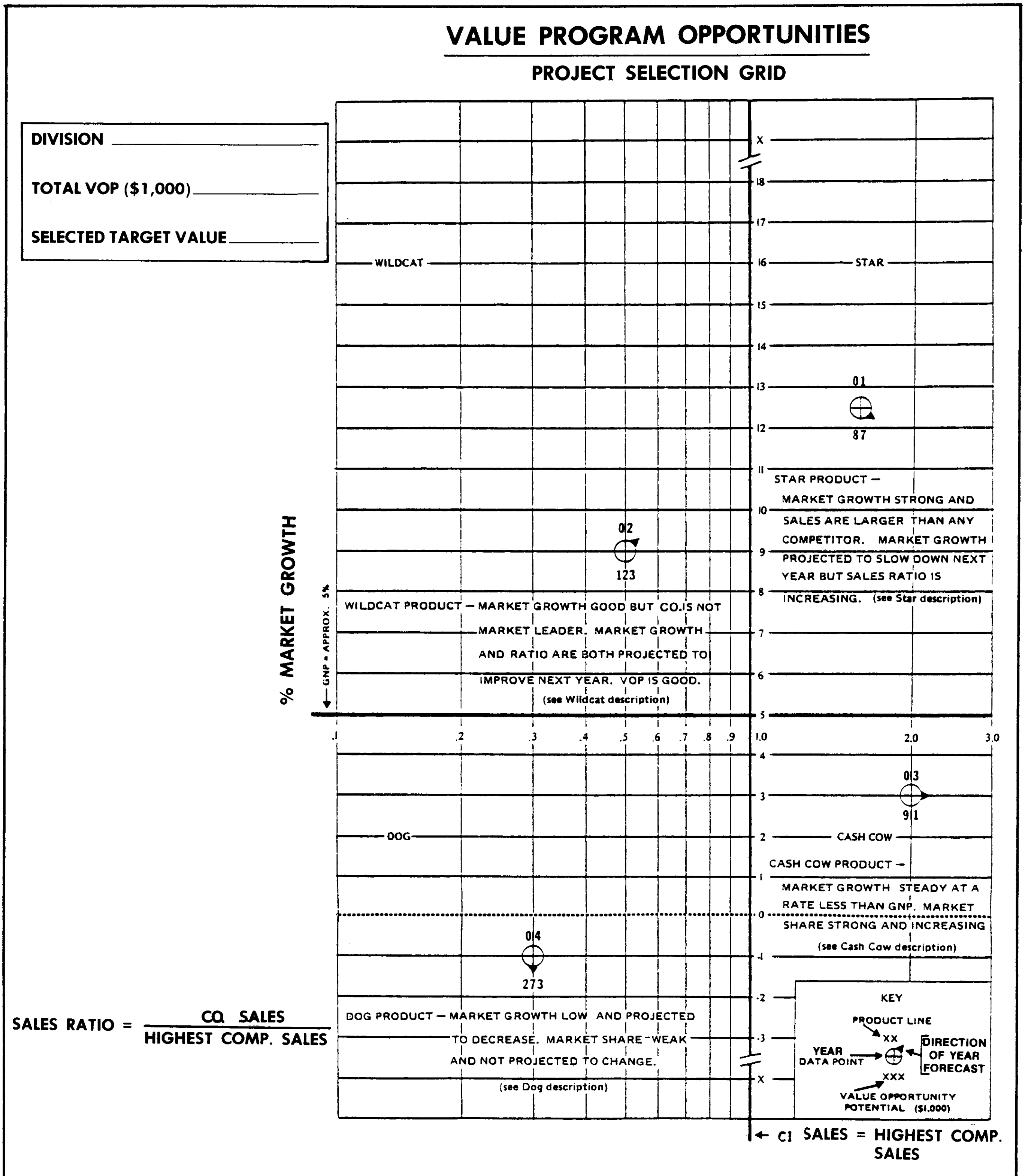

Figure 12

The top and bottom halves in the illustration, are determined by a line representing the annual real growth of the Gross National Product — approximately 5%. The right and left halves are determined by a line representing a market share ratio of '1' (our sales equal to that of the largest competitor).

For each of the plotted products, the VOP value is posted and the direction the plotted point is projected to move in the forecast year is indicated. This grid provides visibility as to where the product is in the market, where it is expected to go, what the potential is for reducing cost. This is merely a data display so the manager of the profit center can apply seasoned judgment in selecting those products that will be studied for value improvement.

The following describe the general strategy and considerations in selecting the project:

STAR — We are the market leader (sales ratio greater than '1') and the market is growing at a rate greater than the gross national product (GNP is 5% in this example). Strategy is to increase market share even at the sacrifice of profits. A reduction in price or an increase of useful features is desirable in order to discourage competitor growth. A high CPR is not necessarily undesirable depending on the reason for the high ratio. If the price has already been reduced to discourage competition, the high CPR may be acceptable. If the price and features are essentially the same as the competition, then the cost is probably excessive. A Value Engineering effort directed at reducing the cost so the price can be reduced to less than the competition is a strategy that should be considered. Reducing the cost and price may still result in a high CPR but would be for strategic purposes. Another strategy consideration is to reduce cost, retain current price, and increase marketing and sales efforts within the budget of the newly available funds.

CASH COW — Low growth potential and strong market share. These are generally mature products that are solid cash generators. A high CPR may be a problem of low price rather than high cost (these products generally evolve from the STAR quadrant where prices may have been lowered). Products in this quadrant should limit the value effort to low-cost implementation, such as producibility type of cost reductions, or highly visible external changes that improve function or esteem value and will permit an increase in price. Major redesign, unless the market is expected to increase growth, should be avoided and the desired CPR can be achieved by some cost reduction and some price increase. The cash generated from these products is used to finance the growth of WILDCAT products.

WILDCAT — Good growth potential and weak market share. Our WILDCAT product is someone else's STAR product. These products need careful study to determine whether the market is looking for a market leader or whether the market has determined a leader. The weak market position generally indicates price, design or availability as a problem. However, the problem could be non-cost related, such as impaired delivery, which would be the primary consideration for a value study project.

A high CPR should only be reduced by a reduction in cost — an increase of price may further weaken market position. A seasoned judgment should be made whether a Value Program effort will result in moving this into the STAR quadrant or whether the market leader is strong enough to further reduce price to discourage competition. Consideration should be given to how close we are to the leader, our Value Opportunity Potential and the direction our strength in the market has been going during the past several years. The most promising candidates are those that can be moved into the STAR quadrant. The least promising may be candidates for dropping.

DOG — Weak market growth and weak market position. This is the worst of both worlds, and, except for extenuating circumstances, are not recommended as value program candidates. Extenuating circumstances would include a market turn-around beyond the next year forecast or a technology breakthrough that may stimulate the market. Justification for keeping this product may be to use it as an entry into other products with higher pay-back. However, any return on an investment in Value Engineering for this area is doubtful.