Bureau of Business Research
Graduate School of Business Administration
University of Michigan

March, 1971

IMPLEMENTATION OF RISK ANALYSIS MODELS FOR THE MANAGEMENT OF PRODUCT INNOVATIONS

Working Paper No. 32

by

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ABSTRACT

This paper is a report on a research project concerned with the general question of the extent to which administrative innovations affect the evaluation of technical innovations in business firms. The specific administrative innovation used in the study is a probabilistic cash flow model. The model is a large-scale simulation model that utilizes estimates of probability distributions for unit process, unit sales, unit costs (for each of several jointly produced products), capital investment, fixed manufacturing costs, and annual marketing and opportunity costs. Alternative marketing and manufacturing strategies can be evaluated through the use of probability distributions for various financial criteria. The paper will discuss the computer model, the experiences of implementing the model in six large industrial firms, and the effect of using the model on organizational behavior in these firms. Special emphasis will be placed on the importance of designing risk analysis models so that they can be useful to the various persons involved in evaluating new-product investment decisions.

BACKGROUND OF THIS PAPER

This paper is based on the studies being conducted at the Bureau of Business Research, as part of a Research Program on Administrative Decisions. This research program has been supported by various firms. The author gratefully acknowledges the excellent computer programming assistance provided by Kathleen Goode, Research Associate, Bureau of Business Research. This paper was prepared for presentation at the XVIIIth International Meeting of the Institute of Management Sciences, Washington, D.C., March 24, 1971.

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Introduction

Many articles concerned with risk analysis models have appeared in the management science literature in recent years [6, 7, 9, 13 and 21]. Most of these articles have concentrated on the technical aspects of the model, after a brief introductory statement pointing out the advantages of using a risk analysis approach. While it is true that this paper will discuss a particular model, the emphasis is on implementation. Specifically, the paper will attempt to answer two questions regarding these particular models. First, should the model be used? Here it will be argued that yes, they should be used, but not for the reasons usually given in the literature. The second question is, will the model be used? Again the answer will be yes, but some situations will be pointed out in which it becomes very difficult to achieve implementation, and there are others where such an approach is not really needed.

Implementation

It is important to recognize that the concern in this paper is not with implementation just for implementation's sake, even though that is a very crucial topic for professional management scientists and one that is often discussed formally and informally in meetings. Neither is this paper strictly concerned with the implementation of risk analysis models because they will increase profits. While many of us have strong visceral feelings that they will improve profits in the long run, we cannot demonstrate this, nor has it been verified in the literature. Indeed, attempts to show that these models will increase profits (or decrease losses) would probably be frustrating and not worth the effort.

The principal reason for discussing the implementation of these models on this occasion is to examine the ways they affect decision-making behavior in the firm. Compare the implementation of risk analysis models with the implementation of managerial accounting, planning methods, and inventory control. As with the use of risk analysis models, the relationship between profits and the use of these activities cannot be scientifically demonstrated. With them, however, there is no myopic doubt about whether or not these activities should be carried out (which is not to say there isn't concern with how they might be improved). The reason is that managers can see the benefit of these activities in showing them where they are compared to where they want to be, and this information helps them in making decisions. For the same reason the implementation of risk analysis models is useful because these models not only indicate where you are compared to where you want to be in the management of major product innovations, but more important they add a new dimension that can be useful in directing management activities.

Risk Analysis Models

The term risk analysis models is used to mean that the relevant financial criteria are represented by probability distributions rather than by only single-point estimates. If, for example, discounted return on investment (ROI) is one of the financial criteria that managers are concerned with, then it can be represented as a distribution so that such questions as these can be answered. What are the chances that ROI will be less than 20 per cent? What is the ROI that has a 50/50 chance of occurring?

For innovation of a major new product these probability distributions must be based on a combination that includes subjective estimates of persons in marketing, research and development, accounting, manufacturing, and so on. That is, management must ultimately face the question of whether or not they will sign on the dotted line to approve the funding of $5 million for the new manufacturing facilities, the advertising campaign, and other expenditures required to launch that new product developed from a recent R and D project. To get the appropriate information to the appropriate persons who influence that decision requires the cooperative efforts of several departments in a firm.

This cooperative effort, the decision-making process, as opposed to the final act of signing on the dotted line, is central to the discussion here. It is during this process that risk analysis models can be most beneficial, although they may have no effect on what is generally called the final decision-making act. It is necessary to expand this point before elaborating upon the concept of a risk analysis model.

Decision-making Behavior

Perhaps the most serious problem in the development of risk analysis models as well as other management science models is the tendency to attach an unwarranted importance to the final decision-making act. That is, most of the proponents of such models emphasize the value of these techniques when top management must decide whether or not to sign on the dotted line and, if they sign, how much to sign for. The assumption is that the firm may be viewed as a single decision-making unit, and therefore the model must be designed to be used by the top decision-making officer.

Unfortunately, this assumption has never been verified. In fact, almost all studies of decision-making behavior in firms show that many acts that are crucial to the final decision occur long before the proposal is submitted for official approval [1, 2, 3, 5, 8, 14, 16 and 20]. This is not to say that those in top management do not influence the decision. Clearly, they do, but they do it in ways that have little bearing on whether a risk analysis model or astrology is used to make the final evaluation. (Neither does this mean that the sympathetic understanding of top management is not a factor in the use of the model--a point to be covered later.)

The crucial stage that determines whether a new product idea will end up before it is more than a gleam in someone's eye or be subjected to the full competitive test of the market place is in the analysis process. It is in this phase of the sequential decision-making that alternatives are evaluated, information collected, and decisions made on when and what to present to the appropriate individuals in the decision-making hierarchy. These results have been discussed in many studies of organizational decision making and will not be detailed here. The important point is that this is the major problem area in the innovation process and the area where the application of risk analysis models offers the most benefits.

The Research Area

Perhaps it is useful to put these thoughts in the perspective of the broader research questions to be dealt with here. The primary concern is the relation between the use of normative models, such as risk analysis, and the organizational structure of firms. Conclusions from research in management science generally emphasize that decision making can be improved by using better normative models. Conclusions from research in organizational behavior generally emphasize the need to improve organizational structure. Although specialists in both areas are seeking ways to achieve positive organizational change, the interdependencies of these two approaches have not been made as explicit as they should be.

Perhaps the best illustration of this problem is the history of the debates over the use of present value in preference to internal rate of return (or one of its many variations). Arguments for and against these basic normative models have been extensively covered in the literature. Although present value is commonly considered to be most generally correct, only recently was it observed that the behavioral implications of the approach do not justify its being used in every situation. Organizational research has shown, however, that the choice of financial criteria has little influence on the final decision [1, 2 and 3]. It has been shown that change must be created through the reward system, but the effect of the financial criteria on the reward system has been ignored.

The relation between model building and organizational structure needs to be explored because it is assumed that the scientific resources furnished by both physical scientists and management scientists could be made more effective if we knew more about this relationship. The old saying that seven out of eight hours of an engineer's time are spent on products that never reach the market may or may not be true, but most observers would agree that improvements could be made in the efficiency of the innovation process. This is, of course, a problem in the allocation of limited resources. But what concerns us here are the resources that are consumed during the innovation-evaluation process, rather than the ranking of alternative investment projects that periodically flow out of this process. This general problem lies behind the attempt here to examine the effects of a risk analysis approach in evaluating technical innovations in several large firms. The research results with four firms are presented in detail in [14]. Additional discussions of the specifics of using subjective probability estimates in this project are reported in [15]. More recently, the field of research has been expanded to include two separate divisions in each of two corporations. Observations from these studies provide the basis for discussing whether a risk analysis model should--or will--be used.

Should and Will Risk Analysis Models Be Used?

The usual arguments for using a risk analysis approach is that a firm attempting to decide whether to make a major financial commitment to a new product must consider and compare many alternatives, and to do this properly there should be an assessment of risk rather than the use of only single-point estimates. Although this philosophy seems incontrovertible, there is no evidence of any great rush to accept this theoretically better method. The reason, of course, is the impossibility of demonstrating in practice that such a technique will lead to better decisions or improved profits.

Others favoring this more formal approach argue that it will give management more control over the complexities involved in investing in major innovations. This has been variously phrased such as "putting top management in the driver's seat," [6] or "forcing meaningful structure on informal reasoning," [4] or "preventing biasing of estimates." [22] These are, of course, even more nebulous reasons for implementing such models, and certainly they run counter to the recommended organizational behavior. Most behavioral scientists would advocate more loosening of the organization rather than more tightening. Such organizational recommendations seem to have the best implementation record, so far as one can judge by the many firms attempting to provide more freedom to various product centers within their companies.

The basic problem with the arguments for introducing risk into the investment analysis process, however, is what they imply for model builders who wish to implement the models. The logical conclusion from the argument that the many alternatives should be more completely evaluated is that the models should be more analytically sophisticated. This in turn has led to the development of some very powerful models that allow a great deal of flexibility in providing subjective probability estimates and make it possible to handle estimates of complex interaction terms.[21]

If the models are continually revised with the sole purpose of improving the way in which financial results are presented, then they are not likely to be useful in affecting the outcomes of decisions, since the type of financial information they portray has little influence on the final decisions. Unfortunately, this means that they are going in the wrong direction to achieve either implementation or the long-run goal of improved decision making.

If we accept the argument that these models are ideally designed to be tools for top management, the logical conclusion is that top management must be persuaded of the power of the method, trained in the method, and encouraged to make the model a standard operating procedure. Top managers are extremely busy men, however; and even if they are convinced it is impossible for them to force the effective use of the procedure in firms where it may meet with resentment or resistance. While it is true that such procedures will not originate at the bottom and move up, it is equally true that they will not originate from the top and move down.

If they are to be implemented in the firm, then top management must show a sympathetic interest and middle managers an active interest derived from their recognition of how the approach can help them accomplish their responsibilities. The latter point is particularly important in this discussion,which will attempt to show that a risk analysis model can be useful in moving a technical innovation from the prototype stage to the production stage.

One of the major problems in this process is posed by the interdependencies between the various persons in the analysis phase. A typical, though oversimplified, illustration is provided by Figure 1. Assume a new product has been developed by the R and D department, has met the technical requirements as established by the firm, and may be in the pilot-plant phase at evaluation. Someone, presumably the sponsor of this product, decides that the next step is to develop the financial justification for expanding the manufacturing facilities to provide for full-scale marketing of the product.

The people in marketing are asked to prepare a formal sales forecast of the product over the next several years of the planning horizon. To do this, they formulate a pricing and marketing program. Their estimates of annual unit sales are then submitted to a manufacturing engineering group which has the responsibility

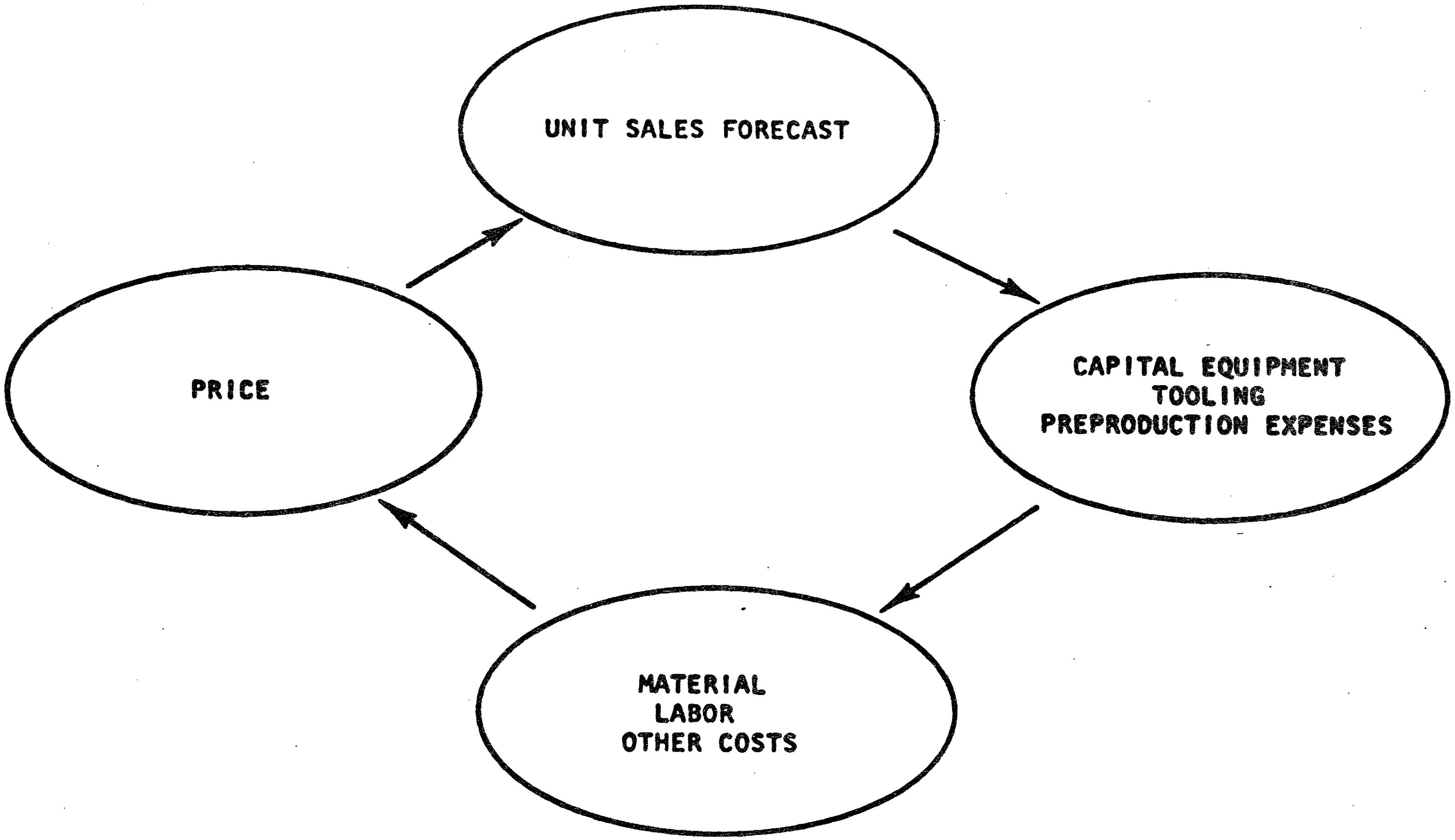

UNIT SALES FORECAST
CAPITAL EQUIPMENT
TOOLING
PREPRODUCTION EXPENSES
MATERIAL
LABOR
OTHER COSTS
PRICE

FIGURE 1

for developing requirements for the type and timing of capital investment, tooling, and the like, based on the particular sales forecast that the group received. Recommendations on whether or not certain parts should be made or bought are often part of this plan.

Altogether, the detailed estimates at this stage may take hundreds of man hours before they are forwarded to the accounting people who are responsible for forecasting unit labor costs, coordinating material costs with purchasing, and estimating other fixed and semifixed costs. All of these cost estimates are conditional on the production plan made earlier. This information is then used to develop cost estimates per unit for each year of the planning horizon. Depending upon the procedures used in a particular firm, the accounting group may develop suggested prices, using cost-plus, target rate of return, or other pricing alternatives, which are submitted to the marketing group for review. A frequent difficulty is that the computed prices may bear little resemblance to the prices assumed by marketing when it prepared the sales forecast. The question then arises whether or not the whole cycle will be repeated, or whether marketing is willing to compromise and assume that the suggested prices will have little effect on the sales forecast. Either situation can create problems in the firm.

Admittedly this example is oversimplified and not typical of all firms, but the trouble does occur often enough to create major problems and feuds between the various departments involved. It is a common source of frustration for an engineering project manager who wants to see his new product introduced by the firm. The important point is the close relation between the standard operating procedures used in firms and the interdependence of units within firms.

It is now possible to consider more fully whether risk analysis should be and will be used. It seems reasonable to assume that decisions can be improved if a fairly complete set of alternatives are considered and if the information that exists within the firm is more fully utilized. These are the arguments usually cited for the use of risk analysis models and they are valid ones. An important justification for the use of a more formal model is that it can reduce some of the existing interdependencies. This can be done with the model to be described. It was one of the important considerations in its design and is an important element in the implementation of all such models.

If the existing analysis procedures create a high degree of interdependence, as illustrated in Figure 1, then it is almost impossible to achieve effective implementation of the model through any decree by top management. That is, if an attempt is made first of all to persuade top management of all the control they will derive from it, then the implementation is probably doomed from the start. If, however, an arrangement is made in which top management has the approach evaluated by the persons involved in the financial analysis of one or two projects, then there is a much greater chance of achieving implementation.

This route to implementation is consistent with the advantage to be gained from it, that is, the way it helps persons responsible for a decision on a specific project,showing them where they collectively stand compared to where they want to go on the project. Thus, the model is ideally designed for the management of information on the project. It is not designed to be a control device by management.

One of the problems that have consistently plagued model building and implementation in management science is that the applicability of the model in a variety of organizational environments has not been sufficiently tested. As a consequence models have been developed that are theoretically complex but not practically useful. In many cases, models are not even tested. A classic example is the theoretical model developed by Wright [23] for investment decision making. After devoting 140 pages to the development of the model, Wright stated that his original intentions were "to test the conclusions empirically by observing a group making a decision," but that the "process of group decision making was so complex that it was impossible to isolate the variables which were to have been analyzed." [23, p. 142]

Wright's dilemma is typical of the problem in developing risk analysis models. In the first place, the idea that the model can be tested by observing a group making a decision is not realistic because decisions evolve in the course of time rather than being made in a single setting. This is especially true of major investment decisions involving innovations. The evolution of the decision process is discussed in detail by Aharoni [1], Bower [2] and Root [15]. Second, as was mentioned earlier here, it is difficult to quantify the advantages of a model. Equally important are the various organizational settings and problem situations that must be examined before evidence can be produced that a particular model or approach is beneficial. This is verified by the work of Lawrence and Lorsch [10 and 11].

Attempts to observe the use of risk analysis in a variety of firms make it clear that this approach is not really needed in all situations. For example, in one of the firms, the working arrangements between the groups did not raise major interdependency problems. The fact that this was the smallest firm in the study indicates that below a certain firm size the model is not really needed.

Even when the model is appropriate, departmental constraints may prevent implementation from being easily achieved, if some persons see it as a threat or intrusion into their normal operating procedures. For example, some accounting analysts are steeped in traditional accounting and unused to thinking in terms of uncertainty and conditional estimates. If members of any one group involved in the analysis process do not see advantages to themselves in using this approach, they can in effect ensure that the procedure will not be used, or at least not used effectively.

The net result of introducing these models as an operating tool to various groups has been mixed. From complete rejection, the implementation ranges to complete acceptance in one firm, which uses it in almost all innovation decisions. The most common pattern has been use on an infrequent basis. That is, firms rely on the model for major investment problems where the alternatives are numerous and complex, but not for all investment decisions.

One of the most effective methods of introducing the risk analysis model into the corporation has been that applied by CPC, International. The steps then employed have been discussed by Stuenkel and Gillespie [18]. Their recommendations include: (1) gaining complete knowledge of the techniques and principles; (2) making the model easily accessible to line managers; (3) achieving understanding and commitment by project management; (4) explaining the process in depth to selected corporate officers; and (5) decentralizing the model for division users. CPC, International has found in-house training seminars to be the most effective way to achieve understanding and implementation.

Some of the considerations that determine whether the model should and can be used have been discussed, but to consider these questions fully, we must understand more about the model, particularly how the model has evolved over repeated uses in several years.

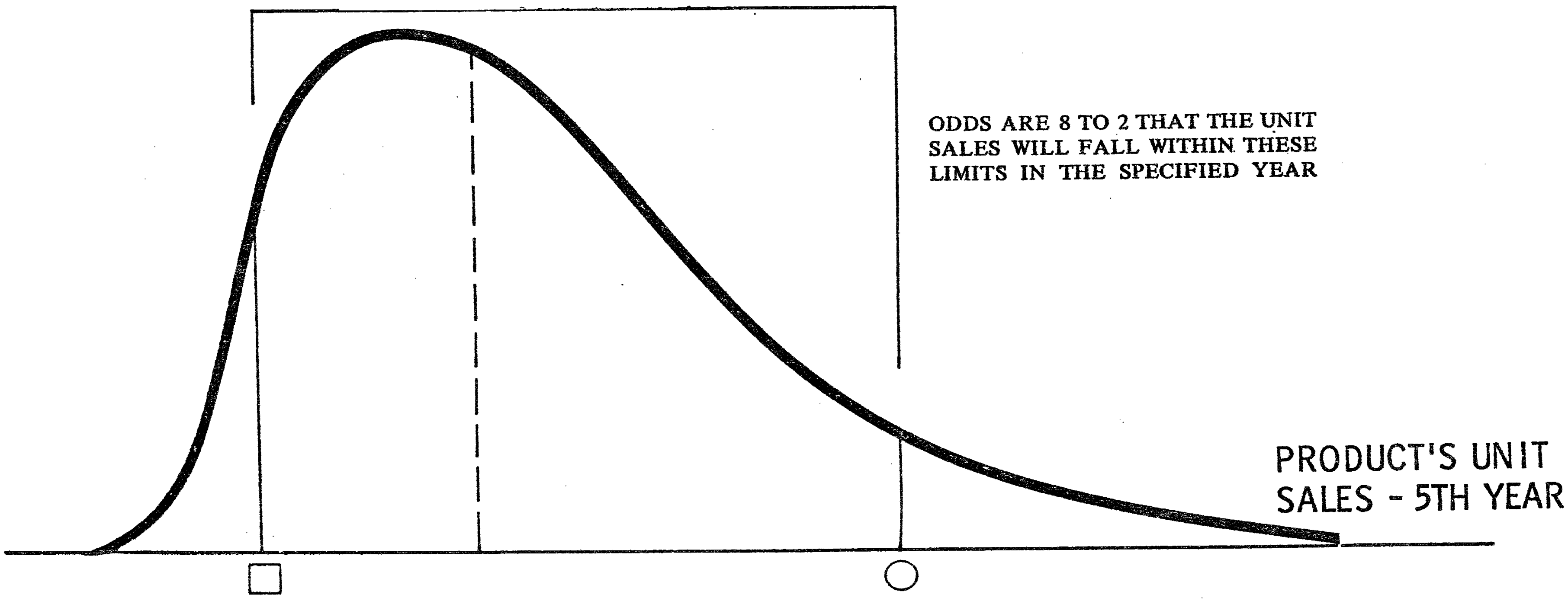
The original model was based on the work of Pessemier [13]. His model was extended by the author on the basis of a variety of applications. As it is briefly described in the next section, this version fulfills a more general purpose than the one currently used in several of the firms participating in the research. Some of these firms have developed custom-made versions that are specifically designed for their own capital investment procedures.

The Computer Simulation Model

This section provides a brief description of the model as it now exists, to permit comparisons between other models with similar objectives and to show the evolving nature of this model. It is important to recognize that the purpose of the model is to help persons in evaluating alternative marketing-manufacturing strategies and in establishing priorities for information. We assume, therefore, that a decision tree analysis precedes the estimation process. The discussion here will be limited to the estimates that can be made for the evaluation of a particular strategy resulting from preliminary discussions. The assumption is that the alternative being evaluated is composed of a set of estimates associated with a marketing plan, a manufacturing plan, and a financial plan.

Before discussing the specific estimates, it is helpful to understand how the subjective probability estimates are obtained. The persons involved in the analysis are asked to provide estimates of the tenth percentile, expected value,and the ninetieth percentile of an assumed lognormal distribution. This is shown graphically in Figure 2. Although an alternative model is available, based on the triangular distribution, all of the firms have been encouraged to use the lognormal version.

The lognormal distribution is preferred because it minimizes the number of estimates required by the persons involved. Only the tenth and ninetieth percentile points are needed to completely define the distribution. Since these are easily understood in terms of the



□ <u>LOWER 10TH PERCENTILE:</u>

THAT LOW ESTIMATE SUCH THAT THERE IS ONLY ONE CHANCE IN TEN THAT THE ACTUAL OUTCOME WILL BE BELOW THIS FIGURE.

○ <u>UPPER 90TH PERCENTILE:</u>

THAT HIGH ESTIMATE SUCH THAT THERE IS ONLY ONE CHANCE IN TEN THAT THE ACTUAL OUTCOME WILL BE ABOVE THIS FIGURE.

FIGURE 2

problem (where a variance estimate would not be), estimators have no particular difficulty in providing the estimates. There is no evidence that the estimates require appreciably more time than single-point estimates, though they may if the estimator needs to make several percentile estimates to describe a probability distribution more completely.

It should be pointed out that the estimate provided for the mean may not be the same as that calculated from the percentiles. Many times it is not clear if the single-point estimate is the median or mode of the distribution. For this reason, the computed mean is always printed as part of the output, so that it may be readily compared to the estimated mean. Few discrepancies showed up between the two figures, but when these occur they always need to be examined. For special problems, it was found necessary to use a negative lognormal distribution, but this rarely happened.

One of the points often raised by model builders is whether or not the computer model should derive a distribution that would fit the percentiles and the estimated mean. Computationally it is possible to do this through the use of a subroutine. It frequently requires, however, assumptions that are difficult to justify. One problem is that some estimators cannot easily distinguish between the mean, mode, and median in a distribution. Another very practical problem is that some users want to provide what they call the "best estimate." They know it is different from the mean, but they consider it necessary for a variety of political reasons.

What must be recognized is that compromises are often necessary in the model in order to suit the convenience of the user. There are good reasons for opposing any procedure that requires the addition of more than two estimates to what persons are already using. Providing five or more estimates of percentiles would demand an undue amount of time in the context of most problems. Consider, for example, the estimate of unit sales. The typical project has three or four distinct product types, at least two marketing strategies, and a planning horizon of ten years. It will require estimates of sixty to eighty probability distributions. Most market analysts are involved in several activities or projects in the firm and therefore cannot devote as much time to each estimate as either they or the model builder would like to have.

An even more important consideration is the context in which the model is being used. The primary use of the model is to allow everyone in the project to gain a feeling of the collective financial status of the project and to be able to make rough comparisons of alternative strategies. Each one is able to do this quickly, as the model is now constituted. The model is to aid the project team, not to make servants of it. Since many factors will affect the final decision regarding the status of the project as it moves through the firm, there is every need to keep the estimation procedures from becoming unnecessarily complicated.

The Marketing Plan

The model provides the flexibility to utilize estimates of the wide variety of product types that a firm may offer when it makes an investment in new facilities for a new product. In some cases, as in the present example, a basic product may be offered in different sizes.* Here the product line consists of a series of motors of different sizes that range in horsepower ratings from 1 HP to 100 HP. In other situations, one product may be a basic hardware item such as a copying machine and the other product the supplies, such as chemically treated paper, that would be sold as a result of selling the machine. In this situation, the planning horizons of the products may be different, and the product's life cycle curves would generally be different.

After it has been determined what product categories will be estimated, the next requirement is to develop one or more marketing strategies. On the basis of the defined strategies, the unit sales are estimated. The specific estimates available for the marketing plan are shown in Table 1. One part of the computer output is the listing of the estimates and the computer means. These are shown in Table 2.

Several additional items of output information are available for the use of the marketing estimators. For example, Table 3 shows

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* The examples used in this description are based on a case prepared for classroom purpose by the author. The case is: "Avon Corporation: A Consultant's Computer Analysis of Pricing Strategy. (Boston: Intercollegiate Case Clearinghouse, ICH 3M39R). The examples here represent a more recent version of the model than provided in this case. A more recent version of the case is being prepared.

TABLE 1

Marketing Strategy Estimates for New Product Analysis Model
for Each Product Type or Market Segment

	10th Percentile	Best	90th Percentile
Unit price	X	X	X
Promotional expenditures		X	
Unit sales	X	X	X
Marketing cost as a percentage of sales		X	

TABLE 2

AVON CORPORATION, ELECTRIC ADJUSTABLE SPEED DRIVE, MAY , 1968, HIGH PRICE STRAT.

O. SENSITIVITY ANALYSES	0	NUMBER OF PRODUCTS	7
OST VOLUME BREAKS	7	SALVAGE VALUE (%)	1.000
EARS CONSIDERED	11	OPPORTUNITY COST OF CAPITAL	.100
ORPORATE TAX RATE	0.48	NUMBER OF TRIALS	200
EPRECIATION IN UNIT COST	NO	COST % CUMULATIVE INVESTMENT	.0
ERMINAL CASH FLOW EARNINGS MULTIPLE	0		

YEAR	ESTIMATED ANNUAL UNIT PRICE MEAN	PERCENTILES 10TH	PERCENTILES 90TH	COMPUTED MEAN PRICE	ESTIMATED ANNUAL UNIT SALES MEAN	PERCENTILES 10TH	PERCENTILES 90TH	COMPUTED MEAN UNITS	PROMOTIONAL COSTS
				PRODUCT 1					
69	0.001	0.001	0.001	0.001	1.	1.	1.	1.	0.
70	1050.000	1030.000	1080.000	1054.883	40.	39.	41.	40.	0.
71	1000.000	960.000	1080.000	1019.312	181.	168.	188.	178.	0.
72	1000.000	940.000	1080.000	1009.053	285.	264.	304.	284.	0.
73	960.000	880.000	1080.000	978.009	368.	326.	420.	372.	0.
74	960.000	860.000	1080.000	967.564	437.	388.	488.	437.	0.
75	910.000	800.000	1080.000	935.924	521.	440.	595.	515.	0.
76	910.000	780.000	1100.000	934.672	540.	446.	630.	535.	0.
77	890.000	750.000	1100.000	918.516	548.	442.	650.	542.	0.
78	890.000	730.000	1152.000	931.716	572.	453.	700.	571.	0.
79	865.000	690.000	1125.000	897.260	539.	413.	672.	536.	0.
				PRODUCT 2					
69	0.001	0.001	0.001	0.001	1.	1.	1.	1.	0.
70	1460.000	1430.000	1500.000	1464.836	27.	26.	28.	27.	0.
71	1390.000	1310.000	1500.000	1403.746	121.	112.	128.	120.	0.
72	1390.000	1300.000	1500.000	1398.607	191.	177.	204.	190.	0.
73	1330.000	1220.000	1500.000	1357.188	246.	219.	269.	244.	0.
74	1330.000	1200.000	1500.000	1346.747	294.	260.	325.	292.	0.
75	1265.000	1110.000	1500.000	1299.304	350.	295.	400.	346.	0.
76	1265.000	1090.000	1520.000	1298.072	360.	300.	420.	358.	0.
77	1240.000	1040.000	1540.000	1280.509	365.	295.	435.	362.	0.
78	1240.000	1020.000	1560.000	1278.921	380.	305.	465.	382.	0.
79	1200.000	960.000	1560.000	1245.971	360.	280.	450.	361.	0.

TABLE 3

M A R K E T I N G   P L A N

AVCN CORPORATION, ELECTRIC ADJUSTABLE SPEED DRIVE, MAY , 1968, HIGH PRICE STRAT.

NUMBER OF PRODUCTS 7
COST VOLUME BREAKS 7
NUMBER OF YEARS CONSIDERED 11

YEAR	AVERAGE ANNUAL DOLLAR SALES	AVERAGE ANNUAL UNIT PRICE	PRODUCT MIX % OF TOTAL DOLLAR SALES PROD 1	PROD 2	PROD 3	PROD 4	PROD 5	PROD 6	PROD 7
69	0.	0.	14.3	14.3	14.3	14.3	14.3	14.3	14.3
70	302770.	2432.	14.0	13.1	19.9	16.9	16.3	10.7	9.1
71	1294747.	2344.	14.1	12.9	20.1	17.0	16.0	10.9	9.0
72	2042851.	2303.	13.9	13.1	20.1	17.0	16.1	11.0	8.8
73	2540951.	2239.	14.1	13.1	19.9	17.0	16.0	10.9	9.0
74	3039271.	2245.	14.0	12.7	20.2	17.1	16.1	11.0	9.0
75	3419861.	2151.	14.1	12.8	19.9	17.1	16.1	11.0	9.1
76	3546736.	2162.	13.7	13.0	19.9	17.0	16.1	11.2	9.0
77	[illegible]	2132.	13.6	13.2	20.1	16.8	16.2	11.3	8.9
78	3568528.	2138.	13.9	13.1	20.3	17.1	15.6	11.2	8.8
79	3354775.	2067.	13.6	13.3	19.7	16.9	16.2	11.4	8.9

the total annual dollar sales for the combined seven products, the average unit price (which is useful in observing the net effect of the pricing plan), and the product mix. These data are summary statistics from the 200 simulation passes of the program. Additional outputs which are available to show the percentiles and expected values of the total annual dollar sales and the cumulative dollar sales are illustrated in Table 4. Although a plotting routine is possible in the program, the output is usually shown only in tabular form.

It should be noted that the variances of the distributions, either input or output are never directly stated. Although these were provided in earlier versions of the program, they were not greatly useful to estimators who were comparing alternative marketing plans.

One of the questions model builders often ask about marketing estimates is whether or not more dependencies between unit prices and unit sales should be built into the program. It is certainly reasonable to expect that if the simulated price exceeded the expected value the simulated unit sales should be below the expected value. An earlier version of the program utilized a function to incorporate this relationship. Although some marketing estimators used this feature in early runs of the program, no one consistently relied on it. Most estimators did not use it at all. The present version of the program does not provide this option, because it was not believed to be useful to marketing estimators.

TABLE 4

AVON CORPORATION, ELECTRIC ADJUSTABLE SPEED DRIVE, MAY , 1968, HIGH PRICE STRAT.

I. DOLLAR SALES ANALYSIS

A. INDIVIDUAL YEAR PERCENTILES

EAR	P=.10	P=.25	P=.50	P=.75	P=.90	EXPECTED VALUE
69	0.	0.	0.	0.	0.	0.
70	299036.	300936.	302458.	304889.	306625.	302770.
71	1256530.	1276373.	1293193.	1313515.	1337476.	1294747.
72	1960799.	1998533.	2038811.	2089403.	2130010.	2042851.
73	2385874.	2448939.	2546794.	2613838.	2684506.	2540951.
74	2861249.	2943385.	3036681.	3137071.	3210101.	3039271.
75	3144418.	3295276.	3437498.	3545317.	3672127.	3419861.
76	3262134.	3399540.	3544554.	3677709.	3834629.	3546736.
77	3179453.	3321348.	3526037.	3704832.	3886349.	3527669.
78	3281675.	3451747.	3664590.	3854772.	4050892.	3668528.
79	2968325.	3124510.	3326782.	3561864.	3795605.	3354775.

B. CUMULATIVE DOLLAR SALES PERCENTILES

EAR	P=.10	P=.25	P=.50	P=.75	P=.90	EXPECTED VALUE
69	0.	0.	0.	0.	0.	0.
70	299036.	300936.	302458.	304889.	306625.	302770.
71	1558994.	1579252.	1595132.	1616817.	1640466.	1597505.
72	3549782.	3594039.	3636503.	3681814.	3726600.	3640345.
73	5987458.	6073661.	6189904.	6274829.	6345907.	6181347.
74	8976565.	9069830.	9222274.	9361799.	9467374.	9220677.
75	12268311.	12446394.	12625675.	12828225.	13009730.	12640606.
76	15688624.	15933793.	16158080.	16419996.	16710165.	16187421.
77	19106064.	19361120.	19696240.	20066800.	20346544.	19715168.
78	22661200.	22963728.	23329872.	23776144.	24174528.	23383584.
79	25869840.	26261712.	26713088.	27173456.	27669280.	26738192.

An interesting problem is why this price-sales interdependency was not considered necessary or useful. Part of the difficulty comes from a lack of time. To require that an estimator explicitly consider this relationship for the many estimates made in the course of analyzing a complex new product program is simply asking too much. More important, however, is that estimators had considered the essential elements of the price-volume relationship when they made their estimates. They argued that once they defined a marketing strategy which is predominantly derived from a pricing curve they had captured the most important elements of this relationship. The variance in the pricing estimates was very small compared to the variance of the unit sales estimates. Thus, estimators were willing to accept the small amount of inconsistency in the relationship in order to gain the benefits of reduced estimating time.

Another aspect of the estimates required in developing the marketing plan is the lack of an explicit statement of how sales of the new products will affect the sales of existing products. This product interdependency issue has been discussed at length by Urban and is one of the features of the SPRINTER model.[21] This factor is undoubtedly important in many, although not all, new product programs. Really the problem is how the estimators prefer to structure this element of the analysis. The approach in this computer model is to allow estimators to state the effects directly, rather than through the use of a mathematical function. One way of doing this is to assume that one of the products being estimated represents existing products and to place negative values on the unit prices. This would have the effect of reducing sales revenues. Another approach is to make direct estimates of the effects on profits. This can be entered as a negative annual fixed cost if the new product line is expected to have an adverse influence on the profits of existing products.

Another program option was available in earlier versions of the program, the serial correlation function for the unit sales. Most marketing estimators would agree that the growth rate of a new product presents the most challenging aspect of the analysis. It was thought, therefore, that a function which explicitly recognized the serial correlation in sales would be a useful feature in analyzing the growth rate problem. The program feature would adjust the mean of the distribution of annual unit sales on the basis of cumulative simulated unit sales. Thus, if the estimator believed that if sales in early years were below average the sales in later years would consequently fall below average, he could easily indicate this belief. Again, this feature was used only to a limited extent and was removed from the present version of the program. The greatest difficulty was that the feature had no corresponding analogue in the usual estimation procedures. Even though many marketing analysts agreed that it was a theoretical improvement, it was not viewed as a practical improvement.

One last example will illustrate the evolutionary process that the current model has undergone. In the original model, it was possible explicitly to consider different competitive environments for a given marketing strategy. That is, the user could provide several sales forecasts for the same marketing strategy and assign a conditional probability estimate to each. The program would provide a financial analysis for the different marketing environments and then calculate a weighted average for them all. This is, of course, the procedure used in computing the uncertainty branch of a decision tree.

Users preferred to concentrate on the results of each of the individual competitive environments and essentially ignored the weighted average results, an attitude that is consistent with the difficulties of implementing the decision-tree approach. One of the problems with this particular option was that estimators did not ordinarily consider the competitive environment in any explicit manner. The usual reason for introducing it into the analysis was to answer a "what if..." type of question. It was simply easier in marketing estimation to show the expected effects of competitive reactions by using the individual environments rather than the expected value of many environments. So long as the basic goal of the analysis was to represent the current status of the project rather than to present results that would be used for a final decision, such an approach was actually more reasonable than the decision-tree method. For these reasons, the current program does not offer the option to estimate conditional competitive environments.

What is important is that the model should always make it as easy as possible for the estimator to structure the problem. The most useful way of doing this is to provide flexibility in the program, so that factors may be stated directly in accounting terms rather than indirectly through the use of mathematical functions. Since the program is intended to be used at several points during the evolutionary process of moving from the R and D prototype to the construction of new facilities, the model must be convenient and must show the important economic factors. That is, the model is designed to be a useful tool in analysis and not to indicate explicitly the ultimate decision.

The Manufacturing Plan

In connection with a given marketing plan, there may be one or more manufacturing plans to be evaluated. The elements of the manufacturing plan, which are shown in Table 5, will be briefly discussed here to show the flexibility that permits the structuring of many different problem situations. The discussion will follow the procedure generally used in cost estimation, that is, determining the investments required in plant and equipment, the fixed and semifixed costs, and the variable costs.

Capital Investment Plan. The capital investment requirements are stated for each year of the planning horizon in terms of best estimate and the tenth and ninetieth percentiles. The size and timing of the capital investment are the critical items in determining the annual capacity available for each product. The investment alternatives most often evaluated are a large initial investment that will provide adequate capacity during most of the planning period,compared with

TABLE 5

MANUFACTURING STRATEGY ESTIMATES

FOR

NEW PRODUCT ANALYSIS MODEL

		ESTIMATES		
		10th Percentile	Best	9th Percentile
1)	FOR EACH YEAR OF THE PLANNING HORIZON:			
	CAPITAL INVESTMENTS	X	X	X
	FIXED MANUFACTURING COSTS	X	X	X
2)	FOR EACH PRODUCT TYPE FOR EACH YEAR:			
	CAPACITY LIMITATIONS		X	
3)	FOR EACH PRODUCT TYPE FOR APPROPRIATE VOLUME:			
	UNIT VARIABLE COST	X	X	X

a smaller initial investment that will be expanded at least once during the project planning period.

The investment plan is one of the most critical elements of the total analysis because of the many ways in which it affects other aspects of the analysis. This is the point where a great deal of cooperation is required to reconcile the engineering and marketing estimates. For example, will the capacity provided be designed to match the ninetieth percentile unit sales estimates or be based on the best estimates? Are there logical incremental investment steps that affect the capacity? If so, the marketing estimators need to know what they are in order to develop realistic marketing plans.

Unfortunately, the usual approach is to develop the manufacturing plan on the basis of a sales forecast consisting of annual single-point unit sales estimates. Some manufacturing engineers view their job as finding the best investment plan for a given sales forecast, even though they are generally critical of the validity of the forecast. Their recognition of the importance of developing and presenting alternative investment plans would be a valuable aid to marketing planners.

In addition to the capital investment estimates, the annual fixed costs are usually required for a complete determination of the capacity needed by product and by year. These costs, which would cover tooling, rearrangement, and the like, are also stated with uncertainty estimates.

A valuable part of the computer analysis in coordinating the marketing and investment plans is information about the effects of capacity limitations. At the end of the 200 simulations, the average annual "lost sales" are calculated for each product, both in units and dollars. These are calculated as the difference between simulated sales and capacity for each simulation run (see Table 6). Capacity limitations are an optimal feature of the program.

Manufacturing Cost Estimates. The computer model is flexible enough to handle the variety of accounting methods and analysis situations required for estimating costs associated with a new product investment proposal. The three broad categories that are available are annual fixed costs, cost as a percentage of sales for overhead allocations, and unit variable costs. These categories may not always suffice for the rigorous classifications needed in accounting, but they generally provide the flexibility needed for structuring the problem situation.

The fixed manufacturing costs for a given strategy are stated in terms of a best estimate and the tenth and ninetieth percentiles. These generally include tooling costs, any plant rearrangement costs, and so on. Depreciation is not included in these estimates because of cash flow calculations. Other annual fixed costs, depreciation, and cost as a percentage of sales are discussed under the financial plan.

Unit Variable Costs. Such items as material and labor costs are generally estimated on a per unit basis because they are variable costs. Usually, however, there will be different levels of these costs for different levels of capacity because of cost breaks on material purchases, different tooling rates, experience curve effects, and

TABLE 6

AVON CORPORATION, ELECTRIC ADJUSTABLE SPEED DRIVE, MAY , 1968,HIGH PRICE STRAT.

AVERAGE $$ SALES LOST DUE TO PLANT CAPACITY LIMITATIONS

YEAR	PRODUCT 1	PRODUCT 2	PRODUCT 3	PRODUCT 4	PRODUCT 5	PRODUCT 6	PRODUCT 7
69	0.	0.	0.	0.	0.	0.	0.
70	0.	0.	0.	0.	0.	0.	0.
71	0.	0.	0.	0.	0.	0.	0.
72	0.	0.	0.	0.	0.	0.	0.
73	0.	0.	0.	0.	0.	0.	0.
74	0.	0.	0.	0.	0.	0.	0.
75	2940.	954.	1557.	0.	3219.	0.	491.
76	9008.	579.	1677.	96.	8144.	0.	634.
77	8765.	570.	6748.	2630.	10570.	0.	1320.
78	23924.	7566.	28854.	6345.	28408.	635.	4380.
79	12472.	6674.	12374.	2206.	18091.	780.	2438.

DOLLAR VALUE OF UNUTILIZED PLANT CAPACITY

YEAR	PRODUCT 1	PRODUCT 2	PRODUCT 3	PRODUCT 4	PRODUCT 5	PRODUCT 6	PRODUCT 7
69	1.	0.	0.	0.	0.	0.	0.
70	591370.	620152.	884827.	862068.	692417.	616957.	432186.
71	431539.	459520.	658795.	664222.	509078.	488490.	330352.
72	317126.	362514.	467799.	527118.	381201.	391473.	260887.
73	222697.	275828.	369542.	415423.	284927.	331290.	205710.
74	163828.	212321.	259512.	327901.	195259.	260209.	148705.
75	86250.	135179.	146848.	225343.	111970.	200132.	95806.
76	70855.	123889.	134133.	199158.	84180.	182224.	91344.
77	66170.	114892.	125842.	198378.	77637.	173793.	88071.
78	57300.	102127.	80691.	162460.	74454.	166470.	79123.
79	75106.	121687.	129308.	201636.	91113.	173827.	91005.

other circumstances. Thus, the program accepts estimates of these variable costs by product type and by volume range, as shown in Table 7. To ensure the conditional nature of unit costs, the program first selects a simulated unit volume for a product; then a sample is drawn from the appropriate cost-volume break.

It should be emphasized that the cost-volume breaks are assumed to be applicable over several years of the planning horizon. That is, the costs are conditional upon a given manufacturing plan and a given annual sales volume. This is a quite different approach from that used by most accounting departments when they develop a unit cost for each year.

To handle manufacturing plans involving a plant expansion that will change the cost-volume relationships during the time horizon, a cost control vector is provided. Thus, it is possible to show one set of cost-volume breaks for the first six years of the project, for example, and a different cost-volume relationship in the remaining six years of the project in evaluating the effects of a plant expansion.

An option is also provided under which the experience curve, or learning curve, may be incorporated into the simulation. If this option is used, the program uses cumulative unit sales for the determination of the appropriate cost distribution. The reason for the number of alternatives available for cost estimation lies in the methods of treating costs. In this reas, more than any other, the program has been changed to provide maximum flexibility.

TABLE 7

Unit Variable Costs, Avon Corporation

COST CONTROL VECTOR 1 PRODUCT 2 LEARNING OPTION = NO

ESTIMATED COST PER UNIT MEAN	PERCENTILES 10TH	PERCENTILES 90TH	ANNUAL PROD. LESS THAN STATED UNITS	CALCULATED MEAN
790.00	750.00	870.00	750.	809.13
735.00	700.00	810.00	1125.	754.22
680.00	650.00	750.00	1500.	699.30
630.00	600.00	690.00	2250.	644.39
577.00	550.00	635.00	2625.	591.91
560.00	525.00	605.00	3000.	564.45
525.00	500.00	580.00	6000.	539.42

COST CONTROL VECTOR 1 PRODUCT 3 LEARNING OPTION = NO

ESTIMATED COST PER UNIT MEAN	PERCENTILES 10TH	PERCENTILES 90TH	ANNUAL PROD. LESS THAN STATED UNITS	CALCULATED MEAN
1320.00	1250.00	1450.00	625.	1348.56
1230.00	1170.00	1350.00	937.	1258.75
1140.00	1080.00	1250.00	1250.	1163.79
1050.00	1000.00	1150.00	1875.	1073.98
970.00	920.00	1070.00	2187.	993.90
924.00	880.00	1015.00	2500.	946.56
880.00	840.00	970.00	5000.	904.09

To aid in the evaluation of a particular manufacturing plan, a summary of information is prepared, as shown in Table 8. This is useful in determining the average in unit variable costs across all products and showing the relationship between manufacturing fixed costs and other cost components.

The Financial Plan

After the marketing and manufacturing plans have been formulated, additional financial estimates are needed to determine the economic effects that the proposed venture may have on the firm. Just as there are numerous combinations of marketing-manufacturing strategies that might be evaluated, numerous considerations will influence the financial plan for a proposal. One of the obvious questions is what criteria should be developed. Although many articles in academic journals have attempted to prove the superiority of present value over ROI, the fact is that most firms want to see both measures. They also want to see many other measures, such as annual cash flows, annual profits, and profits as a percentage of sales. Since all of these measures are easily calculated, there is no problem in providing all of these data in various formats.

The situation that creates more concern with the financial estimates required for an analysis is the need to provide results for several management levels. Most commonly the need is to show how the project will look to a division of a corporation as well as how it will appear as a corporate investment. For example, it is usually

TABLE 8

M A N U F A C T U R I N G   P L A N

AVCN CORPORATION, ELECTRIC ADJUSTABLE SPEED DRIVE, MAY , 1968, HIGH PRICE STRAT.

NUMBER OF PRODUCTS 7
DEPRECIATION IN UNIT COST 0.000
NUMBER OF YEARS CONSIDERED 11

YEAR	AVERAGE ANNUAL UNIT VARIABLE COSTS	AVERAGE ANNUAL VARIABLE COSTS	AVERAGE ANNUAL MFG. FIXED COSTS	AVERAGE ANNUAL OTHER FIXED COSTS	AVERAGE ANNUAL DEPREC.	AVERAGE ANNUAL MFG. COSTS	FIXED COSTS AS A % OF TOTAL COSTS
69	3178.	22249.	1.	1.	62710.	62712.	73.8
70	1560.	194253.	5000.	20211.	83486.	108698.	35.9
71	1551.	856927.	9999.	20179.	104077.	134256.	13.5
72	1540.	1366218.	14999.	201381.	124635.	341016.	20.0
73	1527.	1732706.	21999.	161208.	124635.	307842.	15.1
74	1545.	2091690.	22999.	133582.	124635.	281217.	11.9
75	1525.	2425623.	23999.	106809.	124635.	255444.	9.5
76	1534.	2517271.	23999.	80950.	124635.	229585.	8.4
77	1533.	2536904.	23999.	53358.	124635.	201992.	7.4
78	1529.	2623869.	23999.	40445.	124635.	189080.	6.7
79	1533.	2489402.	28000.	25971.	104077.	158048.	6.0

COMMENTS:

necessary to prepare a divisional analysis which uses straight-line depreciation, no taxes, and no terminal year project cash flows.

This approach shows how the project will affect the division's statements. It is then also necessary to show how the project will look when it is reviewed by corporate management, when accelerated depreciation is used, when federal taxes are included, and when future earnings beyond the planning horizon are included. In addition to these variations, it is necessary to provide flexibility to show the influence of such variables as full costing rather than incremental costing, and so on. Because of the variety of situations that are usually considered during the analysis process, there are extensive financial estimates available, as shown in Table 9.

Cost Estimates for the Financial Plan. The three cost categories most often used by the persons coordinating the financial analysis are depreciation, other fixed costs, and costs as a percentage of sales. The depreciation estimates are conditional on the capital investment schedule and are entered as single-point estimates. There is a routine in the computer model which adjusts the depreciation on the basis of the uncertainty reflected in the investment estimates. Although some of the companies using the model have their own subroutines for calculating depreciation, this is not a feature of the general-purpose model discussed here.

Other annual fixed costs, which usually include additional R and D expenditures among other things, are entered as a best estimate

TABLE 9

FINANCIAL PLAN ESTIMATES

FOR THE

NEW PRODUCT ANALYSIS MODEL

DEPRECIATION SCHEDULE

OTHER ANNUAL FIXED COSTS

COST AS A PERCENT OF SALES - BY PRODUCT BY YEAR

WORKING CAPITAL REQUIREMENTS
(As Percent of Sales or Percents of Costs of Goods Sold-by Year)

TERMINAL YEAR OPTION

TAX RATE

DISCOUNT RATE FOR PRESENT VALUE

RETURN ON INVESTMENT CALCULATION OPTION

and with tenth and ninetieth percentiles. The cost as a percentage of sales is entered by product line by year. In many analysis situations, the dollar expenditures are estimated for each of the first few years, and the cost as a percentage of sales is low for these years. In those instances the normal overhead rate is used in the last few years to cover R and D, selling expense, and so on.

Other Financial Estimates. The investment in working capital--cash, net receivables, inventories--is calculated in the program by using the estimates of working capital either as a percentage of sales or a percentage of cost of goods sold. These estimates are provided for each year at the planning horizon and are computed on an incremental basis.

It is also necessary to show how the cash flows of the terminal year of the project are to be treated. The options usually used are to assume that the investment in working capital will be returned to the project and that the book value of the capital investment will be returned as some percentage of the actual book value. An option is available to estimate the future worth of the project by using a multiple of earnings. Options are usually chosen according to whether the results are being presented to a corporate financial committee or to divisional management.

The estimates of tax rate and discount rate are standard for these types of models. It should be observed, however, that the discount rate is viewed as an opportunity cost rate, which is quite a different interpretation thanthe cost of capital often discussed in financial literature.

Five different options are available for computing the return on investment. The procedure most often used is the method proposed by Teichroew, Robichek and Montalbano.[19] Both the ROI and the present value figures are viewed as useful summary figures, rather than being advanced as the only or even the most important criteria for evaluating the project.

Financial Summary Information. The type of financial summary information that is available from the computer model is listed in Table 10. The model is designed to develop annual cash flows, and all other factors are derived from this procedure. It was found necessary to provide the information in a variety of formats. For example, the cash flow analysis is portrayed in tabular form, as shown in Table 11, for each year and cumulatively by percentiles and average. The profit information is summarized in a similar form, as shown in Table 12. Options are available for plotting this information as part of the output.

A summary of important financial criteria is also shown in Table 13. Here the average profits, cash flows, and profit as a percentage of sales are summarized. In addition, the present values and the rate of return are portrayed by selected percentiles by averages. The frequency distributions for present value and rate of return are also available, as shown in Table 14.

At the bottom of the frequency distribution for the present value outcomes (Table 14) there is an item labeled "Risk = .175." This is the proportion of the 200 simulations that have a negative present

TABLE 10

FINANCIAL SUMMARY INFORMATION AVAILABLE

FROM

NEW PRODUCT ANALYSIS MODEL

TYPE	PROBABILITY ANALYSIS
PROFIT CONTRIBUTION BY PRODUCT TYPE	
FINANCIAL SUMMARY--BEST ESTIMATES ONLY	
DOLLAR SALES BY PRODUCT	
SALES LOST DUE TO CAPACITY SHORTAGE	
VALUE OF UNUTILIZED CAPACITY	
ANNUAL PROFIT AS % OF SALES	
ANNUAL DOLLAR SALES	YES
ANNUAL PROFITS	YES
ANNUAL CASH FLOWS	YES
CUMULATIVE DOLLAR SALES	YES
CUMULATIVE PROFITS	YES
CUMULATIVE CASH FLOWS	YES
RETURN ON INVESTMENT	YES
PRESENT VALUE	YES
SENSITIVITY ANALYSIS	

TABLE 11

AVON CORPORATION, ELECTRIC ADJUSTABLE SPEED DRIVE, MAY , 1968, HIGH PRICE STRAT.

II CASH FLOWS ANALYSIS

A. INDIVIDUAL YEAR CASH FLOWS PERCENTILES

YEAR	P=.10	P=.25	P=.50	P=.75	P=.90	EXPECTED VALUE
69	-2371449.	-2117617.	-1824818.	-1604916.	-1444383.	-1875530.
70	-217453.	-181614.	-142023.	-117094.	-91069.	-151164.
71	-80968.	-51594.	-20464.	14294.	40954.	-20466.
72	191943.	210692.	231424.	251099.	267559.	230790.
73	271842.	295126.	325502.	355416.	380594.	327045.
74	342364.	373542.	404482.	443472.	473685.	408144.
75	345243.	387106.	450641.	501994.	545222.	449266.
76	381881.	455296.	493883.	541245.	597270.	495696.
77	373182.	429301.	500509.	560062.	628217.	499310.
78	383732.	439985.	511204.	603596.	661904.	522511.
79	1483507.	1591037.	1729620.	1907595.	2075566.	1754150.

B. CUMULATIVE CASH FLOWS PERCENTILES

YEAR	P=.10	P=.25	P=.50	P=.75	P=.90	EXPECTED VALUE
69	-2371449.	-2117617.	-1824818.	-1604916.	-1444383.	-1875530.
70	-2504560.	-2264919.	-1995412.	-1745459.	-1610505.	-2026688.
71	-2507664.	-2306376.	-2034706.	-1770089.	-1639338.	-2047155.
72	-2254708.	-2066118.	-1790698.	-1554979.	-1416114.	-1816368.
73	-1917663.	-1732202.	-1479828.	-1246507.	-1085076.	-1489344.
74	-1514234.	-1333951.	-1092266.	-825709.	-673856.	-1081200.
75	-1095341.	-853354.	-626656.	-372852.	-247887.	-631929.
76	-526553.	-348309.	-135002.	111161.	288380.	-136229.
77	-80749.	111618.	375152.	629465.	797394.	363077.
78	453223.	612397.	867973.	1148674.	1324553.	885594.
79	2291228.	2429180.	2603395.	2839011.	3042760.	2639714.

TABLE 12

AVON CORPORATION, ELECTRIC ADJUSTABLE SPEED DRIVE, MAY , 1968, HIGH PRICE STRAT.

III PROFIT ANALYSIS

A. INDIVIDUAL YEAR PROFIT PERCENTILES

EAR	P=.10	P=.25	P=.50	P=.75	P=.90	EXPECTED VALUE
69	-52875.	-48516.	-43308.	-39328.	-36618.	-44179.
70	-15425.	-8481.	-2439.	2395.	7049.	-3243.
71	120222.	132938.	144592.	156462.	169553.	144383.
72	113893.	132978.	152239.	175656.	193903.	153287.
73	167427.	198834.	236526.	265049.	296211.	233790.
74	240713.	273445.	315227.	351802.	397488.	314901.
75	235202.	285051.	349497.	402395.	468689.	348606.
76	262217.	322217.	377161.	431428.	485639.	379052.
77	229810.	283512.	370360.	448258.	530111.	373472.
78	247813.	311772.	399086.	497870.	556345.	406749.
79	164145.	234853.	325998.	417847.	503911.	332917.

B. CUMULATIVE PROFITS PERCENTILES

EAR	P=.10	P=.25	P=.50	P=.75	P=.90	EXPECTED VALUE
69	-52875.	-48516.	-43308.	-39328.	-36618.	-44179.
70	-67171.	-56547.	-45651.	-36873.	-30047.	-47422.
71	57423.	78077.	97980.	115149.	130319.	96963.
72	192877.	217091.	249087.	280451.	309829.	250250.
73	383796.	429622.	482227.	531442.	577717.	484044.
74	661098.	732082.	807750.	863309.	930558.	798950.
75	949388.	1028036.	1153292.	1248469.	1326736.	1147562.
76	1322697.	1404973.	1526932.	1637883.	1749214.	1526607.
77	1634357.	1745928.	1906917.	2031344.	2146051.	1900069.
78	1988910.	2132260.	2291285.	2460097.	2616652.	2306805.
79	2291223.	2429175.	2603391.	2839009.	3042757.	2639713.

TABLE 13

FINANCIAL PLAN

AVCN CORPORATION, ELECTRIC ADJUSTABLE SPEED DRIVE, MAY , 1968, HIGH PRICE STRAT.

EARS CONSIDERED	11
UMBER OF PRODUCTS	7
UMBER OF TRIALS	200
ORPORATE TAX RATE	0.48
ALVAGE VALUE	1.000
PPORTUNITY COST OF CAPITAL	0.10

YEAR	AVERAGE NET PROFITS (A.T.) ANNUAL	CUMULATIVE	AVERAGE NET CASH FLOWS ANNUAL	CUMULATIVE	RETURN ON SALES A.T.
69	-44179.	-44179.	-1875530.	-1875530.	0.0
70	-3243.	-47422.	-151164.	-2026694.	-1.07
71	144383.	96961.	-20466.	-2047160.	11.15
72	153287.	250248.	230790.	-1816369.	7.50
73	233790.	484039.	327045.	-1489323.	9.20
74	314901.	798940.	408144.	-1081179.	10.36
75	348606.	1147546.	449266.	-631913.	10.19
76	379052.	1526598.	495696.	-136217.	10.69
77	373472.	1900070.	499310.	363093.	10.59
78	406749.	2306818.	522511.	885604.	11.09
79	332917.	2639735.	1754150.	2639754.	9.92

PERCENTILES

	P=.10	P=.25	P=.50	P=.75	P=.90	EXPECTED VALUE
ATE OF RETURN	0.100	0.100	0.110	0.130	0.150	0.118
RESENT VALUE	-87835.	55840.	232676.	412100.	534553.	235577.

Comments:

TABLE 14

AVON CORPORATION, ELECTRIC ADJUSTABLE SPEED DRIVE, MAY , 1968,HIGH PRICE STRAT.

DISTRIBUTION FOR PRESENT VALUE OUTCOMES

.... RANGE		....	FREQUENCY
-672844.	TO	-517813.	1.
-517812.	TO	-362780.	1.
-362779.	TO	-207748.	7.
-207747.	TO	-52715.	17.
-52714.	TO	102317.	35.
102318.	TO	257350.	46.
257351.	TO	412382.	43.
412383.	TO	567415.	33.
567416.	TO	722447.	13.
722448.	TO	877471.	4.

RISK = 0.175

DISTRIBUTION FOR RATE OF RETURN OUTCOMES

RATE	FREQUENCY
0.070	1.
0.080	1.
0.090	11.
0.100	57.
0.110	35.
0.120	26.
0.130	28.
0.140	19.
0.150	12.
0.160	5.
0.170	3.
0.180	2.

value. This figure of 17.5 per cent is, of course, the same as the percentage of the rate-of-return calculations that fall below the opportunity cost of capital. The reason for labeling this figure "risk" is that it is the most widely used single measure of the effects of uncertainty in evaluating alternative strategies. To analysts this measure, which represents the chances of falling below a goal rate, is of more value than variance or other measures often associated with risk. Results shown by Aharoni [2] in his study of the analysis of foreign investments accord with this observation.

The financial information discussed thus far has portrayed the summary probability distribution data. This, however, is not the first information that the analysis participants want to examine. The first data to be examined are the results of the run using only the best estimates for each of the variables. The financial summary thus derived (Tables 15 and 16) becomes the control information for comparing the results of the strategy with the usual accounting procedures. A detailed profit contribution is computer for each product (Table 15), and the financial summary for all products is developed (Table 16). Any model that does not provide this type of information for comparison with the accounting records is not likely to be implemented.

An additional feature of this program that is often used is the sensitivity analysis, an option that allows the analyst running the simulation to remove the uncertainty about selected variables. For example, it is possible to determine the effects of uncertainty in only

TABLE 15

AVON CORPORATION, ELECTRIC ADJUSTABLE SPEED DRIVE, MAY , 1968,HIGH PRICE STRAT.,

FINANCIAL SUMMARY USING BEST ESTIMATES

SIMULATION NUMBER 0 RATE OF RETURN 0.120 PRESENT VALUE = 285942.

PRODUCT 1

YEAR	UNIT SALES	UNIT PRICE	UNIT COST	DOLLAR SALES	VARIABLE DOLLAR COST	COSTS AS A % OF SALES	PROMOTIONAL COSTS	PROFIT CONTRIBUTION
69	1.	0.001	450.000	0.	450.	0.	0.	-450.
70	40.	1050.000	450.000	42000.	18000.	840.	0.	23160.
71	181.	1000.000	450.000	181000.	81450.	3620.	0.	95930.
72	285.	1000.000	450.000	285000.	128250.	5700.	0.	151050.
73	368.	960.000	450.000	353280.	165600.	7066.	0.	180614.
74	437.	960.000	450.000	419520.	196650.	8390.	0.	214480.
75	521.	910.000	450.000	474110.	234450.	9482.	0.	230178.
76	540.	910.000	450.000	491400.	243000.	9828.	0.	238572.
77	548.	890.000	450.000	487720.	246600.	9754.	0.	231366.
78	572.	890.000	450.000	509080.	257400.	10182.	0.	241498.
79	539.	865.000	450.000	466235.	242550.	9325.	0.	214360.

PRODUCT 2

YEAR	UNIT SALES	UNIT PRICE	UNIT COST	DOLLAR SALES	VARIABLE DOLLAR COST	COSTS AS A % OF SALES	PROMOTIONAL COSTS	PROFIT CONTRIBUTION
69	1.	0.001	790.000	0.	790.	0.	0.	-790.
70	27.	1460.000	790.000	39420.	21330.	788.	0.	17302.
71	121.	1390.000	790.000	168190.	95590.	3364.	0.	69236.

TABLE 16

Financial Summary

ALL PRODUCTS

YEAR	DOLLAR SALES	CUMULATIVE	VAR. COSTS	MFG. COSTS	OTHER COSTS	COSTS AS A % OF SALES	PROMOTIONAL COSTS	PROFIT CONTRIBUTION
69	0.	0.	21760.	1.	1.	0.	0.	-21760.
70	302370.	302370.	190510.	5000.	20000.	6047.	0.	105812.
71	1287790.	1590160.	848280.	10000.	20000.	25756.	0.	413754.
72	2034280.	3624440.	1329530.	15000.	199000.	40686.	0.	664064.
73	2521190.	6145630.	1708390.	22000.	159000.	50424.	0.	762376.
74	2997760.	9143390.	2030870.	23000.	132000.	59955.	0.	906935.
75	3387735.	12531125.	2389890.	24000.	106000.	67755.	0.	930090.
76	3520410.	16051535.	2484560.	24000.	80000.	70408.	0.	965442.
77	3467460.	19518992.	2495470.	24000.	53000.	69349.	0.	902641.
78	3635510.	23154496.	2618440.	24000.	40000.	72710.	0.	944360.
79	3313075.	26467568.	2460810.	28000.	26000.	66261.	0.	786003.

YEAR	ANNUAL INVESTMENT	COSTS AS % OF INVESTMENT	ANNUAL DEPRECIATION	ANNUAL CHANGE IN WORKING CAPITAL	ANNUAL (A.T.) EARNINGS CASH FLOW	ANNUAL NET CASH FLOW	ANNUAL PROFITS DOLLARS	AFTER TAXES % OF SALES
69	1850000.	0.	61250.	0.	18084.	-1831916.	-43166.	0.0
70	219049.	0.	81250.	19049.	81023.	-138027.	-227.	-0.08
71	262081.	0.	101250.	62081.	248152.	-13929.	146902.	11.41
72	47030.	0.	121250.	47029.	292233.	245204.	170983.	8.41
73	30676.	0.	121250.	30675.	360516.	329839.	239266.	9.49
74	30025.	0.	121250.	30024.	449206.	419181.	327956.	10.94
75	24569.	0.	121250.	24568.	474247.	449678.	352997.	10.42
76	8360.	0.	121250.	8359.	506150.	497790.	384900.	10.93
77	-3335.	0.	121250.	-3336.	487533.	490868.	366283.	10.56
78	10588.	0.	121250.	10587.	515987.	505399.	394737.	10.86
79	-1285294.	0.	101250.	-208723.	429242.	1714535.	327992.	9.90

the marketing estimates by deleting the uncertainty in the manufacturing costs and other costs. This is done by a program option in which only the best estimates are used on the costs. Sensitivity analysis of this kind is useful in determining the value and priority of seeking additional information to reduce the uncertainty surrounding certain estimates.

The Computer Analysis Cost

One of the important considerations in the use of a model of this type is the cost of running the computer program. The computer program, written in FORTRAN IV, was originally developed for the IBM 7094. Since then it has been adopted for a variety of computers ranging from the IBM 360-40 to the IBM 360-67 used at the University of Michigan. The computer cost, on the larger machines, runs from \$2.00 to \$25.00 per run depending on the number of products estimated and the type of output needed. In the early stages of the analysis, when only summary information is needed, and for the typical run of three or four products, the cost is about \$5.00 per run.

Conclusions

To date the investigation into the application of a risk analysis model has shown that the model can be valuable to persons concerned with moving their product innovation through the firm to the point where approval is obtained for investment in new facilities. To achieve these benefits, the model must be oriented to a user. This may mean sacrificing some features that would be nice to have because they are more theoretically advanced but are not needed--at least in early stages of model building and implementation. Implementation, as it has been used in this report, means that the use of the model can change the behavior of participants in the analysis process. This is quite different from simply showing that persons are able to make the necessary estimates of important variables of the model.

Whether or not procedural methods such as the computer model described in this report will ever improve the decisions that a firm makes about new products is simply not known. The question is rather like asking whether advertising improves profits. In both instances, satisfactory answers would be extremely important to management but they can never be furnished. The position taken in this paper is that there are valid reasons for using a risk analysis approach. If decisions about investing in innovations can be improved by allowing more opportunities to propose and evaluate important alternatives and incorporating all of the available information, then the use of this type of model is worthwhile. These benefits were observed in the analysis.

Regardless of the tasks defined by higher management for the analysis group, the participants in the analysis play a vital role in the development of new products. If the group's assigned or perceived role is to develop a single alternative to be presented to the higher managers of a firm, then the approach used to develop that alternative is crucial. If the function of the analysis group is to present several alternatives, then a thorough job of analysis remains a central necessity. A tightly structured analysis procedure under which participants are discouraged from raising the many exploratory questions that are requisite for developing alternatives could result in more harm than good. Implementation of models such as the computer simulation program can be recommended because of its advantages either to top managers of a firm or to the participants of the analysis group. The observations of this study suggest that justifications for implementation be based on the benefits that can be obtained for the analysis group. Benefits to higher management and to the firm should accrue as a result of this use.

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