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Method of Investment Evaluation for Smaller Companies

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Lack of staff specialization often handicaps the small company, preventing it from trying advanced methods of deciding between alternative investment opportunities. Here's a simple method that can be used effectively by such concerns—

A METHOD OF INVESTMENT EVALUATION FOR SMALLER COMPANIES

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In our competitive economy the efficient use of productive resources, and specifically of capital, is vital to the survival and success of a firm. The theory of capital budgeting has been developed rapidly in recent decades, making available to management a number of sophisticated tools for investment evaluation.

However, comparatively few of these tools so far have found their way to widespread operational application.

This is particularly true for the smaller companies, and yet it is these companies which often operate under the most severe competition and for which, therefore, efficient allocation of capital resources is most essential. With the increasing complexity of today's business environment, even the decisions faced by a small company attain a degree of intricacy that generally makes intuitive solutions at best suboptimal.

A number of reasons can be given for this paradox, among them lack of awareness and lack of management education. Perhaps the most important reason is the objection on small-company management's part that most of these "academic" tools involve such complicated analysis that their application is not feasible in the small organization that cannot afford expensive staff specialists. This article, based on a successful implementation of a sophisticated yet operational procedure for investment evaluation in a small company, seeks to show how small companies also can make use of and benefit from today's more advanced methods of capital budgeting. It gives a brief review of some basic elements of modern capital budgeting theory and then presents a proposed scheme for operational implementation of these ideas.

Return on investment

Total return per dollar invested (along with various closely related criteria such as average annual return per dollar invested and total profit per dollar invested) is probably still the most widely used criterion for evaluating business investments today. The total return which an investment will yield over the years is simply added and then divided by the intial investment. Thus, an initial investment of $10,000 which will yield an annual re-

TABLE COMPARING DISCOUNTED RETURNS FROM TWO PROPOSED INVESTMENTS

	Year	1	2	3	4	5
Proposition 1	Initial investment	$10,000				
	Return		$8,000	$6,000	$1,000	$0
Proposition 2	Initial investment	$10,000				
	Return		$4,000	$4,000	$4,000	$4,000

. . . the first major adjustment which should be made by a firm in computing the total return per dollar invested is the inclusion of the time value of money, thus computing the present value of total returns in relation to the present value of initial investment.

turn of $2,000 for eight years will result in a total return of $1.60 per dollar invested.

A major shortcoming of such an approach is that it does not take into consideration what is called the time value of money. A dollar today is worth more than a dollar a year from now; if nothing else, the dollar which we have today can be put in a bank, and interest can be collected on it. The time value of money can be included in the analysis by discounting future costs and benefits to yield what is called their present values.

Assume that a company has the opportunity to invest money at an annual rate of return of 15 per cent: $10,000 invested today would grow to $11,500 a year from now, to $13,200 two years from now (compounding the interest), etc. Hence, the firm would be equally well off receiving $10,000 today, $11,500 a year from now, or $13,200 two years from now. In effect, the present value of $11,500 received a year from now is $10,000, and so is the present value of $13,200 received 2 years hence.

Discount rate

The rate of return which we used to derive these present values is called the discount rate. Generally, if we call the discount rate k, the present value of income n years from now is given by the standard compound interest formula to be:

$$\text{Present value of income n years hence} = \frac{\text{income n years hence}}{(1+k)^n}.$$

Extensive published interest tables are available to derive the value of $(1 + k)^n$.

The discount rate generally represents the "alternative opportunity rate," i.e., the average annual rate of profit per dollar invested available to the firm as an alternative to the investments actually undertaken. As we saw, a company can always put its money into the bank or buy short-term paper to earn an annual profit of 6 per cent. In most cases, however, for a healthy company the discount rate (i.e., the alternative opportunity rate) will be considerably higher; the company may actually forego investment opportunities yielding 10 per cent and higher simply because it has enough opportunities yielding above 15 per cent to fully utilize its management and capital resources.

Since the discount rate is based on the alternative investment opportunities, it clearly varies from one company to another;[1] furthermore, it will vary over time as the general climate of investment opportunities varies in any dynamic business environment. Consequently, a company will use an average discount rate to eliminate short-term fluctuations due to the ran-

[1] One can generally say that, other things being equal, the higher the alternative opportunity rate the better the performance of the company's management in locating lucrative investment opportunities.

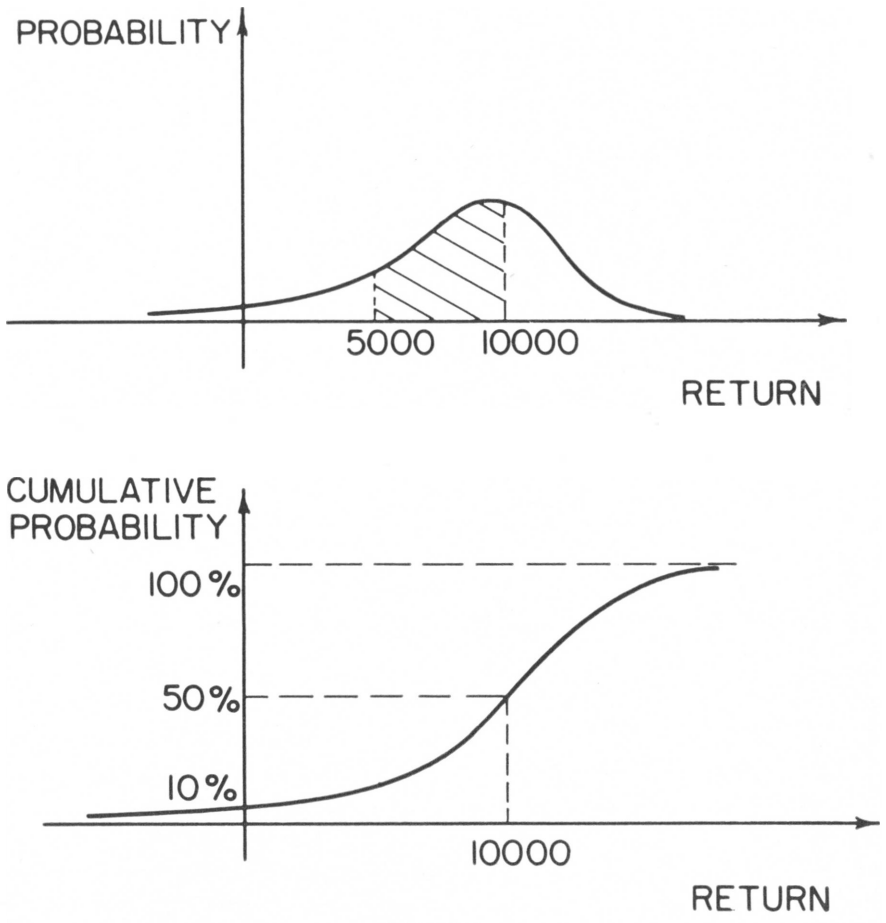

FIGURE 1
Probability Distributions

dom nature of the availability of investment opportunities; however, it will adjust this average periodically to reflect major changes in the general business environment, such as major changes in the industry or in the general economy.

Hence, the first major adjustment which should be made by a firm in computing the total return per dollar invested is the inclusion of the time value of money, thus computing the present value of total returns in relation to the present value of initial investment. For example, consider the two investment propositions described in the table on page 44.

The total returns per dollar of initial investment are 1.5 and 1.6, respectively; hence, by this criterion, Proposition 2 should be preferred. However, considering the time value of money and assuming a discount rate of 15 per cent, the present values of total returns per dollar invested are 1.06 and 1, respectively. We see that now Proposition 1 is the more desirable. The reason for this reversal in preferences is that in Proposition 1 the returns accrue at an earlier time; they can be reinvested immediately, thereby accumulating additional benefits.

Risk

Another major weakness of the standard return on investment criterion is its failure to account for the uncertainties inherent in any business forecast and hence in any prediction about the profitability of an investment. If we say that an investment of $10,000 will yield total returns of $15,000, we do not really mean that this return will be guaranteed. Rather, we may mean that the probability of achieving a return of $15,000 or better is 70 per cent. However, there may be a probability of 10 per cent that we will achieve no positive return at all, thus losing the initial investment of $10,000.

A manager is generally concerned not only with some expected return of a proposition but also with the risk inherent in it, in particular the risk of substantial losses. Hence, a manager should analyze investments in probabilistic terms. Thus, he may wish to know in the above example what the probability is of incurring losses rather than making a positive return, with what probability a return of at least $10,000 will be achieved, or what level of returns will be achieved with a probability of 80 per cent. Such probabilistic assessments are best conveyed in the form of graphs such as those shown in Figure 1 at left.

Both parts of the figure convey the same information in slightly different form. Thus, it is generally a matter of taste and convenience which of the two one wants to use. The upper graph in Figure 1 gives the probability of returns' falling within a certain range. This probability is simply proportional to the area under the curve within

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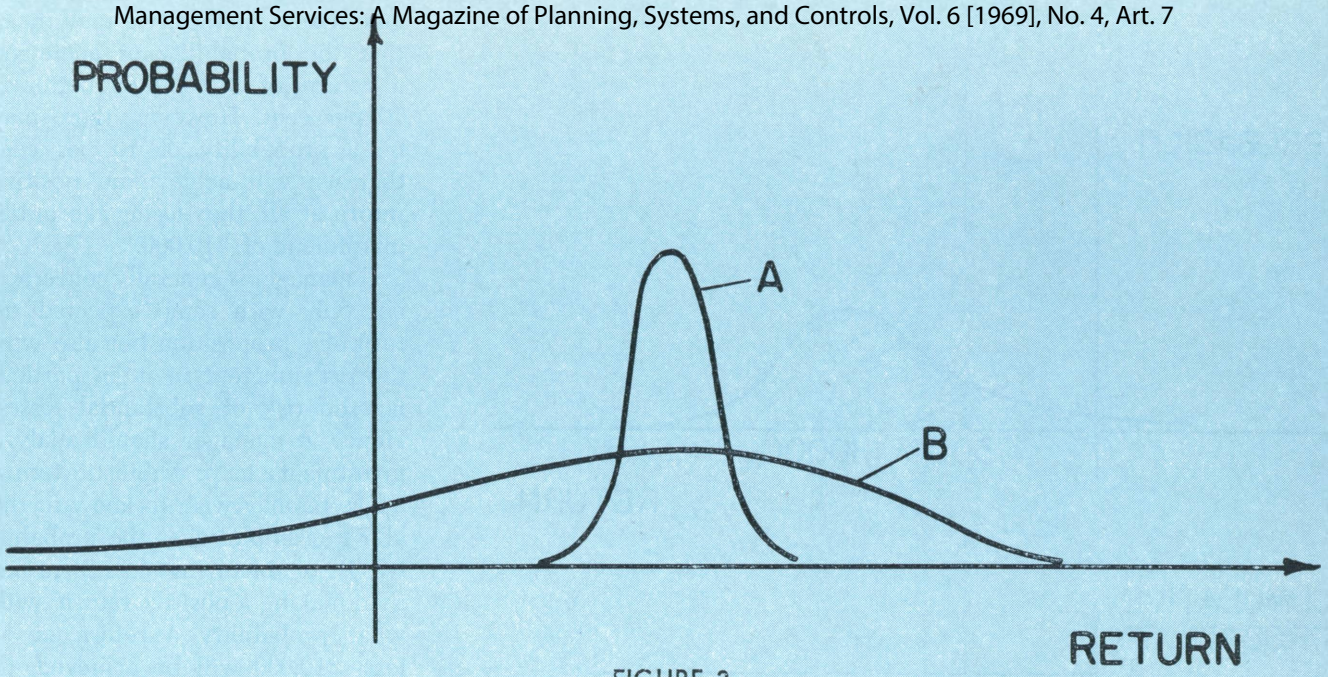

FIGURE 2
Comparative Probability Distributions

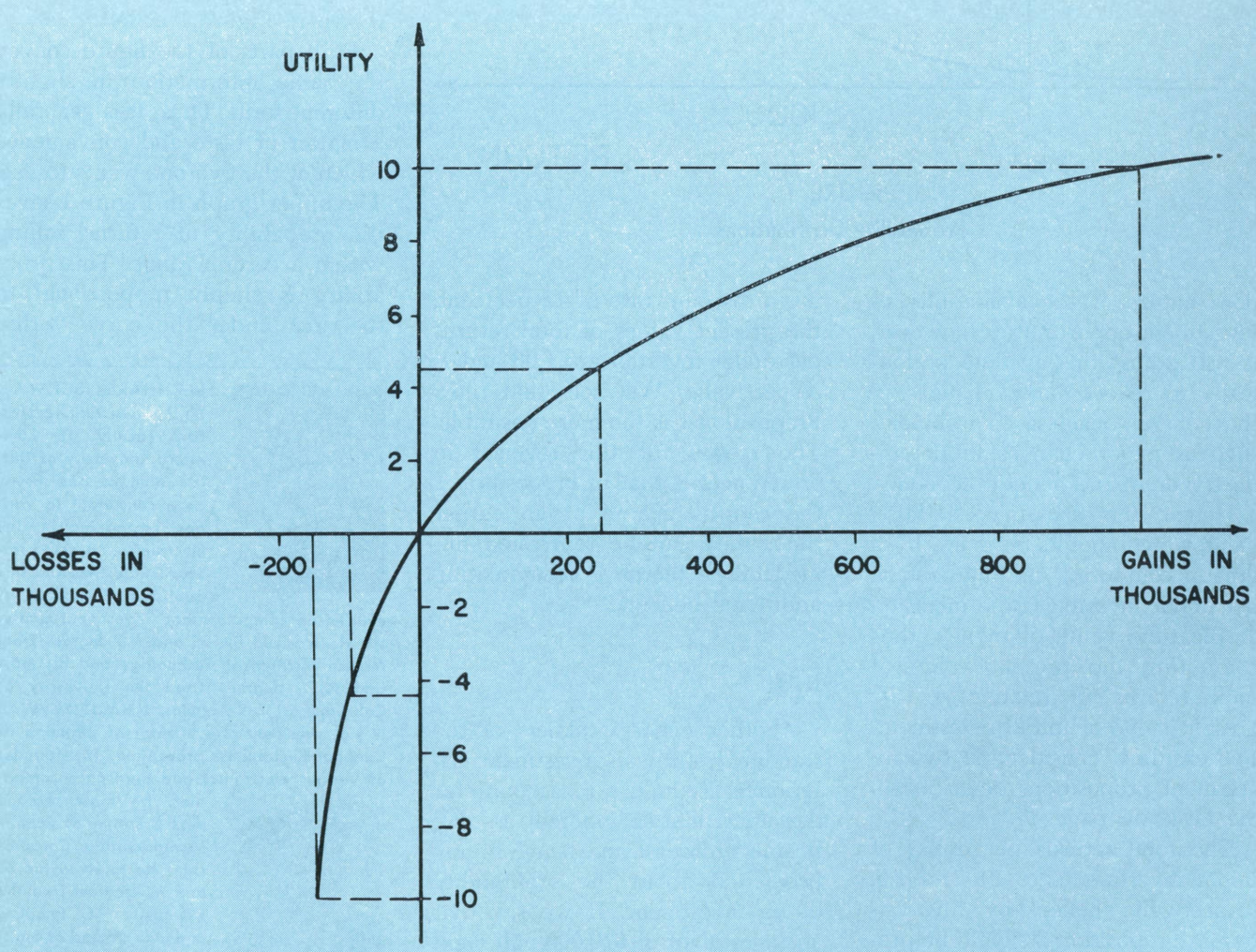

FIGURE 3
Utility Curve

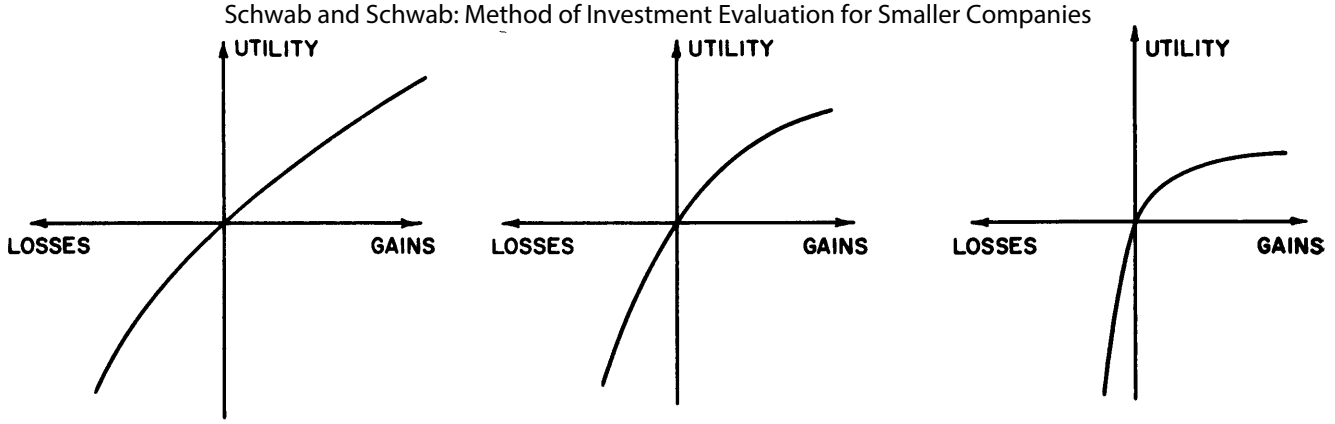

FIGURE 4
Comparative Utility Functions

the range (e.g., the shaded area in the upper part of Figure 1 represents the probability of returns' being between $5,000 and $10,000). The lower graph in Figure 1, called the cumulative probability distribution, gives the probability of returns' falling below a certain limit (e.g., according to this graph, the probability of returns lower than $10,000 equals 50 per cent, and the probability of returns below 0, i.e., a loss, equals 10 per cent).

If we consider only some average or expected return of investment propositions, the preference ranking is trivial: The higher the expected return per dollar invested the better the proposition. However, consider two investment propositions, called A and B, which are described by the probability curves shown in Figure 2 on page 46. Both propositions may in effect yield the same average return; however, Proposition B involves considerably more uncertainty than Proposition A—it represents much more of a gamble, with a possible potential for large gains but also for large losses. Thus, while the expected returns may be equal for both propositions, management may well not be indifferent between the two propositions (e.g., a conservative management averse to risk may reject Proposition B and accept Proposition A—and would do so even if Proposition B should yield a somewhat higher average return than Proposition A). In fact, the ranking of such investment alternatives wil be significantly influenced by management's attitude toward risk, or, in the language of modern decision theory, by management's utility of money gains and losses, i.e., by the relative value which management places on gains and on losses.

Utility curves

Again, such an attitude toward gains or losses is best represented graphically by deriving a "utility curve" as shown in Figure 3 on page 46. In this graph, the vertical distance between the curve and the horizontal line is a measure of the value placed on a given investment outcome (gain to the right or loss to the left). From Figure 3 it would follow that the positive value placed on the gain of the first $100,000 is greater than the value placed on the gain of $100,000 (i.e., the value placed on a gain of $200,000 is less than twice the value placed on a gain of $100,000). Furthermore, the negative value placed on a loss of $100,000 is just as large as the positive value placed on a gain of $250,000; i.e., a 50 per cent chance of making a profit of $250,000 would just be offset by a 50 per cent chance of losing $100,000, and management would be indifferent regarding such a proposition. Similarly, a 50 per cent chance of making a profit of $1,000,000 would be offset by a 50 per cent chance of losing $150,000.

Figure 4 above shows various possible utility functions. The graph on the right represents the most conservative position, i.e., the highest degree of risk aversion (the negative value placed on the loss of a given amount far exceeds the positive value placed on a gain of the same amount), and the graph on the left represents the most liberal position where almost equal values are assigned to gains and losses. The middle graph represents an intermediate position.

Thus, before being able to make intelligent and consistent investment decisions, management has to ask itself consciously what values it places on possible gains and losses. It will generally find that its utility curve is somewhat adverse to risk (i.e., follows the general curvature as shown in the middle and righthand graphs in Figure 4), placing higher negative values on losses than positive values on commensurate gains. Few companies would undertake an investment which will result in a 50 per cent chance of a $100,000 loss even if there is a probability of 50 per cent of making a profit of $100,000, and most will prefer In-

vestment Proposition A over Proposition B in Figure 2. Again, the company's particular utility curve may vary over time—e.g., the negative value placed on losses is likely to depend on the general financial position of the company and hence should be revised periodically, especially if the company goes through a stage of rapid internal development.

It follows, then, that it is inadequate to evaluate investment propositions merely on the basis of their expected total return on investment as was illustrated in the table. Ideally, in evaluating an investment proposition, we would like to derive the probability distribution of the net present value of the benefits to be derived from the investment. We would then assign a personal value derived from our particular utility curve to the present value of each of the possible gains or losses as given by the probability distribution. From this, we could derive the expected value which the investment proposition has to us, thus obtaining a truly valid measure of our preferences in the evaluation of investment alternatives.

However, while it is very valuable to have a clear conceptual understanding of what it is one ideally wants to accomplish, from an operational point of view one might have to compromise such an ideal analysis simply because of the time and costs needed to carry it out. In following the well known rule, "as accurate as necessary—as simple as possible," one needs to balance the costs of carrying out an analysis with the benefits to be derived from it. Thus, simplifications will have to be introduced in the analysis to make it operational for everyday use, especially by the small company—preferably without losing the essential qualities inherent in such sophisticated analysis. It is in this light that the following procedure for investment evaluation—which is being used successfully in the everyday investment decisions of a small company—should be viewed.

INVESTMENT EVALUATION FORM

TITLE BLOCK

PROPOSITION _____ DATE _____ SHEET ____ OF ____
PREPARED BY _____ STUDY BASE _____
ESTIMATES BY: SALES _____ PROFIT _____ EQUIPMENT _____ OTHER _____
DISCOUNT RATE _____ DATA POINT _____ REMARKS _____

PROFIT

		1ST YR.	2ND YR	3RD YR.	4TH YR.	5TH YR.
		COMPOUNDED DISCOUNT RATE AT 15%				
		87	76	66	57	50
1	VOLUME CONTRIBUTION					
2	PROFIT CONTRIBUTION, % BEFORE TAX					
3	PROFIT CONTRIBUTION, $ BEFORE TAX					
4	TAX (50% OF LINE 3)					
5	RETAINED PROFIT (LINE 3 MINUS LINE 4)					
6	DISCOUNTED PROFIT (YEARLY)					
7	DISCOUNTED PROFIT (CUMULATIVE)					

WORKING CAPITAL

8	ACCOUNTS RECEIVABLE (____ DAYS)					
9	INVENTORY (____ DAYS @ ____%)					
10	OTHER					
11	TOTAL WORKING CAPITAL (LINES 8,9,+10)					
12	DISCOUNTED WORKING CAPITAL (YEARLY)					
13	DISCOUNTED WORKING CAPITAL (CUMULATIVE)					
14	SALVAGE VALUE (YEARLY)					
15	DISCOUNTED SALVAGE VALUE (YEARLY)					

DEPRECIABLE CAPITAL INVESTMENT

16	FACILITIES AND EQUIPMENT (YEARLY)					
17	DISCOUNTED FACILITIES AND EQUIPMENT (YRLY)					
18	DISCOUNTED FACILITIES AND EQUIPMENT (CUM.)					
19	DEPRECIATION (YEARLY)					
20	DISCOUNTED DEPRECIATION (YEARLY)					
21	DISCOUNTED DEPRECIATION (CUMULATIVE)					
22	SALVAGE VALUE (YEARLY)					
23	DISCOUNTED SALVAGE VALUE (YEARLY)					

START-UP EXPENSES

24	DEVELOPMENT	
25	PROMOTION	
26	OTHER	
27	SUBTOTAL (TAX DEDUCTABLE, LINES 24,25+26)	
28	EFFECTIVE SUBTOTAL (LINE 27 MINUS 50% TAX SHIELD)	
29	MANAGEMENT (____ DAYS @ ____ $)	
30	TOTAL (LINES 28+29)	

FIGURE OF MERIT THIS DATA POINT

		1ST YR.	2ND YR.	3RD YR	4TH YR.	5TH YR. + TOTAL
31	DISCOUNTED RETURN (CUMULATIVE, LINES 7,15,21+23)					
32	DISCOUNTED INVESTMENT (CUMULATIVE, LINES 30,13+18)					
33	RETURN ON INVESTMENT (LINE 31 OVER 32, YEARLY)					
34	NET PRESENT VALUE (LINE 31 MINUS 32, YEARLY)					
35	UTILITY OF TOTAL NET PRESENT VALUE					
36	PERCENT PROBABILITY THIS DATA POINT					
37	FIGURE OF MERIT THIS DATA POINT (LINE 35 x LINE 36)					

FIGURE 5

Simplified procedure

As in many other cases, a certain degree of standardization in procedures is vital for successful implementation of new ideas. Hence, in order to make the application of a sophisticated approach to investment evaluation operational, standardized forms were developed to be filled out by managers throughout the company when proposing investments. These

forms are shown in Figure 5 on page 48 and Figure 6 below.

It should be noted that these forms were developed for use in a small manufacturing enterprise. Thus, while the general concepts are widely applicable to a variety of investment situations, the particular layout of these forms is geared to investment decisions in a manufacturing environment.

Before giving a detailed description of the individual entries on these forms, let us briefly discuss their overall structure. In consideration of the probabilistic nature of investments, various data points are evaluated. In striking the balance between operational simplicity and accuracy, it was decided to evaluate discrete data points corresponding to various probability levels rather than a continuous probability distribution. Generally, three such points are evaluated[2]: a "most likely," a "pessimistic," and an "optimistic." These data points are chosen in such a way that the estimated probability of doing worse than the pessimistic data point or better than the optimistic data point is 10 per cent, as shown in Figure 7 on page 50.

One sheet is filled out for each data point, resulting in a figure of merit for this data point. These individual figures of merit are combined to give the overall figure of merit for the proposition on the summary sheet shown in Figure 6.

The individual evaluation sheet (Figure 8 on page 51) is divided into various sections. The title block simply serves to provide general information for purpose of identification. Various sections follow: Profit, Working Capital, Depreciable Capital Investments, and Start-Up Expenses. These sections are distinguished as a basis for deriving total return and investment for the proposition. Return is derived as the sum of profits, depreciation (from the section "depreciable capital investment"), and salvage values (from the sections "working capital" and "depreciable capital investments"), all appropriately discounted to give their present values. Total investment is given as the sum of start-up expenses, working capital, and depreciable capital investments, also all appropriately discounted. As is seen from the form, figures are only derived for the first five

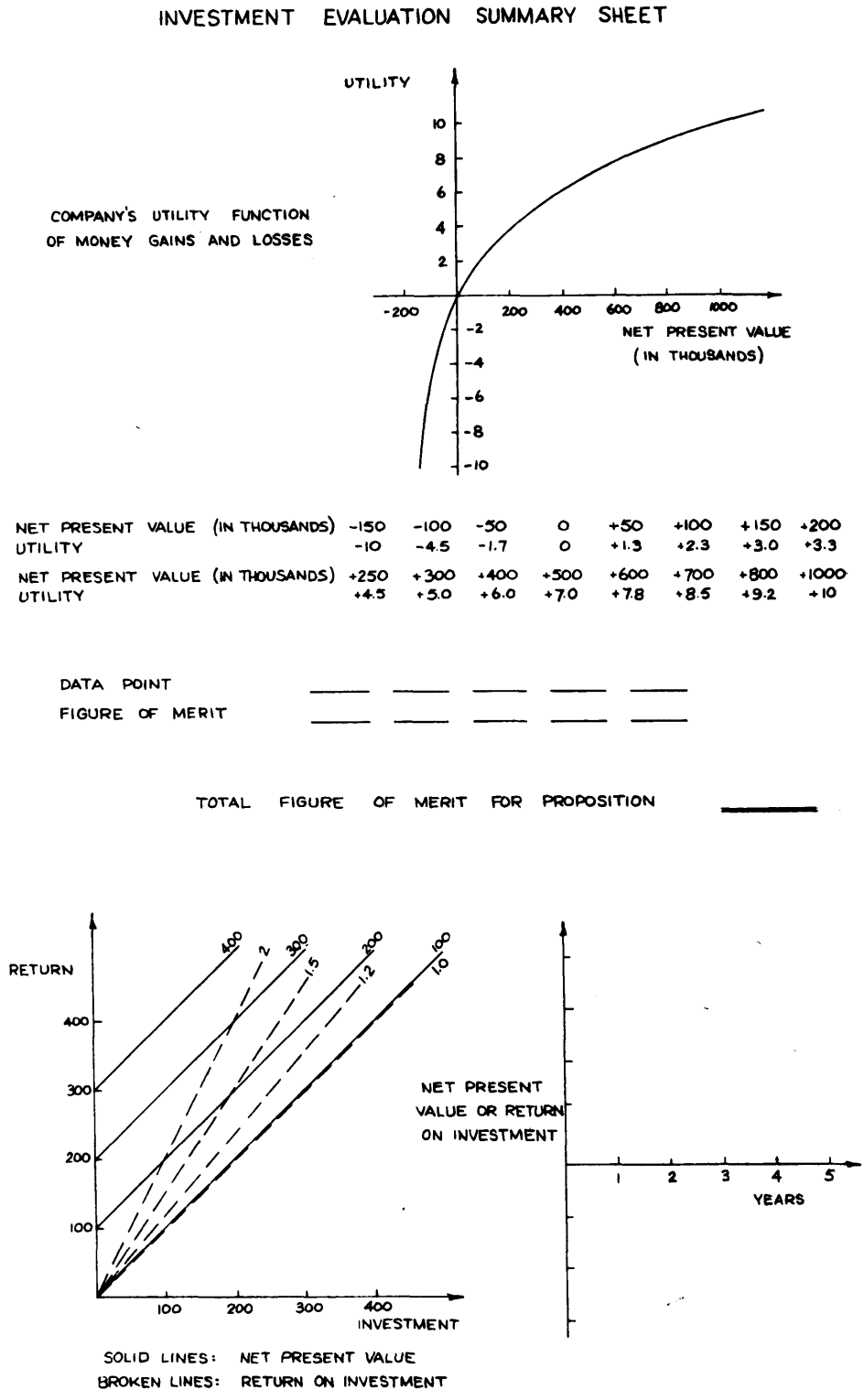

FIGURE 6

[2] Five data points are evaluated for ill defined propositions with particularly wide fluctuations of possible returns.

years; with [illegible] of technological development in the electronics industry for which this form was designed, few manufacturing propositions can be assumed to yield returns beyond that time span.

In the final section, the figure of merit for the data point is derived based on the present value of its potential gain or loss (the net present value given in Line 34), the utility of such gain or loss (as derived from the company's utility function, which is given on the summary sheet), and the probability of this data point. As we have already seen, the figures of merit for the individual data points are then transferred to the summary sheet (Figure 6), where they are added to give the overall figure of merit for the proposition. The summary sheet furthermore includes possibilities for various graphic representations which were found to be helpful in the final evaluation.

A short step-by-step description of the individual entries, illustrated with a numerical example as given [illegible] erational use of this procedure:

Profit

1. *Volume Contribution*—The incremental annual sales volume of the company due to acceptance of the proposition: This may include not only the sales volume of the new product but also its effect on the sales volume of already established products. Entries are always in thousands.

2. *Profit Contribution, percentage before tax*—Average profit prior to taxes in percentage of the incremental sales volume (Line 1): Profits are given after deduction of depreciation and all current operating costs but without consideration of start-up expenses and capital investments.

3. *Profit Contribution, dollars before tax*—Line 1 times Line 2.

4. *Tax*—50 per cent of Line 3; tax reductions due to start-up expenses are accounted for separately in that section.

5. *Retained Profit*—Line 3 minus Line 4.

6. *Discounted Profit*—The yearly entries of Line 5 are multiplied with the compounded discount rate as specified in the title book. The compounded discount multipliers for an annual discount rate of 15 per cent are given in the section heading.

7. *Discounted Profit (cumulative)*—For each year, the sum of all previous annual entries from Line 6 (example: entry for Year 3 in Line 7 equals sum of entries for Years 1, 2, and 3 from Line 6): Gives the cumulative present value of profits earned until that year.

Working capital:

8. *Accounts Receivable*—An assessment is required of the payment habits of the customers under consideration (example: 45 days). Accordingly, as sales volume builds up, an increasing amount of accounts receivable has to be financed. The average investment applicable for each year is the *increment* of the yearly sales volume divided by 365, times the average collection period (in days).

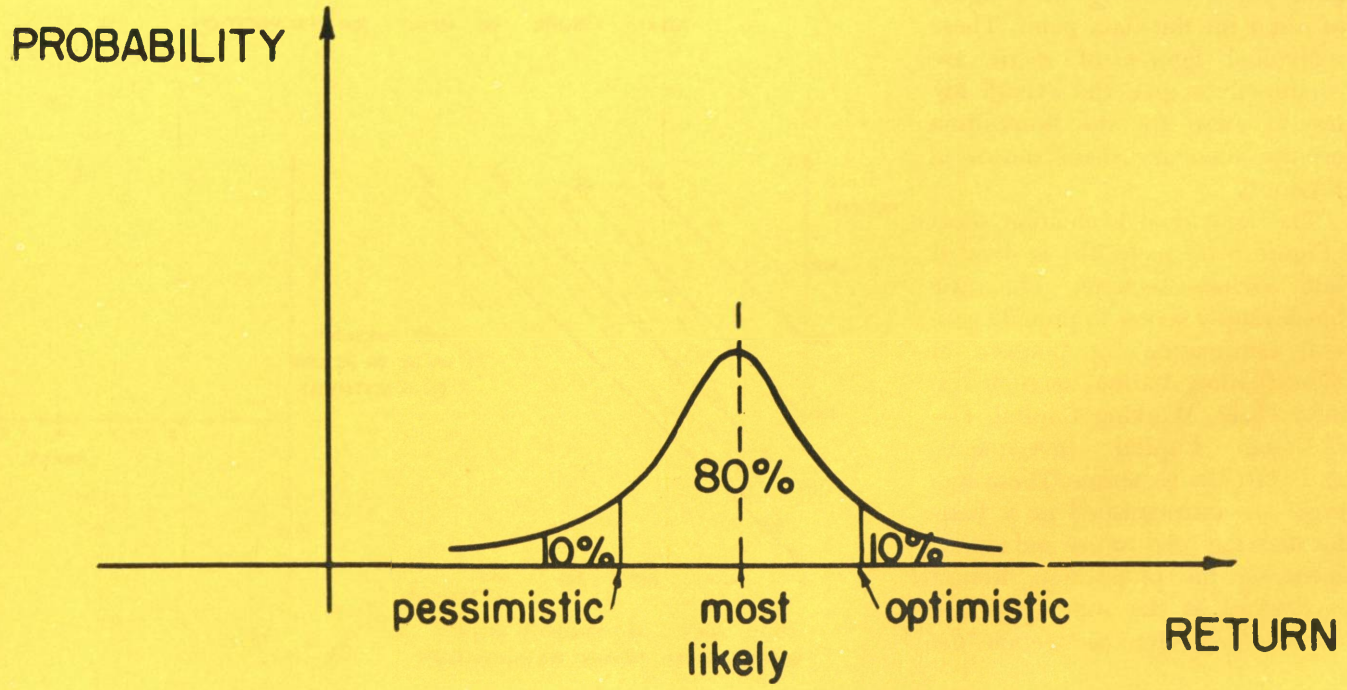

FIGURE 7
Evaluation of Data Points

9. *Inventory*—Included under inventory are raw materials, work in process, finished goods. Inventory is estimated in proportion to sales volume, inventory cost in relation to sales price (example: 30 days' sales volume at 50 per cent sales price). Thus, incremental inventory investment for each year can be estimated from sales figures given in Line 1.

10. *Other* — Include any other working capital requirements.

11. *Total Working Capital*—Total annual investment in working capital: Sum of Lines 8, 9, 10.

12. *Discounted Working Capital* —The yearly entries of Line 11 are multiplied by the compounded discount rate.

13. *Discounted Working Capital (cumulative)*—For each year, the sum of all previous annual entries from Line 12: Gives the cumulative present value of all working capital investment until that year.

14. *Salvage value (yearly)*—Estimated liquidation return upon close-out of this proposition if occurring at the end of each operating year from all of the items in Line 11.

15. *Discounted Salvage Value (yearly)* — The yearly entries of Line 14 are multiplied by the compounded interest rate.

Depreciable capital investments:

16. *Facilities and Equipment*—Covers all capitalized depreciable assets at initial book value as acquired during each year of operation proportional to use in this proposition or as transferred to the project from other previous uses (at proportional book value less depreciation upon transfer).

17. *Discounted Facilities and Equipment*—The yearly entries of Line 16 are multiplied by the compounded interest rate.

18. *Discounted Facilities and Equipment (cumulative)*—For each year, the sum of all previous annual entries from Line 17.

19. *Depreciation* — Total yearly depreciation against all items in Line 16.

INVESTMENT EVALUATION FORM

TITLE BLOCK

PROPOSITION Plastic Spacer DATE 2-26-68 SHEET 2 OF 3
PREPARED BY S.B. STUDY BASE Annual Planning Meeting
ESTIMATES BY: SALES J.R. PROFIT S.B. EQUIPMENT B.F. OTHER —
DISCOUNT RATE 15% DATA POINT M.L. (80%) REMARKS —

PROFIT

		1ST YR.	2ND YR.	3RD YR.	4TH YR.	5TH YR.
		COMPOUNDED DISCOUNT RATE AT 15%				
		87	76	66	57	50
1	VOLUME CONTRIBUTION	10	50	100	[illegible]	[illegible]
2	PROFIT CONTRIBUTION, % BEFORE TAX	10	20	20	20	20
3	PROFIT CONTRIBUTION, $ BEFORE TAX	1	10	20	40	[illegible]
4	TAX (50% OF LINE 3)	0.5	5	10	20	20
5	RETAINED PROFIT (LINE 3 MINUS LINE 4)	0.5	5	10	20	20
6	DISCOUNTED PROFIT (YEARLY)	0.4	3.8	6.6	11.4	10
7	DISCOUNTED PROFIT (CUMULATIVE)	0.4	4.2	10.8	22.2	32.2

WORKING CAPITAL

8	ACCOUNTS RECEIVABLE (45 DAYS)	1.3	5	6.3	13	—
9	INVENTORY (30 DAYS @ 50%)	0.4	1.7	2.1	4	—
10	OTHER	—	—	—	—	—
11	TOTAL WORKING CAPITAL (LINES 8,9,+10)	1.7	6.7	8.4	17	—
12	DISCOUNTED WORKING CAPITAL (YEARLY)	1.5	5.1	5.5	9.7	—
13	DISCOUNTED WORKING CAPITAL (CUMULATIVE)	1.5	6.6	12.1	21.8	21.8
14	SALVAGE VALUE (YEARLY)	1.7	8.4	16.8	33.8	33.8
15	DISCOUNTED SALVAGE VALUE (YEARLY)	1.5	6.6	11	19.1	16.9

DEPRECIABLE CAPITAL INVESTMENT

16	FACILITIES AND EQUIPMENT (YEARLY)	6			6	
17	DISCOUNTED FACILITIES AND EQUIPMENT (YRLY)	5.2			3.5	
18	DISCOUNTED FACILITIES AND EQUIPMENT (CUM.)	5.2	5.2	5.2	8.7	8.7
19	DEPRECIATION (YEARLY)	0.6	0.6	0.6	1.2	1.2
20	DISCOUNTED DEPRECIATION (YEARLY)	0.5	0.5	0.4	0.7	0.6
21	DISCOUNTED DEPRECIATION (CUMULATIVE)	0.5	1	1.4	2.1	2.7
22	SALVAGE VALUE (YEARLY)	4	3	3	7	6
23	DISCOUNTED SALVAGE VALUE (YEARLY)	3.5	2.3	2	4	3

START-UP EXPENSES

24	DEVELOPMENT	3
25	PROMOTION	6
26	OTHER	—
27	SUBTOTAL (TAX DEDUCTABLE, LINES 24,25+26)	9
28	EFFECTIVE SUBTOTAL (LINE 27 MINUS 50% TAX SHIELD)	4.5
29	MANAGEMENT (7 DAYS @ 3 $)	2.1
30	TOTAL (LINES 28+29)	6.6

FIGURE OF MERIT THIS DATA POINT

		1ST YR.	2ND YR.	3RD YR	4TH YR.	5TH YR. + TOTAL
31	DISCOUNTED RETURN (CUMULATIVE, LINES 7,15,21+23)	5.9	14.1	25.2	47.4	54.8
32	DISCOUNTED INVESTMENT (CUMULATIVE, LINES 30,13+18)	13.3	18.4	23.9	37.1	37.1
33	RETURN ON INVESTMENT (LINE 31 OVER 32, YEARLY)	0.44	0.76	1.05	1.27	1.48
34	NET PRESENT VALUE (LINE 31 MINUS 32, YEARLY)	< 7.4 >	< 4.3 >	1.3	10.3	17.7
35	UTILITY OF TOTAL NET PRESENT VALUE					0.46
36	PERCENT PROBABILITY THIS DATA POINT					80%
37	FIGURE OF MERIT THIS DATA POINT (LINE 35 × LINE 36)					37

FIGURE 8

20. *Discounted Depreciation* — The yearly entries of Line 19 are multiplied by the compounded discount rate.

21. *Discounted Depreciation (cumulative)*—For each year, the sum of all previous annual entries from Line 20.

22. *Salvage Value* — Estimated liquidation return upon close-out of this proposition if occurring at the end of each operating year

from disposition of all items in Line 16 (if there is continued use by company or other projects, use book value after depreciation).

23. *Discounted Salvage Value*—The yearly entries of Line 22 are multiplied by the compounded discount rate.

Start-up expenses:

24. *Development* — Even when development costs are fully expensed against burden accounts, proper evaluation of the economics of new products requires indication of the development costs. If there are perpetual product engineering expenses, it is assumed that later years, past the first year of operation, absorb such costs in operations (reduce profits accordingly).

25. *Promotion* — Only start-up promotion or contribution to general promotion expenses is to be shown while current promotion expenses are to be deducted from profits (Lines 2, 3).

26. *Other*—All other start-up expenses except for management (separately in Line 29) such as one-time patent or license expenses, personnel recruiting and training, equipment relocation, etc.

27. *Subtotal*—Should include all tax-deductible start-up expenses: Sum of Lines 24, 25, 26.

28. *Effective Subtotal* — As the full amounts of Line 27 can be used to derive tax savings, the effective subtotal is given by subtracting these tax savings (generally 50 per cent) from the original amounts. Thus, the entries will be given by multiplying the entries of Line 27 by one-half.

29. *Management*—This cost item is most significant for small projects where the management distraction is large compared to the economic significance of the project. Depending upon management's attitude, one can apply management cost on a salary plus burden basis (more executives could be hired) or on an alternate profit potential basis (corporate profits divided by total management hours spent—example: $300 per day for personnel on management level). Since this is not an incremental cost item, it does not offset taxes.

30. *Total*—Includes all start-up expenses: Sum of Lines 28 and 29.

Figure of merit

31. *Discounted Return (cumulative)*—Gives the cumulative net return, appropriately discounted, for each year assuming close-out of the proposition at the end of that year, i.e., the total discounted return which accumulates up to the end of the year for which the entry is made. Derived as the sum of cumulative after tax profit (Line 7), cumulative depreciation (Line 21), and salvage values (Lines 15 and 23). Entry for fifth year gives total discounted net return for this data point of proposition.

32. *Discounted Investment (cumulative)*—Gives the cumulative investment, appropriately discounted, for each year, i.e., the total discounted investment to be made up to the end of the year for which the entry is made. Derived as the sum of cumulative working capital (Line 13), cumulative capital investments (Line 18), and start-up expenses (Line 30). Entry for fifth year gives total discounted investment for this data point of the proposition.

33. *Return on Investment*—Gives the present value of cumulative net return as a percentage of cumulative investment for each year assuming close-out of the proposition at the end of that year (Line 31 divided by Line 32, times 100). Entry for fifth year gives total present value of net return on investment for this data point of the proposition.

34. *Net Present Value (Line 31 minus Line 32)*—Gives the present value of cumulative gains (or losses) to be derived from this proposition for this data point, for each year, assuming close-out of the proposition at the end of that year. Entry for fifth year gives present value of total gains for data point.

35. *Utility of Total Net Present Value*—Utility figure for total net present value is derived from curve and table on summary sheet (Figure 6).

36. *Per Cent Probability This Data Point*—Enter probability for data point from title block.

37. *Figure of Merit This Data Point* — Probability of data point (Line 36) times utility of data point (Line 35); also called expected utility of data point.

The summary sheet (Figure 9 on page 53) starts with a graph and a table giving the company's utility as a function of net present value. It represents the consensus—after some discussion—of the company's top management team regarding the relative values which should be placed on gains and losses of various magnitudes.

In the section below, the figures of merit for each data point are entered from the individual evaluation sheets, and the total figure of merit for the proposition is derived as the sum of these figures.

Graph aids

Two graphs that have been found to be helpful to management in evaluating investments are given at the bottom of the sheet. In the graph to the left, the proposition — characterized by its total discounted net returns and its total discounted investment (Lines 31 and 32)—can be plotted as a point. This visual representation has been found to be especially valuable when various mutually exclusive propositions are evaluated concurrently. In the figure to the right, cumulative return on investment or cumulative net present value can be plotted as a function of time (from Lines 33 and 34), giving valuable information about the dynamic behavior of the proposition over time.

An actual example for the entries in the summary sheet is given in Figure 9. From Figure 8, we derived a figure of merit of 37 for the "most likely" data point. For the "pessimistic" and "optimistic"

data points of this proposition we may have derived net present values of—$10,000 and +$30,000, respectively, with corresponding figures of merit of —3.4 (—0.34 utility × 10 per cent) and +7.8 (+0.78 utility × 10 per cent). The total figure of merit for the proposition becomes 41.4 per cent, or 0.414. Going back to the utility figure and table at the top of the sheet, we see that this total figure of merit corresponds to a net present value of $16,000, which is the net present value of this proposition after adjustment for risk, in the light of the company's attitudes toward risk as expressed in the utility function. This adjusted net present value sometimes is also called the proposition's certainty cash equivalent. In the graph at the bottom of the sheet, the net present value is plotted as a function of time for the "most likely" data point (from Line 34 in Figure 8). Immediately we can see that the proposition will require heavy investments in the first year. After the first year, the balance of cash flows is going to be positive, and shortly before the end of the third year initial investments will have been recovered. Thus, by use of this graph we can visualize conveniently the dynamic behavior of the proposition over time.

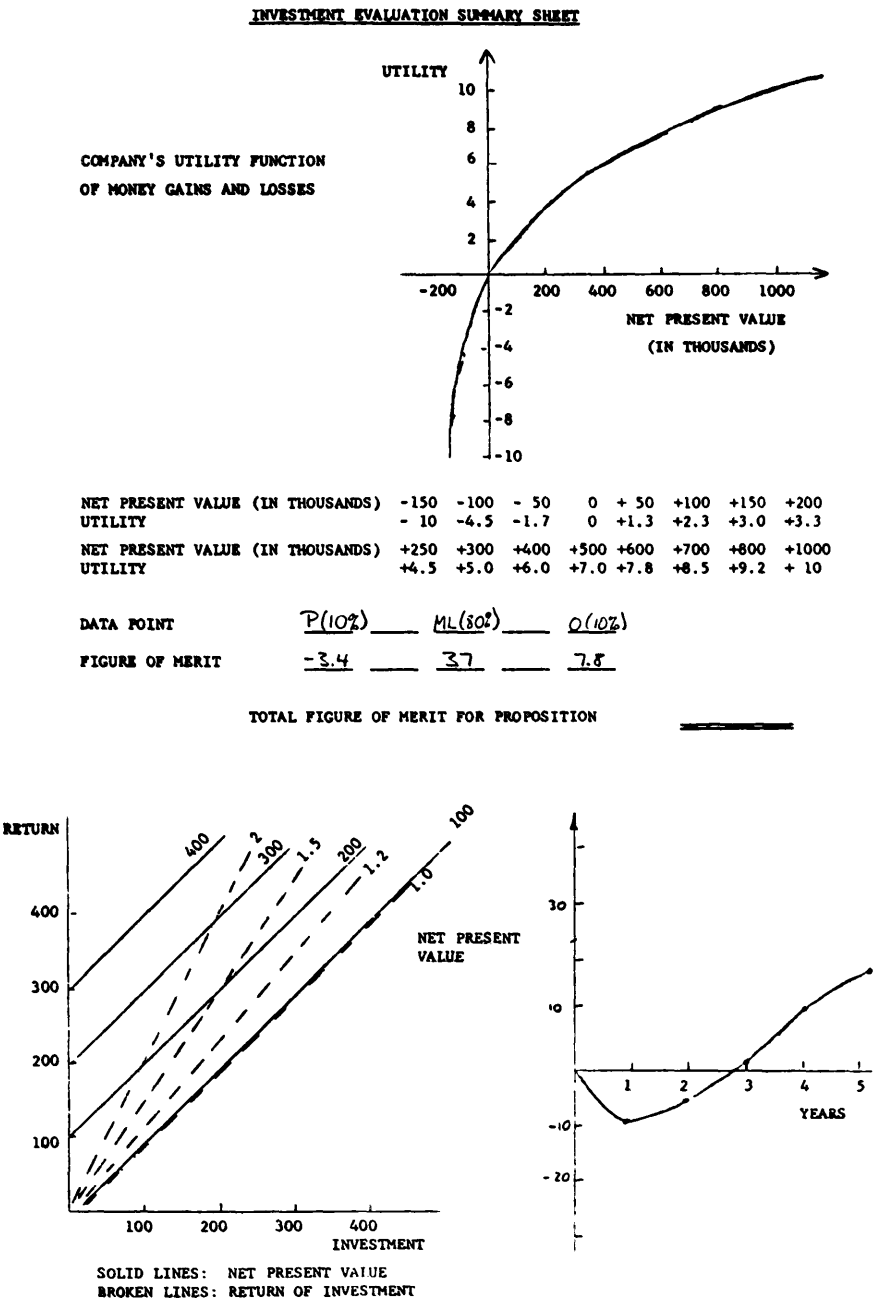

FIGURE 9

These figures aid in the creative interpretation of results, which is perhaps one of the most significant benefits to be derived from the whole procedure. For instance, the final figure of merit of a proposition changes quite apparently as investments are delayed and returns advanced in time. The availability of quantitative results stimulates middle management's resourcefulness in the search for better alternatives, inviting consideration of such alternatives as leasing vs. buying, sharing of investments between propositions, risk reduction possibly at the expense of volume reduction, etc.

The main problem in introducing this method was the training of second-echelon management in the underlying business theories of discounted cash flow, probability, and utility. As often happens, managers with leadership talent and good intuitive judgment were not necessarily inclined to express themselves numerically or to implement numerical procedures. The average training time was three meetings of about two hours each. (It should be mentioned that, when basic data are available, the numerical evaluation of a proposition by this procedure requires about two hours.)

The investment evaluation procedure described in this article was first introduced in 1967 in a company of then only $1 million sales per year. Since then, it has been successfully adopted by the parent company, a diversified medium-size enterprise, for corporate evaluation of divisional projects.