

APPLYING MANAGEMENT PRINCIPLES TO THE QUEST FOR VALUE

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PLAN OF ATTACK

Continuing profit and a fair return on investment are industry's prime movers in the quest for value. Modern industry is primarily concerned with economic values, the most important of which is the value of a company's product in the eyes of its customers. This is the sense in which the word value will be used in the ensuing discussion, and the word product will be used in the sense of either product or service.

Today's military and commercial competition, both among nations and within each nation, has compelled industry to supplant its intuitive approach to value with a number of scientific methods for the analysis of value. Initially some of these methods sought to increase value by working on the cost component alone. When it became evident that only those improvements *which the customer liked* could yield real dollar gains, value analysis began working on *both* the worth and cost components of value.

In its present form value analysis does not compete with management's traditional tools for contributing value. Its function can be compared to the function of the turret in a turret lathe. The turret sequences the use of existing tools, placing the proper tool at the right time, and in the best position, so that each tool contributes most effectively to the desired result.

The function of the value specialist himself is to provide commensurable units and standard scales for the comparison of product worth with product cost, to schedule the timely participation of the diverse skills which contribute to product value, and to motivate the effective interaction of the departments concerned. Fruitfully bringing diverse skills to bear at the key decision points in the life of a product, identifying and reconciling differences in interests, and appealing to common motives constitute a management strategy.

The Strategy

As Sun Tzu, Marshal Saxe, and von Clausewitz have shown, strategy follows definite principles. To derive general principles from the day-to-day workings of a successful value program, one must first of all schedule some time for thinking, for analyzing the operation of the value program itself. This study reveals certain courses of action that consistently yield favorable outcomes, for example:

A combination of the various disciplines in a value analysis task group invariably yields greater results than the work of a similar group representing only one or two disciplines. Each member of the group works at his own specialty with-

out having to guess the effect of his suggestions on the specialties of the others—they are there to tell him. And he contributes fresh, uninhibited ideas to the thinking of the others just as they do to his own thinking. This yields something else—emotional detachment. Here we have two principles involved: the Principle of Balance and Proportion, as applied to the contributing disciplines, and the Principle of Objectivity as applied to the emotional detachment of the neutral team members whose particular specialty is not being discussed at any one time.

The Principles

Certain management principles have proved remarkably useful in the quest for value. They are listed here in their usual sequence of application in value analysis work.

- Direction
- Selectivity
- Objectivity
- Responsibility
- Direct Motivation
- Effective Communication
- Interaction of Skills
- Adequate Information
- Function and Performance
- Balance and Proportion

THE PRINCIPLE OF DIRECTION

***And all I ask is a tall ship
and a star to steer her by.***

—John Masefield

Direction is defined as "guidance or supervision of action or conduct." This guidance, however, is dependent on direction in the broad sense of setting a course. Before setting a course, the line executive has to decide where he wants to go. He can then guide his subordinates in the right direction. The value analyst has a more subtle task. Before he can persuade his equals and convince his superiors to follow a given path, he must show them that the proposed path leads to their goals as well as to his own. He must then offer decision rules that will in each case lead to the common goals.

In the quest for value, decisions have to be made at many a crossroad. Such decisions of direction cannot be handled by problem-solving techniques alone. Problem solving is useful later when problems appear—if indeed they *are* problems. But before techniques for solving problems and for exploiting opportunity can provide the right answers, the right questions have to be asked.

Raphael, the healing archangel in the Apocrypha, cuts through the fuzzy thinking of Tobit with the question, "Do you want a tribe or a family, or a hired man to go with your son?"

The archangel's impatience is understandable, because if ever a celestial agent was sent down to earth with clear directions and well-defined objectives, it was Raphael in the Book of Tobit. The archangel must have been asking the right questions from the beginning, for his mission was successful. One of the reasons for this success is that Raphael knew his destination, understood his goals, and defined his objectives *before* he set out to solve problems and exploit opportunities. He knew where he was going!

The Principle of Direction, in the quest for value, is as simple as that. Before we begin building bridges or digging tunnels, we should know where we are going, and why. Applying the Principle of Direction relates the value program to the goals of the company, establishes specific objectives for the task groups, and shows the participants how to reconcile personal, departmental, and company objectives.

In summary: *Before* we can recognize opportunity, appraise risk, and identify problems, we must *determine direction, set goals, and define objectives.*

THE PRINCIPLE OF SELECTIVITY

There is a subtle difference in meaning between the words *selection* and *selectivity*. *Selection* means choosing one or more from a larger group of options. Akin to *choice*, *selection* is the final *step* in the decision process. *Selectivity*, on the other hand, refers to a systematic *policy* of selection. Solomon applied the principle of selectivity in fortifying the hills of the Negev, in the location of his copper smelters, and undoubtedly in family life with his 300 wives and 700 concubines.

The principle of selectivity in value analysis is applied by appraising the resources available for a given task and then selecting the area where these skills will return highest yield.

The following criteria for selecting products to be analyzed have proved their worth in practice.

- Probability of Implementation
- Availability of Information
- Timeliness
- Potential Yield

The selection should be made in a planning conference between the value specialists and the highest level of management having direct product responsibility. This usually means the division general manager and his staff in a large corporation, or the president and his staff in a small company. Tomorrow's products and the lead products of today's line offer the highest reward for the effort.

Once products have been selected for analysis by a task group, the team to which each product is assigned applies the Principle of Selectivity by concentrating its efforts on the area where that team's particular skills promise the greatest yield for the time, information, and test facilities available.

THE PRINCIPLE OF OBJECTIVITY

Sometimes we feel like shouting, "Get your head out of the sand!" This is really an unreasonable request. Keeping the head in the sand generates a certain measure of tranquility which makes an ostrich's last moments happy until the

hunter reaches him. Who are we to say to the ostrich, "You are sacrificing long range goals for the sake of feeling good now. Stop this self deception. Look at the facts calmly and objectively!"

The truth is that we cannot re-design people or ostriches to be more objective, but we can *combine* them so that biases balance-out generating a greater measure of group objectivity. For this reason it is customary to include in the value group representatives of the required skills who are not themselves emotionally involved with the product. The result is a broad look at the consequences of a recommendation in terms of group welfare as well as individual welfare, in terms of company gain as well as departmental advantage.

THE PRINCIPLE OF RESPONSIBILITY

The word *authority* comes from the Latin *auctor* which means *doer*, hence the close connection with the word *responsibility* which comes from *responsum*, meaning *answer*. A man answers for his acts. Now how can a man answer for his acts if someone is "helping" him against his will?

This problem must be faced sooner or later by every supporting function. In the allocation of tasks to the members of any team or organization one of the men is given the task of calling the shots. He may be the quarterback, the skipper, the company commander, or the symphony conductor. His job is to direct the activities of others.

The smoothest, fastest, and simplest way to operate a value task group is to identify the man in charge, the man responsible at each key decision point in the life of the product, and to go to work for that man. Most decisions involve risk. Risk calls for judgment and courage. We must not fall into the trap of showing great courage when someone else is taking the risk.

For the same reason, the gains in product worth and savings in product cost should always be credited to the risk taker.

In general, the decision-maker can be identified by reviewing in your mind's eye all the people who influence product value at any particular moment. You will see a hemp rope around the neck of one of them. He is the one who hangs if things go wrong. He should be your chief source of information, and he should have the final say-so on your recommendations.

THE PRINCIPLE OF DIRECT MOTIVATION

Imagine a manufacturing engineer walking into the factory saying, "Well, Boys, I sold us down the river, but it is for the good of the company."

This would be remote motivation, a leap that neither nature nor value analysis can take with impunity. And why stop at the company? What about the Free World? The solar system? Why not be really noble and say, "Boys, I sold us down the river, but it is for the good of the Universe!"

Nature evidently has long-range goals. It encourages all living things to survive, grow, and propagate. But it does

not skip the immediate objectives. The male rabbit does not say to the female rabbit, "Pardon me, but Nature, which is the company we all work for, apparently wants to populate the planets with living organisms. In our case the Grand Plan calls for more rabbits. We can do our share by engaging in certain contortions which will result in your being loaded down with future rabbits for the entire production run — but remember — we are all working for the same company. Be noble!" Nature simply does not operate that way. It provides an immediate reward *for every step* leading to the long-range goal. If we want our value task group to get off to a good start, we must provide direct incentives for anyone who has to give ground in the interest of the group; otherwise everybody will simply defend their present ideas, and there will be no change, no movement, no progress.

People usually defend an existing pattern regardless of its merits. Why? Because all change involves risk, of course. But is risk that important? Two laws of nature give us the answer: Survival and Growth. Growth, including propagation, may be the lasting objective, but in point of time, survival must come first. The male rabbit of our story cannot contribute to the Grand Plan if he gets killed first. An employee cannot contribute much to the welfare of the company if he was fired the week before.

For this reason, personal risk is usually the first element considered in business decisions. In the analysis of an existing product, the Principle of Responsibility reminds us of the importance of the risk-taker. He has already taken a number of risks in order to come up with a product. With what additional risks does value analysis threaten this responsible person? With the risks arising from sanctimonious hindsight and ill-informed criticism because the circumstances which imposed yesterday's actions are seldom known today.

To hurdle this obstacle, each member of the value task group must make a conscious effort to understand the reasons for apparent poor decisions, studiously avoiding anything that may cast discredit upon the people responsible for the product. The same decent and practical attitude should be adopted toward the other members of the task group. By safeguarding the integrity and professional reputation of the people involved, we release all the energy that would be spent on protective strategy. This energy then goes into the product *provided* there is direct and immediate motivation for turning out a really good product. Such motivation must also be based upon the Laws of Survival and Growth. In business, survival means not losing your job; growth means looking good in the eyes of your boss *and learning something*.

Every member of the task group must consciously help the other members to satisfy these motives. The resulting commitment to each other's welfare brings about spontaneous recognition of good work. Once recognition has been granted by a man's co-workers, management recognition comes naturally. The task group's contribution is entered in the personnel folder of each member, showing the estimated dollar value of the group's recommendations. Months later,

the actual dollar gains are entered and compared with the hours spent, both in the value workshop and in follow-up effort. A very gratifying ratio of dollar gains to man-hours spent results from the direct motivation generated by paying attention to the Laws of Survival and Growth.

Members of the value analysis task group must agree beforehand to get these elementary laws of nature working for them rather than against them, to minimize the need for defense, and to maximize recognition of good work.

THE PRINCIPLE OF EFFECTIVE COMMUNICATION

Get two design engineers, a cost estimator, a buyer, and a manufacturing engineer together, and the conversation will flow easily about such matters as cream and sugar in the coffee, the recent ball game, and crab grass. Then the electrical engineer explains why he cannot change a special part for a standard one. Pointing to a chart on the table, he says, "You can see that even a slight change will depress this parameter by a whole order of magnitude. Besides, we have to have the best Q we can get."

"The best Q?" asks the Buyer. "That brings to mind what I called this meeting for. If you specify a "special", we will drop below the EOQ."

There is a moment of bewildered silence; then the Manufacturing engineer tries to clarify the matter, "EOQ is Purchasing's version of our ELS. And we are in the same boat. If you don't use a standard item, *we* go below the ELS. PC will have to make two pulls instead of one. We may have to re-stationize and even *re-facilitate!*"

Overawed, the design engineers look helplessly at the chart, then at each other. "Perhaps," suggests the electrical man, "we could —"

But the mechanical engineer is shaking his head. "I am afraid not," he declares, spreading out another chart. "It would take us beyond the bounds of permissible parts density — actually beyond the asymptotic line of the parts density curve."

Of course, if it does *that*, the whole project is abandoned. These people may as well not have met at all. But this hypothetical meeting does illustrate how the secondary functions of language can nullify the primary function as a means of general communication.

One of these secondary functions is to present the social and educational background of the speaker, as illustrated in Shaw's *Pygmalion* and the theatrical hit, *My Fair Lady*. A closely related one is to establish the speaker as a knowledgeable member of a craft or profession. A third and more important function is that of specialized communication *within* a craft or profession. But this can become a habit — a costly habit when general communication is important.

An early task of the value analysis workshop is to achieve effective communication by encouraging all specialists to use as much plain English as possible. For this reason, the value analyst himself must learn and practice the art of plain talk.

THE PRINCIPLE OF INTERACTING SKILLS

When was ever honey made With one bee in the hive?

— Thomas Hood, 1826

Effective interaction of skills constitutes the means whereby man and the social insects have conquered the surface of the earth. In most cities, villages, and farms there are many people, some bees, lots of ants, but few lions and tigers. The ancient monarchs of the forest have not done too well in competition with organized beings. No single human being, no bee, nor ant has the strength, speed, and cunning of the lion or the tiger. But each can develop a specialized skill of its own and use it in concert with its teammates to subjugate creatures having greater strength, sharper fangs, and higher speed.

This interaction of skills has been called *synergetics* from the Greek word *synergos*, working together. A simpler term is the English teamwork. But the concept of teamwork has suffered from a poor understanding of its true meaning. Everybody senses that teamwork is good, that it is desirable, and that it produces results, but few people bother to learn how it works and why. Teamwork can be preached until the word itself sounds like a platitude. But no amount of preaching, exhortation, or locker-room pep talks can build a team. A team or a task group must be carefully put together to combine the skills required by the nature of the planned task. The team members must be trained to apply these skills in patterns which have proved successful in actual experience, for that is how all "rules of the game" and "combinations of plays" are developed. The men and women who make up a team must be committed to the attainment of a common goal, and they must be willing to obey the signals of a quarterback.

The English word teamwork, if we strip it of empty preaching, means more than simply working together. It implies a certain respect for the other fellow which goes with good sportsmanship, a certain mutual loyalty, and a peculiar understanding and use of the environment capable of converting obstacles into stepping stones.

A fine example of inter-discipline teamwork is Nelson's handling of the British fleet during the Napoleonic wars. Nelson met and defeated every fleet a united Europe could send against him. He established such working relationships among wind, sea, ships, and men that even the enemy played a directed role.

Fulfillment of this man's genius was made possible by the discipline, skill, and composition of every ship's company in the fleet.

The teamwork of value analysis is based on the *composition* of the team which must include engineering, purchasing, manufacturing, cost estimating, and marketing skills whenever possible. Closely related skills may be substituted as long as the technical, socio-economic, and financial aspects of product value are covered.

More important even than the balanced combination of

skills is the *combination* of professional and departmental interests. The characteristic outlook of the engineer and of the engineering department is quite different from that of the buyer and the purchasing department. This is true of Finance, Marketing, etc. The *interests* of the *departments* vary in the same way.

When *two* of these interests clash, there is usually some personal conflict, but when *all* pertinent interests are represented, there is a plurality of emotionally detached people who serve as arbiters to compose differences in the interest of the whole.

THE PRINCIPLE OF ADEQUATE INFORMATION

This principle derives from a clearcut pattern in nature. Motion into danger leads to destruction; motion away from danger and toward the sources of life leads to continuing life. The cycle consists of sensing, remembering, screening, and comparing thousands of inputs to select meaningful information — information which affects the welfare of the organism. There is seldom enough of the right kind of information and always too much of the wrong kind. This signal-to-noise ratio yields an inadequate image which must be completed by the imagination and memory.

We do not have to see all four legs of a table to know that it is a table or all the stars of the Great Dipper to find the North Star. Imagination of this sort is the key to pattern-recognition and also a source of self-deception.

Perhaps the most difficult obstacle to the proper use of information is the screening of self-deception and emotional bias. Faith, hope, and fear belong in planning, not in the interpretation of information. The information necessary for successful value analysis must be gathered to *include the information that we do not like and to question the information that we do like*. All data must be graded for authenticity, up-to-dateness, accuracy, completeness, and availability *in a form usable by the task group*.

We used to say, "*Get all the facts!*" You can't get all the facts. If you waited to get them, you would miss the boat. "Get as much as you can" will not do either. It sets no limits. All this calls for a little thinking.

You actually have to consider the consequences of inadequate information, on one hand, and of waiting for too complete information on the other.

Coping with the Information Dilemma

One way to avoid damage from the horns of a dilemma is to locate the point of each horn with precision. One point of our dilemma is the one where the expected benefits begin to outweigh the risk from acting in the dark. We can move safely from this point toward the other which is the one where the losses from delay begin to outweigh the expected benefits from additional knowledge. Getting all the facts really means getting all the facts *within these bounds*. Setting the bounds of adequate information is as important a task as getting the information itself.

THE PRINCIPLE OF FUNCTION AND PERFORMANCE

“What does it do?” is the key question asked by the value specialist when he looks at an industrial product. “What is its function?” he may continue. “Does it have other equally important functions? What about secondary functions?”

In the sense of *performance toward a given end*, the word function is tied to the concepts of direction and end-use. The related word *functional* implies a design in which the user's needs or desires take precedence over the designer's pleasure. Unfortunately the word functional is associated in the layman's mind with austere, unembellished usefulness — the thing should work — no better than it has to — and it should look rugged, and rather ugly; like one of Cromwell's soldiers, or an anvil made at Stalingrad during the siege.

But neither the followers of Cromwell nor the Communist subjects of Stalin were free to seek beauty for its own sake or knowledge for the sheer fun of learning. Their culture and their government told them what to buy. In countries such as the United States, West Germany, and Japan, on the other hand, the customer is a more complex being. He is interested in what the product will do for him *according to his own standards*. Satisfying the customer is the end purpose of all industrial products in the free world.

This dynamic approach to human needs and desires, this concern with the function, is not new. It has been obscured, however, by the naive belief that material progress is governed by material objects, forgetting that movement and dynamic relationships brought the age of materials into being. *Man finds materials, moves materials, manages materials, and transforms materials to provide a function for the satisfaction of some living being somewhere. And this living being — the customer — determines the value of what we offer him in terms both of use and esteem. If he wants a little beauty in his life, and he is willing to pay for it, and he wants it in living color; that is what we must give him! Conversely, if the God of War wants more military equipment for his money, even if the equipment looks horrible, we simply have to comply. A word of warning, however — the God of War is less austere than he pretends to be. If he secretly wants the equipment to look good, and it does not, he may turn it down for “quality.”*

The Principle of Function and Performance imposes two requirements upon us:

- Finding out what the customer really wants our product to do for him.
- Turning out a product that will meet his needs and desires in proportion to the importance he gives them.

Worth of the Function

We have seen that the product must be worth more to the customer than he pays for it, otherwise he would have no reason to make the exchange. The minimum value necessary to compensate the customer for the risk and effort of buying must include the value he places upon (1) confidence, (2) delivery, and (3) service, all of which are usually provided by the supplier over and above the sale price. The sale price then remains as the minimum measure, or lower

limit, of what the function itself is worth to the customer. We have to give him that much product worth *at the very least*.

But breaking even on product worth and compensating the customer for the risk and effort of buying is not enough. To be competitive we have to increase the worth of the function, reduce the sale price, or improve the worth of *how* the function is performed. For example, the function of a grenade launcher is to hurl grenades. The customer pays a portion of the sale price for the capability of hurling grenades a given distance in a given direction, measured in terms of range and accuracy. The rest of the sale price goes into how he wants them hurled — how reliable? how often? over how long a period? under what climatic conditions? etc.

We must elicit from the customer the relative importance of all these characteristics by asking him to assign weighting factors to them. Having converted the sale price into cost-to-us figures, we use the customer's weighting factors to find out how much we can spend on each function or contributing benefit. The resulting figures are then compared with the cost of providing the same function in other industries in order to make sure that *we* provide the required function at least cost in resources.

THE PRINCIPLE OF BALANCE AND PROPORTION

Then let us mingle our ingredients, with a prayer to the gods, Dionysus or Hephaestus or whichever god has been assigned this function of mingling.

— PLATO in the *Philebus*

The amount of resources that can go into a product is determined by what the customer will pay less the indirect expense and profit of the supplier.

Given this limitation of resources, we know that we cannot increase one element of product worth without reducing one or several of the others. What we have to work with, then, are the proportions among the elements of worth that will yield the highest expected value. This means that we cannot follow the old dream of: highest performance, highest reliability, superb quality, lightest weight, smallest size, and lowest cost.

Going after the most of the best of everything amounts only to trying real hard instead of thinking. Achieving a balanced combination of benefits, on the other hand, calls for common sense, not brute effort. “A painter, said Aristotle, “would not give his creation an oversize foot, be this foot ever so beautiful.” neither can *we* endow our creations with exaggerated portions of any one benefit, whether it be economy, reliability, performance, or what have you. Instead we must determine the relative importance of the desired benefits and then combine them in the measure and proportion that will satisfy the customer, for as Plato said, “the qualities of measure and proportion constitute both beauty and excellence.”

In Book II of his *Politics* Aristotle repeats, “. . . it is the perfect balance between its different parts that keeps a state

in being. With respect to an industrial product we can say that, for a given level of resources, the balance and proportion among desired benefits determines the worth of the product.

TACTICS

If applying the foregoing principles governs the strategy in the quest for value, the following sequence of explicit tasks constitutes the tactics. There are other tasks implicit in the application of the general principles, such as analysis, synthesis, and optimization, but they can yield no more than the best combination of benefits for given resources or a given combination of benefits for the least resources. They cannot do both. The tasks listed below, by eliminating waste in one form or another, can actually provide greater results for less effort:

Explicit Tasks

- Verifying Requirements and Constraints
- Validating Tolerances and Allowances
- Adapting to Technical and Economic Change — Updating
- Creating Technical and Economic Change — Innovation
- Reducing Excess Complexity — Simplification

These tasks may be summarized briefly as follows: VERIFICATION, VALIDATION, UPDATING, INNOVATION, and SIMPLIFICATION.

The Task of Verifying Requirements and Constraints

A frequent cause of wasted resources is the requirement for greater benefits than can possibly be used. Every specification must be examined in the light of the customer's needs or desires in order to make sure that we are not providing more than he wants. Every statement that "the customer will not let us do this," or "the customer will not accept that," must be verified, for the absent customer is the last resort of the man who does not want to do something and needs a good reason for not doing it.

The Task of Validating Allowances and Reserves

This task calls for investigation to determine both the need and adequacy of all safety factors, de-rating factors, power reserves, tolerances, and allowances. Meant to offset actual uncertainty, allowances and reserves are often increased to offset the additional uncertainty created when poor scheduling forces designers to guess because they have not been allowed enough time to calculate.

The Task of Updating and Looking Ahead

The faster our technology grows, the greater the opportunities for updating our thinking on new customer requirements, new methods, and new materials. But what is new today is not good enough. We have to design around tomorrow's needs, tomorrow's methods, and tomorrow's materials because our competition may well be ready for tomorrow.

Moreover, the evolution of a product is such that minor defects, each of which is declared unimportant, *together* can throw the product out of the market. Continuously updating a good product, on the other hand, can keep that product in the lead. Systematically anticipating trends can ensure product leadership tomorrow.

The Task of Innovation

It was pointed out earlier that all change involves risk. But change, with its attending risk, is inevitable. Remembering that opportunity goes hand in hand with risk, let us look at the available tactics for coping with change:

- Ignore change and let it happen to us
- Anticipate change and adapt to it
- Initiate change and profit from it

The Task of Updating, previously described, constitutes a conscious and systematic effort to apply the second tactical approach. It represents an active defense but only a defense. To take the initiative, a value task group must undertake the Task of Innovation, a planned and studied group-effort to release each member's ability for combining and modifying existing concepts, for creating new ones, and for putting these concepts to work in one form or another.

The invited address, *Mathematical Creation*, by Henri Poincare, before the Psychological Society of Paris, and Jaques Hadamar's classic, *The Psychology of Invention in the Mathematical Field* (Princeton, 1954) have served as source material for a number of useful books published in the United States on creativity and innovation. The literature is well known thanks to the Universities of Buffalo, Utah, and California, to name only three, and to the work of private institutes and foundations.

In this growing field, rich in the fruits of well-planned experiments and sound scholarship, we should carefully shun the gimmick and be forever wary of the cultist approach. Three recent books on the subject are worth mentioning, Taylor's and Barron's, *Scientific Creativity*, Wiley, 1963; Koestler's *The Act of Creation*, Macmillan, 1964; and Polya's *Mathematical Discovery*, Wiley, 1965.

Under the guidance of professional psychologists, usually available in the training department of most large companies, the value task groups must be given the opportunity to exercise the creative faculties of their members. After all, when we ask the classical value analysis question, "What else will do the job?" We are opening wide the door to innovation.

The Task of Simplification

In a comprehensive study of more than 100 value engineering implemented recommendations, the American Ordnance Association found that:

- 21% improved performance
- 38% improved quality
- 39% reduced weight
- 40% simplified maintenance
- 46% made the product more reliable
- 75% reduced lead time
- 96% made the product easier to produce

Perhaps the least understood and most valuable of these improvements is the reduction in design, procurement, and manufacturing cycles which releases all manner of resources.

Some years ago this writer participated in a major value task group where we were asked to take 15% from the estimated cost of a production job. The group took out 20% of the cost, all right. What surprised management, however, was that we went in after dollars, but ended up with improved performance, higher reliability, and lighter weight.

Normally we do this on purpose, but performance, reliability, and weight were satisfactory in this equipment. The customer would not pay for improvements in any of them. Cost-to-us, however, was *not* satisfactory. Now cost reduction in modern industry is a well developed and skilled specialty, so we brought the cost reduction people into the picture.

They had all gone through formal value analysis training, all we had to do was tell them. "yes you *can* find a better way to provide the function. You do *not* have to think like the drawing. You do *not* have to stick to the bill of materials."

Before their Hallelujahs had died down, we added, "Each of you will head a task group which will include a buyer, a production man, a mechanical engineer and an electrical engineer."

So they went to work, looking for dollars alone. They came out with *dollars* and an improved product! The worth of the improvements could not be added to the price, which was fixed, but the customer was getting more for his money. This increased sales which in turn increased profit. The added volume further reduced cost.

Why did these task groups, making no effort to improve product worth, nevertheless come up with a better product? They had *simplified*. Simplification means fewer parts, fewer interfaces, fewer contacts, less things to go wrong, lower resistance, and less cross-talk and pick-up. The reduction of mechanical friction and electrical resistance results in lower power requirements, smaller transformers, smaller motors and, of course, lighter weight.

An egg is the acme of simplification. Compare it with a package of blue prints for building a chicken.

This brings up a question. Why don't we turn out simple products to begin with? Why do we have to simplify?

A good point. But look at a 1920 airplane and at an airplane today. Now look at a picture of a 1920 chicken. A man-made product changes and adapts much faster than natural organisms which took hundreds of thousands of years to arrive at their present state of ordered, proportioned, and streamlined *complexity*.

Note that we are talking about *simplification*, not *simplicity*. Simplification, as we use it, means the elimination of *excess* complexity. The whole trend in natural organisms and human products is toward greater and greater complexity. This in turn generates more and more excess complexity to be removed.

Some of this excess complexity is the natural and inevitable result of step-by-step product development. This is part of the dynamic process of growth. Every step forward in product design obsoletes some aspect of the earlier design. The remaining physical part may not be worth removing at the time, but sooner or later there will be enough such parts to justify planned simplification.

Even the best-thought-out designs require a systematic search for unnecessary complexity. There would be no new models unless the manufacturer and the customer jointly carried out this search. The customer seeks a product that will serve him in a more direct, more pleasing, and simpler manner. And the manufacturer searches for a way to give him just that.

The question is when to stop refining the product and to put it on the market. In making this decision we should remember that many an "overengineered" product is really *underengineered* — someone did not have time to *simplify*.

CONCLUSION

Principles such as these have always been applied by gifted managers of long experience. To meet today's competition, they have to be applied *systematically* by all persons whose decisions have a significant bearing on product value. This achieves a quantitative understanding, on the part of each decision-maker, of the effects of his decision, not only in his own area, but throughout the company.



THE MOST TRUSTED NAME IN ELECTRONICS