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• *Recent business and management literature abounds with articles or chapters on the role of the manager, theories of management and decision-making, relationships among disciplines, and possible power shifts in management hierarchies because of new quantitative methods. This article evaluates managerial economics and decision techniques for modern management.*

Managerial Economics and Management Decisions

by C. M. Birch

Economics is a study of the allocation of resources among competing uses, and divides somewhat untidily into macro-economics and micro-economics. Macro-economics deals with national problems, such as price levels, money supply, taxation, and recession, while micro covers relatively small elements of the economy: specific prices, individual businesses, particular markets, some special forms of competition, and so forth.

Managerial economics selects from both macro- and micro-economics techniques of analysis that are most pertinent for the businessman who is a manager. The techniques of macro-economics are useful mainly in forecasting, e.g., (1) sales forecasting, (2) estimating changes in future price levels, and (3) predicting general business conditions. In practice, forecasters usually draw on both macro and micro techniques, but mainly on macro's. However, I want to confine myself to that part of managerial economics (by far the larger part) that borrows from micro-economics. This restriction requires selecting methods of analysis relevant to problems of demand, cost, pricing, capital expenditures, profit maximization and competition. Needless to say, sound solutions for these problems are sought diligently and intelligently in well-managed business enterprises. The question of particular interest here is: Can managerial economics improve the quality of management decisions, and what are the implications for managers as decision-makers?

The modern approach of managerial economics is to present methods of analysis in a framework of three different worlds: a world of certainty, a world of risk, and a world of uncertainty. Each of these is defined and discussed below, but it should be pointed out here that traditional managerial economics has developed its tools for use mainly ("entirely" is scarcely too strong a term) in an assumed world of certainty. This, of course, explains the lack of realism that has repelled many real-world managers. This repulsion is perhaps most noticeable among those who have risen to high managerial positions through a string of line jobs, for their training and experience make them impatient with the academic habit of taking obvious unrealities as a foundation for a structure of analysis. However, a considerable dose of realism has been added in the recent past with assumptions about risk. This process has been facilitated by mixing together ingredients of statistics, mathematics, economics, and accounting. The upshot is widespread agreement among the practitioners in the four foregoing fields that the techniques of decision-making have been improved, and that managerial economics itself has taken on a greater practical worth.

As a final introductory comment, it may be noted that attempts to introduce uncertainty have had at least two effects that seem undesirable to many people: (1) increased abstruseness in the analysis itself, and (2) disagreement among the practitioners as to the usefulness of the analysis. On the one hand there have been charges of "fad" by "seat-of-the-pants" managers, and on the other hand, predictions by "the moderns" that have ranged from dire to gleeful about the erosion of the "old-school" type from the managerial elite.

It is my intent here to consider some of the contributions of managerial economics, especially the modifications wrought by the modern approach of distinguishing among certainty, risk, and uncertainty, and then to conclude by reflecting on the importance of quantitative analysis for managers who wish to continue to hold strategic decision-making positions in industry.

Managerial Economics

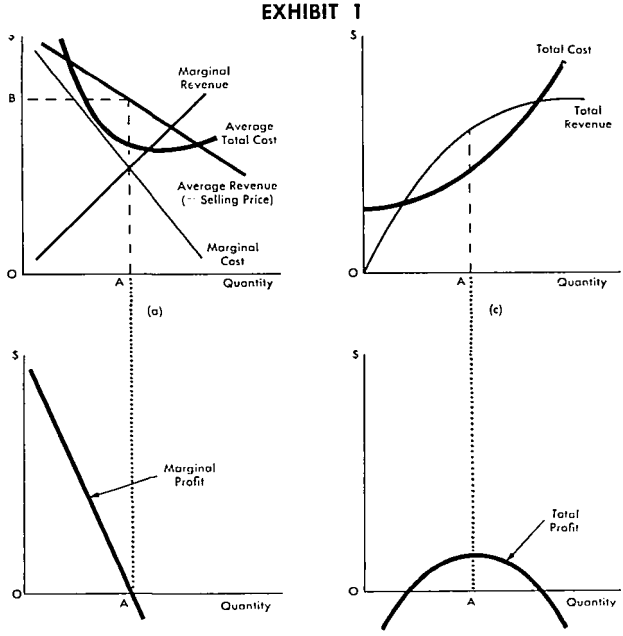
The traditional concerns of managerial economics are:

1. Demand analysis
2. Cost analysis
3. Price and output determination
4. Capital expenditures
5. Profit maximization
6. Competition.

Demand Analysis

Demand is presented conceptually as a set of price-quantity combinations, and graphically as an average revenue curve. From this set may be computed total revenues and marginal revenues (changes in revenues related to output changes), as well as arithmetical relationships within the original set and among alternative sets. Relationships within a given set generate a discussion of price elasticity (percentage quantity changes compared to percentage price changes); relationships among sets involve increases and decreases in demand, as well as cross-elasticities (percentage changes in the quantity of one product compared to percentage changes in the price of another product). Price elasticities are directly related to marginal revenue (e.g., marginal revenues are negative with lower prices when demand is inelastic) and are indirectly related to output and price determination. Changes in demand and cross-elasticities depend on a variety of forces, especially marketing strategies and competitive behaviour. Doubts about the value of demand analysis for the business executive are usually based on the practical impossibility of obtaining sufficient information about price-quantity combinations other than the prevailing price and current level of sales. Frequently there is little or no information about competitors' current sales, and sometimes not even about their present prices. In plain English, the price-setter cannot be certain what sales would be at alternative prices, nor does he know how sales would react to other forces (changes in competitors' prices, different advertising expenditures on his own part, etc.) In modern terms we would say that the fundamental weakness of the economist's demand analysis is the underlying and over-riding assumption (often implicit) of a certainty which in fact does not exist.

EXHIBIT 1



Cost Analysis

Cost analysis in managerial economics customarily divides costs into fixed and variable, then

- total cost is computed by the addition of fixed and variable costs
- unit costs are computed by the division of different total costs by output, and
- marginal costs are computed by comparing an increase in cost to its associated increase in output.

Often the data are available for different quantity/cost combinations explicitly assumed in a cost curve, so the objection of managers is not directed against the implicit (or, at least, often unrecognized) assumption of certainty, but rather emphasizes the needlessness of computing marginal costs since businesses do not use marginal costs even when they can be computed. However, probably almost all economists believe that well managed companies do, or should, recognize marginal costs. Actually, there are illustrations in almost every company of uses—sometimes apparently unconscious uses—of marginal cost.[1] For example, optional equipment on automobiles may be priced on the basis of marginal cost (or, more precisely, a combination of marginal cost and demand elasticity); or as another example, a decision about an increased expenditure on TV advertising may rest on what is essentially marginal analysis, although probably not expressed in marginal jargon.

Price and Output Determination

In managerial economics the best price and output are the price and output that maximize profits. This profit-maximizing equilibrium position may be found by equating marginal cost with marginal revenue, or alternatively and equivalently by maximizing the difference between total revenue and total cost, or, to name one of several other alternatives, by discovering where marginal profit is zero. Historically, the first is used most commonly in economic texts, but the second is quite popular among "business conscious" economists because of the strong resemblance to break-even charts, while the third is most convenient in relating the whole analysis to certainty, risk and uncertainty. Exhibit 1 illustrates the three alternatives, where in each case output OA maximizes profits, but the selling price can be read off only Exhibit 1(a).

[1]See for example J. S. Earley "Marginal Policies of Excellently Managed Companies", *American Economic Review*, March, 1956.

The reasoning of marginal economic analysis is that if there is a desire to maximize profit, then a unit of output will be produced if it adds more to revenue than to cost, that is, if marginal revenue exceeds marginal cost. For quantities smaller than OA, Exhibit 1(a), marginal revenue does exceed marginal cost, while for larger quantities marginal revenue is less than marginal cost. Consequently, every unit up to OA adds something to profit, while every unit beyond OA subtracts from profit, and profit is maximized at OA where marginal revenue equals marginal cost. This is reflected in Exhibit 1(b) in "addition-to-profit" (or marginal profit) terms, because up to OA there is a contribution to profit (marginal profit is positive), while past OA there is a subtraction from profit (negative marginal profit).

Alternative to Exhibit 1(a) is Exhibit 1(c) where the logic of output determination is couched in total terms rather than (unit) marginal terms. Obviously profits are maximized at the output where total revenue minus total cost is a maximum, and this output OA is the same OA as before. If we think of Exhibit 1(c) and picture how total profit is changing from the origin to the intersection of total cost and total revenue, through the quantities where revenue exceeds cost, up to the second point of intersection and beyond, we get a picture of profit comparable to Exhibit 1(d), with the profit curve cutting the X-axis at the outputs where the curves of 1(c) intersect.[2]

The often-expressed comment that prices are just not set the way implied in Exhibit 1(a), nor is output decided upon as marginalism would have it, does not, to my mind, get to the basic underlying difficulty. At least the comment does not reveal the close parallel between this objection and the objections to demand analysis. First of all, to shrug off marginal analysis because business pricing may be done by a mark-up rule of some sort or other ignores the fact that given the assumed goal of profit maximization there is a mathematical relationship between the best mark-up and marginalism *via* elasticity of demand.[3] But more important, because this mathematical relationship exists, the objection put forth is really criticizing the essential position of the certainty assumption in the analysis. Incidentally, and per-

[2]There is a clear explanation of marginal analysis in W. J. Baumol, *Economic Theory and Operations Analysis*, Second Edition, (Prentice-Hall, 1965), Chapter 3.

[3]The profit-maximizing relative margin is the negative reciprocal of the price elasticity of demand. See H. Bierman, C. Bonini, L. Fouraker, R. Jaedicke, *Quantitative Analysis for Business Decisions*, Rev. Ed., (Irwin, 1965) Chapter 22.

haps forgotten, is the fact that the variety of ways for deciding upon a markup is itself an attempt to make a decision in a world where certainty does not prevail.[4]

Other Topics

If enough has been said to illustrate the interests and approach of managerial economics, and to demonstrate the role of certainty, then it is sufficient for the purpose at hand to mention very briefly some of the remaining topics of this discipline. For example, capital expenditure decisions are handled by present value formulas, or by computing annualized earnings, or by estimating and comparing rates of return.[5] A fundamental difficulty is that certainty saturates the treatment of all three, although the way of expressing the difficulty—namely the arbitrary manner of handling different lengths of life—may make it hard to recognize that the objection to certainty is even there, let alone fundamental. It is revealed though by the explanation that it is assumed that recovered funds in the shorter-lived investments will be re-invested when available under circumstances that are a carbon copy of today's opportunities.

A second example of a very important issue (but a lightly-treated issue in this article) is the assumption of profit maximization. Often enough business men do not know which of the limited number of alternative courses of action open to them will maximize profits, nor even the probability of success of many of their decisions. As McGuire has said, under such conditions the notion of maximization becomes meaningless.[6] In a word, how do you maximize profit unless there is certainty?

As a final example there is the lengthy and important subject of market structures or types of competition. But in all cases, cost curves are assumed to be known, and regardless of how competition affects demand, equilibrium can be found by equating marginal costs and revenues. The economic models are saturated with certainty, yet devoid of predictability. Whatever type of market competition is assumed to exist, there is an economic model to explain price and output determination under those competitive conditions, and the model may be extended back to show the implications for employment of resources and payments to resources, or forwards to show long run competitive equilibria position. Yet definitive as the procedures and results are, there is little or no predictive power in terms that are operationally significant for the manager of a business. The models will not predict future prices, shifts in demand, changes in costs, the appearance of new competitors, failures of existing forms, the impact of advertising expenditures, and so forth. If prediction is a criterion of reference, then the models of managerial economics simply are not satisfactory.

Certainty, Risk, Uncertainty

Decision theory uses a simple but convenient device known as a payoff matrix to help distinguish among certainty, risk and uncertainty. A matrix is a two-dimensional array of numbers, each of which is termed an element of the matrix. These numbers are arranged in rows and columns called vectors. For example, the row vectors of a payoff matrix represent the strategies available to the business man, whereas the column vectors are the states of nature, that is, environmental conditions over which the executive has no control. Each element of the matrix is called a payoff: the joint outcome of a particular strategy and a given state of nature. Exhibit 2 illustrates a payoff matrix, where it is assumed that a man must choose between operating a soft drink concession or a "coffee and donut" stand at a summer resort during the coming months.[7]

EXHIBIT 2

State / Strategy	Hot Summer	Cold Summer
Soft Drink Concession	$3,000	$1,500
Coffee and Donut Stand	$1,800	$2,400

In the illustration, if the summer is hot he will make more money selling soft drinks, but if it is cool he will make more money with the "coffee and donut" stand. Suppose on the basis of past experience he has the following information: If the summer is hot he will clear $3,000 if he operates a soft drink concession and $1,800 with the stand. On the other hand, if the summer is cold he will make $1,500 with soft drinks and $2,400 with coffee and donuts. What is an intelligent choice, or what is intelligent behaviour?

[4]The following pricing methods come to mind: cost-plus pricing, flexible mark-up pricing, intuitive pricing, experimental pricing, stable pricing, and incremental cost pricing. These and other methods are discussed by M. H. Spencer and L. Siegelman in *Managerial Economics*, Rev. Ed., (Irwin, 1964), pp. 371-384.

[5]Compare N. Harlan, C. Christenson, R. Vancil, *Managerial Economics*, (Irwin, 1962), Section IV.

[6]J. McGuire, *Theories of Business Behavior*, (Prentice-Hall, 1964), p. 83.

[7]This illustration is from J. Freund and F. Williams, *Elementary Business Statistics*, (Prentice-Hall, 1964), p. 155.

The illustration depicts the essential problem that exists when certainty is removed. With certainty there is only one state of nature though perhaps a vast number of strategies. The decision-maker chooses a strategy by selecting the payoff that is most satisfactory for the attainment of the desired goal. For example, given a schedule of cost figures, he would choose the output that minimizes unit costs if efficiency is his goal; or given a schedule of unit costs and a schedule of selling prices for different volumes he would choose the production (= sales) that maximizes the difference between total revenue and total cost (i.e., he maximizes profits).

Payoffs

In risk and uncertainty situations there is not only more than one strategy but there is also more than one state of nature. In risk situations by definition, the probability of each state of nature is known "objectively". This knowledge ordinarily is based on historical data, thus weather records for many past years may reveal that 20 per cent of the summers are cold, so it could be agreed that the probability of a cold summer is 0.20. With uncertainty it is impossible for the decision maker to assign objective probabilities to the states of nature that affect his payoffs. One procedure is to assign individual (or personal) probabilities based on such factors as experience, advice, and intuition; another is to more or less hopelessly assign equal probabilities to all states; and a third is to choose a decision rule that does not use probabilities.[7]

If we return to the discussion surrounding Exhibit 1, we might express it in a payoff form in which the outputs are strategies; in this case we would have a column of outputs (strategies) and a single column of (e.g.) average cost numbers—and so one average cost curve. Similarly, all the other cost, revenue and profit numbers are single columns. For example, consider the profit vector of Exhibit 3 which is a tabular representation of Exhibit 1 (a), where small numbers are used for the sake of simplicity.

EXHIBIT 3

Volume	Profit
1	$ 2
2	4
3	6
4	8
5	10

To maximize profit we choose an output (= sales) of 5 units. Changing to a world of risk we assume

(1) production and sales may not be equal,

(2) historical sales data for different months (or any convenient time period) provide the probabilities of selling different monthly production volumes.

For example, in Exhibit 4 it is assumed that selling price is $5.00 per unit (fixed prices are not essential to the analysis), cost price is $3.00 per unit, and the numbers in the cells of the matrix are net profit figures.[8]

EXHIBIT 4

		State (Quantity that will be sold)					
		0	1	2	3	4	5
Probability for Sales		.05	.13	.24	.28	.30	.00
Strategy	0	$ 0	$ 0	$ 0	$0	$0	$ 0
(No. to be	1	−3	+2	2	2	2	2
produced)	2	−6	−1	4	4	4	4
	3	−9	−4	1	6	6	6
	4	−12	−7	−2	3	8	8
	5	−15	−10	−5	0	5	10

If one unit is produced and not sold the payoff is −$3, but if the one produced is sold then the payoff is $2, and since no more can be sold if only one is available, the balance of the row is also $2. If two are produced and neither sold there is a loss of $6, while if only one is sold the payoff is a loss of $1, and if two can be sold then the payoff is a profit of $4 (when production is two); similarly for the rest of the table. Hence, a risk situation implies a table of payoffs instead of a column of payoffs as in certainty examples. In addition, there is a probability vector, with one probability for each sales figure; and it may be noted that the diagonal is the profit vector of Figure 3.

[7] There is a wide variety of definitions of risk and uncertainty in the literature. Here we are using "risk" for objective probability situations, and "uncertainty" for cases of subjective probability, and in both instances maximizing expected value (as explained below), with the observation that maximizing expected value is only one possible decision rule. Other decision rules are recognized later in this article, but it should be pointed out here that some authors prefer to define uncertainty as a situation where there are neither objective nor subjective probabilities; with this definition, decision problems under uncertainty are solved either by a rule that does not need probabilities or by arbitrarily assigning equal probabilities to all states of nature. See for example, D. W. Miller and M. K. Starr, *Executive Decisions and Operations Research*, (Prentice-Hall, 1960), Chap. 5.

[8] The construction of payoff figures can be made quite realistic. Specifically, different types of fixed, variable and semi-variable costs can be allowed for, such as the re-sale or scrap value of unsold goods, and relatively intangible costs may be recognized, for example the cost of goodwill that occurs when customers are annoyed by shortages. Nevertheless, complexities in the construction of payoff values do not affect the techniques under discussion here.

Decision Rules

Now to decide on the quantity to produce a decision rule is needed. There is no obvious solution as to the best rule, but of the many suggested in the literature, a popular one is to maximize expected value. This involves computing the expected value of each strategy (in this case production volumes), and choosing the one with the highest expected value. These values are easy to compute since they are only weighted averages. Specifically, each number in the strategy row headed "1" is multiplied by the probability of that payoff occurring (that is, by the probability that the sales volume will be at the level needed to generate the profit payoff), and the results are summed. Thus, a production of 1 has an expected value of: (.05) (−$3) + (.13) ($2) + (.24) ($2) + (.28) ($2) + (.30) ($2) + (.00) ($2) = $1.75. This may be interpreted to mean that if the business man were to produce at a level of one unit, then over a long period of time he could expect to earn a profit of $1.75 on an average for each sales period during the whole time. Similarly, the expected values of strategies 2, 3, 4 and 5 are $2.85, $2.51, $1.25 and −$1.75, respectively. Therefore, the best strategy is to produce two units.[10]

In a world of uncertainty the historical data for objective probabilities would be non-existent or incomplete so only subjective probabilities could be assigned. This might occur, for example, in scheduling production of a new product. Uncertainty could be increased by a lack of information about payoffs. We usually act as if we know the payoffs for every strategy-state combination, but really there are imponderable contingencies that could alter radically the payoff matrix.

As already indicated, there are many decision rules in addition to maximizing expected value, and there is no one criterion most satisfactory for making decisions under uncertainty. One possibility is to assume that all states are equally likely (the Laplace criterion), another is to choose the strategy that minimizes the worst payoff that can befall in each state (the minimax principle), and so on.[11] These other decision rules are often preferred to maximizing expected value when the decision is "unique" in the sense that not only is there an absence of historical data for probabilities, but the rationale for using probabilities is shaky since the problem calling for a decision is unlikely to recur.

In spite of the critical tone of any of the foregoing remarks it would not be accurate to leave the impression that managerial economics is relatively useless without a mixture of risk or uncertainty. Besides the logical and analytical values of traditional managerial economics, there are useful certainty models not referred to in this paper, which are quite properly within the domain of managerial economics. For example, there are inventory models and there is linear programming. Both of these may on occasion be made more powerful by risk and uncertainty elements, but they are important even in their simplest forms, sometimes as substitutes for marginal analysis. Linear programming, for example, arrives at maximum values in some instances where marginal analysis does not operate satisfactorily, because linear programming is not restricted by expressing constraints as equalities. My intent is not to dispute the value of traditional managerial economics, but to emphasize modern developments and the significance of these for advisers to management or managers themselves.

CONCLUSION

Management is above all an operation, and management men need operational definitions, analyses and decisions. It is not then inappropriate to ask what is operationally significant in these pages. And I would like to direct an answer to some of the people in three classes of occupations: professors of managerial economics, professional accountants and management men and women.

(1) First of all, there are still managerial economists who are overly sensitive to criticism. As they defend their domain against all comers they battle in abstruse treatments the topics mentioned above (prices reflect changes in demand, utilization of marginal costs, adjustments to competition, etc.). At the same time they emphasize distinctions between long and short-run, the idea of opportunity cost and the importance of the equimarginal principle that the value of marginal

[10]Sometimes the dollar payoffs do not adequately represent the value of a particular strategy-state combination to a particular decision maker, so maximizing expected value does not produce an attractive solution. For example, it may be that $100,000 for certain would be preferred to a 15 per cent chance at one million dollars and an 85 per cent chance of receiving nothing, even though the gamble has an expected value of .15 ($1,000,000) + .85 ($0) = $150,000. This difficulty can be handled by discovering the decision-maker's utility for various dollar amounts through the standard-lottery technique, explained by R. Schlaiffer in *Introduction to Statistics for Business Decisions*, (McGraw-Hill, 1961), Chap. 1.

[11]There is a good discussion of decision rules in W. Morris, *The Analysis of Management Decisions* (Irwin, 1964), Chapter

products be equal in all activities. Some of these battlers are usually strong in condemning accounting treatments of costs, claiming that historical data do not reflect opportunity costs, deriding accounting valuation of assets for failing to mirror economic values, and urging that some allocations of overhead are irrational.[12] Yet the analyses of case studies in managerial textbooks intended to implement economic principles rarely if ever disagree with the best thinking of the accounting profession. For example, there is little to quarrel about (although much to explain) in applications to make or buy dilemmas, problems in allocating advertising expenditures, pricing a new product, price wars, illustrations of costs not affected by decisions (e.g. compare opportunity costs and the accounting analysis of variable costing) and the issue of whether or when selling prices should respond to changes in unit fixed costs.

Perhaps there are too many straw men being set up and wrestled with on both sides. The managerial economists seem to gain little by repeatedly listing objections to break-even analysis (limitations that are fully recognized by accountants) and accountants are not making much headway by protesting that mark-up pricing is more realistic than marginal analysis, for it is just not true that "the inherent weakness in the marginal cost analysis is that it is not particularly helpful in establishing the selling price of a product."[13]

(2) I would like to add some support to ideas already being emphasized by a few accountants. Surely professional accountants have a responsibility—and universities have a responsibility in training men and women who will be future professional accountants—to study new approaches to old problems. This responsibility grows out of a fact that can be ignored only at the peril of the accounting profession: the mountains of accountants' data are gold mines of information, but the accountants do not always mine gold. Today people are being trained in operations research or management science or (sometimes) managerial economics, who are learning how to use the accountants' gold in new ways, and the accountants must learn these ways or lose influence. Cost statements, accounting data, financial analyses, that have been called finished products heretofore, are now raw data. Others are learning to put to a strategic use information provided by accountants. The decisions to be made regarding the future require thinking in terms of probable payoffs rather than past (certain) incomes and outlays. Until now, the accountants have been as wedded to certainty as have others, but others are learning to formalize intuitive judgments through probabilities, and so must accountants.

There is plenty of thought being given to the "new mathematics", the "new statistics", the "new economics", but is there a "new accounting"? There is a voice or two crying out, but little headway has been made in shaking out the idea that accounting data are known facts. Too little heed is being paid to the occasional lone voice. As one accountant expressed it:

> If we are to accept the challenge that is before us, we must sacrifice some of the precision that has been the traditional mark of the accountant; we must have the imagination to realize the potential value of being able to say that certain information is correct within limits, instead of ignoring important variable factors because they do not remain stationary long enough for us to apply precise yardsticks.[14]

(3) Decision-making under risk is becoming an application of rules that are more sophisticated than the rules of traditional managerial economics. But the hard problem is decision-making under uncertainty, and this requires judgment and experience as well as rules and techniques. Management will have to ascertain which events are more likely than others and combine this result with payoffs associated with various decisions. Implicit in any intuitive strategy for either risk or uncertainty is a probability distribution, and a main task of modern analysis is to recognize the existence and manipulate the importance of probability distributions.

No competent business executive wants to be the captive of a quantitative model, for he knows that abstraction errors always accompany theoretical analysis. Quantitative analysis is at best an aid to judgment and imagination, and at worst a substitute for them. It can help in a problem that may appear hopelessly complex if intuition is the only weapon of attack, but at the same time many business problems cannot yet be given a quantitative representation, and in these instances management must continue to use qualitative models and solutions. ●

[12] To cite one of a large number of examples: W. Haynes, *Managerial Economics*, (Dorsey Press, 1963), Chapter 7.

[13] T. J. Diggory "The Role of Standards for Cost Control and Pricing", *Cost and Management* (January, 1963), p. 28.

[14] "The Measure of Management" (editorial), *Cost and Management*, (February, 1962), p. 50.