# THE DESIGN OF A PROBABILISTIC SIMULATION MODEL FOR THE EVALUATION OF RISKY INVESTMENTS AND THE DEVELOPMENT OF A SCHEME FOR ITS IMPLEMENTATION

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CHAPTER 1

## INTRODUCTION

Of all business decisions taken, none affect the future competitive strength of a company as much as investment decisions. Present day investment decisions set the future course of a company and necessarily exclude the availability of certain strategies in the future. Furthermore, the long term nature of investment decisions makes possible the burdening of future generations by those who take these decisions today. In Joel Dean's words, "........ capital - expenditure decisions form the framework for a company's future development and are a major determinant of efficiency and competitive power. The wisdom of these corporate investment decisions therefore, has a profound effect upon a company's future earnings and growth."[1] When one views the conglomeration of all enterprises, one sees that a nation's development is ultimately also under the dictates of investment decisions. Merret and Sykes state, "......... whereas individual firms and individual industries may escape notice and criticism with an inadequate rate of growth, an individual nation is not in this position. Of no important Western nation is this more true than Britain where criticism and concern over our inadequate rate of growth has reached significant proportions. While this low rate of growth since the war, and particularly in the last decade, is commonly thought to be due primarily to an inadequate amount of investment, the evidence suggests[2] that it is rather the quality of the investment which is at fault."[3]

If the economic development and viability of a nation can be so adverse-

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1. Joel Dean - "Measuring the Productivity of Capital" The Management of Corporate Capital, p. 21.
2. P.E.P. - Growth in the British Economy.
3. A.J. Merret & A. Sykes - The Finance and Analysis of Capital Projects, p. xii.

ly affected by the quality of investment decisions, a company must, because of its size and less diversified nature, be even more sensitive to such influences. This suggests therefore, that any actions or analyses, that can upgrade investment quality, should be undertaken Of particular importance are:

i) Long term planning of Capital Projects in line with company goals,

ii) The effectiveness of the Capital Administration process,

iii) The quality of data used in appraisals,

iv) The use o. the most meaningful and informative tools of analysis,

and v) "Post-mortems" and feed-back of results actually achieved.

In this paper aspect (iv) above will be covered from an applied research, South African, point of view, with particular attention being given to a probabilistic simulation technique for the evaluation of risky investments. The discussion plan is to review capital budgeting research; to select from this review the most pertinent and practical measures and analytical tools; to design a probabilistic simulation model which will include these measures and analytical tools; to run a project through the developed model and to examine the results produced; to assess the efficacy of the model and to make suggestions on possible improvements; to interpret the results of a survey of South African capital budgeting practices; and finally, to develop a scheme for implementation of the model in the light of the survey's findings.

Before embarking on the main themes of this paper, the purpose of the dissertation, assumptions made and definitions of common terms should be communicated and each of these will now be handled in the sequence given.

## Purpose of Dissertation

When the writer conducted the survey, he was often perturbed at the reaction that he was trying to design a panacea for all capital investment problems and errors. Needless to say this attitude raises two major problems; some managements may use the probabilistic simulation model as an 'end' and not a 'means to an end' while others may discount the usefulness of the model because it is based on inadequate and subjective data which cannot possibly, they reason, give one the 'only' true answer. The purpose of this dissertation is to design a probabilistic simulation model which will serve as a better capital budgeting tool than those generally employed at present in South Africa. It is hoped that the tool will be found to be more sensitive, comprehensive and meaningful, especially in its specific role of quantifying risk and capital productivity. The supremacy of judgement in the final analysis however, must on no account be relegated.

## Assumptions

Are Profits Controlling? : Joel Dean asks the question, "To what degree are investment decisions actually controlled by profit considerations?"[4] In appraising an investment one often implicitly assumes that maximisation of capital productivity is a company's prime objective which of course need not, and is unlikely to be the case in practice. The question of whether profit adequacy and not maximisation is more realistic has regularly been raised,[5] while the multi-purpose nature of a firm has suggested that one cannot talk of one goal but a series of goals which may even conflict.[6] Nevertheless, the importance of being able to measure productivity and being able to compare rates of return with some hurdle rate must not be diluted if a firm's economic purpose is to be achieved amongst other things. Thus the assumption in this dissertation is that capital productivity and its proper measurement are still important elements to any investment decision.

'Garbage in Garbage Out!' : This famous computer adage equally applies to this scheme and it will be assumed that the forecasts prepared are well conceived. As the quality of the forecasts will dictate the meaningfulness of the results, it is strongly recommended that efforts be made to continually improve

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4. Joel Dean - op. cit., p. 22.
5. P.F. Drucker - The Practice of Management.
6. H.A. Simon - "On the concept of Organisational Goal" Business Strategy, edited by H.I. Ansoff.

the forecast techniques used and, where feasible, that market research be undertaken.

Annual Compounding: There is no theoretical foundation for compounding quarterly, semi-annually or annually because in most cases cash flows, in reality, take place continuously and one could argue, therefore, that compounding should be continuous. Whilst continuous compounding can be used, the fact that one's cash flow estimates tend to be based on some interval makes the use of discrete interval compounding acceptable for most purposes. In this dissertation it will be assumed that compounding will take place semi-annually.[7]

## Definitions

Capital Budgeting : J.C. Van Horne suggests that : "Capital Budgeting involves a current investment in which the benefits are expected to be received beyond one year[8] in the future. .... (this) suggests that the investment in any asset with a life of less than (or equal to) a year falls into the realm of working-capital management, whereas any asset with a life of more than one year involves capital budgeting."[9] Whilst this definition may be considered adequate, theoretically, one may wish for practical reasons to embody also a qualification as to the amount of the outlay. For instance, one may wish to have a cut-off point below which outlays are considered expenses; this cut-off point to vary from company to company.

Risk : One must differentiate between two types of risk, Business risk and Financial risk. J.C. Van Horne defines these as : "..... the term 'Business

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7. This aspect will be discussed in greater detail in Chapter 2.
8. J.C. Van Horne qualifies this: 'The use of one year as a line of demarcation is somewhat arbitrary.'
9. J.C. Van Horne - Financial Management and Policy, p. 45.

risk' .... (means) the risk associated with the operation of the firm. Business risk exists apart from the risk inherent in the way a firm is financed. The latter is known as Financial risk ...."[10] In this dissertation our main concern will be the evaluation of Business risk, although Financial risk will be considered where applicable.

Cost of Capital : This is defined as the discount rate that should be used in the capital budgeting process to arrive at the Net Present Value of an investment. More specific details of this will be covered later.

Cut-off Point : This is the minimum rate of return required in order to render an investment acceptable. In theory this is the return by which one links the effect of an investment decision to share price. It is minimum return looked for by investors at the margin.

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10. J.C. Van Horne - op. cit., p. 46.

CHAPTER 2

## REVIEW OF CAPITAL BUDGETING RESEARCH

This chapter will deal with research into the measurement of capital productivity and the quantification of risk. The former will cover the different methodological approaches highlighting their attributes and weaknesses, while the latter will enquire into the meaningfulness of present appraisal techniques in view of the many uncertainties that invariably exist in investment evaluation. Means of quantifying risk will then be considered.

### Capital Productivity Measurement

The conventional methods of measurement are : 'Book rate of Return', 'Payback', 'Degree of Necessity', 'Net Present Value', and 'Internal Rate of Return'. Each of these will be handled in the order given.

### Book Rate of Return

This method has many variations but in order not to overdo the analysis, the method will be taken as the ratio of an average book profit or initial book profit over an average capital employed, or an initial book profit over initial investment. The survey, conducted into South African practices reveals that approximately sixty-nine percent of the companies interviewed use this technique amongst others. This indicates that it is still popular even though it has many shortcomings.

The ostensible virtue of this method is its simplicity and its use of readily available accounting information. The use of 'ostensible' is purposeful, because it is the method's very simplicity which eventually destroys its usefulness. In many analyses between 'Book rate of Return' and 'Internal

Rate of Return' the inaccuracy of 'Book Return' has been shown.[11] The inaccuracy partially results from income being measured in accounting terms and not as cash flows which are the true transaction vehicle by which a firm interacts and exploits its environment. Accounting income for instance, can be significantly distorted by the use of varying depreciation, expensing and provision policies. The other inadequacy, perhaps even more important, is that 'Book Return' ignores the magnitude and timing of cash flows, implying that benefits received in the last year can be valued at the same rate as those in the first year. This assumption is unrealistic and becomes more so as the world experiences higher rates of inflation.[12] Another criticism is that the risk associated with predicting future receipts is ignored, implying that when forecasting income one's estimates do not become more uncertain as one moves more into the future.

If one compares 'Average book return on initial capital' with 'Internal Rate of Return', the method which we will subsequently substantiate as the correct capital productivity measure, the inaccuracy of 'Book Return' can be well illustrated by figure[13] 2 : 1. From this figure one sees that the higher

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11. Two particularly good analyses are :
    H.G. Hill Jr. - "A New Method of Computing Rate of Return on Capital Expenditures" p. 35.,
    M.J. Gordon - "The Payoff Period and Rate of Profit" p. 48.,
    both of which are in <u>The Management of Corporate Capital</u>, edited by Ezra Solomon.
12. Strictly speaking inflation and the cost of capital would be formulated into a discount factor as follows :
    $$1 / (1 + d)^n (1 + k_e)^n$$
    where d = average inflation rate , $k_e$ = cost of capital.
    Multiplying out one gets : $1 / (1 + d + k_e + dk_e)^n$
    Thus the inflation rate increases the importance of discounting.
13. Adapted from A.J. Merret & A. Sykes - op. cit., p. 224.

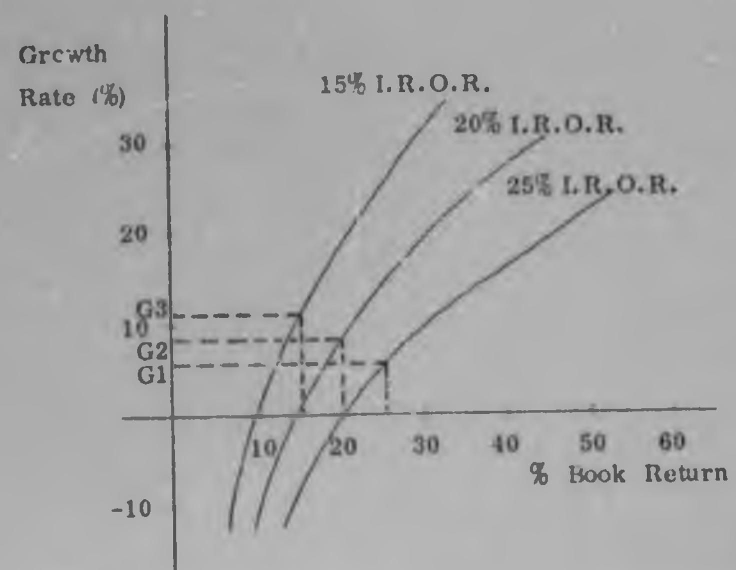


Fig. 2 : 1 - Internal Rate of Return and Book Rate of Return (on initial capital) compared for projects with earnings increasing and decreasing at a constant rate of growth.

the 'Internal Rate of Return'[14] the lower the growth rate at which 'Book Return'[15] equals I.R.O.R. At growth rates greater than $G_1$ (for I.R.O.R. at twenty-five percent), the discrepancy between I.R.O.R. and B.R. increases, with B.R. overestimating return. The converse holds at growth rates below $G_1$. It is interesting to note that the magnitude of the discrepancy between I.R.O.R. and B.R. changes relative to the level of I.R.O.R. At a growth rate of twenty percent, the fifteen percent I.R.O.R. gives a B.R. of approximately nineteen percent, an error coefficient of twenty-seven percent (4/15) while the twenty-five percent I.R.O.R. gives a B.R. of approximately forty-three percent, an error coefficient of seventy-two percent (18/25).

## Payback Method

Merret and Sykes define the payback[16] method as 'the time period it

14. Abbreviated to I.R.O.R.
15. Abbreviated to B.R.
16. Abbreviated to P.B.

takes for an investment to generate sufficient incremental cash to recover its initial incremental capital outlay in full .....'[17]

The popularity[18] of this method rests on its simplicity and its implicit quantification of risk. This latter aspect can be best explained in terms of uncertainty being a function of time. If two projects with identical initial investments have different P. B. periods, the one with the shorter P. B. can be seen to be less risky because its P. B. is dependent on less prediction. This is further re-inforced by the knowledge that change is relative to time and therefore the longer the time period required to achieve P. B. the greater the possibility that competitive advantage may deteriorate.

The limitations of the P. B. method are however, serious. To begin with the P. B. period is not a measure of profitability[19] because it ignores

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17. A.J. Merret & A. Sykes - op. cit., p. 228.
18. Eighty-one percent of the firms interviewed said they used P. B. This response indicates that this method is the most commonly used in South Africa at present.
19. It should be mentioned that in very special circumstances the P. B. period can be used as a profitability index by using its reciprocal $k = S / C$ where S is a constant annual Net Cash Flow, C is the cost of the initial and only investment, and the project's life tends to infinity.

<u>Proof</u> : I.R.O.R. is found by solving for k

$$C = \sum_{t=1}^{\infty} \frac{S}{(1+k)^t} = \frac{S}{(1+k)} + \frac{S}{(1+k)^2} + \ldots\ldots + \frac{S}{(1+k)^{\infty}} \qquad 1$$

Multiplying 1 by $1 / (1 + k)$ one gets :

$$\frac{C}{(1+k)} = \frac{S}{(1+k)^2} + \frac{S}{(1+k)^3} + \ldots\ldots\ldots + \frac{S}{(1+k)^{\infty+1}} \qquad 2$$

Subtracting 2 from 1

$$C - C / (1 + k) = S / (1 + k) - S / (1 + k)^{\infty+1} \text{ where } S / (1 + k)^{\infty+1} \to 0$$

$$C \quad (1 + k - 1)/(1 + k) = S / (1 + k)$$

$$k = S / C$$

See also M.J. Gordon - op. cit., pp. 48 - 49.

cash flows after the P. B. period. This means that a project with a high P. B. could have a zero or very low I. R. O. R.

Other criticisms are that during the P. B. period no weight is given to the timing and magnitude of cash flows and that knowing the payback of mutually exclusive projects is not sufficient to make an intelligent choice. Finally, one must stress the inadequacy of P. B. as a method of risk appraisal, because it only takes account of investment risk relative to time and this it does in very crude terms.

<u>Degree of Necessity</u>

The degree of urgency of a project might be such that it cannot be postponed until more profitable projects have been implemented. Often such projects may not even be quantifiable as to return and yet their sanction is essential. Typically, projects of this type are mandatory for political, safety, health, strategic or other reasons. Thus we can conclude that this type of appraisal should have a place in any practical capital budgeting scheme.

It has however, the serious disadvantage of not only circumventing capital productivity measurement but possibly, through its influence, reducing capital budgeting as a whole into a contest of personalities. Joel Dean states on this point : "The biggest share of the capital - expenditure money will go to the division heads who are the most eloquent or most persistent in presenting their requests, rather than to those who have taken the time and effort necessary to make an objective appraisal of the project's economic worth."[20] Finally, there is the criticism that urgency is not a measurable quantity and therefore comparison between projects of the necessity type is difficult if not impossible.

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20. Joel Dean - op. cit., p. 25.

Present Value Techniques

In 1953 Horace G. Hill Jr. reported the following findings of the Philadelphia Chapters' investigation in capital appraisal techniques : "The Investors' Method (I.R.O.R.) made the best showing because it used only the cash transactions and it gave full weight to the time factors on each such transaction. The Average Book Method showed its inferiority because it supplemented the cash transactions by the inclusion of regular book charges and it gave no heed to the time factor."[21] This statement highlights the two major advantages of present value techniques, (1) the techniques utilise cash flow data and therefore distortions caused by different depreciation and expensing policies are avoided, and (2) the magnitude and time effect of cash flows is adequately taken account of. The validity of the assumption that cash flows of the same magnitude received in two different periods have different present values should now be illustrated. If one were offered an investment which would yield R50 at the end of the first year and second year, the first question that one would pose in one's evaluation is, what is the opportunity cost of my money ? Assuming that ten percent per annum is the rate, one would formulate the acceptance criterion as 'a minimum of ten percent per annum.' This latter qualification "per annum" means that money received in a later period must support a higher finance charge or to put it another way, the same cash flow received in two succeeding periods will have different present values because of their varying finance charge commitment. Thus, in our example, the finance charge on the first R50 is ten percent, while that for the second R50 is twenty-one percent. Mathematically the present value will therefore be :

$$P.V. = \frac{R50}{1,10} + \frac{R50}{1,21} = \underline{R86.77}$$

Thus one will accept the proposal so long as the amount of the investment is less than or equal to R86.77. Relating the present value of R86.77 to the two

21. H.G. Hill - op. cit., p. 45.

R50 receipts, one finds that R45.45 is the present value of the first R50, while R41.32 is the present value of the second R50. Therefore the finance charge burdens[22] are respectively R4.55 and R8.68, and it is these burdens, which one imposes, that render equal cash flows in succeeding periods unequal in today's terms. To conclude, "In any economy in which capital has value, the time value of money is an important concept."[23]

Looking to some of the limitations of present value techniques one finds that its most serious defect is that it only measures capital productivity and cannot quantify risk. Although one can adjust one's hurdle rate to allow for varying risk, this method is oblique, crude and can be misleading because the compounding effect of variations from expected values is difficult if not impossible to gauge. Thus one must conclude that present value techniques have reached the ultimate in capital productivity measurement but are inadequate in the important area of risk quantification.

On a more practical level one can criticise the use of present value techniques on the grounds that they are often tedious to perform and inappropriate because of limitations in the basic data. The inappropriateness of sophistication, in such cases, not only absorbs an unwarranted amount of effort, but adds credence to data which should, in reality be viewed with great suspicion. Both of these criticisms suggest a prudent selection of appraisal tecnniques to suit given situations - a factor to be borne in mind when one devises a capital budgeting scheme.

From the above discussions it is evident that discounting takes up most of one's time in the calculation of present values and therefore tables of discount factors would be extremely useful. Today annual, semi-annual and quarterly compounded discount factors are in fact freely available but for

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22. The writer likes to think of this as a 'service charge', the longer the period of use, the higher the service charge.

23. J.C. Var Horne - op. cit., p. 53.

completeness one should cover their derivation.

Starting with a realistic view, one could state that cash flows take place from minute to minute with an irregular pattern and therefore, the discounting of cash flows should be continuous. Utilising the classic compound interest formula, one can easily derive the continuous discounting formula :

$$P(1 + r)^{n} = C \qquad (2 : 1)$$

where P = present value; r = annual rate of interest; n = number of years; and C = terminal value.

Rearranging (2 : 1) one gets :

$$(1 + r) = \sqrt[n]{C/P} \qquad (2 : 2)$$

If one now considers that the effective rate, r percent per annum, is converted m times per annum such that :

$(1 + r) = (1 + j/m)^{m}$ , one can substitute as follows :

$$(1 + j/m)^{m} = \sqrt[n]{C/P} \qquad (2 : 3)$$

where j = nominal interest rate per year; number of compoundings per year. In order to simplify (2 : 3) let $1/k = j/m$ , therefore :

$$(1 + 1/k)^{jk} = \sqrt[n]{C/P}$$

$$(1 + 1/k)^{k} = \sqrt[nj]{C/P}$$

but $(1 + 1/k)^{k} = e$

limit $k \longrightarrow \infty$

therefore

$$e = \sqrt[nj]{C/P}$$

$$e^{jn} = C/P$$

$$P = C/e^{jn} \qquad \text{or } P = Ce^{-jn} \qquad (2 : 4)$$

where $e = 2,71828$

Utilising the formula (2 : 4) one can now determine continuous factors: For example, if j = 10 percent and n = 1, 2 and 3 years the factors are :

End of Year 1 : $e^{-jn} = e^{-,10} = ,90484$

End of Year 2 : $e^{-jn} = e^{-,20} = ,81873$

End of Year 3 : $e^{-jn} = e^{-,30} = ,74082$

On the other hand if one wishes to know the compound growth factor in order to determine the cash flow value, one, two and three years hence, the formula (2 : 4) $P = C/e^{jn}$ can easily be rearranged to :

$$Pe^{jn} = C \qquad (2:5)$$

Thus at a nominal rate $j = 10$ percent, the effective rates for 1, 2 and 3 years are :

| | | | | |
|---|---|---|---|---|
| $e^{jn}$ | = | $e^{,10}$ | = 1,10517 | 10,517 % over one year |
| $e^{jn}$ | = | $e^{,20}$ | = 1,22140 | 22,140 % over two years |
| $e^{jn}$ | = | $e^{,30}$ | = 1,34986 | 34,986 % over three years. |

On this basis R100 000 invested for three years will yield R134 986 (100 $000e^{,30}$). Conversely, R134 986 received at the end of three years will, on the basis of continuous compounding, yield a present value of R100 000 (134 $986e^{-,30}$), at a nominal interest rate of ten percent.

From the above one has obtained an insight into the workings of continuous compounding and one needs to examine its relationship to a management's statement of return. Generally speaking, managements do not, the writer believes, conceptualise return in continuous terms, but on an annual compounded basis. They normally stipulate a desired return of r percent per annum, implying that this return is to be compounded annually. Economists however, suggest that managements' conceptualisation is an effective annual rate, which one should use to determine the continuous compounded rate to be applied to continuous cash flows. An example will help to illustrate this point :

> Management of ABC & Co. desire an annual return of fifteen percent after tax, therefore :
>
> $$(1+r)^n = (1+j/m)^{mn} \qquad (2:6)$$
>
> Rearranging (2 : 6) one gets :
>
> $$\sqrt[mn]{(1+r)^n} = 1 + j/m$$
>
> Therefore interest charge per conversion period at an effective rate r is:
>
> $$i = \sqrt[m]{(1+r)} - 1 \qquad (2:7)$$
>
> where $i = j/m$ = interest rate per conversion period.

Taking formula (2 : 7) one can derive the daily compounded rate to achieve an effective annual rate of fifteen percent by letting m = 365,

$$
\begin{aligned}
i &= \sqrt[365]{(1{,}15)} - 1 \\
&= \text{antilog}\,({,}0607/365) - 1 \\
&\approx 1{,}0004 - 1 \\
&\approx \underline{0{,}0004}
\end{aligned}
$$

Thus to achieve management's effective rate of fifteen percent per annum, daily cash flows must be discounted at a daily compounded rate of 0,04 percent. Theoretically, cash flows are continuous and therefore the above example should be extended to infinity. As this extension, however, has little practical purpose the daily compounded example will be taken as the limit for purposes of this dissertation.

According to the discussion so far, it could be concluded that for realistic purposes daily discounting of cash flows should be undertaken when measuring capital productivity. Whilst this statement cannot be refuted, that is, cash flows are in fact at least day to day, the inability to produce meaningful cash flow forecasts on a daily basis makes even this approach impractical. The proponents of daily or continuous discounting may counter this argument with the notion that daily or even continuous cash flows can be simply determined by dividing by an appropriate number. For example, if cash flows are prepared on a yearly basis one could determine an average daily inflow by dividing by three hundred and sixty-five. This answer may at first appear feasible but if reality is the claim for daily and continuous compounding, how realistic is the assumption of constant daily cash flows? In practice cash flows are subject to significant variation because of tax payments etc. and therefore, the suggested averaging of discrete cash flow predictions seems untenable.

To sum up, a practical approach to discounting seems to be to discount on the basis of the discrete intervals used in predicting cash flows; the duration of the interval to be determined by the accuracy of prediction. If prediction on a six monthly cycle can be accurately undertaken, then discounting on a semi-annual basis would be warranted. In the simulation developed in this dissertation, semi-annual discounting has been used because of the significant influence of provisional tax payments and annual tax settlements.

Discussion so far has concentrated on Present Value without reference to its two major elements, Net Present Value and Internal Rate of Return. Unfortunately these two techniques are often confused and sometimes they are even considered to be equivalent. Both measures are in fact very different, for one is an absolute measure while the other is a relative measure. Net Present Value[24] can be mathematically defined as :

$$\text{N.P.V.} = \sum_{t=0}^{n} C_t \;/\; (1 + k_o)^t$$

where $C_t$ is the net cash flow after tax in period t, and $k_o$ is the firm's cost of capital. The acceptance criterion is whether N.P.V. exceeds zero, given that capital rationing does not apply and that risk is held constant between proposals. Where however, risk varies and rationing does apply, the Profitability Index is used in an attempt to apply limited funds to investments on the "Efficient Frontier"[25]. The Profitability Index[26] can be defined as :

$$\text{P.I.} = \frac{\text{N.P.V.} + \text{Initial Cash Outlay}}{\text{Initial Cash Outlay}}$$

Using the P.I. one can, so to speak, "optimise" the firm's net worth by selecting projects that have acceptable Profitability Indices relative to risk and if these projects require funds in excess of the available resources, then one would select, within a given risk level, investments with the highest weighted average P.I.

Internal Rate of Return can be defined as : " ... the discount rate that equates the present value of the expected cash outflows with the present value of the expected inflows. Mathematically, it is represented by that rate r,

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24. Abbreviated to N.P.V.

25. J.C. Van Horne - op. cit., p. 30.

26. Abbreviated to P.I.

such that ..."[27]

$$\sum_{t=0}^{n} C_t / (1 + r)^t = C$$

where $C_t$ is the net cash flow in period t. The acceptance criterion is whether r exceeds the hurdle rate for a given level of risk.

The natural question to be posed at this stage is 'Do N.P.V. and I.R.O.R. techniques give the same signals and if not which is superior?' The answer to this question depends on what one is trying to decide. "..... As a formal accept or reject criterion, both yield (I.R.O.R.) and present value (N.P.V.) would lead to the same selection of projects. All projects which have yield in excess of the cost of capital must also have a positive net present value."[28] However, when one wishes to rank proposals in order to select them subject to a capital rationing constraint, I.R.O.R. is inferior to N.P.V. Table 2 : 1[29] illustrates this in the extreme, where the ranking by I.R.O.R. is the converse to that by N.P.V.

| Project | Annual Net Cash Flows | Initial Investment | Life | I.R.O.R. | N.P.V. @ 8% |
|---|---|---|---|---|---|
| A | R100 | R750 | 30 | 13 | R376 |
| B | R200 | R1004 | 10 | 15 | R338 |
| C | R100 | R502 | 10 | 15 | R169 |
| D | R52 + R259 | R259 | 4 | 20 | R104 |
| E | R100 | R259 | 4 | 20 | R 72 |

Table 2 : 1 - Contrasting Ranking of Investments by I.R.O.R. N.P.V. and P.I.

This anomaly can be explained with reference to the re-investment rate.

27. J.C. Van Horne - op. cit., p. 55.
28. A.J. Merret & A. Sykes - op. cit., p. 149.
29. Adapted from A.J. Merret & A. Sykes - op. cit., p. 151.

The I. R. O. R. assumes a re-investment rate equivalent to its internal rate, which may of course not be realistic, particularly where the internal rate of return is high. Take for instance Table 2 · 2[30] :

| Year | Proposal A | Proposal B | |
|---|---|---|---|
| 0 | R - 23 616 | R - 23 616 | |
| 1 | 10 000 | nil | |
| 2 | 10 000 | 5 000 | Cash Flows |
| 3 | 10 000 | 10 000 | |
| 4 | 10 000 | 32 675 | |
| | R 8 083 | R 10 347 | N. P. V. @ 10% |
| | 25% | 22% | I. R. O. R. |
| | 1,34 | 1,44 | P. I. |
| | R 46 410 | R 49 725 | Terminal Value |

Table 2 : 2 - Contrasting Selection Criteria for two Investments.

From the above example, which has two proposals with identical initial investments, selection by I. R. O. R. would not be optimal at a re-investment rate of ten percent as is proven by the terminal values for the proposals. If selection had been based on N. P. V. or P. I. the selection would have been correct. This appears to indicate that selection for mutually exclusive proposals should be based on net present value or the P. I. This, however, is only a "half" truth, because if the cost of capital is not equal to the re-investment rate selection by N. P. V. or P. I. can be sub-optimal. Examination of Table 2 : 3 reveals that while two mutually exclusive Proposals A and B both have the same initial outlay and term, A has the higher N. P. V. and P. I. at a cost of capital of eight percent. To choose A , however, would not optimise the firm's net worth as indicated by B's greater terminal value of R16 599.

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30. Adapted from J. C. Van Horne - op. cit., p. 62.

| Proposal | Annual Net Cash Flow | Initial Investment | Life (years) | I.R.O.R. | N P.V. @ 8% | P.I. | 24th Yr's T.V.[31] @ 18% |
|---|---|---|---|---|---|---|---|
| A | R46 | R296 | 24 | 15% | R484 | 2,64 | R13 317 |
| B | R150 for 2 yrs, R20 thereafter. | R296 | 24 | 20% | R142 | 2,49 | R16 599 |
| C | R23 | R148 | 24 | 15% | R242 | 2,64 | R 6 658 |
| D | R31 | R148 | 12 | 18% | R234 | 2,58 | R 7 892 |

Table 2 : 3 - Illustration that N.P.V. Ranking can be sub-optimal.

Comparing the two mutually exclusive Proposals C and D, one finds that if one chose on the basis of N.P.V. or P.I. , C would be preferred to D, because it has the greater N.P.V. and P.I. This of course would also be sub-optimal as one is comparing two projects of varying duration and therefore they are not comparable as such. What is required is for one to determine terminal values for the proposals to a common terminal date. On such a basis one finds that D, with a terminal value of R7 892, is preferable to C.

From this , the conclusion can be drawn that the re-investment rate is the central issue to taking the optimal decision, and therefore the reliability of I.R.O.R. or N.P.V. depends not on theoretical elegance but on which of these measures uses a discount rate closest to the re-investment rate.[32] This can be graphically illustrated for two projects in Table 2 : 2. According to Figure 2 : 2 : "Whenever the profit profiles of two projects cross one another, the N.P.V. of the one with the lower (I.R.O.R.) will exceed that of the one with the higher (I.R.O.R.) to the left of the crossover point. Therefore if the cost of capital is less than the crossover discount rate, the (I.R.O.R.)

31. Abbreviation of Terminal Value.

32. Ezra Solomon makes this and other related points in his article: "The Arithmetic of Capital Budgeting Decisions" - The Management of Corporate Capital.

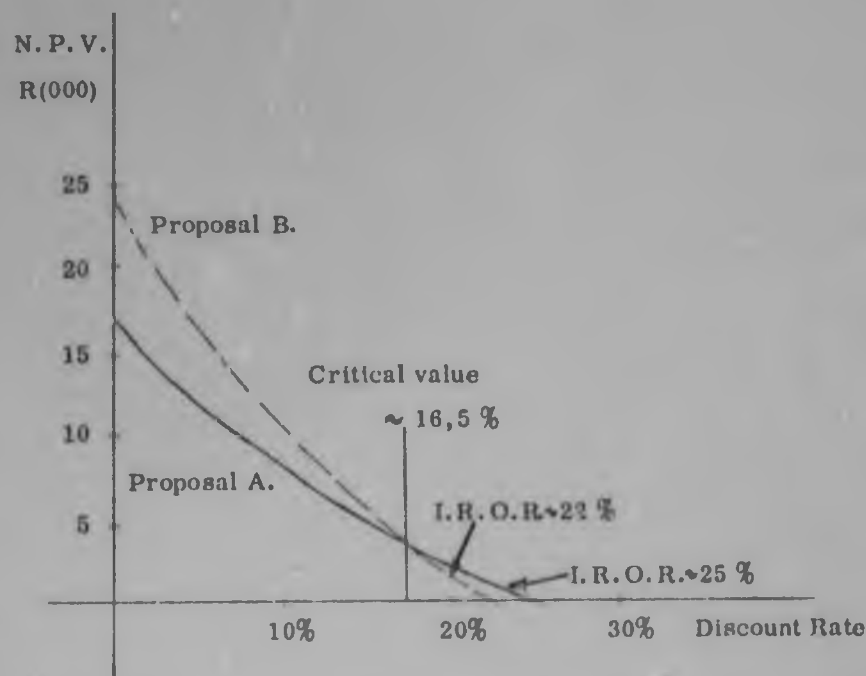


Fig. 2 : 2 - Illustrating N. P. V. as a Function of the Discount Rate.

and N. P. V. methods will yield conflicting results."[33] For the re-investment rates to the left of the crossover point, N. P. V. gives the correct signals even though it has used a cost of capital less than the re-investment rate. At re-investment rates to the right of the crossover point, N. P. V. will give the wrong signals if the cost of capital is a rate less than the crossover rate.

While this exposition is useful its practical effects are limited and one therefore requires to develop some practical solution to this dilemma. The first possibility is to ignore the cost of capital and to use rather the re-investment rate for discounting purposes.[34] This has the added advantage that it obviates the calculation of a firm's cost of capital, an aspect over which much controversy exists. The disadvantage of this alternative is, however, that the economic contribution by a project to a firm's net worth is not quantified.

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33. J. F. Weston & E. F. Brighton - Managerial Finance, p. 204.
34. Ezra Solomon - op. cit., p. 77.

The second alternative, the one which the writer favours and has used in his simulation, is to retain N. P. V. based on cost of capital and to use , for selection purposes, a new return measure which is based on terminal values.[35] This new measure which Solomon calls the Overall Rate of Return[36] quantifies the overall return on funds employed to a common terminal date. While the funds are employed in the project, they are expected to earn the internal rate, and while they are not employed as such, they are expected to earn income at the re-investment rate.[37] Thus for major projects one would determine I.R.O.R. , O.R.O.R. and N. P. V. Calculation of each of these is considered prudent because they are in reality complementary; each measure gives different information about a project. Table 2 : 4 illustrates the calculation of the suggested measures for a project.

| Year | Cash Flows R | N. P. V. @ 8% R | I.R.O.R. @ 20% R | O.R.O.R. - Re-investment @ 10% Funds Re-inv. | Income on Re-inv. | Total Inflow | P. V. @ 10% of Outflow |
|---|---|---|---|---|---|---|---|
| 0 | -200 | -200 | -200 | - | - | - | 200 |
| 1 | 50 | 46 | 42 | 50 | - | 50 | - |
| 2 | - 25 | - 21 | - 17 | - | 5 | 55 | 21 |
| 3 | 100 | 79 | 58 | 100 | 5,5 | 160,5 | - |
| 4 | 150 | 110 | 72 | 150 | 16,0 | 326,5 | - |
| 5 | 112 | 76 | 45 | 112 | 32,6 | 471,1 | - |
| | | R 90 | 0 | | | | R 221 |

O.R.O.R. = $221\ (1 + r)^5 = 471{,}1$ , therefore r = 16,33 percent

O.N.P.V.[38] = R100

N.P.V. = R 90

I.R.O.R. = 20 percent

Table 2: 4 - Worksheet for Calculation of I.R.O.R., N.P.V. & O.R.O.R.

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35. Ezra Solomon - op. cit., p. 77.
36. Abbreviated to O.R.O.R.
37. E. Renshaw in "A Note on the Arithmetic of Capital Budgeting Decisions" in The Management of Corporate Capital, suggests on

From this example one can draw the following statement :

'The investment is expected to employ R221 for five years at an overall rate of return of 16,3 percent per annum after tax. The terminal value of the investment is expected to be R471. Furthermore, analysis of this investment reveals that the project is expected to yield twenty percent per annum and an economic contribution of R90, while re-investment is expected to contribute ten percent per annum and to raise the total economic contribution of the investment, by R10, to R100.'

In the writer's opinion the above statement takes full advantage of all available data and presents it in a meaningful and enlightening manner which the businessman can easily appreciate. In the simulation developed in this dissertation, this approach has been taken.

"Limit D.C.F. in Capital Budgeting"

This very interesting aspect was raised by E.M. Lerner and A. Rappaport[39], and deserves special attention in this dissertation. Basically, the idea is that maximisation of N.P.V. may lead to erratic income patterns and that this may result in shareholders considering the earnings stream of the company as poorly managed, unreliable or speculative, an image which could well lead to a lowering of the price/earnings ratio for the shares.

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37. pp. 82 and 83 that one should also consider splitting the re-investment rate into an "Outflow" rate and an "Inflow" rate. He suggests that in certain situations the "Outflow" rate is likely to be lower than the "Inflow" rate. Where applicable this refinement is recommended.
38. Abbreviation for Overall Net Present Value.
39. E.M. Lerner and A. Rappaport - "Limit D.C.F. in Capital Budgeting", Harvard Business Review, September - October, 1968.

Some contend that the adverse effects of erratic earnings can be mitigated by a steadily increasing dividend policy. Whilst this may be true for the short term, erratic earnings will, in the long run, affect share values, particularly if the erratic earnings stream also affects liquidity. This latter aspect is clearly important, for dividend payouts should not undermine the working capital requirements of the company. An example will help to illustrate these points. A company has two portfolios to select from, Portfolio A yields a net present value of R315 844 and Portfolio B yields a net present value of R300 616 at a cost of capital of ten percent. The cash flow data for both portfolios are given below in Table 2 : 5.

| Year | Portfolio A | | | Portfolio B | | |
|---|---|---|---|---|---|---|
| | Profit after tax | Deprecia-tion | Net Cash Flows | Profit after tax | Deprecia-tion | Net Cash Flows |
| 0 | (50 000) | 5 000 | (45 000) | (50 000) | 5 000 | (45 000) |
| 1 | (25 000) | 5 000 | (20 000) | 10 000 | 5 000 | 15 000 |
| 2 | ( 5 000) | 5 000 | - | 15 000 | 5 000 | 20 000 |
| 3 | 100 000 | 5 000 | 105 000 | 25 000 | 5 000 | 30 000 |
| 4 | 25 000 | 5 000 | 30 000 | 40 000 | 5 000 | 45 000 |
| 5 | 100 000 | 5 000 | 105 000 | 50 000 | 5 000 | 55 000 |
| 6 | 25 000 | 5 000 | 30 000 | 60 000 | 5 000 | 65 000 |
| 7 | 100 000 | 5 000 | 105 000 | 70 000 | 5 000 | 75 000 |
| 8 | 100 000 | 5 000 | 105 000 | 90 000 | 5 000 | 95 000 |
| 9 | 100 000 | 5 000 | 105 000 | 110 000 | 5 000 | 115 000 |
| 10 | 125 000 | 5 000 | 130 000 | 150 000 | 5 000 | 155 000 |

Table 2 : 5 - Contrasting Portfolios' Earnings and Cash Flow Patterns.

If one is to choose the portfolio which will maximise net worth, Portfolio A would be selected. Its earnings and cash flow patterns are, however, not as sound as those of Portfolio B. This is effectively shown by figure 2 : 3. If one is particularly concerned with liquidity and one desires steadily increasing earnings, Portfolio B might well be chosen in preference to Portfolio A,

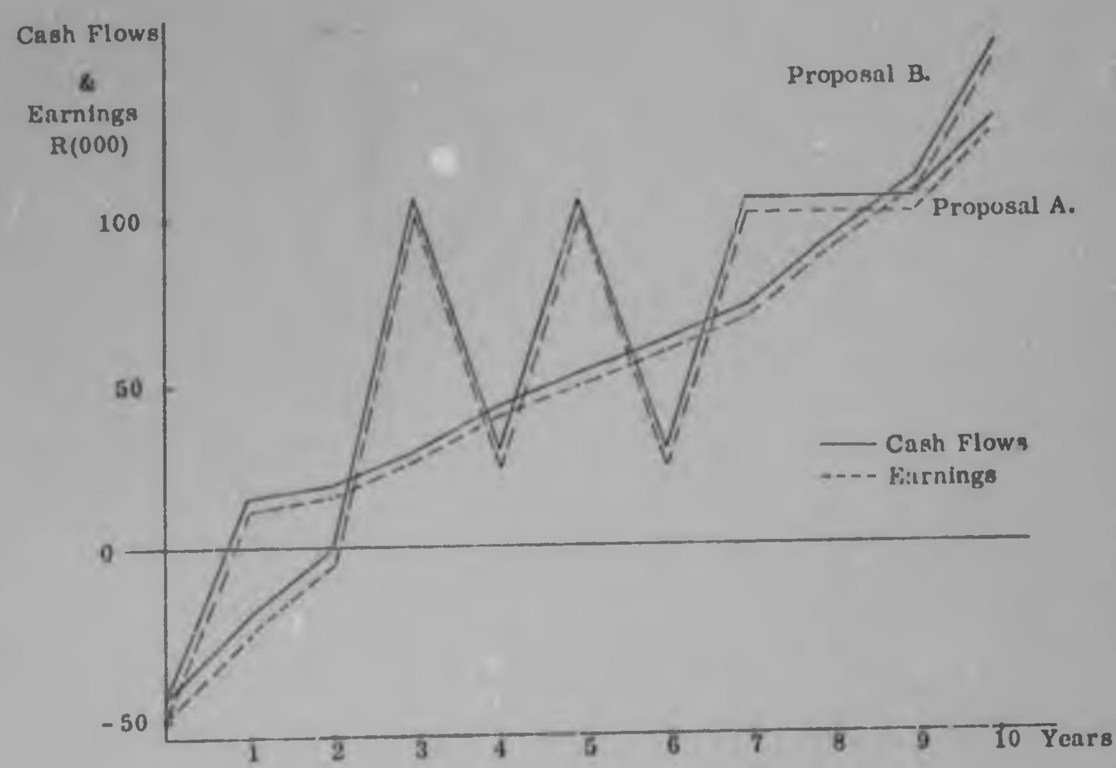


Fig. 2 : 3 - Illustrating Cash Flow and Earnings Patterns for two mutually exclusive Portfolios.

notwithstanding the latter's higher N. P. V.

The conclusion to be drawn from this section is that the capital budgeting decision should not rest solely on maximisation of N. P. V., but should also consider the earnings and / or cash flow patterns of available projects so as to ensure that the selected portfolio of projects yields earnings and cash flows consistent with the company's long term earnings and dividend goals.

## Probability Techniques

'The President of a big international corporation told me recently, "I can't understand why our investment policy hasn't worked the way we expected." Some years ago, he explained, the executive committee had decided that every capital investment, to be acceptable, would have to show an estimated before-tax average annual return on capital of twenty percent. The rule had been scrupulously followed, yet actual results had averaged fourteen percent. "And we've got some of the best analysts in the business," added the frustrated President."[40] This quotation epitomises the reaction of many disenchanted executives, who are at a loss to explain why their investment decisions do not pay off. The answer is not difficult to find, many investments are quoted to yield an average return and as such the actual yield can be expected to be distributed around this mean rate. The spread of likely results, being a function of uncertainty, represents in fact the inherent risk of a proposal. One can distinguish five sources of risk, namely :

'i) Risk from undertaking insufficient numbers of similar investments;
ii) Risk from misinterpretation of data;
iii) Risk from bias in the data and in its assessment;
iv) Risk from a changing external economic environment invalidating much of the usefulness of past experience, and
v) Risk from errors of analysis.'[41]

From the above it is clear that risk is an essential element of the capital budgeting process and as such its influence must be quantified if meaningful statements of return are to be made. Statements of return that ignore quantification of risk are quite meaningless; for example, how can one effectively choose between two proposals knowing that they respectively yield twenty percent and forty percent. If the proposal with the lower yield has a disproportionately lower risk element, it would be superior to the other proposal. Graphically, one can illustrate this by means of figure 2 : 4, which indicates that the former proposal (Proposal 1) is on the "Efficient Frontier" while the latter (Proposal 2) is not.

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40. D.B. Hertz - "Investment Policies that pay off" - Income Theory and Rate of Return, p. 257. - edited by J.L. Livingstone & T.J. Burns, 1971.

41. A.J. Merret & A. Sykes - op. cit., pp. 176 - 177.

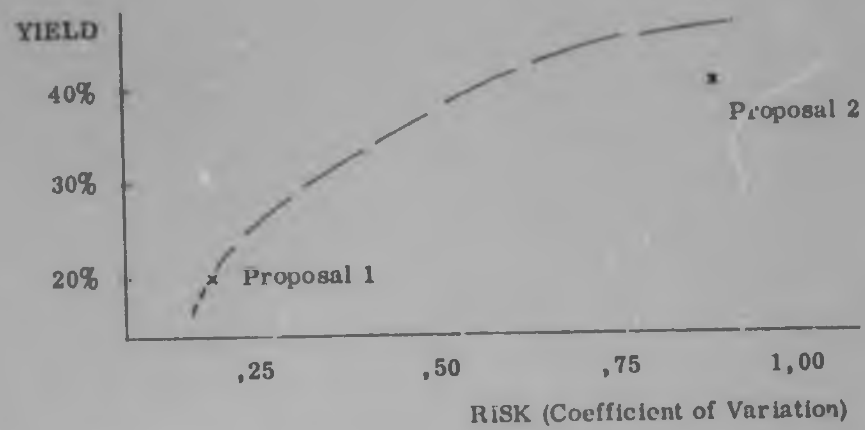


Fig. 2 : 4 - Illustrating the use of Risk and Yield for Selection purposes.

Another illustrative way to make the same point is to consider two proposals which are both expected to yield twenty percent per annum, but which have different distributions. (see figure 2 : 5).

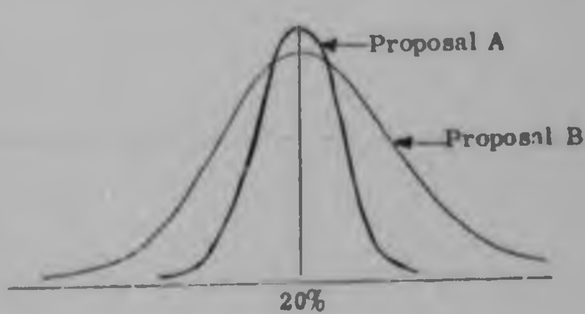


Fig. 2 : 5 - Comparison of two Proposals with identical expected yields but varying spread (Assuming Normality).

As Proposal A has less spread than Proposal B, one can expect that, for a given level of probability, Proposal A's yield will actually fall within limits less than those for Proposal B and thus Proposal A is superior to Proposal B. From this observation, one can state two principles of risk quantification, one, risk is measured by spread, statistically termed variance and two, that the relative risk between projects can be established by means of their respective coefficients of variation.[42] Thus if Proposal A and Proposal B had respectively standard deviations of five percent and ten percent, their relative risks would be :

$$\text{Proposal A} = \frac{0,05}{0,20} = 0,25$$

$$\text{Proposal B} = \frac{0,10}{0,20} = 0,50$$

Peturning to the opening quote, one can now state that the reason why some investment decisions do not appear to pay off, is that risk has been ignored in determining the limits within which the actual yield can be expected to fall. In short, investments should not be expressed to earn an expected yield but rather a yield within limits around the mean at a given level of probability (see figure 2 : 6). In this way the risk inherent in a project is highlighted and management is not deceived as to the likely range of results.

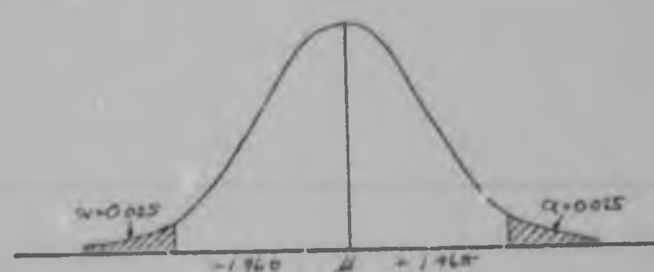


Fig. 2 : 6 - Drawing of normal limits around the mean yield - assuming $\mu$ and $\sigma$ are given a priori.

The point concerning the relevance and meaningfulness of risk quantification has now been made but the methodology of quantification has not been covered, and this is the next issue that will be taken up. Before we do so, however, an important qualification must be made :

> " ...... a host of problems make the incorporation of risk into capital budgeting a difficult matter indeed. Consequently, the methods are

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42. Defined as the mean rate of return divided by the standard deviation.

far from perfect. Nevertheless, they do provide insight into the important dimension of risk. This dimension should not be ignored in capital budgeting simply because evaluating it is difficult. It has far too great an influence on the value of the firm to its shareholders."[43]

Risk-adjusted Rate Approach

One means of adjusting for risk is simply to adjust the discount rate or the cut-off rate in keeping with the degree of risk. The former applies to N.P.V. calculations while the latter applies to I.R.O.R. calculations. A example will clarify the use of this method. Assume a proposal has an outflow of R10 000 in year 0, a constant cash inflow of R4 500 per year for three years, and that management sets the risk-adjusted rate at twelve percent.

| | | | | |
|---|---|---|---|---|
| N.P.V. | = | -10 000 + 4 500 (2,4018) | = | R808 |
| I.R.O.R. | | -10 000 + 4 500 (2,2459) | = | R107 |
| | | -10 000 + 4 500 (2,2096) | = | R(57) |

$$\text{Therefore I.R.O.R.} \approx 0{,}16 + \frac{107}{164} \approx 16{,}65 \text{ percent.}$$

The decision in this case would be to accept the proposal on one of two bases, because the N.P.V. is positive or because the I.R.O.R. is greater than the risk-adjusted required rate.

The principle criticism of this methodology is that one may be able to di[illegible] that one proposal is riskier than another but it is difficult to determine by h[illegible] much. The setting of the risk-adjusted rate is therefore, likely to be arbitrary and inconsistent; two factors which render the technique too crude for most purposes.

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43. J.C. Van Horne - op. cit., p. 122.

Certainty-equivalent Approach

This method modifies cash flows to certainty-equivalent amounts, by means of a factor alpha, alpha being defined as :

$$\alpha_t = \frac{\text{Certain Cash Flow in Period t}}{\text{Estimated Cash Flow in Period t}}$$

Using $\alpha_t$ to modify estimated cash flows one can then calculate the conventional capital productivity measures as follows :

$$\text{N.P.V.} = \sum_{t=0}^{n} \frac{\alpha_t A_t}{(1 + i)^t}$$

where $\alpha_t$ is the certainty-equivalent factor, $A_t$ is the estimated cash flow in period t and i is the risk-free rate.

$$\text{I.R.O.R.} \longrightarrow \sum_{t=0}^{n} \frac{\alpha_t A_t}{(1 + r)^t} = 0$$

where r is the I.R.O.R. to be compared with a risk-free cut-off rate.

Like the Risk-adjusted Rate Approach, this approach suffers from practical difficulties in quantifying its modifier $\alpha_t$. Strictly speaking $\alpha_t$ would have to be calculated for each period because the riskiness of cash flows can be expeced to vary from period to period. Although the Certainty-equivalent Approach can be shown to be superior to the Risk-adjusted Rate Approach[44], it nevertheless is also too crude for most purposes.

Probability Distribution Approach

"Of all the approaches for dealing with risky investment, the use of probability distributions is perhaps the most feasible."[45] The idea under this approach is, as previously described, to give management not only an expected rate of return or N. P. V. but to also establish the limits of possible re-

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44. J.C. Van Horne - op. cit., pp. 128 - 131.

45. J.C. Van Horne - op. cit., p. 131.

sults around this expected value. The method assumes that the distribution of cash flows in each period is given à priori and that the cash flows are independent from period to period. On this basis the calculation of the relevant statistics becomes :

$$\overline{N.P.V.} = \sum_{t=0}^{n} \frac{\overline{A_t}}{(1+i)^t}$$

where $\overline{A_t}$ [46] is the expected value of net cash flow in period t, and i is the risk-free rate.

The standard deviation of the probability distribution of net present values is :

$$\sigma = \sqrt{\sum_{t=0}^{n} \frac{\sigma_t^2}{(1+i)^{2t}}}$$

where $\sigma_t$ [47] is the standard deviation of the probability distribution of possible net cash flows in period t.

Once one has these details one can then determine probability limits for the project at a given level of probability as follows :

$$N.P.V. = \overline{N.P.V.} \pm Z_\alpha \sigma$$

where $\alpha$ is the probability in the tails of the distribution. Alternatively, one can determine the probability of obtaining a given net present value by standardising the difference as follows :

$$Z_{obs} = \frac{N.P.V. - \overline{N.P.V.}}{\sigma}$$

where $Z_{obs}$ is the number of standard deviations of the observed N. P. V. from the $\overline{N.P.V.}$ For example, if the $\overline{N.P.V.}$ is R1173 and $\sigma$ is R1827, the probability of getting a N. P. V. less than or equal to zero is twenty - six

46. $\overline{A_t} = \sum_{x=1}^{n} A_{xt} P_{xt}$
where $A_{xt}$ is the cash flow of the xth possibility in period t and $P_{xt}$ is the probability frequency for this cash flow.
47. $\sigma_t = \sqrt{\sum_{x=1}^{n} (A_{xt} - \overline{A_t})^2 P_{xt}}$

percent.[48]

While this approach to captital budgeting for risky investments is superior to the previously mentioned techniques it suffers from two defects. One, it relies on the assumption of independency of cash flows, which in many situations is not realistic and two, it is inadequate in handling uncertainty. F.S. Hiller[49] and others have developed techniques to overcome the first criticism but unfortunately for complex situations the practical solution is to approximate the standard deviation by simulation. The second criticism is,in the writer's opinion, even more serious as it points to the inadequacy of the technique to quantify risk inherent in the elements of a project. With the technique discussed above it is assumed that management can obtain an accurate distribution of cash flows for each period. This appears to undermine the whole role of risk quantification. Each element of the project is uncertain and therefore one in practice needs to operate with the basic elements, like market size, market share, market price, variable costs of production etc. If one has ten strategic elements[50] each with ten possibilities, then one infact has to contend with ten billion possible combinations, which is an impossible judgemental task. The solution to this dilemma is to sample at random from the various distributions and to simulate results for each sample. This technique was first suggested by D.B. Hertz[51] and in his model he provided for the following

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48. $Z_{obs} = \frac{0 - 1173}{1873} = -0{,}642$

49. F.S. Hiller - "The Derivation of Probabilistic Information for the Evaluation of Risky Investments." - Management Science, April, 1963.

50. By strategic element is meant an element of a project that critically influences the profit outcome of a project.

51. D.B. Hertz - "Risk Analysis in Capital Investment." - Harvard Business Review, 42 Jan. - Feb., 1964 and "Investment Policies that Pay-off." - Harvard Business Review, 46 Jan. - Feb., 1968.

elements :

| Market Analysis | Investment Cost Analysis | Operating and Fixed Cost |
|---|---|---|
| 1. Market Size | 5. Investment Required | 7. Operating Costs |
| 2. Selling Price | 6. Residual Value of Investment | 8. Fixed Costs |
| 3. Market Growth | | 9. Useful Life of Facilities |
| 4. Share of Market | | |

The basis of his technique was to sample from each distribution (see figure 2 : 7) and with this sample data to generate the requires cash flow data.

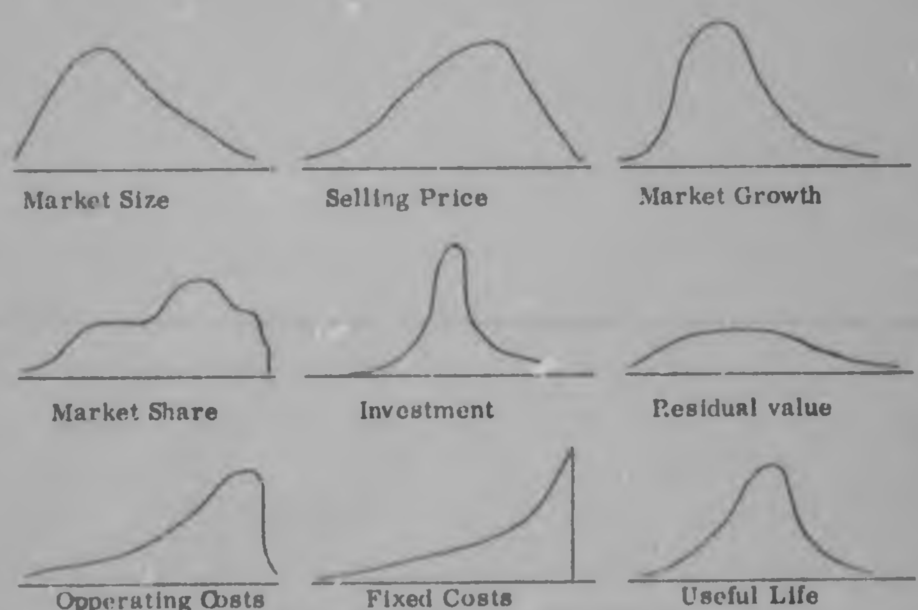


Fig. 2 : 7 - Distributions of Strategic Elements.

For each simulation he then obtained either a N. P. V. or an I. R. O. R. After carrying out this process many times, he then analysed the results to give him a cumulative probability distribution of return (see figure 2 : 8) or N. P. V. for the project.

Hertz's simulation technique is a major break-through for it enables management to vigorously interact with the strategic elements of a project

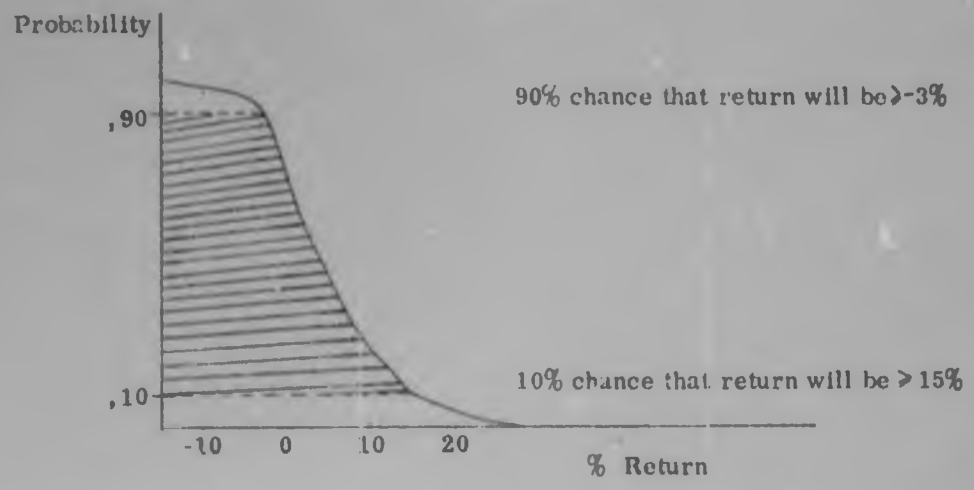


Fig. 2 : 8 - Probability Distribution of Project's I.R.O.R. together with statements of chance.

without constraint; no longer do managements have to ignore spread around expected values. To sum up, the simulation technique enables one to quantify risk, to develop risk/profit profiles and to sensitivity test projects against certain strategic elements.

Two major criticisms have been made of the Hertz type simulation, one, that the strategic elements are often dependent, while, " ..... the selection and use of the key input factors (in Hertz' Model) implies that these factors are independent of each other."[52] and two, that the distributions of the strategic variables are subjective estimates ; Hertz concedes this point : "These profiles for the elements that enter into an investment project are sometimes determined from historical or other objective data, but they are more likely to be subjective estimates by those most familiar with the various parts of the overall proposal."[53]

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52. D. Patrick - "Analysis of Investment Policies that Pay-off" - Income Theory and Rate of Return, p. 272.

53. D. B. Hertz - op. cit., p. 259.

The first criticism can easily be overcome by allowing within the simulation for conditional statements of dependency. In the simulation developed in this dissertation this refinement has been incorporated. The second criticism is symptomatic of the uncertain situation one is trying to gauge and is therefore not, in the writer's opinion, a deficiency but rather a qualification of which one must be aware. In fact, this attitude underlies the whole topic of capital budgeting, as capital budgeting techniques must be seen as aids to the decision process. They will never be comprehensive or 'reality' tested enough to replace judgement as the paramount element of the investment decision process under conditions of uncertainty. The better the aid, however, the less the unknowns which judgement must appraise and consider, and therefore any techniques which supply insights not previously available should be employed if their cost does not outweigh their value. This is the approach that has been taken in this dissertation.

In conclusion, one can state that the need to quantify risk has been stressed, and the definition of risk and its unit of measure have been established. Furthermore, the different techniques at quantifying risk have been discussed and the Hertz type simulation was highlighted as the technique offering the best gauge and scope for the evaluation of risky investments. In the next chapter a model will be developed taking into account all the points made in this chapter together with other refinements.

CHAPTER 3

## SYSTEMS DESIGN FOR A PROBABILISTIC SIMULATION MODEL

This chapter is divided into three sections, Overview of Capital Expenditure Control System, Design Specification for the Probabilistic Simulation Model, and Principles of Cash Flow Generation.

### Overview of Capital Expenditure Control System

The Capital Expenditure Control System is a sub-system of the Management Control System (see figure 3 : 1 below).

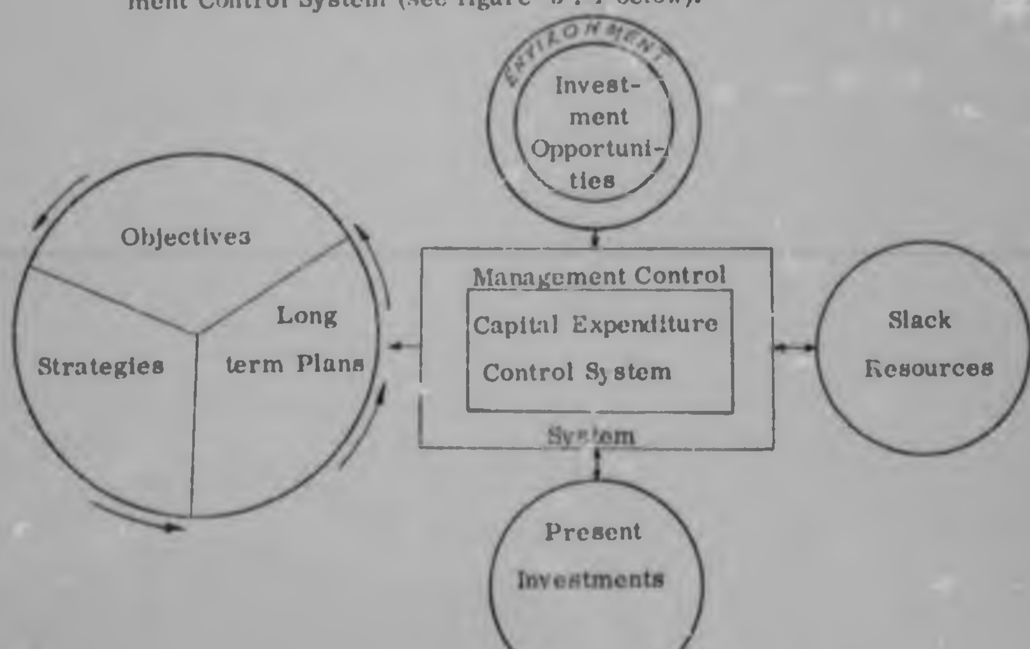


Fig. 3 : 1 - Capital Expenditure Control System as a sub-system of the Management Control System.

The Capital Expenditure Control System is responsible for developing investment opportunities and for their appraisal (Capital Budgeting); evaluation against a firm's objectives, goals, strategies and long term plans; implementation; and post implementation audit. The Probabilistic Simulation Model developed in this dissertation can be seen as part of the Capital Budgeting process, and it is to be used in evaluating large investments of critical importance to a firm's long term survival.

In the Capital Budgeting process two further categories of investment are commonly found, one, small investments and replacements; two, strategic non-quantifiable investments. The former are normally appraised by means of N.P.V., I.R.O.R. or Payback. It is recommended that these investments should be appraised by both N.P.V. and I.R.O.R. for reasons given in Chapter Two. Furthermore, it is recommended that special provision be made to guard against all replacements being put into this category, because some may need [illegible] ...tification, particularly if they involved products in the maturity or dec... [illegible] ges of the product life cycle.

[illegible] ...c investments are normally appraised on some subjective scale of '[illegible] in order to ensure that such investments are essential and that they are properly scheduled. Because this category is subjectively assessed and is open to abuse, stringent controls are recommended to guard against abuse.

Design Specification for the Probabilistic Simulation Model

The model should provide, for the reasons given in the previous Chapter, for the following :

i) Random sampling of the strategic variable data, in order to determine the data combination for each simulation.
ii) Conditional Statements to cover dependency, if any, between the strategic variables.
iii) Half-yearly profit and loss factors. The loss factors are necessary in order not to truncate the project's probability distribution of I.R.O.R. at zero.

iv) N.P.V. and I.R.O.R. for each simulation.

v) Mean Cash Flow data for the project as a whole. This will be used to graph the cash flow pattern of the project.

vi) O.R.O.R. on funds for the project as a whole.

vii) Probability statements of I.R.O.R. and N.P.V. for the project as a whole.

On a more general basis the model should take into account the following additional requirements for the reasons given :

i) Flexible 'weighted average' cost of capital factors - flexibility is essential as cost of capital can be expected to change over time.

ii) Inflation factors for each monetary variable as each variable may inflate at different rates. It is often erroneously assumed that selling prices and costs will inflate commensurately with serious consequences in today's world of high inflation. This can be well illustrated relative to the product life cycle (see figure 3 : 2).

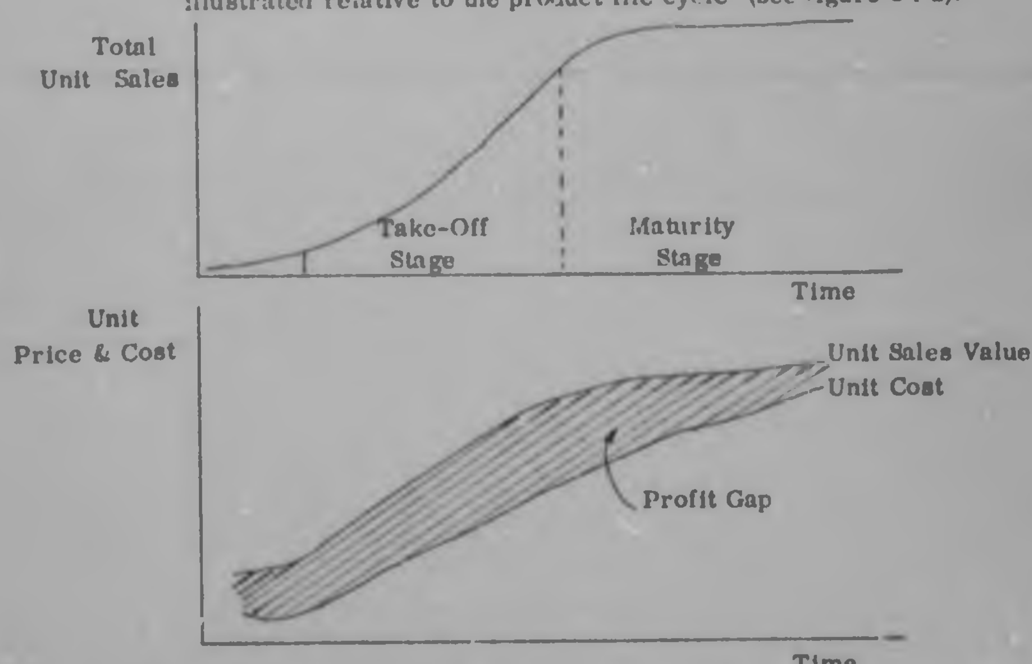


Fig. 3 : 2 - Illustrating that competition in the Maturity Stage of the Product Life Cycle may cause a profit squeeze, under conditions of inflation.

iii) Random number generator which will be used to select initial variables for each simulation.

iv) Growth factors for each variable for each year. These will be used to generate yearly data for each simulation.

v) Independent parameter inputs for working capital items, tax allowances, tax rate, salvage values, etc.

vi) Fixed investments during the course of a project.

vii) Allowance for Provisional Tax payments on a half-yearly basis.

viii) A mechanism for the generation of cash flow data on a half-yearly basis.

and ix) Policy risk profiles, against which the project's risk profile will be compared for evaluation purposes.

The design emphasis must be to keep all inputs to the minimum as to quantity and complexity. Where detailed analysis of inputs or complexity is required, the simulation should, wherever possible, perform these as an ancillary operation.

Principles of Cash Flow Generation

Discounting Term and Cash Flow Placement : For the reasons discussed earlier, cash flow intervals are usually set at that discrete interval which can be served accurately by one's forecasting facilities. Thus, whilst generation of continuous or daily cash flow data is theoretically possible, it is often impractical because one's forecasting cannot meaningfully be reduced to such a time interval. In this simulation the significant influence of provisional tax payments suggests that a half-yearly cash flow interval should be used. The next consideration is that of cash flow placement in a period. If one expects to receive a cash flow of R600 evenly during the six months January to June, one could argue that to place the flow as at the end of March would be more correct than at the beginning of January or the end of June. To place the flow at the beginning of January would result in the present value of the cash flow being overstated while the converse holds if the cash flow is placed at the end of June.

Unfortunately, the assumption of an even cash flow pattern during a period is often inappropriate and therefore one commonly encounters the conservative policy of considering cash flows as occuring instantaneously at the end of a period. The simulation will adopt this conservative practice and therefore the assumption will be that cash flows occur instantaneously at the end of each six monthly period.

Incremental Cash Flow Principle : In economics one often encounters the concept of considering incremental cost (marginal cost) and incremental revenue (marginal revenue) in order to appraise the economic benefits of a given action. The soundness of this principle cannot be over-estimated when generating cash flows. One must consider the incremental cash flows of a project in the broadest possible sense. This will ensure that a project's contribution is properly gauged and "Cannibalisation"[54] of existing sales is not over looked.

After-Tax Cash Flows : It is sometimes erroneously considered that an investment's worth should be appraised before tax. The reason why this practice is unsound is that it does not appraise a project's net worth in its purest form, that is, its expected contribution to the firm's shareholders. Second, it ignores the tax implications of different depreciation, inventory valuation, expensing and capital structure policies. Take for example, the tax effects of using debenture capital instead of preference share capital in financing an investment. The interest on the former is tax deductible while dividends to the latter are not. One can, therefore, state that tax should be

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54. "Cannibalisation" refers to the situation where a project's turnover is partially secured from a firm's existing turnover. Thus, total sales do not change by the total amount of a project's expected turnover. When evaluating a project one must ensure that one only takes into account the incremental sales unless the balance from existing sales will definitely be lost without this new investment.

considered an expense[55] and that it should be treated as a cash outflow when payment is due.

Net Cash Flow on Total Capital or on Shareholders' Funds ? Strictly speaking, a firm's prime objective is to generate profits for its shareholders and as such payments made to other providers of long term capital should be considered as outflows by the firm. The ultimate test of a project's worth is therefore, whether or not its net present value is positive after deduction of interest outflows and after discounting at the firm's equity cost of capital. This approach has the added refinement that it quantifies the effects of different "gearing"policies. Notwithstanding this, however, this approach is not commonly employed except in marginal cases because "the primary issue with many projects will frequently be the total amount of capital which is at risk and the return per unit of capital per unit of time that it is at risk."[56] Furthermore, calculation of N.P.V. and I.R.O.R. on the basis of total capital has the advantage of simplicity and ease of application because it does not require computation of these measures on the equity element alone. In the simulation developed in this dissertation the "total capital" approach has been adopted.[57]

Working Capital : Cash flow data should take into account all working capital requirements. Furthermore, these short term investments should be made a function of sales, in order that increasing Working Capital requirements are not overlooked as the project's turnover increases.

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55. H.G. Hill Jr. - op. cit., p. 37. and
    J. Dean - op. cit., p. 30.
56. A.J. Merret & A. Sykes - op. cit., p. 125.
57. Where a project is marginal, however, the refinement of calculating N.P.V. and I.R.O.R. on the equity portion alone should be employed - See A.J. Merret & A. Sykes - op. cit., p. 125.

Cash Outflows and Inflows Only : This principle needs to be stressed, because one can easily mistake a book receipt or expense as a cash flow. The most typical expense of this nature is depreciation. It is required for the calculation of tax liability but it must not be deducted as a cash outflow.

Salvage Values : Cash flow data should also provide for salvage values at the end of the project's life. Salvage values should be considered not only for fixed[58] assets but also for current[58] assets. Furthermore, one invariably finds that salvage values differ from the "Receiver's" book-values at date of salvage and therefore one must also provide for the tax effects of this difference. The difference will be either a depreciation recoupment or a loss on sale of asset.

Having now set down the Systems Design for a Probabilistic Simulation Model, the next chapter will give a detailed account of the actual simulation suite developed in accord with this design.

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58. These terms are to be understood in their accounting context, namely, current assets = debtors, inventory, etc.
fixed assets = Building, Plant and Equipment, Furniture , etc.

CHAPTER 4

## COMMENTARY ON SIMULATION SUITE

### General Overview

Figure 4 : 1 gives a flow chart for the simulation suite. Working through the diagram from "start" to "end" one sees that the initial steps are to load the probability data (programme RRJSO1) and to generate random numbers for each simulation (programme RRJSO3). Next, programme RRJSO2 performs the selection of the strategic variables from the probability tables set up by programme RRJSO1, according to the random numbers established for each simulation by programme RRJSO3. Next, programme RRJSO4 processes the output from programme RRJSO2 in three respects; one, it generates annual data for each simulation by means of growth factors, two, it applies, where appropriate, inflation factors, and three, it takes into account any dependency between variables. At this stage the variable data is complete and is ready for processing by the "master" programme RRJSO5, which generates all cash flow data and calculates all the statistics specified in Chapter Three. A detailed commentary will now be given on each of the above sub-units of the simulation suite.

### Loading of Probability Data - Programme RRJSO1

In order to simplify the input requirements, this programme accepts input in the form given in figure 4 : 2. One notes from this illustration that the suite provides for the following twelve strategic variables :

Market Information

i) Total Market Size,

ii) Firm's Market Share,

iii) Firm's Selling Price,

iv) Product's Life.

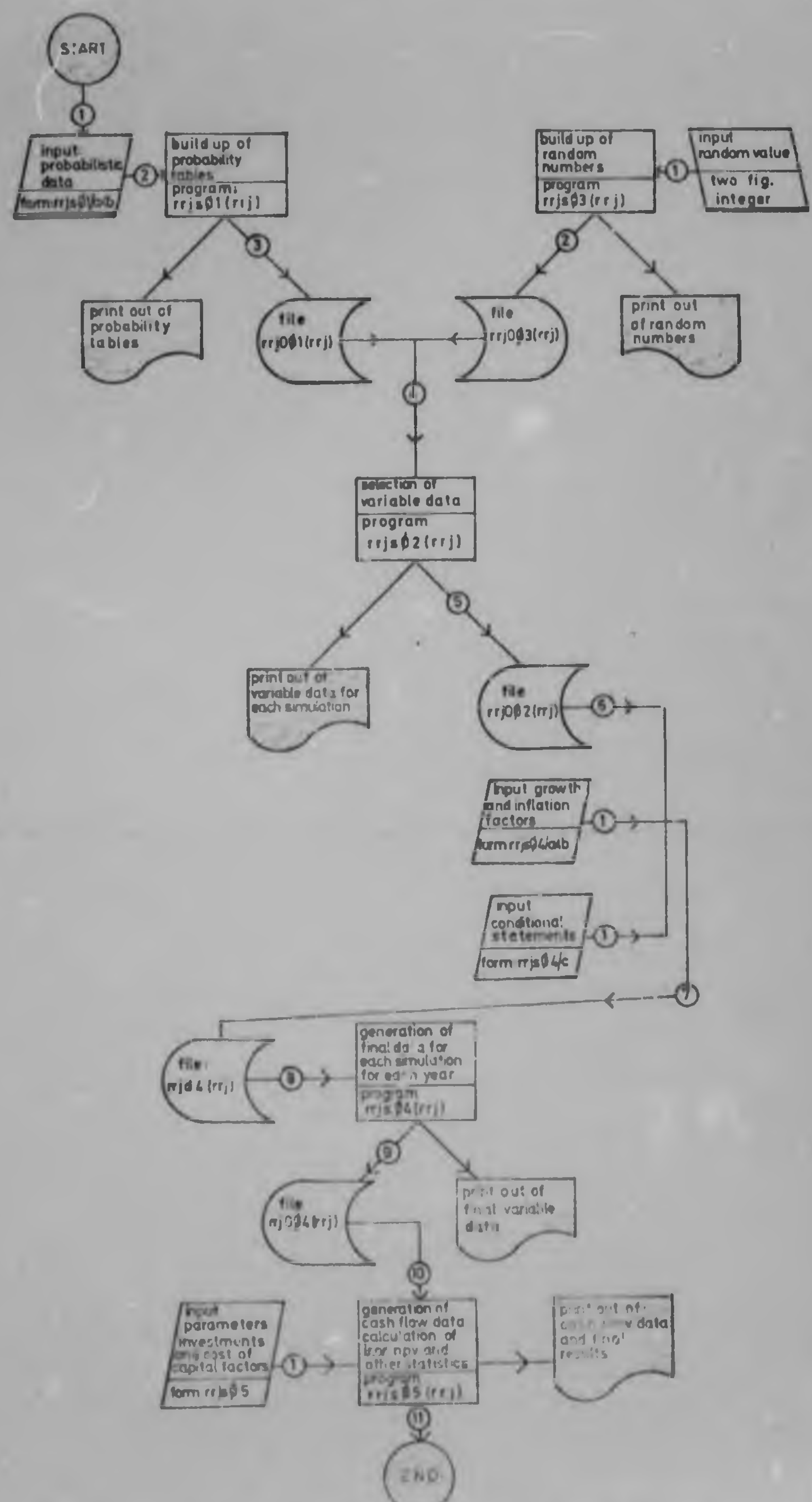



FIG. 4.1 FLOW CHART OF SIMULATION SUITE.

## PROBABILITY DATA — INPUT DOCUMENT RRJS01/1

| | MARKET SIZE IN UNITS | | MARKET SHARE AS PERCENTAGE | | MARKET PRICE OF PRODUCT | | AVERAGE VARIABLE PRODUCTION COSTS | | TOTAL FIXED PRODUCTION COSTS | | TOTAL MARKETING COSTS | | CONTROL TOTALS | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FIELDS | FIGURE | PROB. | FIGURE | PROB. | FIGURE | PROB. | FIGURE | PROB. | FIGURE | PROB. | FIGURE | PROB. | FIGURE | PROB. |
| | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | [illegible] | [illegible] |
| | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | | 26560 | 35 |
| | | | | | | | [illegible] | [illegible] | | | | | 11200 | 5 |
| CONTROL TOTALS | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| DECIMALS | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | | 2 | |

**FIG.** 4:2 INPUT DOCUMENT FOR PROGRAMME RRJS01

## PROBABILITY DATA – INPUT DOCUMENT CONTINUED RRJS01/2

| | TOTAL SELLING COSTS | | OTHER FIXED EXPENSES | | OTHER VARIABLE EXPENSES RELATIVE TO UNIT SALES | | PRODUCT LIFE IN YEARS | | PLANT LIFE IN YEARS | | INVESTMENT | | CONTROL TOTALS SHEETS 1/2 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FIELDS | FIGURE | PROB. | FIGURE | PROB. | FIGURE | PROB. | FIGURE | PROB. | FIGURE | PROB. | FIGURE | PROB. | FIGURE | PROB. |
| | 5000000 | 30 | 15000000 | 80 | 150 | 20 | 1000 | 20 | 1000 | 20 | 500000000 | 30 | [illegible] | 272 |
| | 5500000 | 35 | 20000000 | 20 | 200 | 70 | 1200 | 20 | 1200 | 20 | 600000000 | 50 | [illegible] | 425 |
| | 6000000 | 25 | | | 250 | 10 | 1400 | 30 | [illegible] | 30 | 700000000 | 20 | [illegible] | 270 |
| | | | | | | | 1600 | 30 | [illegible] | 30 | | | [illegible] | 160 |
| | | | | | | | | | | | | | 26260 | 30 |
| | | | | | | | | | | | | | 11300 | 3 |
| CONTROL TOTALS | 16500000 | 00 | 35000000 | 00 | 600 | 00 | 5200 | 00 | 6200 | 00 | 1800000000 | 00 | 23961477505 | 200 |
| DECIMALS | 2 | | 2 | | 2 | | 1 | | 2 | | 1 | | 2 | |

**FIG.** 4:2 INPUT DOCUMENT FOR PROGRAMME RRJS01

Marketing and Distribution Expenses

i) Marketing Costs - Promotions, Advertising, etc.

ii) Total Selling Costs - Salesmen, Warehousing, etc.

Manufacturing Information

i) Variable Production Costs,

ii) Total Fixed Production Costs,

iii) Plant's Life,

iv) Value of Initial Investment.

Other Expenses

i) Other Variable Expenses relative to Unit Sales,

ii) Other Fixed Expenses.

The probabilities quoted against a given value in figure 4 : 2 are used by the programme to iterate probability tables for each variable. Thus, in the case of Market Size the programme will allot the numbers one to one hundred as follows :

| | | | |
|---|---|---|---|
| 170 000 units | 1 | - | 15 |
| 190 000 units | 16 | - | 60 |
| 210 000 units | 61 | - | 80 |
| 230 000 units | 81 | - | 100 |

The manner in which this allotment takes place is illustrated in figure 4 : 3 which is a print out of programme RRJSO1. One sees from these details that the programme uses separate arrays for each strategic variable and thus the above data is set up as follows :

ARRAY "A" - MARKET SIZE

| | | |
|---|---|---|
| 170 000 units | A(1) | A(15) |
| 190 000 units | A(16) | A(60) |
| 210 000 units | A(61) | A(80) |
| 230 000 units | A(81) | A(100) |


**FIG.** 4:3 DISPLAY OF PROGRAMME RRJ501

```
      IF(KA.GT.100) GOTO 5
      DO 4 I=KA,KAA
      A(I)=A1
    4 CONTINUE
      KA=KAA+1
    5 IF(KB.GT.100) GOTO 7
      DO 6 I=KB,KBB
      B(I)=A2
    6 CONTINUE
      KB=KBB+1
    7 IF(KC.GT.100) GOTO 9
      DO 8 I=KC,KCC
      C(I)=A3
    8 CONTINUE
      KC=KCC+1
    9 IF(KD.GT.100) GOTO 11
      DO 10 I=KD,KDD
      D(I)=A4
   10 CONTINUE
      KD=KDD+1
   11 IF(KE.GT.100) GOTO 13
      DO 12 I=KE,KEE
      E(I)=A5
   12 CONTINUE
      KE=KEE+1
   13 IF(KF.GT.100) GOTO 2
      DO 14 I=KF,KFF
      F(I)=A6
   14 CONTINUE
      KF=KFF+1
      GOTO 2
   15 KKKK=KEE+KHH+KFF+KGG+KRR+KSS
      IF(KKKK.EQ.600) GOTO 28
      READ(5,16)A7,K7,A8,K8,A9,K9,A10,K10,A11,K11,A12,K12
   16 FORMAT(6(F12.2,I3))
      KEE=KEE+K7
      KHH=KHH+K8
      KFF=KFF+K9
      KGG=KGG+K10
      KRR=KRR+K11
      KSS=KSS+K12
C LOADING OF ARRAYS
      IF(KG.GT.100) GOTO 18
      DO 17 I=KG,KGG
      G(I)=A7
   17 CONTINUE
      KG=KGG+1
   18 IF(KH.GT.100) GOTO 20
      DO 19 I=KH,KHH
      H(I)=A8
   19 CONTINUE
      KH=KHH+1
   20 IF(KP.GT.100) GOTO 22
      DO 21 I=KP,KPP
      P(I)=A9
   21 CONTINUE
      KP=KPP+1
   22 IF(KQ.GT.100) GOTO 24
      DO 23 I=KQ,KQQ
```

FIG. 4:3 DISPLAY OF PROGRAMME RRJS01

```
      W(I)=A10
   23 CONTINUE
      KW=KW+1
   24 IF(KW.GT.100) GOTO 26
      DO 25 I=KS,KWW
      R(I)=A11
   25 CONTINUE
      KR=KR+1
   26 IF(KS.GT.100) GOTO 15
      DO 27 I=KS,KSS
      S(I)=A12
   27  CONTINUE
      KS=KS+1
      GOTO 15
C TESTING OF ARRAYS
   28 WRITE(7,29)
   29 FORMAT(////20X,'DETAILED PRINT OUT OF ARRAYS IN DESCENDING ORDER (1>100)'/20X,56('*')////9X,'MARKET SIZE',5X,'MARKET SH
     ARE',8X,'MAX.UNIT PRICE',10X,'PAR.VAR.C.',8X,'PAR.FIXED C.',9X,'MARKETING C.'// /)
      WRITE(7,30)(A(I),B(I),C(I),D(I),E(I),F(I),I=1,100)
   30 FORMAT(6(8X,F12.2))
      WRITE(7,31)
   31 FORMAT(///12(('*')////10X,'SELLING C.',8X,'OTHER FIX.C.',8X,'OTHER VAR.C.',8X,'PRODUCT LIFE',10X,'PLANT LIFE',10X,'INVE
     STMENT'///)
      WRITE(7,32)(G(I),H(I),P(I),Q(I),R(I),S(I),I=1,100)
   32 FORMAT(6(8X,F12.2))
      STOP
      END
```

FIG. 4.3 DISPLAY OF PROGRAMME RRJS01

The final output of this programme, which will be used as input into programme RRJSO2 is partially illustrated in figure 4 : 4. One notes from this that the market size estimate of 170 000 units appears fifteen times, which checks with the above. One can likewise check the other variables quoted in figure 4 : 2.

It is interesting to note that the probability distributions supplied à priori to this programme can have an infinite number of shapes, as is illustrated by the graphs in figure 4 : 5, which is based on the data in figure 4 : 2.

Random Number Generator - Programme RRJSO3

This programme utilises an I. B. M. sub-routine called "Randu" for the generation of random numbers. The generated numbers are then arranged into one array "Irand", which conforms to the specifications set up on programme RRJSO1. Each column of the array "Irand" represents one strategic variable, while each row represents the random numbers for each simulation. A detailed print out of programme RRJSO3 is given in figure 4 : 6 while its output is partially given in figure 4 : 7.

Selection of Strategic Data for each Simulation - Programme RRJSO2

Having the outputs of programmes RRJSO1 and RRJSO3 available, programme RRJSO2, which is detailed in figure 4 : 8, now selects the strategic data by matching the random numbers for each simulation with the equivalent variables in the probability tables. For instance, simulation "One" has, according to figure 4 : 7, the random numbers 1, 1, 3, 11, 41, 47, 14, 62, 47, 23, 15, 83, which result in the selection of the following strategic information from the probability tables set up by programme RRJSO1 :

| | Array Element | Value |
|---|---|---|
| Market Size | A (1) | 170 000 units |
| Market Share | B (1) | 40 % |

DETAILED PRINT OUT OF ARRAYS IN DESCENDING ORDER (1>100)

| MARKET SIZE | MARKET SHARE | MARKET PRICE | MAN.VAR.C. | MAN.FIXED C. | MARKETING C. |
|---|---|---|---|---|---|
| 170000.00 | .40 | 135.00 | 102.00 | 550000.00 | 100000.00 |
| 170000.00 | .40 | 135.00 | 102.00 | 550000.00 | 100000.00 |
| 170000.00 | .40 | 135.00 | 102.00 | 550000.00 | 100000.00 |
| 170000.00 | .40 | 135.00 | 102.00 | 550000.00 | 100000.00 |
| 170000.00 | .40 | 135.00 | 102.00 | 550000.00 | 100000.00 |
| 170000.00 | .40 | 135.00 | 102.00 | 550000.00 | 100000.00 |
| 170000.00 | .40 | 135.00 | 102.00 | 550000.00 | 100000.00 |
| 170000.00 | .40 | 135.00 | 102.00 | 550000.00 | 100000.00 |
| 170000.00 | .40 | 135.00 | 102.00 | 550000.00 | 100000.00 |
| 170000.00 | .40 | 135.00 | 102.00 | 550000.00 | 100000.00 |
| 170000.00 | .45 | 140.00 | 104.00 | 550000.00 | 100000.00 |
| 170000.00 | .45 | 140.00 | 104.00 | 550000.00 | 100000.00 |
| 170000.00 | .45 | 140.00 | 104.00 | 550000.00 | 100000.00 |
| 170000.00 | .45 | 140.00 | 104.00 | 550000.00 | 100000.00 |
| 170000.00 | .45 | 140.00 | 104.00 | 550000.00 | 100000.00 |
| [illegible] | .45 | 140.00 | 104.00 | 550000.00 | 100000.00 |
| | | 140.00 | 104.00 | 550000.00 | 100000.00 |
| | | | 104.00 | 550000.00 | |

| SELLING C. | OTHER FIX.C. | OTHER VAR.C. | PRODUCT LIFE | PLANT LIFE | INVESTMENT |
|---|---|---|---|---|---|
| 500000.00 | 150000.00 | 1.50 | 10.00 | 10.00 | [illegible] |
| 500000.00 | 150000.00 | 1.50 | 10.00 | 10.00 | [illegible] |
| 500000.00 | 150000.00 | 1.50 | 10.00 | 10.00 | [illegible] |
| 500000.00 | 150000.00 | 1.50 | 10.00 | 10.00 | 5000000.00 |
| 500000.00 | 150000.00 | 1.50 | 10.00 | 10.00 | 5000000.00 |
| 500000.00 | 150000.00 | | 10.00 | 10.00 | 5000000.00 |
| [illegible] | 150000.00 | | 10.00 | 10.00 | 5000000.00 |
| | | | 10.00 | 10.00 | 5000000.00 |
| | | | | | 5000000.00 |
| | | | | | [illegible] |

FIG. 4.4 OUTPUT FROM PROGRAMME RRJS01

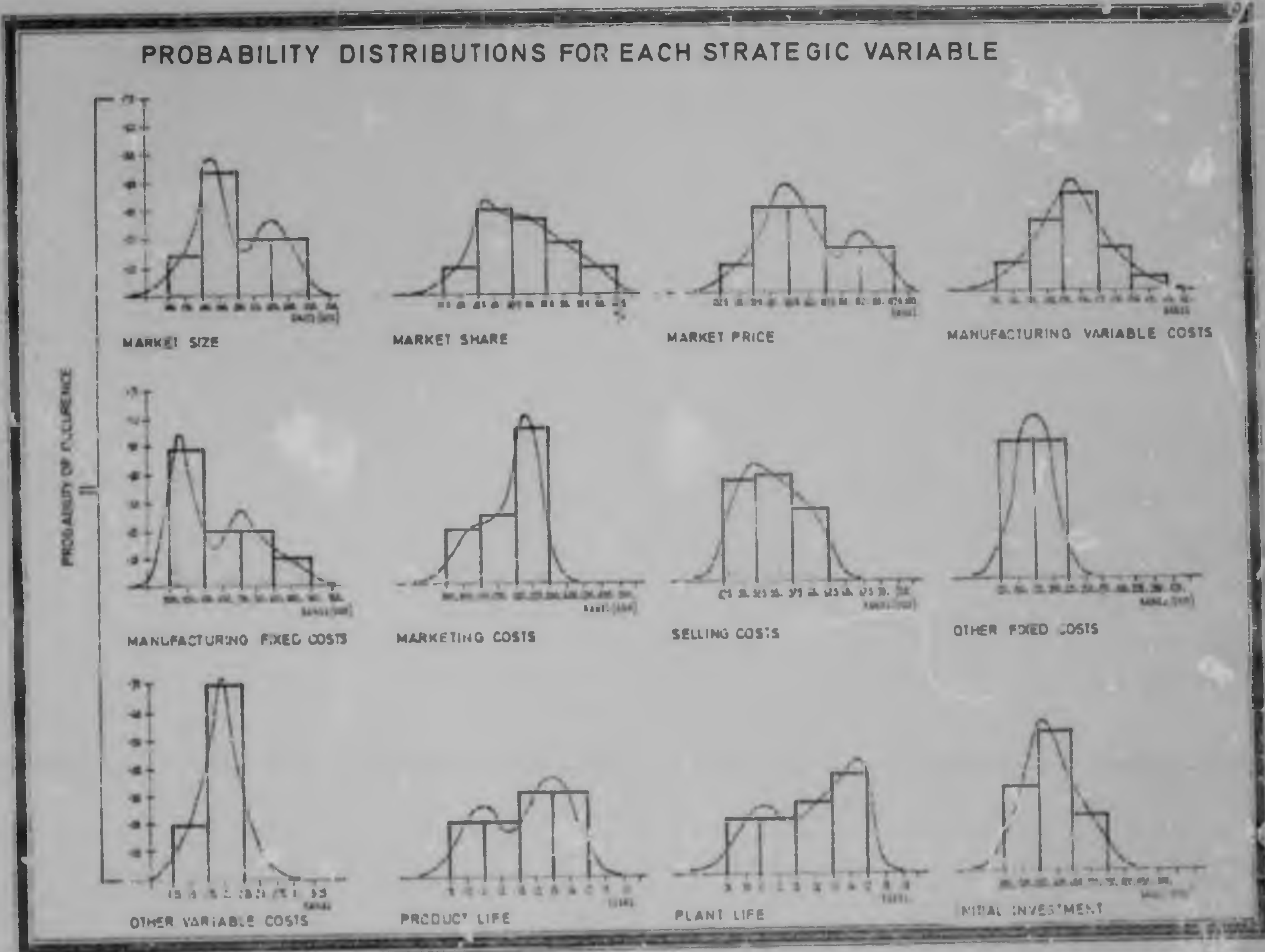



FIG. 4.5 PROBABILITY DISTRIBUTIONS FOR STRATEGIC VARIABLES

```
RAJVEN   ACCT 28   BUSINESS ADMIN.                  FILE  RRJS03                 TUE  6/2/71 (71-037)      TIME 11.17

C DETERMINATION OF RANDOM NUMBERS.
      DIMENSION IRAND(100,12)
      READ(7,100)IX
  100 FORMAT(I2)
      DO 101 I=1,100
      IROW=I
      DO 102 K=1,12
      CALL RANDU(IX,IY,Y)
      IR=(IY/214748371)+1
      IRAND(IROW,K)=IR
      IX=IY
  102 CONTINUE
  101 CONTINUE
      WRITE(6,103)
  103 FORMAT(20X,'PRINT OUT OF RANDOM NUMBERS (12X100) EACH ROW ONE SIMULATION'/20X,60('*')/)
      WRITE(6,104)
  104 FORMAT(' SIMU.NO. MARKET  MARKET  SHARE?  MAN.VAR. MAN.FIX. MARKETG. SELLING  OTHER  OTHER  PRODUCT  PLANT  I
CONT. NVEST-'/13X,'SIZE   SHARE   PRICE   COSTS   COSTS   COSTS   COSTS FIX.COSTS V.COSTS   LIFE   LIFE   MENT')
      DO 106 IROW=1,100
      WRITE(6,105)IROW,(IRAND(IROW,K),K=1,12)
  105 FORMAT(3X,I3,6X,I3,6X,I3,6X,I3,6X,I3,6X,I3,6X,I3,6X,I3,6X,I3,6X,I3,6X,I3,6X,I3,6X,I3)
  106 CONTINUE
      STOP
      END
/INC RANDU
      END
```

FIG. 4.6 DISPLAY OF PROGRAMME RRJS03

RRJVEM ACCT 28 BUSINESS ADMIN. FILE RRJ003 TUE 6/2/73 (73-0371) TIME 11.17

PRINT OUT OF RANDOM NUMBERS (12X100);EACH ROW ONE SIMULATION

| SIMU.NO. | MARKET SIZE | MARKET SHARE | MARKET PRICE | MAN.VAR. COSTS | MAN.FIX. COSTS | MARKETG. COSTS | SELLING COSTS | OTHER FIX.COSTS | OTHER V.COSTS | PRODUCT LIFE | PLANT LIFE | INVEST-MENT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 1 | 3 | 11 | 41 | 47 | 14 | 62 | 47 | 23 | 15 | 81 |
| 2 | 68 | 63 | 72 | 64 | 41 | 70 | 54 | 97 | 59 | 29 | 83 | 36 |
| 3 | 74 | 21 | 98 | 67 | 79 | 72 | 28 | 19 | 66 | 33 | 100 | 8 |
| 4 | 48 | 19 | 87 | 55 | 49 | 99 | 57 | 53 | 10 | 80 | 92 | 38 |
| 5 | 100 | 55 | 38 | 30 | 41 | 81 | 23 | 6 | 32 | 39 | 54 | 72 |
| 6 | 49 | 49 | 54 | 85 | 27 | 97 | 65 | 58 | 87 | 34 | 57 | 88 |
| 7 | 23 | 42 | 90 | 27 | 11 | 24 | 45 | 59 | 49 | 42 | 14 | 50 |
| 8 | 95 | 22 | 76 | 66 | 12 | 77 | 57 | 50 | 88 | 81 | 46 | 50 |
| 9 | 32 | 46 | 1 | 73 | 28 | 15 | 41 | 16 | 30 | 34 | 42 | 47 |
| 10 | 100 | 79 | 83 | 84 | 58 | 100 | 75 | 54 | 49 | 12 | 30 | 78 |
| 11 | 95 | 73 | 64 | 5[illegible] | 42 | 9 | 76 | 76 | 73 | 54 | 69 | 33 |
| 12 | 76 | 63 | 96 | [illegible] | 68 | 72 | 18 | 67 | 41 | 44 | 95 | 81 |
| 13 | 36 | 93 | 30 | 49 | 28 | 27 | 9 | 12 | 98 | 74 | 89 | 33 |
| 14 | 96 | 86 | 57 | 40 | 74 | 93 | 88 | 44 | 76 | 17 | 13 | 32 |
| 15 | 74 | 61 | 100 | 96 | 38 | 24 | 8 | 33 | 78 | 79 | 6 | 47 |
| 16 | 95 | 54 | 73 | 55 | 75 | 56 | 63 | 73 | 71 | 76 | 19 | 28 |
| 17 | 1 | 57 | 32 | 82 | 9 | 17 | 24 | 89 | 21 | 22 | 48 | 34 |
| 18 | 31 | 44 | 87 | 33 | 15 | 97 | 47 | 11 | 48 | 93 | 23 | 3 |
| 19 | 19 | 84 | 39 | 56 | 27 | 58 | 11 | 42 | 54 | 50 | 15 | 38 |
| 20 | 91 | 22 | 96 | 81 | 19 | 88 | 60 | 71 | 98 | 36 | 35 | 80 |
| 21 | 19 | 17 | 35 | 56 | 27 | 55 | 94 | 67 | 59 | 49 | 70 | 82 |
| 22 | 60 | 23 | 100 | 94 | 73 | 91 | 88 | 12 | 85 | 99 | 35 | 27 |
| 23 | 17 | 3 | 71 | 98 | 55 | 48 | 91 | 19 | 97 | 10 | 90 | 51 |
| 24 | 5 | 47 | 61 | 68 | 61 | 54 | 74 | 62 | 5 | 72 | 93 | 11 |
| 25 | 34 | 7 | 39 | 71 | 77 | 23 | 84 | 42 | 100 | 26 | 53 | 68 |
| 26 | 55 | 38 | 33 | 56 | 44 | 60 | 68 | 67 | 94 | 64 | 36 | 42 |
| 27 | 32 | 12 | 87 | 20 | 33 | 21 | 36 | 29 | 51 | 41 | 93 | 90 |
| 28 | 2 | 6 | 22 | 82 | 93 | 25 | 17 | 73 | 19 | 78 | 75 | 44 |
| 29 | 91 | 67 | 64 | 7 | 46 | 97 | 67 | 36 | 12 | 49 | 89 | 91 |
| 30 | 53 | 99 | 14 | 100 | 75 | 48 | 14 | 59 | 27 | 35 | 68 | 45 |
| 31 | 56 | 85 | 9 | 94 | 63 | 53 | 69 | 34 | 14 | 40 | 10 | 4 |
| 32 | 47 | 27 | 42 | 10 | 82 | 4 | 44 | 26 | 13 | 44 | 47 | 87 |
| 33 | 95 | 73 | 3 | 81 | 60 | 36 | 77 | 47 | 87 | 99 | 16 | 8 |
| 34 | 5 | 58 | 5 | 10 | 18 | 3 | 76 | 34 | 22 | 30 | 84 | 33 |
| 35 | 58 | 29 | 98 | 86 | 97 | 11 | 94 | 64 | 39 | 57 | 47 | 69 |
| 36 | 43 | 38 | 43 | 17 | 22 | 75 | 60 | 82 | 57 | 3 | 11 | 40 |
| 37 | 42 | 51 | 68 | 90 | 34 | 93 | 55 | 98 | 95 | 87 | 71 | 44 |
| 38 | 27 | 65 | 91 | 20 | 49 | 32 | 73 | 52 | 58 | 96 | 94 | 97 |
| 39 | 34 | 54 | 100 | 96 | 79 | 10 | 52 | 23 | 16 | 53 | 30 | 9 |
| 40 | 82 | 15 | 54 | 95 | 89 | 59 | 63 | 87 | 61 | 83 | 50 | 56 |
| 41 | 87 | 21 | 43 | 68 | 23 | 35 | 100 | 89 | 15 | 7 | 34 | 43 |
| 42 | 49 | 12 | 28 | 65 | 39 | 49 | 45 | 35 | 4 | 8 | 18 | 37 |
|  |  | 20 | 79 | 14 | 97 |  |  | 84 | 33 | 42 | 58 | 69 |
|  |  |  | 64 | 10 |  |  |  | 28 | 84 | 56 | 11 | 46 |
|  |  |  |  |  |  |  |  |  | 81 | 85 | 64 | 36 |
|  |  |  |  |  |  |  |  |  |  | 26 |  |  |

FIG. 4.7 OUTPUT FROM PROGRAMME RRJS03

```
*****************************************************************************************************************************
RRJVEM   ACCT 28   BUSINESS ADMIN.                    FILE  RRJS02                    MON 25/6/73 (73-176)      TIME 11.11
*****************************************************************************************************************************

      C SELECTION OF VARIABLE DATA.
        DIMENSION SIMU(100,12),A(100),B(100),C(100),D(100),E(100),F(100),G(100),H(100),P(100),Q(100),R(100),S(100),IRAND(100,12
CONT.  )
        DO 1 I=1,100
        A(I)=0.0
        B(I)=0.0
        C(I)=0.0
        D(I)=0.0
        E(I)=0.0
        F(I)=0.0
        G(I)=0.0
        H(I)=0.0
        P(I)=0.0
        Q(I)=0.0
        R(I)=0.0
        S(I)=0.0
      1 CONTINUE
        DO 3 K=1,12
        DO 2 I=1,100
        SIMU(I,K)=0.0
        IRAND(I,K)=0.0
      2 CONTINUE
      3 CONTINUE
        READ(5,4)
      4 FORMAT(12(/))
        READ(5,5)(A(I),B(I),C(I),D(I),E(I),F(I),I=1,100)
      5 FORMAT(6(8X,F12.2))
        READ(5,6)
      6 FORMAT(10(/))
        READ(5,7)(G(I),H(I),P(I),Q(I),R(I),S(I),I=1,100)
      7 FORMAT(6(8X,F12.2))
        READ(5,8)
      8 FORMAT(4(/))
        READ(5,9)((IRAND(IROW,K),K=1,12),IROW=1,100)
      9 FORMAT(12X,I3,6X,I3,6X,I3,6X,I3,6X,I3,6X,I3,6X,I3,6X,I3,6X,I3,6X,I3,6X,I3,6X,I3)
        DO 10 I=1,100
        SIMU(I,1)=A(IRAND(I,1))
        SIMU(I,2)=B(IRAND(I,2))
        SIMU(I,3)=C(IRAND(I,3))
        SIMU(I,4)=D(IRAND(I,4))
        SIMU(I,5)=E(IRAND(I,5))
        SIMU(I,6)=F(IRAND(I,6))
        SIMU(I,7)=G(IRAND(I,7))
        SIMU(I,8)=H(IRAND(I,8))
        SIMU(I,9)=P(IRAND(I,9))
        SIMU(I,10)=Q(IRAND(I,10))
        SIMU(I,11)=R(IRAND(I,11))
        SIMU(I,12)=S(IRAND(I,12))
     10 CONTINUE
        WRITE(7,11)
     11 FORMAT(////20X,'DETAILED PRINT OUT OF VARIABLE DATA FOR EACH SIMULATION'/20X,55('*')////)
        WRITE(7,12)
     12 FORMAT(1X,'SIM.NO',1X,'MARKET SIZE',6X,'MARKET SHARE',9X,'MARKET PRICE',10X,'MAN.VAR.C.',8X,'MAN.FIXED C.',9X,'MARKETI
CONT.  NG C.')
```

FIG. 4:8 DISPLAY OF PROGRAMME RRJS02

```
      DO 14 IROW=1,100
      WRITE(7,13)IROW,(SIPU(IROW,K),K=1,6)
   14 CONTINUE
   13 FORMAT(3X,I3,2X,F12.2,5(8X,F12.2))
      WRITE(7,15)
   15 FORMAT(///132('*')////1X,'SIM.NO.',2X,'SELLING C.',8X,'OTHER FIX.C.',8X,'OTHER VAR.C.',8X,'PRODUCT LIFE',10X,'PLANT LIF
CONT. E',10X,'INVESTMENT'///)
      DO 16 IROW=1,100
   16 WRITE(7,13)IROW,(SIPU(IROW,K),K=7,12)
      STOP
      END
```

FIG. 4:8 DISPLAY OF PROGRAMME RRJS02

| | Array Element | Value |
|---|---|---|
| Market Price | C (3) | R135.00 |
| Manufacturing Variable Cost | D(11) | R104.00 |
| Manufacturing Fixed Cost | E(41) | R550 000.00 |
| Marketing Costs | F(47) | R140 000.00 |
| Selling Costs | G(14) | R500 000.00 |
| Other Fixed Costs | H(62) | R200 000.00 |
| Other Variable Costs | P(47) | R2.00 |
| Product Life | Q(23) | 12 years |
| Plant Life | R(15) | 10 years |
| Initial Investment | S(83) | R7 000 000.00 |

Partial displays of the output of programme RRJSO2 are given in figure 4 : 9 and one notes that the data check with the above example.

Build up of Annual Data - Programme RRJSO4

This programme, a detailed print out of which is given in figure 4 : 10, handles the final preparation of the strategic data for a maximum of thirty years. Using the line numbers given in figure 4 : 10 one can identify the following major steps in the programme :

Lines 1 to 34 establish the required arrays and they set these arrays to zero.
Line 35 reads into the array "Growth" the growth factors to be applied to each simulation.
Line 36 reads into the array "Escal" the inflation factors to be applied to each simulation. The input document used for the growth and inflation factors is shown in figure 4 : 11, while the graphical illustration of these factors for each strategic variable is shown in respectively figures 4 : 12 and 4 : 13. It is interesting to note that the factors are applied independently to each strategic variable, and thus total flexibility is achieved.
Line 38 reads, into the various arrays, data on statements of dependence

58

DETAILED PRINT OUT OF VARIABLE DATA FOR EACH SIMULATION

| SIM.NO: | MARKET SIZE | MARKET SHARE | MARKET PRICE | MAN.VAR.C. | MAN.FIXED C. | MARKETING C. |
|---|---|---|---|---|---|---|
| 1 | 170000.00 | .40 | 135.00 | 104.00 | 550000.00 | 140000.00 |
| 2 | 210000.00 | .50 | 150.00 | 106.00 | 550000.00 | 140000.00 |
| 3 | 210000.00 | .45 | 145.00 | 106.00 | 750000.00 | 140000.00 |
| 4 | 190000.00 | .45 | 155.00 | 106.00 | 550000.00 | 140000.00 |
| 5 | 230000.00 | .50 | 140.00 | 104.00 | 550000.00 | 140000.00 |
| 6 | 190000.00 | .50 | 145.00 | 108.00 | 550000.00 | 140000.00 |
| 7 | 190000.00 | .50 | 145.00 | 104.00 | 550000.00 | 120000.00 |
| 8 | 230000.00 | .45 | 150.00 | 106.00 | 550000.00 | 140000.00 |
| 9 | 190000.00 | .50 | 135.00 | 108.00 | 550000.00 | 100000.00 |
| 10 | 230000.00 | .55 | 150.00 | 108.00 | 650000.00 | 140000.00 |
| 11 | 230000.00 | .55 | 150.00 | 106.00 | 550000.00 | 100000.00 |
| 12 | 210000.00 | .50 | 155.00 | 102.00 | 650000.00 | 140000.00 |
| 13 | 190000.00 | .60 | 140.00 | 106.00 | 550000.00 | 120000.00 |
| 14 | 230000.00 | .55 | 145.00 | 106.00 | 750000.00 | 140000.00 |
| 15 | 210000.00 | .50 | 155.00 | 106.00 | 550000.00 | 120000.00 |
| 16 | 230000.00 | .50 | 150.00 | 106.00 | 750000.00 | 140000.00 |
| 17 | | | 140.00 | 108.00 | 550000.00 | 100000.00 |
| | | | | 104.00 | 550000.00 | [illegible] |
| | | | | [illegible] | 550000.[illegible] | |

| SIM.NO: | SELLING C. | OTHER FIX.C. | OTHER VAR.C. | PRODUCT LIFE | PLANT LIFE | INVESTMENT |
|---|---|---|---|---|---|---|
| 1 | 500000.00 | 200000.00 | 2.00 | 12.00 | 10.00 | 7000000.00 |
| 2 | 550000.00 | 200000.00 | 2.50 | 12.00 | 16.00 | 6000000.00 |
| 3 | 500000.00 | 150000.00 | 2.00 | 12.00 | 16.00 | 5000000.00 |
| 4 | 550000.00 | 200000.00 | 1.50 | 16.00 | 16.00 | 6000000.00 |
| 5 | 500000.00 | 150000.00 | 2.00 | 12.00 | 14.00 | 6000000.00 |
| 6 | 550000.00 | 200000.00 | 2.00 | 12.00 | 14.00 | 7000000.00 |
| 7 | 550000.00 | 200000.00 | 2.00 | 14.00 | 12.00 | 6000000.00 |
| 8 | 550000.00 | 150000.00 | 2.00 | 16.00 | 16.00 | 6000000.00 |
| 9 | 550000.00 | 150000.00 | 2.00 | 12.00 | 14.00 | 6000000.00 |
| 10 | 550000.00 | 200000.00 | 2.00 | 10.00 | 12.00 | 6000000.00 |
| 11 | 600000.00 | 200000.00 | 2.00 | 14.00 | 16.00 | 6000000.00 |
| 12 | 500000.00 | 200000.00 | 2.00 | 14.00 | 16.00 | 7000000.00 |
| 13 | 500000.00 | 150000.00 | 2.50 | 16.00 | 16.00 | 6000000.00 |
| 14 | 600000.00 | 200000.00 | 2.00 | 10.00 | 10.00 | 6000000.00 |
| | [illegible]00000.00 | 150000.00 | | 16.00 | 10.00 | 6000000.00 |
| | | [illegible] | | 16.00 | 10.00 | 5000000.00 |
| | | | | [illegible] | 14.00 | 7000000.00 |
| | | | | | | [illegible]0000.00 |

FIG. 4.9 OUTPUT FROM PROGRAMME RRJS02

```
RRJVEH   ACCT 28    BUSINESS ADMIN.                FILE   RRJS04                MON 25/6/73 (73-176)      TIME 11.11

C BUILD UP OF VARIABLE DATA INTO ARRAYS COVERING A MAXIMUM OF THIRTY YEARS:

C DATA BASED ON:-
C I)COMPOUND GROWTH FACTORS.
C II) CONDITIONAL STATEMENTS OF PROBABILITY.
C III) COMPOUND INFLATION FACTORS.

C THE PROGRAM RUNS EACH OF THE ABOVE ASPECTS SEPARATELY,IN THE SEQUENCE GIVEN.
C ________________________________________________________________________



      DIMENSION SIMU(100,12),GROWTH(31,12),DATA30(31,12),ESCAL(31,12),KODE(100),INDV(100),INDV1(100),NINDV(100),VALUE1(100)
      DIMENSION VALUE2(100),VALUE3(100)
      COMMON KODE,INDV,INDV1,NINDV,VALUE1,VALUE2,VALUE3,LIMIT1,LIMIT,DATA30,LUMM
      READ(9,1)LIMIT
    1 FORMAT(I2)
      DO 3 I=1,100
      KODE(I)=0
      INDV(I)=0
      INDV1(I)=0
      NINDV(I)=0
      VALUE1(I)=0.0
      VALUE2(I)=0.0
      VALUE3(I)=0.0
      DO 2 K=1,12
    2 SIMU(I,K)=0.0
    3 CONTINUE
      DO 5 L=1,LIMIT
      DO 4 K=1,12
      GROWTH(L,K)=0.0
      DATA30(L,K)=0.0
    4 ESCAL(L,K)=0.0
    5 CONTINUE
      READ(9,6)((GROWTH(L,K),K=1,9),L=1,LIMIT)
      READ(9,7)((ESCAL(L,K),K=3,9),L=1,LIMIT)
      READ(9,8)LIMIT1
      READ(9,9)(KODE(I),INDV(I),VALUE1(I),INDV1(I),VALUE2(I),NINDV(I),VALUE3(I),I=1,LIMIT1)
    6 FORMAT(9F3.0)
    7 FORMAT(7F3.0)
    8 FORMAT(I3)
    9 FORMAT(I3,I2,F12.2,I2,F12.2,I2,F12.2)
      READ(9,10)
   10 FORMAT(5(/))
      READ(9,11)((SIMU(I,K),K=1,6),I=1,100)
   11 FORMAT(6(8X,F12.2))
      READ(9,12)
   12 FORMAT(10(/))
      READ(9,11)((SIMU(I,K),K=7,12),I=1,100)
      WRITE(6,13)
   13 FORMAT('1',34X,'DETAILED PRINT OUT OF FINAL VARIABLE DATA FOR ONE HUNDRED SIMULATIONS.'/35X,69('*')/35X,69('*'))

      INNN=0
   14 DO 16 L=1,LIMIT
```

FIG. 4:1 0 DISPLAY OF PROGRAMME RRJS04

```
      DO 15 K=1,12
   15 DATA30(L,K)=0.0
   16 CONTINUE
      INN=INN+1
      IF(SIMU(INN,10).LE.SIMU(IAN,11).AND.SIMU(INN,10).LT.LIMIT)GOTO 17
      IF(SIMU(INN,11).LE.SIMU(IAN,10).AND.SIMU(INN,11).LT.LIMIT)GOTO 18
      LUMMY=LIMIT
      GOTO 19
   17 LUMMY=SIMU(IAN,10)+1.
      GOTO 19
   18 LUMMY=SIMU(IAN,11)+1.
      GOTO 19
   19 DATA30(1,12)=SIMU(IAN,12)
      DATA30(1,11)=SIMU(INN,11)
      DATA30(1,10)=SIMU(IAN,10)
      DO 20 K=1,9
   20 DATA30(2,K)=(GROWTH(2,K)/100.)*SIMU(IAN,K)
      DO 22 K=1,9
      DO 21 L=3,LUMMY
   21 DATA30(L,K)=(GROWTH(L,K)/100.)*DATA30(L-1,K)
   22 CONTINUE
      DO 24 K=3,9
      FACTOR=1.00
      DO 23 L=2,LUMMY
      FACTOR=FACTOR*(ESCAL(L,K)/100.)
      DATA30(L,K)=FACTOR*DATA30(L,K)
   23 CONTINUE
   24 CONTINUE
      CALL ADJT
      WRITE(7,25)IAN,LUMMY
   25 FORMAT(///20X,'DATA FOR SIMULATION NUMBER ',I3,5X,'.  YEARS IN PROJECT: ',I2/20X,50('*'))
      WRITE(7,26)
   26 FORMAT(5X,'MARKET SIZE',8X,'MARKET SHARE',8X,'MARKET PRICE',10X,'MAN.VAR.C.',8X,'MAN.FIXED C.',9X,'MARKETING C.')
      DO 28 L=1,LUMMY
      LCT=L-1
      WRITE(7,27)LCT,(DATA30(L,K),K=1,6)
   27 FORMAT(' YR. ',I2,1X,F12.2,5(8X,F12.2))
   28 CONTINUE
      WRITE(7,29)
   29 FORMAT(/10X,'SELLING C.',8X,'OTHER FIX.C.',8X,'OTHER VAR.C.',AX,'PRODUCT LIFE',10X,'PLANT LIFE',10X,'INVESTMENT')
      DO 31 L=1,LUMMY
      LCT=L-1
      WRITE(7,30)LCT,(DATA30(L,K),K=7,12)
   30 FORMAT(' YR. ',I2,1X,F12.2,5(8X,F12.2))
   31 CONTINUE
      IF(IAN.GE.100)GOTO 32
      GOTO 14
   32 STOP
      END

      SUBROUTINE ADJT

            DIMENSION NCOF(100),INDV(100),INDV1(100),NINDV(100),VALUE1(100),VALUE2(100),VALUE3(100),DATA30(31,12)
      COMMON NCOF,INDV,INDV1,NINDV,VALUE1,VALUE2,VALUE3,LIMIT1,LIMIT,DATA30,LUMMY
      DO 1017 L=1,LIMIT1
      IF(NCOF(L).EQ.100) GOTO 1001
      IF(NCOF(L).EQ.101)GOTO 1003
      IF(NCOF(L).EQ.102)GOTO 1005
      IF(NCOF(L).EQ.103)GOTO 1007
```

FIG. 4.10 DISPLAY OF PROGRAMME RRJS04

```
      IF(KODE(L).EQ.104)GOTO 1009
      IF(KODE(L).EQ.105)GOTO 1011
      IF(KODE(L).EQ.106)GOTO 1013
      IF(KODE(L).EQ.107)GOTO 1015

1001 DO 1002 I=2,LUPPY
1002 IF(DATA30(I,INDV(L)) LT.VALUE1(L))DATA30(I,NINDV(L))=VALUE3(L)
     GOTO 1017
1003 DO 1004 I=2,LUPPY
1004 IF(DATA30(I,INDV(L)).LE.VALUE1(L))DATA30(I,NINDV(L))=VALUE3(L)
     GOTO 1017
1005 DO 1006 I=2,LUPPY
1006 IF(DATA30(I,INDV(L)).EQ.VALUE1(L)) DATA30(I,NINDV(L))=VALUE3(L)
     GOTO 1017
1007 DO 1008 I=2,LUPPY
1008 IF(DATA30(I,INDV(L)).NE.VALUE1(L))DATA30(I,NINDV(L))=VALUE3(L)
     GOTO 1017
1009 DO 1010 I=2,LUPPY
1010 IF(DATA30(I,INDV(L)).GT.VALUE1(L))DATA30(I,NINDV(L))=VALUE3(L)
     GOTO 1017
1011 DO 1012 I=2,LUPPY
1012 IF(DATA30(I,INDV(L)).GE.VALUE1(L))DATA30(I,NINDV(L))=VALUE3(L)
     GOTO 1017
1013 DO 1014 I=2,LUPPY
1014 IF(DATA30(I,INDV(L)).GE.VALUE1(L).AND.DATA30(I,INDV1(L)).LT.VALUE2(L))DATA30(I,NINDV(L))=VALUE3(L)
     GOTO 1017
1015 DO 1016 I=2,LUPPY
1016 IF(DATA30(I,INDV(L)).LE.VALUE1(L).AND.DATA30(I,INDV1(L)).GT.VALUE2(L))DATA30(I,NINDV(L))=VALUE3(L)
1017 CONTINUE
     RETURN
     END
```

FIG. 4.10 DISPLAY OF PROGRAMME RRJS04

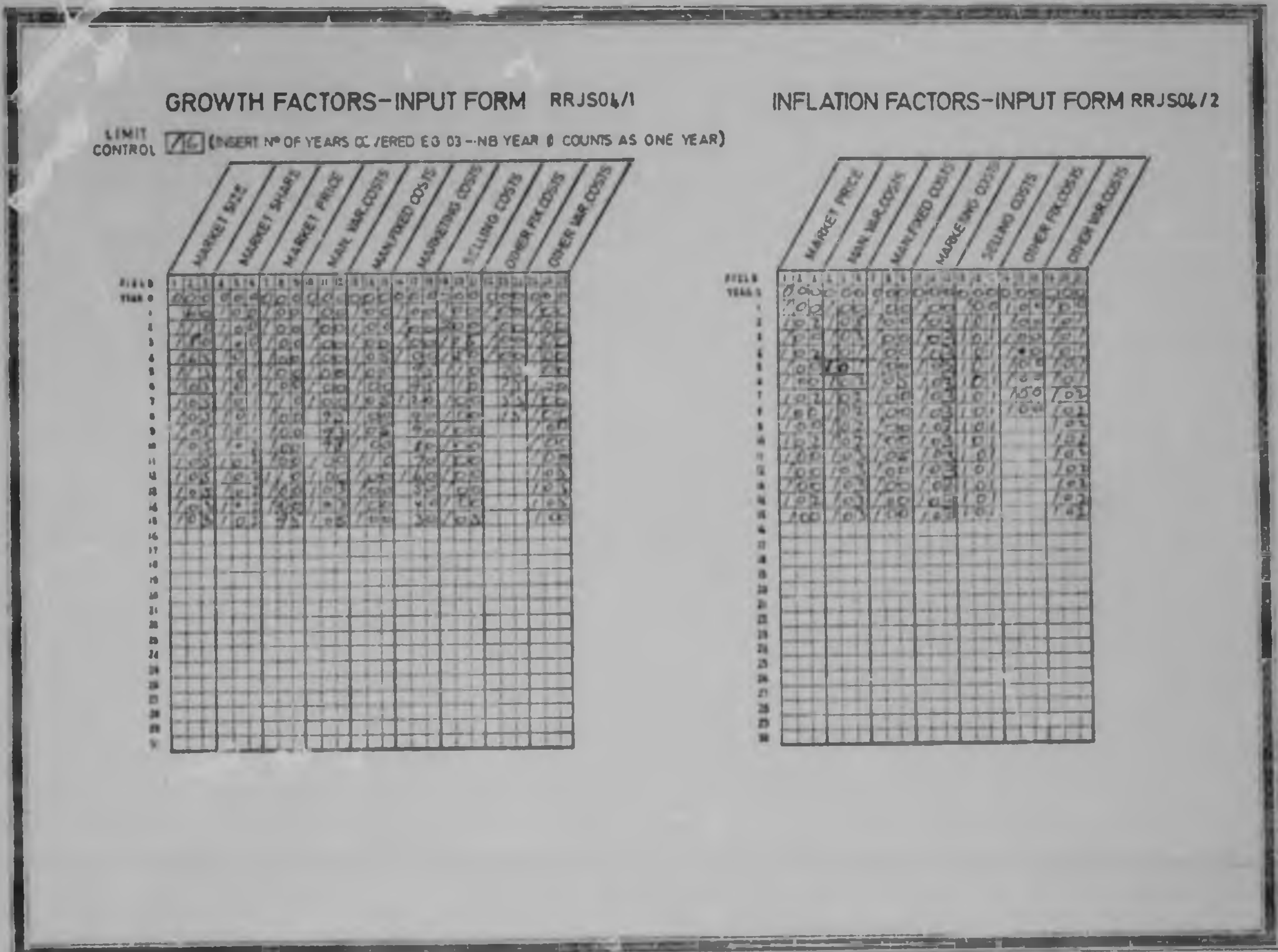



FIG. 4.11 INPUT DOCUMENT FOR PROGRAMME RRJS04

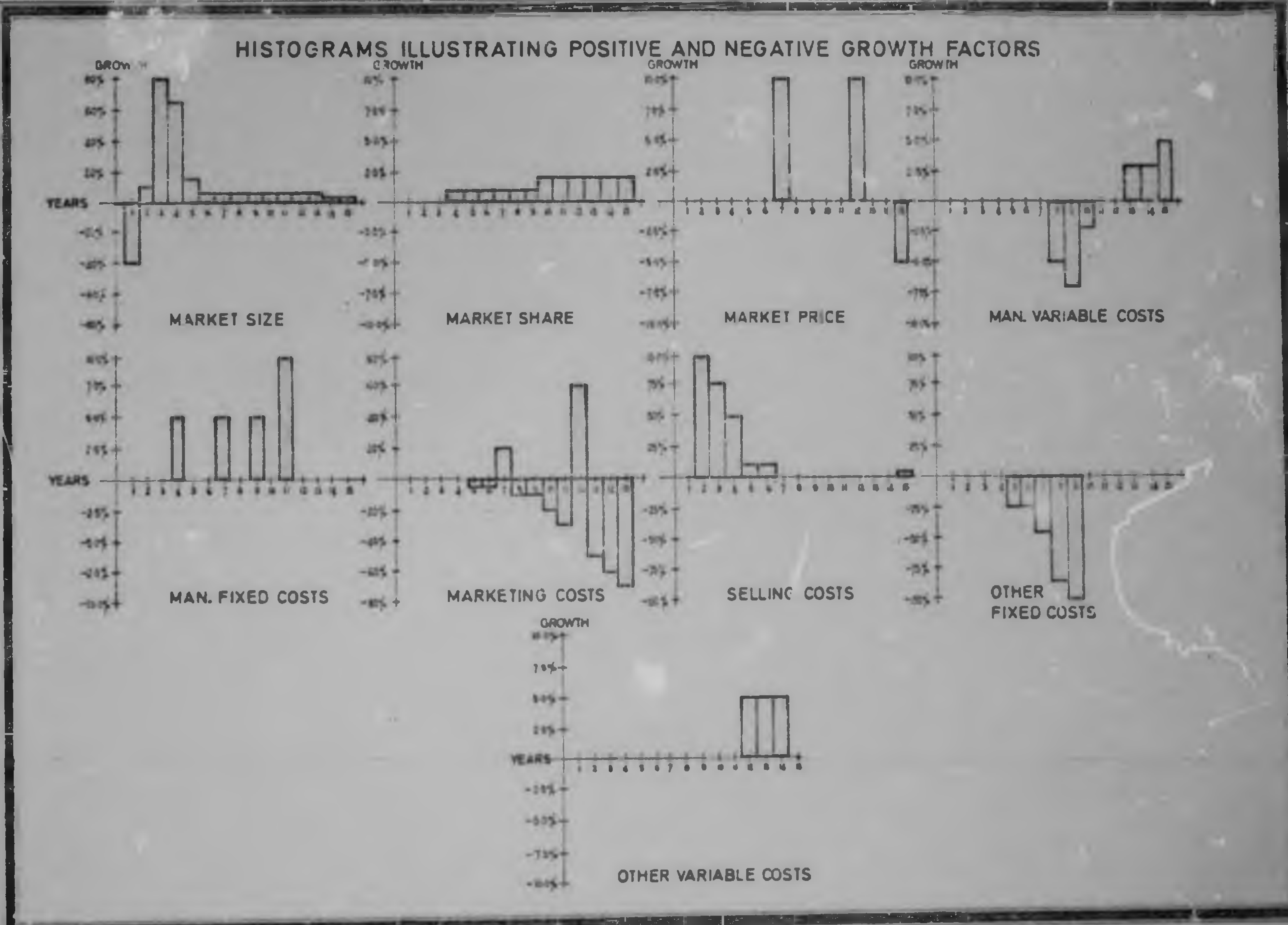



FIG. 4·12 HISTOGRAMS OF GROWTH FACTORS.

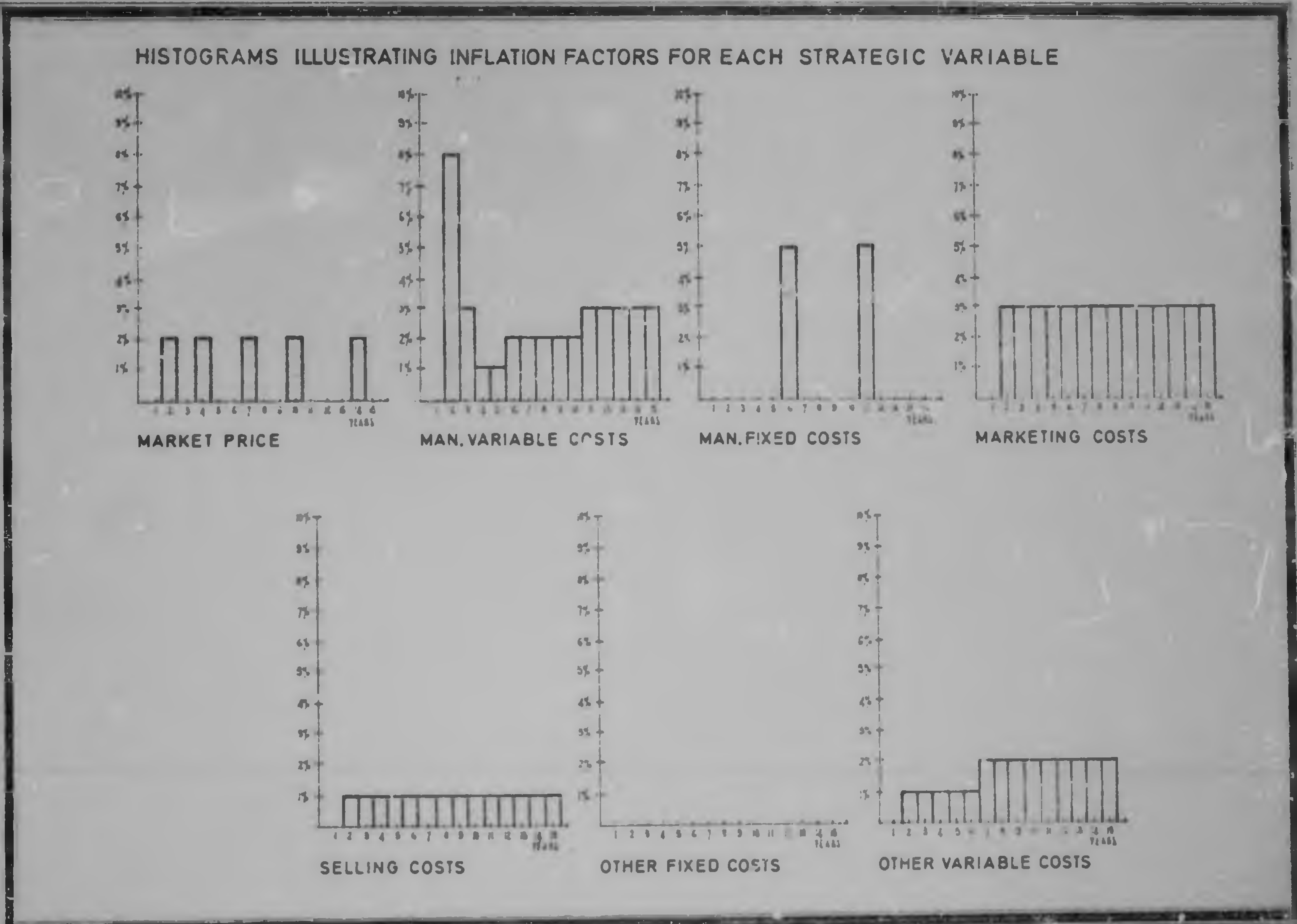



FIG. 2-13 HISTOGRAMS OF INFLATION FACTORS

between two or more variables. This information is supplied in the form illustrated in figure 4 : 14.

Lines 45 and 49 read into the array "Simu" the data output of the previous programme RRJSO2. At this stage all relevant data are loaded and the programme proceeds to process the data.

Lines 59 and 60 test for 'product life' being less than 'plant life' or vice-versa, in which case the simulation's duration is automatically reduced to the lower life, if and only if this is less than the expected maximum number of years for the project as a whole.

Lines 71 and 74 apply the growth factors to the relevant strategic variables for each simulation, while line 80 applies the inflation factors to the relevant data. Finally, line 82 calls in sub-routine "ADJT" which is given in lines 105 to 143. This sub-routine is responsible for the processing of all conditional statements of dependency. The final results of this programme are then printed out and used as input to the "master" programme RRJSO5. A partial display of RRJSO4's output is given in figure 4 : 15.

## Calculation of Cash Flows and Other Statistics - "Master" Programme RRJSO5

This programme is responsible for the generation of six monthly cash flows, the calculation of discount factors, the calculation of I.R.O.R. and N.P.V. for each simulation, the calculation of various overall measures of capital productivity and for the quantification of risk. Using the line numbers given in the programme, which is detailed in figure 4 : 16, one can identify the following major segments :

Lines 1 to 123 define the various variables used in the programme.

Lines 125 and 126 set up the required arrays.

Line 132 reads into the programme the parameters to be used. This data input is furnished in the form given in figure 4 : 17, part (a) Parameters. The balance of the information, contained in figure 4 : 17, namely, part (b) Project investments during years one to three and part (c) Cost of Capital factors, is fed into the programme by respectively lines 141 and 145.

## CONDITIONAL PROBABILITY INPUT FORM

RRJS04/3

03 (NUMBER OF CONDITIONAL STATEMENTS)

| FIELD NUMBER | STATEMENT CODE | [illegible] | GIVEN VALUE | [illegible] | ANOTHER GIVEN VALUE FOR DOUBLE STATEMENT | [illegible] | VALUE TO BE GIVEN TO DEP. VARIABLE |
|---|---|---|---|---|---|---|---|
| | 106 | 01 | 200500000 | 03 | 14500 | 03 | 14500 |
| | 107 | 02 | 50 | 03 | 24500 | 03 | 24500 |
| | 106 | 01 | 500000000 | 03 | 24000 | 03 | 24000 |

FIG. 4·14 INPUT DOCUMENT FOR PROGRAMME RRJS04

DETAILED PRINT OUT OF FINAL VARIABLE DATA FOR ONE HUNDRED SIMULATIONS.

DATA FOR SIMULATION NUMBER 1 . YEARS IN PROJECT: 11

| | MARKET SIZE | MARKET SHARE | MARKET PRICE | MAN.VAR.C. | MAN.FIXED C. | MARKETING C. |
|---|---|---|---|---|---|---|
| YR. 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| YR. 1 | [illegible] | 0.40 | 135.00 | 104.00 | 550000.00 | 140000.00 |
| YR. 2 | [illegible] | 0.40 | 137.70 | 112.32 | 550000.00 | 144199.90 |
| YR. 3 | 201759.50 | 0.43 | 145.00 | 115.69 | 550000.00 | 148525.80 |
| YR. 4 | 333233.10 | 0.40 | 145.00 | 116.85 | 577499.50 | 152981.40 |
| YR. 5 | 353218.00 | 0.41 | 145.00 | 118.01 | 577499.50 | 149692.10 |
| YR. 6 | 402378.50 | 0.41 | 145.00 | 120.37 | 606374.00 | 146473.60 |
| YR. 7 | [illegible] | 0.42 | 157.59 | 122.78 | 636692.20 | 181041.30 |
| YR. 8 | 441621.60 | 0.42 | 157.59 | 118.98 | 636692.20 | 167825.20 |
| YR. 9 | [illegible] | 0.42 | 157.59 | 112.86 | 668526.30 | 155973.80 |
| YR. 10 | [illegible] | 0.43 | 160.74 | 112.22 | 668526.30 | 128192.60 |

| | SELLING C. | OTHER FIX.C. | OTHER VAR.C. | PRODUCT LIFE | PLANT LIFE | INVESTMENT |
|---|---|---|---|---|---|---|
| YR. 0 | 0.00 | 0.00 | 0.00 | 12.00 | 10.00 | 7000000.00 |
| YR. 1 | [illegible] | 200000.00 | 2.00 | 0.00 | 0.00 | 0.00 |
| YR. 2 | [illegible] | 200000.00 | 2.02 | 0.00 | 0.00 | 0.00 |
| YR. 3 | 1785171.00 | 200000.00 | 2.04 | 0.00 | 0.00 | 0.00 |
| YR. 4 | [illegible] | 200000.00 | 2.06 | 0.00 | 0.00 | 0.00 |
| YR. 5 | [illegible] | 150000.00 | 2.08 | 0.00 | 0.00 | 0.00 |
| YR. 6 | [illegible] | 112500.00 | 2.10 | 0.00 | 0.00 | 0.00 |
| YR. 7 | 3371623.00 | 61474.97 | 2.14 | 0.00 | 0.00 | 0.00 |
| YR. 8 | [illegible] | 9281.25 | 2.19 | 0.00 | 0.00 | 0.00 |
| YR. 9 | 3459484.00 | 0.00 | 2.23 | 0.00 | 0.00 | 0.00 |
| YR. 10 | 3473773.00 | 0.00 | 2.28 | 0.00 | 0.00 | 0.00 |

DATA FOR SIMULATION NUMBER 2 . YEARS IN PROJECT: 13

| | MARKET SIZE | MARKET SHARE | MARKET PRICE | MAN.VAR.C. | MAN.FIXED C. | MARKETING C. |
|---|---|---|---|---|---|---|
| YR. 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| YR. 1 | [illegible] | 0.50 | 150.00 | 106.00 | 550000.00 | 140000.00 |
| YR. 2 | [illegible] | 0.50 | 153.00 | 114.48 | 550000.00 | 144199.90 |
| YR. 3 | [illegible] | 0.50 | 153.00 | 117.91 | 550000.00 | 148525.80 |
| YR. 4 | [illegible] | 0.50 | 156.06 | 119.09 | 577499.50 | 152981.40 |
| YR. 5 | [illegible] | 0.51 | 156.06 | 120.28 | 577499.50 | 149692.10 |
| YR. 6 | [illegible] | 0.52 | 156.06 | 122.69 | 606374.00 | 146473.60 |
| YR. 7 | [illegible] | 0.52 | 240.00 | 125.14 | 636692.20 | 181041.30 |
| YR. 8 | [illegible] | 0.53 | 240.00 | [illegible] | 636692.20 | 167825.20 |
| YR. 9 | [illegible] | 0.53 | 240.00 | 115.03 | 668526.30 | 155973.90 |
| YR. 10 | [illegible] | 0.54 | 240.00 | 114.98 | 668526.30 | 128192.60 |
| YR. 11 | 654190.70 | 0.55 | 240.00 | 118.43 | 772146.60 | 92426.81 |
| YR. 12 | [illegible] | 0.56 | 240.00 | 121.99 | 772146.60 | 192319.30 |

| | | OTHER FIX.C. | | ...LIFE | PLANT LIFE | INVESTMENT |
|---|---|---|---|---|---|---|
| | | | | | 16.00 | 6000000.00 |

FIG. 4.15 OUTPUT FROM PROGRAMME RRJS04

```
RRJVEH   ACCT 28   BUSINESS ADMIN.            FILE   RRJSOS            THU 21/6/73 (73-172)      TIME 11.43

C     MASTER PROGRAM USED TO CALCULATE:-
C
C     I) SIX MONTHLY NET CASH FLOWS. (FINISHED STOCK CONTROL BASED ON AVERAGE COST.WITH RAW MATERIALS AND W.I.P. BEING
C        ASSESSED AS A PERCENTAGE OF FINISHED STOCK. DEPRECIATION TAKEN AS STRAIGHT-LINE.)
C
C     II) INTERNAL RATE OF RETURN AND NET PRESENT VALUE FOB EACH SIMULATION.
C
C     III) OVER ALL NET PRESENT VALUE.
C
C     ANCILLARIES INCLUDE:-
C
C     I) SUBROUTINES TO CALCULATE DISCOUNT FACTORS ( -40% TO 80%);
C
C     II) MECHANISM TO GROUP RETURNS INTO A FREQUENCY TABLE;
C
C     ----------------------------------------------------------------------------------------------------------------
C
C     DEFINITIONS:-
C     ***********
C     PFG=RAW MATERIALS AND W.I.P AS A PERCENTAGE OF FINISHED STOCK; RMAT=INVESTMENT IN RAW MATERIALS YEAR 0;
C     STKT=FINISHED STOCK TURN; TAXR=NORMAL TAX RATE; TINITA=INITIAL ALLOWANCE ON PLANT AND MACHINERY; TINVA=INVESTMENT
C     ALLOWANCE ON PLANT AND MACHINERY(TINVAP) AND ON BUILDINGS(TINVAB); TAXINC=TAXABLE INCOME
C     TRDEP=TAX RATE OF DEPRECIATION ON PLANT AND MACHINERY(TRDEPP),ON BUILDINGS(TRDEPB),ON MOTOR VEHICLES(TRDEPM)
C     ON FURNITURE(TRDEPF); BKV=BOOK VALUE OF FIXED ASSETS-PLANT AND MACHINERY(BKVP),BUILDINGS(BKVB),MOTOR VEHICLES(BKVMV),
C     FURNITURE(BKVF); ADEP=ANNUAL DEPRECIATION CHARGE-PLANT AND MACHINERY(ADEPP),BUILDINGS(ADEPB),MOTOR VEHICLES(ADEPM),
C     FURNITURE(ADEPF); DEPAM=DEPRECIABLE AMOUNT-PLANT AND MACHINERY(DEPAMP),BUILDINGS(DEPAMB),MOTOR VEHICLES(DEPAPM),
C     FURNITURE(DEPAMF);PPUCOP=PURCHASES AS A PERCENTAGE OF COST OF PRODUCTION;DEBTM=MONTHS TRADE CREDIT;
C     DEBTOR=DEBTOR COLLECTION IN MONTHS; SALV=SALVAGE VALUE AS A PERCENTAGE OF BOOK VALUE* -PLANT AND MACHINERY(SALVP),
C     BUILDINGS(SALVB),MOTOR VEHICLES(SALVM),FURNITURE(SALVF); SALVA=SALVAGE VALUE AS A PERCENTAGE OF BOOK VALUE OF
C     SHORT TERM ASSETS OTHER THAN INVENTORY; SALVI=SALVAGE VALUE AS A PERCENTAGE OF INVENTORY BOOK VALUE.
C
C     **ADDITIONS TO ABOVE:
C     TRDEPO=TAX RATE OF DEPRECIATION ON OTHER ASSETS;SALVO=SALVAGE PERCENTAGE OTHER ASSETS; DEPAMO=DEPRECIABLE AMOUNT OTHER
C     ASSET; TBKV=TOTAL BOOK VALUE YEAR 1; EFFECT=NET INVESTMENT IN SHORT TERM ASSETS AND LIABILITIES.
C     INCLUDING INVENTORY(VALUE OF EFFECT NEGATIVE WHEN ASSETS>LIABILITIES); CASHF1(M)= CASH FLOW AFTER
C     TAX PERIOD M; CASHF2(M)= CASH FLOW AFTER TAX AND INVESTMENT IN SHORT TERM ASSETS AND LIABILITIES;
C
```

FIG. 4:16 DISPLAY OF PROGRAMME RRJSOS

```
C      TAXA=TAX ALLOWANCE ON SCRAPPING ASSETS;LIMIT=NUMBER OF YEARS IN EACH SIMULATION(INC YEAR 0);
C
C      LIMIT1=NUMBER OF SIX MONTHLY PERIODS IN EACH SIMULATION(INC YEAR 0); LIMIT2=NUMBER OF YEARS IN
C
C      EACH SIMULATION(EXCL YEAR 0);DISCF1,DISCF2,DISCF3= SUBROUTINES USED TO CALCULATE DISCOUNT FACTORS.

C      DISCF1 CALCULATES 1% TO 40%,DISCF2 CALCULATES 41% TO 80%,AND DISCF3 CALCULATES -1% TO -40%; RATE(N)=INTERNAL
C
C      RATE OF RETURN FOR SIMULATION N; XSUM=SUM OF CASH FLOWS PERIOD M; XSQRD(M)=SUM OF CASH FLOWS SQUARED
C
C      PERIOD M; XMEAN=EXPECTED CASH FLOW VALUE PERIOD M; STD(M)= STANDARD DEVIATION PERIOD M;
C
C      ORGIN  ORIGINAL INVESTMENT; PROFI1=PROFITABILITY INDEX; PROB3/5 & PROB4/6 =LOWER & UPPER TOLERANCE LIMIT VALUES;
C
C       IGAP=ARRAY USED FOR GROUPING RETURNS INTO A FREQUENCY TABLE; CLASS1 AND
C
C      CLASS2= RESPECTIVELY OPENING AND CLOSING CLASS LIMITS; RMEAN= MEAN INTERNAL RATE OF RETURN;

C      ASTD=STANDARD DEVIATION OF RETURN DATA; CV=COEFFICIENT OF VARIATION OF RETURN DATA;

C      TINV(M,K) AND ADEP(M,K) = RESPECTIVELY BOOK-VALUE AND ANNUAL DEPRECIATION OF ASSETS BOUGHT DURING PROJECT( M= SIX

C      MONTHLY PERIOD AND K= TYPE OF ASSET. M RANGES FROM 3 TO 8 AND K RANGES FROM 1 TO 5,WITH RESPECTIVELY PLANT, BUILDINGS

C      MOTOR VEHICLES,FURNITURE AND OTHER ASSETS BEING REPRESENTED BY K,1 THROUGH 5)

C      NOC(M)= PERCENTAGE COST OF CAPITAL PERIOD M( PLEASE NOTE NOC HAS A MAXIMUM OF 40%).

C      SNPV= NET PRESENT VALUE FOR SIMULATION N; SNPVM AND SNPVSD= RESPECTIVELY MEAN NET PRESENT VALUE AND STANDARD

C      DEVIATION( ASSUMING DEPENDANCY OF CASH FLOWS);

C      REINV= REINVESTMENT RATE; XINFLO= PRESENT VALUE OF TOTAL FUNDS USED DURING THE COURSE OF THE PROJECT;

C      OUTFLO= TERMINAL VALUE OF TOTAL FUNDS; RATER= YIELD ON TOTAL FUNDS.

C      (* PLEASE NOTE THAT BY BOOK VALUE AT SALVAGE IS MEANT THAT VALUE IN THE BOOKS AT THE END OF THE LAST YEAR OF THE PROJEC
CONT.  T).
C      ------------------------------------------

C      DATA3(L,1)=MARKET SIZE YEAR L.
C      DATA3(L,2)=MARKET SHARE YEAR L.
C      DATA3(L,3)=MARKET PRICE YEAR L.
C      DATA3(L,4)=VARIABLE PRODUCTION COSTS YEAR L.
C      DATA3(L,5)=TOTAL FIXED PRODUCTION COSTS YEAR L.
C      DATA3(L,6)=TOTAL FIXED MARKETING COSTS YEAR L.
C      DATA3(L,7)=TOTAL FIXED SELLING COSTS YEAR L.
C      DATA3(L,8)=TOTAL OTHER FIXED COSTS YEAR L.
C      DATA3(L,9)=OTHER VARIABLE COSTS YEAR L. RELATED TO UNIT SALES YEAR L.
C      DATA3(L,10)=PRODUCT LIFE IN YEARS.
C      DATA3(L,11)=PLANT LIFE IN YEARS.
C      DATA3(   )=TOTAL INVESTMENT YEAR 0.

C                 --------------------------


C            NIT SALES YEAR L.
C            TURNOVER YEAR L.
C            CLOSING STOCK LEVEL YEAR L.
```

FIG. 4:16 DISPLAY OF PROGRAMME RRJS05

```
C       FACTS(L,4)=PRODUCTION UNITS TO INVENTORY OR INVENTORY UNITS TO SALES.
C       FACTS(L,5)=PRODUCTION IN UNITS YEAR L.
C       FACTS(L,6)=AVERAGE COST OF STOCK YEAR L.
C       FACTS(L,7)=COST OF SALES YEAR L.
C       FACTS(L,8)=PROFIT BEFORE DEPRECIATION AND TAX YEAR L.
C       FACTS(L,9)=TAX PAYABLE YEAR L.
C       FACTS(L,10)=INVESTMENT IN  SHORT TERM ASSETS AND LIABILITIES.
C       FACTS(L,11)=INVESTMENT IN INVENTORY.
C       FACTS(L,12)=TOTAL COST OF PRODUCTION YEAR L.

C       ------------------------------------------------------------------------

        DIMENSION DATA3(31,12),FACTS(31,12),CASHF1(62),CASHF2(62),CASHF3(62),DISC1(62,40),DISC2(62,40),DISC3(62,40),TINV1(8,5)
     ,SNPV(100)
        DIMENSION XSUM(62),XSQRD(62),XMEAN(62),STD(62),IGRP(40),CLASS1(40),CLASS2(40),RATE(100),TINV(8,5),ADEP(8,5),ACC(31)
        COMMON DISC1,DISC2,DISC3
        READ(9,1)LIMIT
      1 FORMAT(I2)
        LIMIT1=LIMIT*2
        LIMIT2=LIMIT-1
        READ(9,2)STRT,TAXR,TINITA,TINVAP,TINVAB,TRDEPP,TRDEPB,TRDEPM,TRDEPF,TRDEPO,PIP,PIB,PIMV,PIF,PIO,PFG,DEBTM,DEBTOR,PPOCOP
     ,SALVP,SALVB,SALVM,SALVF,SALVO,SALVA,SALVI,RMAT,REINV
      2 FORMAT(F4.2,F8.4,14(F4.3),10(F4.2),F10.0,F2.0)
        HREINV=REINV
        XREINV=(SQRT(1.+(REINV/100.)))-1.
        DO 172 M=1,8
        DO 171 K=1,5
        TINV(M,K)=0.0
171     ADEP(M,K)=0.0
172     CONTINUE
        READ(9,173)((TINV(M,K),K=1,5),M=3,8)
173     FORMAT( 5F12.2)
        DO 174 L=1,LIMIT
174     NOC(L)=0
        READ(9,175)(NOC(L),L=1,LIMIT)
175     FORMAT(31I2)
        DO 4 M=1,67
        XSUM(M)=0.0
        XSQRD(M)=0.0
        XMEAN(M)=0.0
        STD(M)=0.0
        DO 3 K=1,40
        DISC1(M,K)=0.0
        DISC3(M,K)=0.0
      3 DISC2(M,K)=0.0
      4 CONTINUE
        DO 5 M1=1,40
        IGRP(M1)=0
        CLASS1(M1)=0.0
      5 CLASS2(M1)=0.0
        DO 6 I=1,100
        SNPV(I)=0.0
      6 RATE(I)=0.0

        READ(10,207)
207     FORMAT(2(/))

        DO 74 N=1,100

```

FIG. 4:16 DISPLAY OF PROGRAMME RRJS05

```
C     CLEARANCE OF ARRAYS IN PREPARATION OF NEXT SIMULATION RUN.
C     ----------------------------------------------------------

      DO 8 L=1,LIMIT
      DO 7 K=1,12
      DATA31(L,K)=0.0
    7 FACTS(L,K)=0.0
    8 CONTINUE
      DO 9 M=1,LIMIT1
      CASHF1(M)=0.0
      CASHF2(M)=0.0
      CASHF3(M)=0.0
    9 CONTINUE
      DO 201 M=1,8
      DO 200 K=1,5
      TINV1(M,K)=0.0
  200 ADEP(M,K)=0.0
  201 CONTINUE
      BKVP=0.0
      BKVB=0.0
      BKVMV=0.0
      BKVF=0.0
      BKVO=0.0
      FACTS(1,11)=RMAT
      READ(10,10)LUMMY
   10 FORMAT(///74X,I2//)
      READ(10,12)((DATA31(L,K),K=1,6),L=1,LUMMY)
      READ(10,11)
   11 FORMAT(/)
      READ(10,12)((DATA31(L,K),K=7,12),L=1,LUMMY)
   12 FORMAT(6(8X,F12.2))
C     CALCULATION OF UNIT SALES AND TURNOVER.
C     ---------------------------------------

      DO 13 L=2,LUMMY
      FACTS(L,1)=DATA31(L,1)*DATA31(L,2)
   13 FACTS(L,2)=FACTS(L,1)*DATA31(L,3)

C     CALCULATION OF DATUM STOCK LEVEL IN UNITS.
C     ------------------------------------------

      DO 14 L=2,LUMMY
      FACTS(L,3)=FACTS(L,1)/STKT
   14 FACTS(L,4)=FACTS(L,3)-FACTS(L-1,3)

C     PRODUCTION IN UNITS AND CALCULATION OF TOTAL COST OF PRODUCTION.
C     ----------------------------------------------------------------

      DO 15 L=2,LUMMY
      TPC=0.0
      FACTS(L,5)=FACTS(L,4)+FACTS(L,1)
      FACTS(L,12)=FACTS(L,5)*DATA31(L,4)*DATA31(L,5)
      STKV=FACTS(L,12)+FACTS(L-1,3)*FACTS(L-1,6)
      FACTS(L,6)=STKV/(FACTS(L,5)+FACTS(L-1,3))
      FGOODS=FACTS(L,3)*FACTS(L,6)
      FACTS(L,11)=(1.+PFG)*FGOODS
   15 CONTINUE
```

FIG. 4:16 DISPLAY OF PROGRAMME RRJS05

```
      DO 21 L=2,LUMMY
C     CALCULATION OF COST OF SALES.
C     ------------------------------
      FACTS(L,7)=FACTS(L,1)*FACTS(L,6)
C     ASCERTAINMENT OF PROFIT BEFORE TAX:
C     -----------------------------------
      FACTS(L,8)=FACTS(L,2)-FACTS(L,7)-DATA31(L,6)-DATA31(L,7)-DATA31(L,8)-DATA31(L,9)*FACTS(L,1)
C     DETERMINATION OF CASH FLOW EFFECT  OF SHORT TERM ASSETS AND LIABILITIES:
C     ------------------------------------------------------------------------
      FACTS(L,10)=((PPOCOP*FACTS(L,12))/12.)*DEBTM-(FACTS(L,2)/12.)*DEBTC9
C     DETERMINATION OF TAXABLE INCOME:
C     --------------------------------
      IF(L.EQ.2) GOTO 16
      GOTO 17
   16 DEPAMP=PIP*DATA31(1,12)*(1.-TINITA)
      ADEPP=TRDEPP*DEPAMP
      BKVP=DEPAMP-ADEPP
      DEPAMB=PIB*DATA31(1,12)
      ADEPB=DEPAMB*TRDEPB
      BKVB=DEPAMB-ADEPB
      DEPAMM=PIMV*DATA31(1,12)
      ADEPM=DEPAMM*TRDEPM
      BKVMV=DEPAMM-ADEPM
      DEPAMF=PIF*DATA31(1,12)
      ADEPF=DEPAMF*TRDEPF
      BKVF=DEPAMF-ADEPF
      DEPAMO=PIO*DATA31(1,12)
      ADEPO=DEPAMO*TRDEPO
      BKVO=DEPAMO-ADEPO
      TAXINC=FACTS(L,8)-(TINITA*TINVAP)*DATA31(1,12)*PIP-ADEPP-TINVAB*DEPAMB-ADEPB-ADEPM-ADEPF-ADEPO
   17 IF(L.LE.4)GOTO 176
      GOTO 185
  176 DEPR=0.0
      DO 177 I=1,2
      IF(I.EQ.1)GOTO 179
      M=L*2
      P=.25
      GOTO 180
  179 M=L*2-1
      P=.75
  180 DEPAMI=TINV(M,1)*(1.-TINITA)
      ADEP(M,1)=TRDEPP*DEPAMI
      TINV(M,1)=DEPAMI-ADEP(M,1)*P
```

FIG. 4:16 DISPLAY OF PROGRAMME RRJ505

```
      ADEP(M,2)=TRDEPB*TINV(M,2)
      TINV1(M,2)=TINV(M,2)-ADEP(M,2)*P

      ADEP(M,3)=TRDEPM*TINV(M,3)
      TINV1(M,3)=TINV(M,3)-ADEP(M,3)*P

      ADEP(M,4)=TRDEPF*TINV(M,4)
      TINV1(M,4)=TINV(M,4)-ADEP(M,4)*P

      ADEP(M,5)=TRDEPO*TINV(M,5)
      TINV1(M,5)=TINV(M,5)-ADEP(M,5)*P
177   DEPR=ADEP(M,1)*P+ADEP(M,2)*P+ADEP(M,3)*P+ADEP(M,4)*P+ADEP(M,5)*P+DEPR
      IF(L.EQ.2)GOTO 178

      IF(BKVP.LT.ADEPP)ADEPP=BKVP
      IF(BKVB.LT.ADEPB)ADEPB=BKVB
      IF(BKVMV.LT.ADEPM)ADEPM=BKVMV
      IF(BKVF.LT.ADEPF)ADEPF=BKVF
      IF(BKVO.LT.ADEPO)ADEPO=BKVO
      L1=L*2-2
      DO 181 M=3,L1
      DO 182 K=1,5
      IF(TINV1(M,K).LT.ADEP(M,K))ADEP(M,K)=TINV1(M,K)
182   CONTINUE
181   CONTINUE

      BKVP=BKVP-ADEPP
      BKVB=BKVB-ADEPB
      BKVMV=BKVMV-ADEPM
      BKVF=BKVF-ADEPF
      BKVO=BKVO-ADEPO

      DO 196 M=3,L1
      DO 195 K=1,5
195   TINV1(M,K)=TINV1(M,K)-ADEP(M,K)
196   CONTINUE

      TBKV1=0.0
      DO 198 M=3,8
      DO 197 K=1,5
197   TBKV1=TBKV1+TINV1(M,K)
198   CONTINUE
      TBKV=BKVP+BKVB+BKVMV+BKVF+BKVO+TBKV1
      DEPR1=0.0
      DO 184 M=3,L1
      DO 183 K=1,5
183   DEPR1=DEPR1+ADEP(M,K)
184   CONTINUE

      TAXINC=FACTS(L,8)-ADEPP-ADEPB-ADEPM-ADEPF-ADEPO-DEPR-DEPR1-(TINITA+TINVAP)*(TINV(L*2-1,1)+TINV(L*2,1))-TINVAB*(TINV(L*2
CONT. -1,2)+TINV(L*2,2))
      GOTO 19
185   IF(TBKV.LE.0.0)GOTO 20

      IF(BKVP.LT.ADEPP)ADEPP=BKVP
      IF(BKVB.LT.ADEPB)ADEPB=BKVB
      IF(BKVMV.LT.ADEPM)ADEPM=BKVMV
      IF(BKVF.LT.ADEPF)ADEPF=BKVF
      IF(BKVO.LT.ADEPO)ADEPO=BKVO
```

FIG. 4.16 DISPLAY OF PROGRAMME RRJS05

```
      DO  187 M=3,8
      DO 186 K=1,5
      IF(TINV1(M,K).LT.ADEP(M,K))ADEP(M,K)=TINV1(M,K)
186   CONTINUE
187   CONTINUE

      BKVP=BKVP-ADEPP
      BKVB=BKVB-ADEPB
      BKVMV=BKVMV-ADEPM
      BKVF=BKVF-ADEPF
      BKVO=BKVO-ADEPO
      DO  189 M=3,8
      DO 188 K=1,5
188   TINV1(M,K)=TINV1(M,K)-ADEP(M,K)
189   CONTINUE
      TBKV1=0.0
      DO 191 M=3,8
      DO 190 K=1,5
190   TBKV1=TBKV1+TINV1(M,K)
191   CONTINUE
      TBKV=BKVP+BKVB+BKVMV+BKVF+BKVO+TBKV1

      DEPR1=0.0
      DO 193 M=3,5
      DO 192 K=1,5
192   DEPR1=DEPR1+ADEP(M,K)
193   CONTINUE

      TAXINC=FACTS(L,8)-ADEPP-ADEPB-ADEPM-ADEPF-ADEPO-DEPR1
      GOTO 19
178   TAXINC=TAXINC-DEPR-(TINITA+TINVAP)*(TINV(3,1)+TINV(4,1))-TINVAB*(TINV(3,2)+TINV(4,2))
      GOTO 19

   19 FACTS(L,9)=TAXINC*TAXR
      GOTO 21
   20 FACTS(L,9)=FACTS(L,8)*TAXR
   21 CONTINUE

C     SPLIT UP OF ANNUAL PROFIT DATA INTO SIX MONTHLY DATA:
C     -----------------------------------------------------

      IX=0
   22 DO 24 L=1,LUMMY
      DO 23 M=1,2
      IX=IX+1
   23 CASHF1(IX)=FACTS(L,8)/2.
   24 CONTINUE

C     DETERMINATION OF CASH FLOW AFTER TAX.(DELAY TAKEN AT ABOUT SIX MONTHS):
C     PROVISIONAL TAX PAYMENTS TAKEN AT THE END OF THE FIRST AND SECOND SIX MONTHS OF EACH YEAR. THE FINAL TAX
C     ADJUSTMENT TAKEN AT ONE TO SIX MONTHS AFTER THE END OF EACH YEAR. PROVISIONAL PAYMENTS TAKEN AS 1/2 OF THE
C     PREVIOUS YEAR'S TAX.
C     ---------------------------------------------------------------------------------------------------------

      DO 25 L=3,LUMMY
      Z1=L*2-1
      Z2=L*2
      CASHF1(Z1)=CASHF1(Z1)-FACTS(L-1,9)/2.-(FACTS(L-1,9)-FACTS(L-2,9))
      CASHF1(Z2)=CASHF1(Z2)-FACTS(L-1,9)/2.
```

FIG. 4.1E DISPLAY OF PROGRAMME RRJS05

```
   25 CONTINUE

C     DETERMINATION OF CASH FLOW AFTER INVESTMENTS IN SHORT AND LONG TERM ASSETS:
C     ----------------------------------------------------------------------
      CASHF2(1)=-DATA31(1,12)*.25
      CASHF2(2)=-DATA31(1,12)*.75-FACTS(1,11)
      DO 194 M=3,8
194   CASHF1(M)=CASHF1(M)-TINV(M,1)-TINV(M,2)-TINV(M,3)-TINV(M,4)-TINV(M,5)
      DO 26 L=2,LUMMY
      Z1=L*2-1
      Z2=L*2
      EFFECT=(FACTS(L,10)-FACTS(L-1,10))/2.-(FACTS(L,11)-FACTS(L-1,11))/2.
      CASHF2(Z1)=CASHF1(Z1)-EFFECT
      CASHF2(Z2)=CASHF1(Z2)+EFFECT
   26 CONTINUE

C     DETERMINATION OF SALVAGE VALUES AND FINAL TAX ADJUSTMENT:
C     ---------------------------------------------------

      L=LUMMY
      DO 199 M=3,8
      BKVP=BKVP+TINV1(M,1)
      BKVB=BKVB+TINV1(M,2)
      BKVMV=BKVMV+TINV1(M,3)
      BKVF=BKVF+TINV1(M,4)
199   BKVO=BKVO+TINV1(M,5)
      TAXA=TAXR*((1.-SALVP)*BKVP+(1.-SALVB)*BKVB+(1.-SALVM)*BKVMV+(1.-SALVF)*BKVF+(1.-SALVO)*BKVO+(1.-SALVA)*(-1)*(FACTS(L,10
CONT. ))+(1.-SALVI)*FACTS(L,11)))
      CASHF2(LUMMY*2)= CASHF2(LUMMY*2)+SALVP*BKVF+SALVB*BKVB+SALVM*BKVMV+SALVF*BKVF+SALVO*BKVO+(-1)*(FACTS(L,10)*SALVA)+FACTS
CONT. (L,11)*SALVI+TAXA-(FACTS(L,9)-FACTS(L-1,9))
      FACTS(L,9)=FACTS(L,9)-TAXA
      L=0
C CALLING OF SUBROUTINE DISCF1 TO CALCULATE DISCOUNT FACTORS 1% TO 40% & DISCOUNTING OF CASH FLOWS.
C ---------------------------------------------------------------------------------

      IF(DISC1(1,1).GT.0.0) GOTO 27

      CALL DISCF1
27    TOTAL1=0.0
      DO 41 M=1,LIMIT1
41    TOTAL1=CASHF2(M)+TOTAL1
      IF(TOTAL1.LT.0.0) GOTO 40
      IF(TOTAL1.EQ.0.0) GOTO 51
      DO 29 INT=5,40,5
      TOTAL=0.0
      INTR=INT
      DO 28 M=1,LIMIT1
      CASHF3(M)=CASHF2(M)*DISC1(M,INT)
   28 TOTAL=CASHF3(M)+TOTAL
      IF(TOTAL.LE.0.0) GOTO 30
   29 CONTINUE
      GOTO 33
   30 INTRB=INTR-4
      DO 32 INT=INTRB,INTR
      TOTAL=0.0
      INTR1=INT
      DO 31 M=1,LIMIT1
      CASHF3(M)=CASHF2(M)*DISC1(M,INT)
   31 TOTAL=CASHF3(M)+TOTAL
```

FIG. 4:16 DISPLAY OF PROGRAMME RRJS05

```
      IF(TOTAL.LT.0.01) GOTO 52
      IF(TOTAL.EQ.0.01) GOTO 53
   52 CONTINUE

C CALLING OF SUBROUTINE DISCF2 TO CALCULATE DISCOUNT FACTORS 41% TO 80% & DISCOUNTING OF CASH FLOWS.
C ------------------------------------------------------------------------------------------------
   53 IF(DISC2(1,1).GT.0.0) GOTO 34
      CALL DISCF2
   34 DO 36 INT=5,40,5
      TOTAL=0.0
      INTR=INT
      DO 35 M=1,LIMIT1
      CASHF3(M)=CASHF2(M)*DISC2(M,INT)
   35 TOTAL=CASHF3(M)+TOTAL
      IF(TOTAL.LE.0.01) GOTO 37
   36 CONTINUE
      GOTO 54
   37 INTRB=INTR-4
      DO 39 INT=INTRB,INTR
      TOTAL=0.0
      INTR1=INT+40
      DO 38 M=1,LIMIT1
      CASHF3(M)=CASHF2(M)*DISC2(M,INT)
   38 TOTAL=CASHF3(M)+TOTAL
      IF(TOTAL.LT.0.01) GOTO 52
      IF(TOTAL.EQ.0.01) GOTO 53
   39 CONTINUE
C CALLING OF SUBROUTINE DISCF3 TO CALCULATE DISCOUNT FACTORS -1% TO -40% & DISCOUNTING OF CASH FLOWS.
C ------------------------------------------------------------------------------------------------

   40 TOTAL1=0.0
      IF(DISC3(1,1).GT.0.0) GOTO 42

      CALL DISCF3
   42 DO 44 INT=5,40,5
      TOTAL=0.0
      INTR=INT
      DO 43 M=1,LIMIT1
      CASHF3(M)=CASHF2(M)*DISC3(M,INT)
   43 TOTAL=CASHF3(M)+TOTAL
      IF(TOTAL.GE.0.0) GOTO 45
   44 CONTINUE
      GOTO 48
   45 INTRB=INTR-4
      DO 47 INT=INTRB,INTR
      TOTAL=0.0
      INTR1=INT
      DO 46 M=1,LIMIT1
      CASHF3(M)=CASHF2(M)*[illegible]C3(M,INT)
   46 TOTAL=CASHF3(M)+TOTAL
      IF(TOTAL.GT.0.0) GOTO 49
      IF(TOTAL.EQ.0.0) GOTO 50
   47 CONTINUE
   48 RATE(N)=-41.33
      GOTO 55
   49 R1=-INTR1
      RATE(N)=R1+.99
      GOTO 55
   50 R1=-INTR1
```

FIG. 4.16 DISPLAY OF PROGRAMME RR:S05

```
      RATE(N)=R1
      GOTO 55
51    RATE(N)=0.0
      GOTO 55

   52 R1=INTR1
      RATE(N)=R1-.99
      GOTO 55
   53 R1=INTR1
      RATE(N)=R1
      GOTO 55
   54 RATE(N)=81.00



C     CALCULATION OF N.P.V. FOR EACH SIMULATION.
C     ------------------------------------------

   55 DO 202 L=1,LUMMY
      M1=L*2-1
      M2=L*2
      SNPV(N)=CASHF2(M1)*DISC1(M1,NOC(L))+SNPV(N)
202   SNPV(N)=CASHF2(M2)*DISC1(M2,NOC(L))+SNPV(N)
C     SUMMATION OF ONE HUNDRED CASH FLOWS FOR EACH PERIOD AND SUMMATION OF EACH CASH FLOW AFTER SQUARING IN PREPARATION
C     OF CALCULATION OF MEANS AND STANDARD DEVIATIONS.
C     ----------------------------------------------------------------------------------------------------------------

      DO 56 M=1,LIMIT1
      XSUM(M)=CASHF2(M)+XSUM(M)
   56 XSQRD(M)=CASHF2(M)*CASHF2(M)+XSQRD(M)
C     WRITE OUT OF PERTINENT DATA :
C     -----------------------------

      IF(N.GT.1) GOTO 58
      WRITE(7,57)
   57 FORMAT(30X,'PRINT OUT OF PERTINENT DATA & SIX MONTHLY CASH FLOWS FOR ONE HUNDRED SIMULATIONS.'/30X,81('*')/30X,81('*')/
CONT. //)
   58 WRITE(7,59)N
   59 FORMAT(//10X,'SIMULATION NUMBER ',I2/10X,20('*')//10X,'COST OF ',4X,'TURNOVER',4X,'COST OF ',4X,'PROFIT BEFORE',2X,'TAX
CONT.   PAYABLE',2X,'  DEBTORS,   ',2X,'INVENTORY',1X,2(3X,'CASH FLOW'))
      WRITE(7,60)
   60 FORMAT(8X,'PRODUCTION',18X,'SALES ',6X,'DEP.& TAX',17X,'CREDITORS ETC',2X,'INVESTMENT',3X,'MID-YEAR.',5X,'YEAR END.')
      WRITE(7,61)
   61 FORMAT(8X,10('_'),2X,10('_'),2X,10('_'),4X,13('_'),2X,11('_')2X,13('_'),1X,11('_'),2X,10('_'),2X,10('_')/)
      DO 62 L=1,LIMIT
      LOT=L-1
   62 WRITE(7,63)LOT,FACTS(L,12),FACTS(L,2),FACTS(L,7),FACTS(L,8),FACTS(L,9),FACTS(L,10),FACTS(L,11),CASHF2(L*2-1),CASHF2(L*2
CONT. )
   63 FORMAT(1X,'YR.',I2,F12.2,F12.2,F12.2,5X,F12.2,1X,F12.2,3X,F12.2,F12.2,F12.2,F12.2)
      WRITE(7,203)SNPV(N)
203   FORMAT(/10X,'NET PRESENT VALUE  = ',F12.2/10X,33('*'))
      IF(RATE(N).EQ.(-41.0)) GOTO 70
      IF(RATE(N).LT.0.0) GOTO 68
      IF(RATE(N).EQ.81.0) GOTO 72
      R1=RATE(N)-.005
      INT=R1
      INT1=RATE(N)
      IF(INT1.GT.INT) GOTO 66
   64 RATE1=.99+RATE(N)
```

FIG. 4:16 DISPLAY OF PROGRAMME RRJS05

```
      WRITE(7,65)RATE(N),RATEX
   65 FORMAT(/10X,'INTERNAL RATE OF RETURN IS BETWEEN ',F7.2,' AND ',F7.2,' PERCENT.'/10X,63('*'))
      GOTO 74
   66 WRITE(7,67)RATE(N)
   67 FORMAT(/10X,'INTERNAL RATE OF RETURN IS ',F7.2,' PERCENT.'/10X,43('*'))
      GOTO 74
   68 X1=RATE(N)+.005
      INT=X1
      INT1=RATE(N)
      IF(INT1.LT.INT) GOTO 66

      RATEX=RATE(N)-.98
      WRITE(7,69)RATE(N),RATEX
   69 FORMAT(/10X,'INTERNAL RATE OF RETURN IS BETWEEN ',F7.2,' AND ',F7.2,' PERCENT.'/10X,63('*'))
      GOTO 74
   70 WRITE(7,71)
   71 FORMAT(10X,'INTERNAL RATE OF RETURN IS BELOW -40.00% PERCENT.'/10X,49('*'))
      GOTO 74
   72 WRITE(7,73)
   73 FORMAT(/10X,'INTERNAL RATE OF RETURN IS OVER  80.00% PERCENT.'/10X,48('*'))
   74 CONTINUE

      WRITE(7,75)
 75   FORMAT('1',34X,'SUMMARY OF INTERNAL RATES OF RETURN AND NET PRESENT VALUES.'/35X,59('*')/35X,59('*')//35X,'SIMULATION',
     111X,'RETURN IS:-',9X,'NET PRESENT VALUE:'/37X,'NUMBER:'/35X,10('_'),6X,20('_'),5X,18('_')/)
      IZ=0
      DO 78 N=1,100
      IF(ABS(RATE(N)-(-41.01)).LE.0.001)GOTO 76
      GOTO 78
 76   IZ=IZ+1
      IF(IZ.EQ.50)WRITE(7,300)
      WRITE(7,77)N,SNPV(N)
   77 FORMAT(38X,I3,4X,9X,'BELOW  -40.00 %',12X,F12.2)
   78 CONTINUE
      DO 85 I=1,40
      REG=I
      XNUM1=-41.01+REG
      XNUM2=-41.+REG
      DO 81 N=1,100
      IF(ABS(RATE(N)-XNUM1).LE.0.001)GOTO 79
      GOTO 81
 79   IZ=IZ+1
      IF(IZ.EQ.50)WRITE(7,300)
      RATEX=RATE(N)-.98
      WRITE(7,80)N,RATEX,RATE(N),SNPV(N)
   80 FORMAT(38X,I3,4X,7X,F7.2,'% / ',F7.2,'%',10X,F12.2)
   81 CONTINUE
      DO 84 N=1,100
      IF(ABS(RATE(N)-XNUM2).LE.0.001)GOTO 82
      GOTO 84
 82   IZ=IZ+1
      IF(IZ.EQ.50)WRITE(7,300)
      WRITE(7,83)N,RATE(N),SNPV(N)
   83 FORMAT(38X,I3,4X,12X,F7.2,' %',15X,F12.2)
   84 CONTINUE
   85 CONTINUE
      DO 88 N=1,100
      IF(ABS(RATE(N)-(-0.01)).LE.0.001)GOTO 86
      GOTO 88
```

FIG. 4.5 DISPLAY OF PROGRAMME RRJS05

```
86    IZ=IZ+1
      IF(IZ.EQ.50)WRITE(7,300)
      RATEX=RATE(N)-.98
      WRITE(7,87)N,RATEX,RATE(N),SNPV(N)
   87 FORMAT(38X,I3,4X,7X,F7.2,'% / ',F7.2,'%',10X,F12.2)
   88 CONTINUE

      DO 95 I=1,81
      REG=I
      XNUM1=REG-1.
      XNUM2=REG-.99
      DO 91 N=1,100
      IF(ABS(RATE(N)-XNUM1).LE.0.001)GOTO 89
      GOTO 91
89    IZ=IZ+1
      IF(IZ.EQ.50)WRITE(7,300)
      WRITE(7,90)N,RATE(N),SNPV(N)
   90 FORMAT(38X,I3,4X,12X,F7.2,' %',15X,F12.2)
   91 CONTINUE
      DO 94 N=1,100
      IF(ABS(RATE(N)-XNUM2).LE.0.001)GOTO 92
      GOTO 94
92    IZ=IZ+1
      IF(IZ.EQ.50)WRITE(7,300)
      RATEX=RATE(N)+.98
      WRITE(7,93)N,RATE(N),RATEX,SNPV(N)
   93 FORMAT(38X,I3,4X,7X,F7.2,'% / ',F7.2,'%',10X,F12.2)
   94 CONTINUE
   95 CONTINUE
      DO 98 N=1,100
      IF(ABS(RATE(N)-81.0).LE.0.001)GOTO 96
      GOTO 98
96    IZ=IZ+1
      IF(IZ.EQ.50)WRITE(7,300)
      WRITE(7,97)N,SNPV(N)
   97 FORMAT(38X,I3,4X,9X,'ABOVE  80.00 %',13X,F12.2)
   98 CONTINUE
300    FORMAT('1',34X,'SUMMARY OF INTERNAL RATES OF RETURN AND NET PRESENT VALUES.'/35X,59('*')/35X,59('*')//35X,'SIMULATION'
CONT.  ,11X,'RETURN IS:-',9X,'NET PRESENT VALUE:'/37X,'NUMBER:'/35X,10('_'),6X,20('_'),5X,18('_')/)

C     CALCULATION OF MEAN NET PRESENT VALUE AND STANDARD DEVIATION ASSUMING DEPENDANCY OF CASH FLOWS.
C     ------------------------------------------------------------------------------------------

      TOTAL1=0.0
      TOTAL2=0.0
      DO 204 N=1,100
      TOTAL1=SNPV(N)+TOTAL1
204   TOTAL2=(SNPV(N)**2)+TOTAL2
      SNPVM=TOTAL1/100.
      SNPVSD=SQRT(100./99.)*SQRT(TOTAL2/100.-(SNPVM**2))

C     CALCULATION OF EXPECTED CASH FLOW VALUES & STANDARD DEVIATIONS PER PERIOD,EACH COMPRISING ONE HUNDRED CASH FLOWS.
C     ------------------------------------------------------------------------------------------------------------
   99 DO 100 M=1,LIMIT1
      XMEAN(M)=XSUM(M)/100.
  100 STD(M)=SQRT(100./99.)*SQRT((XSQRD(M)/100.)-(XMEAN(M)**2))

C     CALCULATION OF RETURN DETAILS ON TOTAL FUNDS.
C     ---------------------------------------------
```

**FIG. 4.16 DISPLAY OF PROGRAMME RRJS05**

```
      TOTAL=0.0
      DO 302 M=1,LIMIT1
302   TOTAL=XMEAN(M)+TOTAL
      IF(TOTAL.LT.0.0) GOTO 311
      XINFLO=0.0
      OUTFLO=0.0
      DO 303 M=1,LIMIT1
      IF(XMEAN(M).LT.0.0) GOTO 305
      IF(XMEAN(M).GE.0.0) GOTO 304
304   OUTFLO=XMEAN(M)*(1.+XREINV)**(LIMIT1-M)+OUTFLO
      GOTO 303
305   XINFLO=(-1.)*XMEAN(M)*DISC1(M+1,MREINV)+XINFLO
      GOTO 303
303   CONTINUE
      B=OUTFLO/XINFLO
      C=ALOG10(B)
      D=LIMIT1-1
      E=C/D
      F=10**E
      RATEM=(F*F)-1.
      RATEM=RATEM*100.

C     CALCULATION OF  TOLERANCE LIMITS.
C     (ASSUMING DEPENDANCY OF CASH FLOWS)
C     ------------------------------------------------
      ORGINV=(XMEAN(1)*DISC1(1,NOC(1))+XMEAN(2))*(-1.)
      PROB5=SNPVM+3.75*SNPVSD
      PROB6=SNPVM-3.75*SNPVSD
      PROFI1=(SNPVM+ORGINV)/ORGINV
      CVSNPV=(SNPVSD/SNPVM)*100.

C     GROUPING OF INTERNAL RATES OF RETURN INTO A FREQUENCY TABLE.
C     ------------------------------------------------------------

      DO 130 N=1,100

      IF(ABS(RATE(N)-(-40.01)).LE.0.001)GOTO 103
      IF(ABS(RATE(N)-(-35.01)).LE.0.001)GOTO 104
      IF(ABS(RATE(N)-(-30.01)).LE.0.001)GOTO 105
      IF(ABS(RATE(N)-(-25.01)).LE.0.001)GOTO 106
      IF(ABS(RATE(N)-(-20.01)).LE.0.001)GOTO 107
      IF(ABS(RATE(N)-(-15.01)).LE.0.001)GOTO 108
      IF(ABS(RATE(N)-(-10.01)).LE.0.001)GOTO 109
      IF(ABS(RATE(N)-(-5.01)).LE.0.001)GOTO 110
      IF(ABS(RATE(N)-(-0.01)).LE.0.001)GOTO 111

      IF(RATE(N).LT.5.) GOTO 112
      IF(RATE(N).LT.10.) GOTO 113
      IF(RATE(N).LT.15.) GOTO 114
      IF(RATE(N).LT.20.) GOTO 115
      IF(RATE(N).LT.25.) GOTO 116
      IF(RATE(N).LT.30.) GOTO 117
      IF(RATE(N).LT.35.) GOTO 118
      IF(RATE(N).LT.40.) GOTO 119
      IF(RATE(N).LT.45.) GOTO 120
      IF(RATE(N).LT.50.) GOTO 121
      IF(RATE(N).LT.55.) GOTO 122
      IF(RATE(N).LT.60.) GOTO 123
```

FIG. 4.18 DISPLAY OF PROGRAMME RRJS05

```
      IF(RATE(N).LT.65.) GOTO 124
      IF(RATE(N).LT.70.) GOTO 125
      IF(RATE(N).LT.75.) GOTO 126
      IF(RATE(N).LT.80.) GOTO 127
      IF(RATE(N).LT.85.) GOTO 128
  103 NZ=18
      GOTO 129
  104 NZ=19
      GOTO 129
  105 NZ=20
      GOTO 129
  106 NZ=21
      GOTO 129
  107 NZ=22
      GOTO 129
  108 NZ=23
      GOTO 129
  109 NZ=24
      GOTO 129
  110 NZ=25
      GOTO 129
  111 NZ=26
      GOTO 129
  112 NZ=1
      GOTO 129
  113 NZ=2
      GOTO 129
  114 NZ=3
      GOTO 129
  115 NZ=4
      GOTO 129
  116 NZ=5
      GOTO 129
  117 NZ=6
      GOTO 129
  118 NZ=7
      GOTO 129
  119 NZ=8
      GOTO 129
  120 NZ=9
      GOTO 129
  121 NZ=10
      GOTO 129
  122 NZ=11
      GOTO 129
  123 NZ=12
      GOTO 129
  124 NZ=13
      GOTO 129
  125 NZ=14
      GOTO 129
  126 NZ=15
      GOTO 129
  127 NZ=16
      GOTO 129
  128 NZ=17

  129 ISRP(NZ)=ISRP(NZ)+1
  130 CONTINUE
```

FIG. 4:16 DISPLAY OF PROGRAMME RRJ505

```
C     CALCULATION OF MEAN INTERNAL RATE OF RETURN,STANDARD DEVIATION AND COEFFICIENT OF VARIATION.
C     -----------------------------------------------------------------------------------

      RMEAN0=IGRP(18)*(-42.5)+IGRP(19)*(-37.5)+IGRP(20)*(-32.5)+IGRP(21)*(-27.5)+IGRP(22)*(-22.5)+IGRP(23)*(-17.5)+IGRP(24)*(
 -12.5)+IGRP(25)*(-7.5)+IGRP(26)*(-2.5)
      RMEAN1=IGRP(1)*2.5+IGRP(2)*7.5+IGRP(3)*12.5+IGRP(4)*17.5+IGRP(5)*22.5+IGRP(6)*27.5+IGRP(7)*32.5+IGRP(8)*37.5+IGRP(9)*42
 .5
      RMEAN2=IGRP(10)*47.5+IGRP(11)*52.5+IGRP(12)*57.5+IGRP(13)*62.5+IGRP(14)*67.5+IGRP(15)*72.5+IGRP(16)*77.5+IGRP(17)*82.5+
 RMEAN1+RMEAN0

      RSTD0=IGRP(18)*42.5*42.5+IGRP(19)*37.5*37.5+IGRP(20)*32.5*32.5+IGRP(21)*27.5*27.5+IGRP(22)*22.5*22.5+IGRP(23)*17.5*17.5
 +IGRP(24)*12.5*12.5+IGRP(25)*7.5*7.5+IGRP(26)*2.5*2.5
      RSTD1=IGRP(1)*2.5*2.5+IGRP(2)*7.5*7.5+IGRP(3)*12.5*12.5+IGRP(4)*17.5*17.5+IGRP(5)*22.5*22.5+IGRP(6)*27.5*27.5
      RSTD2=IGRP(7)*32.5*32.5+IGRP(8)*37.5*37.5+IGRP(9)*42.5*42.5+IGRP(10)*47.5*47.5+IGRP(11)*52.5*52.5+IGRP(12)*57.5*57.5
      RSTD3=IGRP(13)*62.5*62.5+IGRP(14)*67.5*67.5+IGRP(15)*72.5*72.5+IGRP(16)*77.5*77.5+IGRP(17)*82.5*82.5+RSTD1+RSTD2+RSTD0


      RMEAN=RMEAN2/100.
      RSTD=SQRT(100./99.)*SQRT((RSTD3/100.)-(RMEAN*RMEAN))
      CV=(RSTD/RMEAN)*100.

C     CALCULATION OF 95% TOLERANCE LIMITS.
C     ----------------------------------------

      PROB3=RMEAN+3.75*RSTD
      PROB4=RMEAN-3.75*RSTD


C     CREATION OF CLASS LIMITS.
C     -------------------------

      CLASS1(18)=-45.00
      CLASS1(19)=-40.00
      CLASS1(20)=-35.00
      CLASS1(21)=-30.00
      CLASS1(22)=-25.00
      CLASS1(23)=-20.00
      CLASS1(24)=-15.00
      CLASS1(25)=-10.00
      CLASS1(26)=-5.00
      CLASS1(1)=0.00
      CLASS1(2)=5.00
      CLASS1(3)=10.00
      CLASS1(4)=15.00
      CLASS1(5)=20.00
      CLASS1(6)=25.00
      CLASS1(7)=30.00
      CLASS1(8)=35.00
      CLASS1(9)=40.00
      CLASS1(10)=45.00
      CLASS1(11)=50.00
      CLASS1(12)=55.00
      CLASS1(13)=60.00
      CLASS1(14)=65.00
      CLASS1(15)=70.00
      CLASS1(16)=75.00
      CLASS1(17)=80.00
```

FIG. 4:16 DISPLAY OF PROGRAMME RRJS05

```
      CLASS2(1)=4.99
      CLASS2(2)=9.99
      CLASS2(3)=14.99
      CLASS2(4)=19.99
      CLASS2(5)=24.99
      CLASS2(6)=29.99
      CLASS2(7)=34.99
      CLASS2(8)=39.99
      CLASS2(9)=44.99
      CLASS2(10)=49.99
      CLASS2(11)=54.99
      CLASS2(12)=59.99
      CLASS2(13)=64.99
      CLASS2(14)=69.99
      CLASS2(15)=74.99
      CLASS2(16)=79.99
      CLASS2(17)=84.99
      CLASS2(18)=-40.01
      CLASS2(19)=-35.01
      CLASS2(20)=-30.01
      CLASS2(21)=-25.01
      CLASS2(22)=-20.01
      CLASS2(23)=-15.01
      CLASS2(24)=-10.01
      CLASS2(25)=-5.01
      CLASS2(26)=-0.01

C     PRINT OUT OF SIMULATIONS TOTAL FINAL RESULTS.
C     ---------------------------------------------

      WRITE(7,131)
  131 FORMAT('1',30X,'PRINT OUT OF INTERNAL RATE OF RETURN DATA FOR ONE HUNDRED SIMULATIONS.'/31X,70('*')/31X,70('*'))
      WRITE(7,132)
  132 FORMAT(//10X,'FREQUENCY TABLE OF RETURNS.',35X,'STATISTICS:'/9X,28('*'),8X,64('*')//)
      WRITE(7,133)
  133 FORMAT(10X,27('_')/9X,'|              |          |'/9X,'|    CLASS     | FREQUENCY|'/9X,'|   INTERVAL   |
CONT. |'/9X,'|______________|__________|')
      WRITE(7,134)(CLASS1(NZ),CLASS2(NZ),IGRP(NZ),NZ=18,26)
  134 FORMAT(9X,'|',F6.2,' TO ',F6.2,'|',4X,I2,4X,'|')
      WRITE(7,135)(CLASS1(NZ),CLASS2(NZ),IGRP(NZ),NZ=1,5)
  135 FORMAT(9X,'| ',F5.2,' TO  ',F5.2,'|',4X,I2,4X,'|')
      WRITE(7,137)CLASS1(6),CLASS2(6),IGRP(6),RMEAN
      WRITE(7,136)CLASS1(7),CLASS2(7),IGRP(7)
  136 FORMAT(9X,'| ',F5.2,' TO  ',F5.2,'|',4X,I2,4X,'|',20X,'*********************************************')
      WRITE(7,135)(CLASS1(NZ),CLASS2(NZ),IGRP(NZ),NZ=8,10)
  137 FORMAT(9X,'| ',F5.2,' TO  ',F5.2,'|',4X,I2,4X,'|',20X,'EXPECTED RATE OF RETURN  = ',F5.2,' PERCENT')
      WRITE(7,139)CLASS1(11),CLASS2(11),IGRP(11),RSTD
      WRITE(7,138)CLASS1(12),CLASS2(12),IGRP(12)
  138 FORMAT(9X,'| ',F5.2,' TO  ',F5.2,'|',4X,I2,4X,'|',20X,'*********************************************')
      WRITE(7,135)(CLASS1(NZ),CLASS2(NZ),IGRP(NZ),NZ=13,16)
  139 FORMAT(9X,'| ',F5.2,' TO  ',F5.2,'|',4X,I2,4X,'|',20X,'STANDARD DEVIATION       = ',F5.2,' PERCENT')
      WRITE(7,140)CLASS1(17),CLASS2(17),IGRP(17),CV
  140 FORMAT(9X,'| ',F5.2,' TO  ',F5.2,'|',4X,I2,4X,'|',20X,'COEFFICIENT OF VARIATION = ',F5.1,'%')
      WRITE(7,141)
  141 FORMAT(9X,'|______________|__________|',20X,33('*')/9X,'|    TOTAL  --> |   100    |'/9X,'|______________|______
CONT. __|'//)

      WRITE(7,142)PROB3,PROB4
  142 FORMAT(10X,'ASSUMING NORMALITY AND DEPENDANCY OF CASH FLOWS,THERE IS A 95% PROBABILITY THAT THE RETURN WILL BE:-'/13X,'
```

FIG. 4:16 DISPLAY OF PROGRAMME RRJS05

```
 ((LESS THAN OR EQUAL TO    ',F12.2/12X,'(2)GREATER THAN OR EQUAL TO ',F12.2/10X,100('*')//////)
      WRITE(7,143)
  143 FORMAT('1',31X,'PRINT OUT OF AGGREGATE EXPECTED RESULTS.'/32X,40('*')/32X,40('*'))
      WRITE(7,144)
  144 FORMAT(/////20X,'PRINT OUT OF MEAN CASH FLOWS & STANDARD DEVIATIONS PER PERIOD.'/20X,62('*'))
      WRITE(7,145)
  145 FORMAT(/20X,'CASH FLOW',7X,'CASH FLOW',8X,'STD.DEV.',8X,'STD.DEV.'/20X,'MID-YEAR.',7X,'YEAR END.',7X,'MID-YEAR.',7X,'YE
 AR END.'/20X,9('_'),7X,9('_'),7X,9('_'),7X,9('_'))
      DO 146 L=1,LIMIT
      LOT=L-1
  146 WRITE(7,147)LOT,XMEAN(L*2-1),XMEAN(L*2),STD(L*2-1),STD(L*2)
  147 FORMAT(13X,'YR. ',I2,2X,4(4X,F12.2))
      WRITE(7,206)
 206  FORMAT('1',20(/),21X,'ASSUMING DEPENDANCY OF CASH FLOWS SAMPLE STATISTICS ARE:-'/21X,50('*')/21X,50('*'))
      WRITE(7,148)SNPVM,PROFI1,SNPVSD
  148 FORMAT(///32X,'NET PRESENT EXPECTED VALUE = ',F12.2/32X,41('*')//32X,'PROFITABILITY INDEX        = ',F12.2/32X,41('*')/
 /32X,'STANDARD DEVIATION          = ',F12.2/32X,41('*')/)
      WRITE(7,149)CVSNPV
  149 FORMAT(/32X,'COEFFICIENT OF VARIATION   = ',F9.2,' %'/32X,41('*')/)
      WRITE(7,151)PROBS,PROBA
  151 FORMAT(////10X,'ASSUMING NORMALITY AND DEPENDANCY OF CASH FLOWS,THERE IS A 95% PROBABILITY THAT THE NET PRESENT VALUE W
 ILL BE:-'/13X,'(1) LESS THAN OR EQUAL TO    ',F12.2/12X,'(2) GREATER THAN OR EQUAL TO ',F12.2/10X,111('*'))
      WRITE(7,313)
 313  FORMAT('1'////47X,'DETAILS OF EXPECTED RETURN ON TOTAL FUNDS'/47X,41('*')/47X,41('*')////////)
      WRITE(7,314)XINFLO,LIMIT,RATEM
 314  FORMAT(30X,'TAKING A MACRO VIEW, THE RESULTS OF THIS SIMULATION INDICATE THAT TOTAL'/30X,'FUNDS OF R ',F10.0,' CAN BE I
 NVESTED BY THE FIRM FOR A PERIOD OF ',I2,'.5'/30X,'YEARS AT AN ESTIMATED RETURN OF ',F5.1,' PERCENT PER ANNUM.'//)
      WRITE(7,315)MEAN,REINV
 315  FORMAT(30X,'THE FUNDS ARE EXPECTED TO GENERATE ',F5.1,' PERCENT PER ANNUM WHILST EMPLOYED'/30X,'BY THE PROJECT AND TO G
 ENERATE ',F5.1,' PERCENT PER ANNUM ON RE-INVESTMENT.')
      WRITE(7,316)LIMIT,OUTFLO
 316  FORMAT(30X,'THE TERMINAL VALUE OF THE FUNDS ',I2,'.5 YEARS AFTER INITIAL INVESTMENT IS '/30X,'EXPECTED TO BE R ',F10.0,
 //36X,'(PLEASE NOTE THAT THESE RESULTS ARE BASED ON EXPECTED VALUES.)')
      GOTO 318
 311  WRITE(7,313)
      WRITE(7,317)
 317  FORMAT(36X,'AS THE SIMULATION YIELDS A NEGATIVE INTERNAL RATE OF RETURN THESE'/36X,'DETAILS WILL NOT BE GENERATED.')
C
C     WRITE OUT OF DISCOUNT FACTORS.
C     ------------------------------
 318  WRITE(7,152)
  152 FORMAT('1',37X,'SIX MONTHLY DISCOUNT FACTORS FROM -40% TO 90%.'/38X,46('*')/38X,46('*'))
      WRITE(7,153)
  153 FORMAT(/10X,'PROFIT FACTORS'/10X,14('_')//)
      WRITE(7,154)
  154 FORMAT(11X,'1%',4X,'2%',4X,'3%',4X,'4%',4X,'5%',4X,'6%',4X,'7%',6X,'8%',4X,'9%',3X,'10%',3X,'11%',3X,'12%',3X,'13%',3X,
 '14%',3X,'15%',3X,'16%',3X,'17%',3X,'18%',3X,'19%',3X,'20%'/)
      DO 155 I=1,62
      M=I-2
  155 WRITE(7,156)M,(DISC1(I,K),K=1,20)
  156 FORMAT(1X,'PER.',I2,20F6.3)
      WRITE(7,157)
  157 FORMAT(//10X,'21%',3X,'22%',3X,'23%',3X,'24%',3X,'25%',3X,'26%',3X,'27%',3X,'28%',3X,'29%',3X,'30%',3X,'31%',3X,'32%',3
```

FIG. 4:16 DISPLAY OF PROGRAMME RRJS05

```
X,'33%',3X,'34%',3X,'35%',3X,'36%',3X,'37%',3X,'38%',3X,'39%',3X,'40%'/)
      DO 158 I=1,62
      M=I-2
  158 WRITE(7,156)M,(DISC1(I,K),K=21,40)
      WRITE(7,159)
  159 FORMAT(//10X,'41%',3X,'42%',3X,'43%',3X,'44%',3X,'45%',3X,'46%',3X,'47%',3X,'48%',3X,'49%',3X,'50%',3X,'51%',3X,'52%',3
X,'53%',3X,'54%',3X,'55%',3X,'56%',3X,'57%',3X,'58%',3X,'59%',3X,'60%'/)
      DO 160 I=1,62
      M=I-2
  160 WRITE(7,156)M,(DISC2(I,K),K=1,20)
      WRITE(7,161)
  161 FORMAT(//10X,'61%',3X,'62%',3X,'63%',3X [illegible] ,3X,'65%',3X,'66%',3X,'67%',3X,'68%',3X,'69%',3X,'70%',3X,'71%',3X,'72%',3
X,'73%',3X,'74%',3X,'75%',3X,'76%',3X,'77%',3X,'[illegible]%',3X,'79%',3X,'80%'/)
      DO 162 I=1,62
      M=I-2
  162 WRITE(7,156)M,(DISC2(I,K),K=21,40)
      WRITE(7,163)
  163 FORMAT(/'1',9X,'LOSS FACTORS.'/10X,13('_')//)
      WRITE(7,164)
  164 FORMAT(11X,'1%',4X,'2%',4X,'3%',4X,'4%',4X,'5%',4X,'6%',4X,'7%',4X,'8%',4X,'9%',3X,'10%',3X,'11%',3X,'12%',3X,'13%',3X,
'14%',3X,'15%',3X,'16%',3X,'17%',3X,'18%',3X,'19%',3X,'20%'/)
      DO 165 I=1,62
      M=I-2
  165 WRITE(7,166)M,(DISC3(I,K),K=1,20)
  166 FORMAT(1X,'PER.',I2,20(1X,F5.2))
      WRITE(7,167)
  167 FORMAT(//10X,'21%',3X,'22%',3X,'23%',3X,'24%',3X,'25%',3X,'26%',3X,'27%',3X,'28%',3X,'29%',3X,'30%',3X,'31%',3X,'32%',3
X,'33%',3X,'34%',3X,'35%',3X,'36%',3X,'37%',3X,'38%',3X,'39%',3X,'40%'/)
      DO 168 I=1,62
      M=I-2
  168 WRITE(7,166)M,(DISC3(I,K),K=21,40)


C     PRINT OUT OF PARAMETERS.
C     ------------------------

      TAXR=TAXR*100.
      PPOCOP=PPOCOP*100.
      TINITA=TINITA*100.
      TINVAP=TINVAP*100.
      TINVAB=TINVAB*100.
      TRDEPP=TRDEPP*100.
      TRDEPB=TRDEPB*100.
      TRDEPM=TRDEPM*100.
      TRDEPF=TRDEPF*100.
      TRDEPO=TRDEPO*100.
      SALVP=SALVP*100.
      SALVB=SALVB*100.
      SALVF=SALVF*100.
      SALVO=SALVO*100.
      SALVM=SALVM*100.
      SALVA=SALVA*100.
      SALVI=SALVI*100.
      PIP=PIP*100.
      PIB=PIB*100.
      PIMV=PIMV*100.
      PIF=PIF*100.
      PIO=PIO*100.
      PFG=PFG*100.
```

FIG. 4:16 DISPLAY OF PROGRAMME RRJS05

```
        WRITE(7,320)
        WRITE(7,321)STKT,DEBTOR,DEBTM,AMAT
        WRITE(7,322)PPOCOP,REINV,TAXR
        WRITE(7,324)TINIT4
        WRITE(7,323)TINVAP
        WRITE(7,325)TRDEPP,SALVP
        WRITE(7,326)
        WRITE(7,323)TINVAB
        WRITE(7,325)TRDEPB,SALVB
        WRITE(7,327)
        WRITE(7,325)TRDEPF,SALVF
        WRITE(7,328)
        WRITE(7,325)TRDEPM,SALVM
        WRITE(7,329)
        WRITE(7,325)TRDEPO,SALVO
        WRITE(7,320)
        WRITE(7,330)SALVA,SALVI
        WRITE(7,331)PIP,PIB,PINV,PIF,PIO
        WRITE(7,332)PFG

  320   FORMAT('1',34X,'PRINT OUT OF SIMULATION PARAMETERS'/35X,34('*')/35X,34('*')//)
  321   FORMAT(30X,'STOCK TURN ---------------------------->   ',F5.1//30X,'AVERAGE DEBTOR MONTHS -------------->   ',F4.1//30X,'A
CONT. VERAGE CREDITOR MONTHS ------------>   ',F4.1//30X,'RAW MATERIAL INVESTMENT YEAR 0   ',F11.2/)
  322   FORMAT(30X,'PURCHASES AS % OF COST OF PRODUCTION   ',F5.2//30X,'% REINVESTMENT RATE ---------------->   ',F4.1//  30X,'
CONT. NORMAL CORPORATE TAX % RATE -------->   ',F5.1//30X,'PLANT & EQUIPMENT'/30X,17('_'))
  323   FORMAT(35X,'INVESTMENT ALLOWANCE ---------->   ',F4.1,'%')
  324   FORMAT(35X,'INITIAL ALLOWANCE ------------->   ',F4.1,'%')
  325   FORMAT(35X,'WEAR & TEAR ALLOWANCE --------->   ',F4.1,'%'/35X,'SALVAGE VALUE AS % OF BOOK VALUE   ',F5.1//)
  326   FORMAT(30X,'BUILDINGS'/30X,9('_'))
  327   FORMAT(30X,'FURNITURE & FITTINGS'/30X,20('_'))
  328   FORMAT(30X,'MOTOR VEHICLES'/30X,14('_'))
  329   FORMAT(30X,'OTHER ASSETS'/30X,12('_'))
  330   FORMAT(30X,'LIQUID ASSETS - % SALVAGE VALUE ---->   ',F5.1/30X,'INVENTORY - % SALVAGE VALUE -------->   ',F5.1//)
  331   FORMAT(30X,'ANALYSIS OF INITIAL INVESTMENT',30X,30('_')/35X,'% PLANT & EQUIPMENT ->   ',F5.2/35X,'% BUILDINGS --------->
CONT.   ',F5.2/35X,'% MOTOR VEHICLES ---->   ',F5.2/35X,'% FURNITURE & FITTINGS   ',F5.2/35X,'% OTHER ASSETS ------>   ',F5.3//)
  332   FORMAT(30X,'RAW MAT. & W.I.P. AS % OF FINISHED STK. ',F4.1)
        WRITE(7,208)
  208   FORMAT(///59X,11('*')/59X,'END OF JOB.'/59X,11('*'))
        STOP
        END



        SUBROUTINE DISCF1
        DIMENSION DISC1(62,40),DISC2(62,40),DISC3(62,40)
        COMMON DISC1,DISC2,DISC3
C       PROGRAM USED TO GENERATE DISCOUNT FACTORS FOR RATES 1% TO 40%. CALCULATIONS BASED ON YEARLY EFFECTIVE
C       RATES AND SEMI-ANNUAL CASH FLOWS.
C       ------------------------------------------------------------------------------------------------
        DO 170 K=1,40
        DO 169 I=1,31
        M2=I*2
        M1=M2-1
        I1=M1-2
        I2=M2-2
        F=K
        R=F/100.
```

FIG. 4:16 DISPLAY OF PROGRAMME RRJS05

```
      DISC1(M1,K)=1./((SQRT(1.+R))**I1)
 169  DISC1(M2,K)=1./((SQRT(1.+R))**I2)
  170 CONTINUE
      RETURN
      END



      SUBROUTINE DISCF2
      DIMENSION DISC1(62,40), DISC2(62,40),DISC3(62,40)
      COMMON DISC1,DISC2,DISC3
C     PROGRAM USED TO GENERATE DISCOUNT FACTORS 41% TO 80%.
C     ------------------------------------------------------------

      DO 1002 K=1,40
      DO 1001 I=1,31
      M2=I*2
      M1=M2-1
      I1=M1-2
      I2=M2-2
      F=K+40
      R=F/100.
      DISC2(M1,K)=1./((SQRT(1.+R))**I1)
 1001 DISC2(M2,K)=1./((SQRT(1.+R))**I2)
 1002 CONTINUE
      RETURN
      END



      SUBROUTINE DISCF3
      DIMENSION DISC1(62,40),DISC2(62,40),DISC3(62,40)
      COMMON DISC1,DISC2,DISC3
C     PROGRAM USED TO GENERATE DISCOUNT FACTORS -1% TO -40%.
C     ------------------------------------------------------------
      DO 1004 K=1,40
      DO 1003 I=1,31
      M2=I*2
      M1=M2-1
      I1=M1-2
      I2=M2-2
      F=K
      R=-F/100.
      DISC3(M1,K)=1./((SQRT(1.+R))**I1)
 1003 DISC3(M2,K)=1./((SQRT(1.+R))**I2)
 1004 CONTINUE
      RETURN
      END
```

FIG. 4:16 DISPLAY OF PROGRAMME RRJS05

GENERAL INPUT DOCUMENT RRJ S05

## A) PARAMETERS

punching row no

1 | 16 | NUMBER OF YEARS IN EACH SIMULATION

| | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | PLANT | BUILDINGS | MOTOR VEHICLES | FURNITURE | OTHER | PLANT | BUILDINGS | MOTOR VEHICLES | FURNITURE | OTHER | [illegible] | [illegible] | [illegible] | [illegible] | PLANT | BUILDINGS | MOTOR VEHICLES | FURNITURE | OTHER | SHORT TERM ASSETS | INVENTORY | [illegible] | [illegible] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| fields | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] |
| | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | | | | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 10 | 5 | [illegible] | [illegible] | | [illegible] | [illegible] |
| understood decimals | 2 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | | 0 | 0 |

## B) PROJECT INVESTMENTS DURING YEARS 1 TO 3

| | PLANT | BUILDINGS | MOTOR VEHICLES | FURNITURE | OTHER |
|---|---|---|---|---|---|
| fields | 1–12 | 13–24 | 25–36 | 37–48 | 49–60 |
| period 3 | 1000000 | | 1000000 | | |
| 4 | 5000000 | | | 500000 | 500000 |
| 5 | 500000 | | | | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |

## C) COST OF CAPITAL FACTORS

| year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| fields | 5 | 8 | [illegible] | [illegible] | 9 | [illegible] | 9 | 10 | 10 | 10 | 10 | 11 | 11 | 11 | 12 | 12 | | | | | | | | | | | | | | | |

FIG. 4:17 INPUT DOCUMENT FOR PROGRAMME RRJS05

Lines 147 to 193 handle the clearance of all variables and arrays by setting them to zero.

Lines 195 to 201 handle the input of all data prepared by programme RRJSO4 and at the conclusion of this operation all data inputs are complete. Programme RRJSO5 is now ready to generate cash flows for each simulation.

Lines 202 to 207 calculate Unit Sales and Turnover value on the basis :

$$\text{Unit Sales}_t = \text{Total Market Size}_t \times \text{Firm's Market Share}_t$$

$$\text{Turnover}_t = \text{Unit Sales}_t \times \text{Firm's Average Selling Price}_t$$

Lines 209 to 214 calculate Datum Stock levels in units using the basis :

$$\text{Finished Datum Stock level}_t = \text{Unit Sales}_t \div \text{Finished Stock turn}_t$$

$$\text{Finished Stock Units required or released}_t = \text{Datum Stock level}_t - \text{Datum Stock level}_{t-1}$$

Lines 216 to 222 calculate required production in units and value on the basis :

$$\text{Production in Units}_t = \text{Unit Sales}_t + \text{Units required by or released from Stock}_t$$

$$\text{Total Cost of Production} = (\text{Production in units}_t \times \text{Variable Cost of Production}) + \text{Total Fixed Production Expenses}$$

Lines 223 to 227 calculate the average cost of finished goods, and the value of datum inventory on the basis :

$$\text{Total Value of Finished Goods}_t = \text{Total Cost of Production}_t + (\text{Finished Datum Stock level}_{t-1} \times \text{Average cost of Finished Goods}_{t-1})$$

$$\text{Average Cost of Finished Goods}_t = \text{Total value of Finished Goods}_t \div (\text{Production in Units}_t + \text{Finished Datum Stock level}_{t-1})$$

$$\text{Value of Finished Datum Stock}_t = \text{Average cost of Finished Goods}_t \times \text{Finished Datum Stock level}_t$$

$$\text{Value of all Datum Stock} = \text{Value of Finished Datum Stock}_t \times (1 + PFG)$$

where PFG = Raw Materials and W.I.P. Stocks as a decimal fraction of Finished Datum Stock value.

Lines 232 to 235 handle the determination of cost of sales on the basis :

$$\text{Cost of Sales}_t = \text{Unit Sales}_t \times \text{Average Cost of Finished Goods}_t$$

Lines 238 to 241 determine the net profit before depreciation and tax on the basis :

| | R |
|---|---|
| Turnover | xxx |
| Less Cost of Sales | xxx |
| Less Total Marketing Costs | xxx |
| Less Total Selling Costs | xxx |
| Less Total Other Fixed Costs | xxx |
| Less Total Other Variable Costs | |
| (Variable Rate x Unit Sales) | xxx |
| Net Profit before Depreciation and Tax | xxx |

Lines 243 to 246 handle the cash flow effect of short term investments on the basis :

Value of short term Investments$_t$ = (Total Cost of Production $\div$ 12 x P x C ) - (Annual Turnover $\div$ 12 x D )

where P = Purchases as a decimal fraction of cost of Production; C = Trade Credit Months; D = Debtor Months.

Lines 248 to 382 handle the taxation effects on cash flows and they provide for the following :

i) An Investment Allowance and an Initial Allowance on Plant and Equipment,

ii) An Investment Allowance on Building,

and iii) Wear and Tear Allowances on Buildings, Plant and Equipment, Motor Vehicles, Furniture and Other Assets.

Taxable income is derived by deduction of the above from profit and then tax payable is determined as follows :

Tax Payable$_t$ = Taxable Income x Tax Rate

Lines 384 to 405 split the annual profit estimates into six monthly estimates and they determine the half-yearly cash flow balance after tax payments. The final adjustment, between tax payable for a given year and the amounts provisionally paid, is assumed to take place in the six months following the year end. Thus, for a given period the tax effects would be taken as follows:

| Six Monthly Period | 11 | 12 | 13 |
|---|---|---|---|
| Profit before Depreciation and Tax | R500 | R500 | R600 |
| Less Provisional Tax Payments | | | |
| based on previous year's Tax | (160) | (160) | (200) |
| Final adjustment for previous year[59] | (80) | —— | (80) |
| Net Cash Flow | R260 | R340 | R320 |

Lines 407 to 419 take into account the cash flow effects of changes in working capital requirements and the cash flow effects of long term investments.

Lines 421 to 434 handle the Salvage Value effects on cash flows at the end of a project and the resultant tax adjustment caused by the salvaging of investments.

Lines 435 to 543 handle the calculation of discount factors via sub-routines "DISCF1", "DISCF2", and "DISCF3" (see lines 1070 to 1130) and the calculation of I.R.O.R. and N.P.V. for each simulation.

Lines 551 to 597 handle the print out of all data on each simulation, that is, each simulation's cash flow details, I.R.O.R. and N.P.V.

Lines 599 to 672 handle the sorting of the simulations according to ascending I.R.O.R. and the listing of these results.

Lines 674 to 683 handle the calculation of the mean and standard deviation for the N.P.V. results while lines 685 to 689 determine the mean and standard deviation for the cash flow data per period.

Lines 691 to 714 are responsible for the calculation of the overall rate of return.

Lines 716 to 723 calculate the tolerance limits for the distribution of N.P.V. The use of tolerance limits is theoretically correct because one is not interested in the population's $\overline{\text{N.P.V.}}$ but the limits for any one outcome at a given probability level.[60]

Lines 725 to 810 handle the grouping of the I.R.O.R. results into a frequency table, while lines 811 to 832 calculate the mean, standard deviation and coefficient of variation for this data, and the tolerance limits for an individual result at the ninety-five percent level.

---

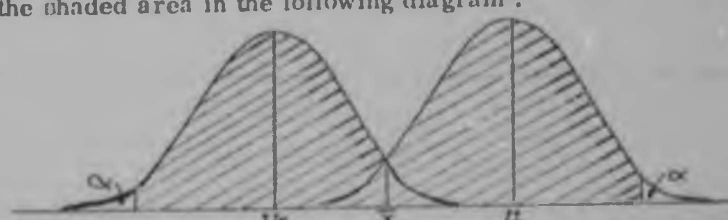
59. Based on Tax rate of forty percent and extra taxable income of R200 from year to year - therefore taxable income for periods 7/8 = R600 ; 9/10 = R800.

Lines 836 to 1064 handle the tabulation of all relevant data, namely, overall project statistics, discount factors and parameter inputs. Finally, the programme has, from lines 1070 to 1130, three sub-routines to calculate the necessary discount factors.

The commentary is now complete and in the next chapter the final results of the simulation suite will be considered. It should be noted that in Appendix I full details are given of the simulation suite's input requirements.

---

60. Graphically one can illustrate the range of individual outcomes as the shaded area in the following diagram :



Contrasting Confidence and Tolerance Limits, one finds that the latter exceed the former in range.

$$U_{NPV} = \overline{X}_o \pm 1,96 \frac{\sigma}{\sqrt{n}}$$

$$X_{NPV} = \overline{X}_o \pm 3,75\sigma$$

where $\alpha = 0,025$

CHAPTER 5

A SPECIMEN RUN AND THE INTERPRETATION THEREOF

In many of the illustrations given in Chapter Four, the input data used for the specimen run and some of the preliminary outputs were given. In this chapter, therefore, the outputs of programmes RRJSO4 and RRJSO5 will only be discussed. Although the output of programme RRJSO4 was previously given, it will be repeated in this chapter for ease of exposition and completeness.

Figure 5 : 1 illustrates the variable data for simulation number 1, and one sees from this that in this case the project is expected to run for eleven years, including year zero. This checks with the details given for 'Product Life' and 'Plant Life', and the fact that the maximum period for any simulation is sixteen years, including year zero. In this case the 'Plant Life' is ten years and therefore the inclusion of year zero extends the project to eleven years. A further point to be noted is the effect of the following three conditional statements, which have been fed into the process :

i) If market size is greater than or equal to 200 000 units and market price is less than R145. 00, then market price must be increased to R145. 00.
ii) If market share is less than or equal to fifty percent and market price is greater than R245. 00, then market price must be reduced to R245. 00
iii) If market size is greater than or equal to 500 000 units and market price is less than R240. 00, then market price must be increased to R240. 00.

Examination of the data for simulation number 1 reveals that the above conditional statements have been complied with. The first statement applies

DETAILED PRINT OUT OF FINAL VARIABLE DATA FOR ONE HUNDRED SIMULATIONS.

DATA FOR SIMULATION NUMBER 1 . YEARS IN PROJECT: 11

| | MARKET SIZE | MARKET SHARE | MARKET PRICE | MAN.VAR.C. | MAN.FIXED C. | MARKETING C. |
|---|---|---|---|---|---|---|
| YR. 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| YR. 1 | [illegible] | 0.40 | 135.00 | 104.00 | 550000.00 | 140000.00 |
| YR. 2 | 112197.00 | 0.40 | 137.70 | 112.32 | 550000.00 | 144199.90 |
| YR. 3 | 201759.50 | 0.40 | 145.00 | 115.59 | 550000.00 | 148925.80 |
| YR. 4 | 339233.10 | 0.40 | 145.00 | 116.85 | 577491.50 | 152981.40 |
| YR. 5 | 333218.00 | 0.41 | 145.00 | 118.01 | 577499.50 | 149692.10 |
| YR. 6 | 402378.50 | 0.41 | 145.00 | 120.37 | 606374.00 | 144473.60 |
| YR. 7 | 422497.10 | 0.42 | 157.59 | 122.78 | 636692.20 | 181041.30 |
| YR. 8 | 443621.60 | 0.42 | 157.59 | 118.98 | 636692.20 | 167825.20 |
| YR. 9 | 405802.30 | 0.42 | 157.59 | 112.86 | 668526.30 | 155973.80 |
| YR. 10 | [illegible] | 0.43 | 160.74 | 112.82 | 668526.30 | 128192.60 |

| | SELLING C. | OTHER FIX.C. | OTHER VAR.C. | PRODUCT LIFE | PLANT LIFE | INVESTMENT |
|---|---|---|---|---|---|---|
| YR. 0 | 0.00 | 0.00 | 0.00 | 12.00 | 10.00 | 7000000.00 |
| YR. 1 | [illegible] | 200000.00 | 2.00 | 0.00 | 0.00 | 0.00 |
| YR. 2 | 1009999.00 | 200000.00 | 2.02 | 0.00 | 0.00 | 0.00 |
| YR. 3 | 1785171.00 | 200000.00 | 2.04 | 0.00 | 0.00 | 0.00 |
| YR. 4 | [illegible] | 200000.00 | 2.06 | 0.00 | 0.00 | 0.00 |
| YR. 5 | 3004727.00 | 150000.00 | 2.08 | 0.00 | 0.00 | 0.00 |
| YR. 6 | [illegible] | 112500.00 | 2.10 | 0.00 | 0.00 | 0.00 |
| YR. 7 | 3371623.00 | [illegible] | 2.14 | 0.00 | 0.00 | 0.00 |
| YR. 8 | [illegible] | 9281.25 | 2.19 | 0.00 | 0.00 | 0.00 |
| YR. 9 | [illegible] | 0.00 | 2.23 | 0.00 | 0.00 | 0.00 |
| YR. 10 | 3473773.00 | 0.00 | 2.28 | 0.00 | 0.00 | 0.00 |

DATA FOR SIMULATION NUMBER 2 . YEARS IN PROJECT: 13

| | MARKET SIZE | MARKET SHARE | MARKET PRICE | MAN.VAR.C. | MAN.FIXED C. | MARKETING C. |
|---|---|---|---|---|---|---|
| YR. 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| YR. 1 | [illegible] | 0.50 | 150.00 | 106.00 | 550000.00 | 140000.00 |
| YR. 2 | [illegible] | 0.50 | 153.00 | 114.48 | 550000.00 | 144199.90 |
| YR. 3 | [illegible] | 0.50 | 153.00 | 117.91 | 550000.00 | 148925.80 |
| YR. 4 | 411641.30 | 0.50 | 156.06 | 119.03 | 577499.50 | 152981.40 |
| YR. 5 | [illegible] | 0.51 | 156.06 | 120.28 | 577499.50 | 149692.10 |
| YR. 6 | [illegible] | 0.52 | 156.06 | 122.69 | 606374.00 | 144473.60 |
| YR. 7 | [illegible] | 0.52 | 240.00 | 125.14 | 636692.20 | 181041.30 |
| YR. 8 | [illegible] | 0.53 | 240.00 | 121.26 | 636692.20 | 167825.20 |
| YR. 9 | [illegible] | 0.53 | 240.00 | 115.03 | 668526.30 | 155973.90 |
| YR. 10 | [illegible] | 0.54 | 240.00 | 114.98 | 668526.30 | 128192.60 |
| YR. 11 | [illegible] | 0.55 | 240.00 | 118.43 | 772146.60 | 92476.81 |
| YR. 12 | [illegible] | 0.56 | 240.00 | 121.99 | 772146.60 | 152319.30 |

| | OTHER FIX.C. | [illegible] LIFE | PLANT LIFE | INVESTMENT |
|---|---|---|---|---|
| | | | 16.00 | 6000000.00 |

FIG. 51 VARIABLE DATA FOR SIMULATION NUMBER 1

as soon as market size exceeds 200 000 units as is evident from market price increasing to R145. 00 for years three, four, five and six. In year seven, the condition does not apply as price exceeds R145. 00. The second and third statements do not apply at any stage to simulation number one, as market price never exceeds R245. 00 and market size never equals or exceeds 500 000 units. Before leaving figure 5 : 1, it should be mentioned that all the data in this example have been manually audited and that this audit can be found in Appendix IV.

Figure 5 : 2 gives the results for simulation number one. From this one observes that the project is expected to yield a loss before depreciation and tax in the years one, two, three, four and six, that the project's losses will reduce tax liability for the company as a whole in the first six years and that the project will require substantial outflows in the years zero, one, three, four, five and six. The net present value for the project is expected to yield -R7 638 184 and that the I. R. O. R. is expected to be in the region of -0,01 to -0,99 percent per annum. In short, this simulation indicates that the project could yield a loss, and that earnings may not cover the firm's cost of capital. Once again mention should be made that these results have been checked and that the details of the manual audit are in Appendix IV.

Having repeated the simulation process one hundred times, the final results of each simulation are then summarised in ascending order of I. R. O. R. For the specimen run the results are given in figure 5 : 3. From this list one observes that simulations 1, 73, 76, 83, and 48 are expected to yield less than the cost of capital, while simulations 11 and 98 are expected to earn a yield in excess of forty-five percent per annum. Figure 5 : 4 groups these results into a frequency table and shows that the simulation has an expected I. R. O. R. of twenty-six percent per annum, a standard deviation of 10,7 percent and a coefficient of variation of 41,1 percent. The ninety-five percent tolerance limits for the project indicate the return could be as great as 66,11 percent or as low as -14,11 percent. Figure 5 : 5 gives mean and standard deviation cash flow statistics per period for the project as a whole. Figure 5 : 6 indi-

PRINT OUT OF PERTINENT DATA & SIX MONTHLY CASH FLOWS FOR ONE HUNDRED SIMULATIONS.

SIMULATION NUMBER 1

| | COST OF PRODUCTION | TURNOVER | COST OF SALES | PROFIT BEFORE DEP.& TAX | TAX PAYABLE | DEBTORS, CREDITORS ETC | INVENTORY INVESTMENT | CASH FLOW MID-YEAR. | CASH FLOW YEAR END. |
|---|---|---|---|---|---|---|---|---|---|
| YR. 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 500000.00 | -1750000.00 | -975000.00 |
| YR. 1 | 5677192.00 | 5537792.00 | 4693365.00 | -111972.80 | -1448417.00 | -725938.70 | 1304773.00 | -1831341.00 | -1231342.00 |
| YR. 2 | 5666384.00 | 6179965.00 | 5516035.00 | -780426.30 | -793523.90 | -848673.90 | 1531846.00 | 1557258.00 | 198841.30 |
| YR. 3 | 10761720.00 | 11713640.00 | 9856888.00 | -441740.80 | -652991.90 | -1607438.00 | 2717337.00 | -1461529.00 | -807035.90 |
| YR. 4 | [illegible] | 19327900.00 | 16125190.00 | -129748.00 | -528196.70 | -2671821.00 | 4478086.00 | -1280873.00 | -1139943.00 |
| YR. 5 | [illegible] | 22782300.00 | 19097690.00 | 63379.75 | -490946.30 | -3191509.00 | 5300811.00 | -500214.90 | -315417.70 |
| YR. 6 | 20661420.00 | 23921390.00 | 20395880.00 | -412354.90 | -530581.50 | -3352515.00 | 5662491.00 | -319298.20 | -242047.80 |
| YR. 7 | [illegible] | 27764140.00 | 22317210.00 | 1632647.00 | 630869.10 | -3989614.00 | 6203230.00 | 972330.00 | 492695.00 |
| YR. 8 | [illegible] | 29562920.00 | 22936460.00 | 2465371.00 | 980649.10 | -4231838.00 | 6361314.00 | -444351.50 | 717096.40 |
| YR. 9 | [illegible] | 30530410.00 | 22956650.00 | 3842[illegible]31.00 | 1531504.00 | -4503886.00 | 6375251.00 | 938175.50 | 1287951.00 |
| YR.10 | 24740490.00 | 33805150.00 | 24432920.00 | 5290752.00 | 63847.00 | -4760586.00 | 6785223.00 | 895424.00 | 10366240.00 |
| YR.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| YR.12 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| YR.13 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| YR.14 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| YR.15 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

PRESENT VALUE = -7638194.00

INTERNAL RATE OF RETURN IS BETWEEN -0.01 AND -0.99 PERCENT.

SIMULATION NUMBER 2

| | COST OF PRODUCTION | TURNOVER | COST OF SALES | PROFIT BEFORE DEP.& TAX | TAX PAYABLE | DEBTORS, CREDITORS ETC | INVENTORY INVESTMENT | CASH FLOW MID-YEAR. | CASH FLOW YEAR END. |
|---|---|---|---|---|---|---|---|---|---|
| YR. 0 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 500000.00 | -1500000.00 | -900000.00 |
| YR. 1 | [illegible] | 8669190.00 | 7133165.00 | 1269325.00 | -728628.70 | -1301535.00 | 1980936.00 | -1744572.00 | -1266572.00 |
| YR. 2 | 8631607.00 | 10602880.00 | 8374792.00 | 598053.00 | -187622.80 | -1512176.00 | 2125801.00 | 1064215.00 | 389987.00 |
| YR. 3 | [illegible] | 17395163.00 | 15198380.00 | 1256485.00 | 81004.00 | -2667947.00 | 4220714.00 | -1344794.00 | -803298.17 |
| YR. 4 | [illegible] | 32178130.00 | 25948220.00 | 3213130.00 | 863661.50 | -4531712.00 | 6956096.00 | -1001139.00 | -734910.00 |
| YR. 5 | 30930800.00 | 37677130.00 | 29987130.00 | 4877373.00 | 1129363.00 | -5182041.00 | 8211039.00 | -327437.50 | 459220.00 |
| YR. [illegible] | [illegible] | 40318670.00 | 32264320.00 | 3521727.00 | [illegible] | -5757381.00 | 8743393.00 | 376655.50 | 642355.00 |
| | | [illegible] | 34464670.00 | [illegible] | | -10194470.00 | 9571122.00 | 9948618.00 | 9921597.00 |
| | | | | | | [illegible] | 10001390.00 | -590903.00 | 8701461.00 |
| | | | | | | | 10020340.00 | [illegible] | [illegible] |

FIG. 5-2 RESULTS FOR SIMULATION NUMBER 1.

SUMMARY OF INTERNAL RATES OF RETURN AND NET PRESENT VALUES.

| SIMULATION NUMBER: | RETURN IS:- | NET PRESENT VALUE: |
|---|---|---|
| 1 | -0.99% / -0.01% | -7638184.00 |
| 73 | 2.01% / 2.99% | -5734007.00 |
| 76 | 7.01% / 7.99% | -2191321.00 |
| 83 | 7.01% / 7.99% | -2733812.00 |
| 48 | 9.01% / 9.99% | -873198.00 |
| 23 | 11.01% / 11.99% | 1176851.00 |
| 17 | 13.01% / 13.99% | 3706807.00 |
| 49 | 13.01% / 13.99% | 3298096.00 |
| 71 | 13.01% / 13.99% | 3950556.00 |
| 84 | 13.01% / 13.99% | 3240230.00 |
| 25 | 14.01% / 14.99% | 6062542.00 |
| 28 | 14.01% / 14.99% | 5060486.00 |
| 31 | 14.01% / 14.99% | 5305060.00 |
| 42 | 14.01% / 14.99% | 5314817.00 |
| 34 | 15.01% / 15.99% | 5472085.00 |
| 90 | 15.01% / 15.99% | 5834612.00 |
| 66 | 16.01% / 16.99% | 4812557.00 |
| 72 | 16.01% / 16.99% | 7212836.00 |
| 75 | 16.01% / 16.99% | 7147758.00 |
| 36 | 17.01% / 17.99% | 8630253.00 |
| 94 | 17.01% / 17.99% | 10442400.00 |
| 19 | 18.01% / 18.99% | 10980490.00 |
| 57 | 18.01% / 18.99% | 10849570.00 |
| 9 | 19.01% / 19.99% | 15075210.00 |
| 26 | 19.01% / 19.99% | 13984150.00 |
| 54 | 19.01% / 19.99% | 10717380.00 |
| 64 | 19.01% / 19.99% | 12753940.00 |
| 70 | 19.01% / 19.99% | 15770140.00 |
| 21 | 20.01% / 20.99% | 19586960.00 |
| 30 | 20.01% / 20.99% | 18447680.00 |
| 35 | 20.01% / 20.99% | 17960090.00 |
| 59 | 20.01% / 20.99% | 12718470.00 |
| 79 | 20.01% / 20.99% | 12672040.00 |
| 81 | 20.01% / 20.99% | 16178030.00 |
| 95 | 20.01% / 20.99% | 16815370.00 |
| 6 | 21.01% / 21.99% | 18098010.00 |
| 24 | 21.01% / 21.99% | 17916950.00 |
| 89 | 21.01% / 21.99% | 18835280.00 |
| 22 | 22.01% / 22.99% | 17069440.00 |
| 39 | 22.01% / 22.99% | 16810550.00 |
| 51 | 22.01% / 22.99% | 26334440.00 |
| 77 | 22.01% / 22.99% | 23378490.00 |
| 86 | 22.01% / 22.99% | 17242300.00 |
| 88 | 22.01% / 22.99% | 19390410.00 |
| 100 | 22.01% / 22.99% | 18223260.00 |
| 52 | 23.01% / 23.99% | 25077980.00 |
| 65 | 23.01% / 23.99% | 20812750.00 |
| 82 | 23.01% / 23.99% | 22028590.00 |
| 96 | 23.01% / 23.99% | 17564560.00 |

FIG. 53 SUMMARY OF RESULTS

| SIMULATION NUMBER | RETURN (S) - | NET PRESENT VALUE |
|---|---|---|
| 7 | 24.01% / 24.99% | 22560890.00 |
| 32 | 24.01% / 24.99% | 25515790.00 |
| 56 | 24.01% / 24.99% | 27670200.00 |
| 60 | 24.01% / 24.99% | 29952170.00 |
| 38 | 25.01% / 25.99% | 32577080.00 |
| 61 | 25.01% / 25.99% | 21412680.00 |
| 69 | 25.01% / 25.99% | 25349520.00 |
| 93 | 25.01% / 25.99% | 26037160.00 |
| 37 | 26.01% / 26.99% | 36096780.00 |
| 43 | 26.01% / 26.99% | 29025800.00 |
| 50 | 26.01% / 26.99% | 27612780.00 |
| 97 | 26.01% / 26.99% | 31623240.00 |
| 4 | 27.01% / 27.99% | 31695450.00 |
| 13 | 27.01% / 27.99% | 39824410.00 |
| 27 | 27.01% / 27.99% | 31290410.00 |
| 87 | 27.01% / 27.99% | 35524670.00 |
| 67 | 28.01% / 28.99% | 38382750.00 |
| 3 | 29.01% / 29.99% | 31904730.00 |
| 18 | 29.01% / 29.99% | 28731530.00 |
| 58 | 30.01% / 30.99% | 28091150.00 |
| 80 | 30.01% / 30.99% | 39761870.00 |
| 92 | 30.01% / 30.99% | 33859840.00 |
| 2 | 31.01% / 31.99% | 38142220.00 |
| 15 | 31.01% / 31.99% | 29868270.00 |
| 74 | 34.01% / 34.99% | 43059200.00 |
| 91 | 34.01% / 34.99% | 34249450.00 |
| 12 | 35.01% / 35.99% | 54219040.00 |
| 46 | 35.01% / 35.99% | 48806540.00 |
| 62 | 35.01% / 35.99% | 33654250.00 |
| 40 | 36.01% / 36.99% | 55103920.00 |
| 41 | 36.01% / 36.99% | 39322520.00 |
| 20 | 38.01% / 38.99% | 51067840.00 |
| 29 | 38.01% / 38.99% | 64724750.00 |
| 53 | 38.01% / 38.99% | 49870440.00 |
| 58 | 38.01% / 38.99% | 53002380.00 |
| 76 | 38.01% / 38.99% | 52741040.00 |
| 99 | 39.01% / 39.99% | 59856120.00 |
| 14 | 40.01% / 40.99% | 51[illegible]31660.00 |
| 8 | 41.[illegible] / 41.99% | 65259740.00 |
| 10 | 41.01% / 41.99% | 52000200.00 |
| 23 | 41.01% / 41.99% | 5499[illegible]70.00 |
| 44 | 41.01% / 41.99% | 7241[illegible]0.00 |
| 67 | 41.01% / 41.99% | 9867[illegible]50.00 |
| 5 | 42.01% / 42.99% | 62362040.00 |
| 16 | 42.01% / 42.99% | 47769930.00 |
| 49 | 42.01% / 42.99% | 79410600.00 |
| 90 | 42.01% / 42.99% | 59452640.00 |
| 63 | 43.01% / 43.99% | 69952970.00 |
| 85 | 43.01% / 43.99% | 52624190.00 |
| 11 | 45.01% / 45.99% | 79364500.00 |
| 98 | 48.01% / 48.99% | 91638[illegible]0.00 |

FIG. 53 SUMMARY OF RESULTS

PRINT OUT OF INTERNAL RATE OF RETURN DATA FOR ONE HUNDRED SIMULATIONS.

FREQUENCY TABLE OF RETURNS.

| CLASS INTERVAL | FREQUENCY |
|---|---|
| -45.00 TO -40.01 | 0 |
| -40.00 TO -35.01 | 0 |
| -35.00 TO -30.01 | 0 |
| -30.00 TO -25.01 | 0 |
| -25.00 TO -20.01 | 0 |
| -20.00 TO -15.01 | 0 |
| -15.00 TO -10.01 | 0 |
| -10.00 TO -5.01 | 0 |
| -5.00 TO -0.01 | 1 |
| 0.00 TO 4.99 | 1 |
| 5.00 TO 9.99 | 3 |
| 10.00 TO 14.99 | 9 |
| 15.00 TO 19.99 | 14 |
| 20.00 TO 24.99 | 25 |
| 25.00 TO 29.99 | 15 |
| 30.00 TO 34.99 | 7 |
| 35.00 TO 39.99 | 11 |
| 40.00 TO 44.99 | 12 |
| 45.00 TO 49.99 | 2 |
| 50.00 TO 54.99 | 0 |
| 55.00 TO 59.99 | 0 |
| 60.00 TO 64.99 | 0 |
| 65.00 TO 69.99 | 0 |
| 70.00 TO 74.99 | 0 |
| 75.00 TO 79.99 | 0 |
| 80.00 TO 84.99 | 0 |
| TOTAL ==> | 100 |

STATISTICS:

EXPECTED RATE OF RETURN = 26.00 PERCENT

STANDARD DEVIATION = 10.70 PERCENT

COEFFICIENT OF VARIATION = 41.15

ASSUMING NORMALITY AND DEPENDANCY OF CASH FLOWS, THERE IS A 95% PROBABILITY THAT THE RETURN WILL BE:-
I)LESS THAN OR EQUAL TO 66.11
II)GREATER THAN OR EQUAL TO -14.11

FIG. 54 I.R.O.R. STATISTICS

PRINT OUT OF AGGREGATE EXPECTED RESULTS.
**********************************************

PRINT OUT OF MEAN CASH FLOWS & STANDARD DEVIATIONS PER PERIOD.
***********************************************************************

| | CASH FLOW MID-YEAR. | CASH FLOW YEAR END. | STD.DEV. MID-YEAR. | STD.DEV. YEAR END. |
|---|---|---|---|---|
| YR. 0 | -1437500.00 | -4332450.00 | 164726.30 | [illegible]50 |
| YR. 1 | -1890574.00 | -1390574.00 | 138835.30 | 14[illegible].20 |
| YR. 2 | 1113366.00 | 221850.10 | 185168.30 | 180513.30 |
| YR. 3 | -1473054.00 | -952788.80 | 235023.20 | 257188.10 |
| YR. 4 | -17[illegible]9.00 | -1111193.00 | 418571.30 | 473170.70 |
| YR. 5 | 1731[illegible]0.30 | 2241080.00 | 4078532.00 | 4209134.00 |
| YR. 6 | -4[illegible]9314.30 | 1945762.00 | 764260.50 | 3423416.00 |
| YR. 7 | 4150119.00 | 4214051.00 | 3455291.00 | 3655214.00 |
| YR. 8 | 1893703.00 | 445506[illegible].00 | 3871616.00 | 3703342.00 |
| YR. 9 | 815[illegible]433.00 | 9109347.00 | 3422283.00 | 3582344.00 |
| YR. 10 | 4910135.00 | 13543690.00 | 4363[illegible]2.00 | 9020870.00 |
| YR. 11 | 5034247.00 | 6760120.00 | 4231711.00 | 4795866.00 |
| YR. 12 | 5375162.00 | 12198370.00 | 4830342.00 | 11600330.00 |
| YR. 13 | 3530905.00 | 3753589.00 | 4485066.00 | 4770192.00 |
| YR. 14 | 3547219.00 | 4923925.00 | 4516438.00 | 14482510.00 |
| YR. 15 | 979143.10 | 4057180.00 | 2619227.00 | 10747920.00 |

FIG. 5.5 CASH FLOW STATISTICS.

cates that the project's expected N. P. V. is R28,16 million, that its profitability index is 5,30, that its standard deviation is high at R21,2 million and that its coefficient of variation is 75,27 percent. The ninety-five percent tolerance limits suggest that the project could earn a N. P. V. between -R51,32 million and R107,65 million. Finally, figure 5 : 7 summarises the project's total expected potential, namely 'funds of R11,99 million can be invested for 15,5 years at an estimated overall return of 21,2 percent per annum.'

For completeness of exposition figures 5 : 8 and 5 : 9, which give a partial illustration of the discount factors used in the simulation, and figure 5 : 10, which records parameters used by the simulation, are also furnished.

Turning now to the interpretation of the results produced by the simulation, one can draw the following observations and conclusions. The graphic illustrations of the simulation's results in figure 5 : 11 (i) indicate there is a ninety percent chance that I.R.O.R. may exceed eighteen percent per annum, while there is a ten percent chance that I.R.O.R. may exceed forty-two percent per annum. In the case of N.P.V. there is a ninety percent chance that N.P.V. may exceed R10 million, while there is a ten percent chance that it may exceed R62,5 million. The cash flow pattern of the project, given in figure 5 : 11 (iii), indicates, however, that cash outflows are quite demanding with inflows only being expected from the fifth year onwards : The volatility of cash flows, indicated by the shaded area of figure 5 : 11 (iii), is also possibly a serious consideration. Turning now to the tolerance limits in figure 5 : 12 (i), one observes that statistically speaking one could get an I.R.O.R. as low as -14,11 percent and as high as 66,11 percent at $\alpha = 0,025$. As the range of these statistics is far greater than that indicated by the simulation results, one should view the tolerance limits as the theoretical extreme, with more weight being given to the simulation results as one increases one's sample size.[61] Thus, on a sample of many thousands of simulations, one might

---

61. Strictly speaking, as the sample size increases the tolerance limits and the sample distribution of results should move toward one another.

```
ASSUMING DEPENDANCY OF CASH FLOWS SAMPLE STATISTICS ARE:-
**********************************************************
**********************************************************

          NET PRESENT EXPECTED VALUE =  28161870.00
          *****************************************

          PROFITABILITY INDEX        =         5.30
          *****************************************

          STANDARD DEVIATION         =  21194350.00
          *****************************************

          COEFFICIENT OF VARIATION   =      75.27 %
          *****************************************

ASSUMING NORMALITY AND DEPENDANCY OF CASH FLOWS.THERE IS A 95% PROBABILITY THAT THE NET PRESENT VALUE WILL BE:-
   I) LESS THAN OR EQUAL TO    107648100.00
  II) GREATER THAN OR EQUAL TO -51324440.00
***************************************************************************************************************
```

FIG. 56 N.P.V. STATISTICS.

DETAILS OF EXPECTED RETURN ON TOTAL FUNDS
******************************************

TAKING A MACRO VIEW, THE RESULTS OF THIS SIMULATION INDICATE THAT TOTAL FUNDS OF R 11989350. CAN BE INVESTED BY THE FIRM FOR A PERIOD OF 16.5 YEARS AT AN ESTIMATED RETURN OF 21.2 PERCENT PER ANNUM.

THE FUNDS ARE EXPECTED TO GENERATE 24.C PERCENT PER ANNUM WHILST EMPLOYED BY THE PROJECT AND TO GENERATE 15.0 PERCENT PER ANNUM ON RE-INVESTMENT. THE TERMINAL VALUE OF THE FUNDS 16.5 YEARS AFTER INITIAL INVESTMENT IS EXPECTED TO BE R 235043500.

(PLEASE NOTE THAT THESE RESULTS ARE BASED ON EXPECTED VALUES.)

FIG. 57 STATEMENT OF PROJECT'S WORTH.

SIX MONTHLY DISCOUNT FACTORS FROM -40% TO 80%.

PROFIT FACTORS

| | 1% | 2% | 3% | 4% | 5% | 6% | 7% | 8% | 9% | 10% | 11% | 12% | 13% | 14% | 15% | 16% | 17% | 18% | 19% | 20% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PER.-1 | [illegible] | [illegible] | 1.015 | 1.020 | [illegible] | [illegible] | 1.034 | 1.039 | 1.044 | 1.049 | 1.054 | 1.059 | 1.061 | 1.066 | 1.072 | 1.077 | 1.082 | 1.086 | 1.091 | 1.095 |
| PER. 0 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| PER. 1 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.967 | 0.962 | 0.959 | 0.953 | 0.949 | 0.945 | 0.941 | 0.937 | 0.933 | 0.928 | 0.925 | 0.921 | 0.917 | 0.913 |
| PER. 2 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.935 | 0.926 | 0.917 | 0.907 | 0.901 | 0.893 | 0.885 | 0.877 | 0.870 | 0.862 | 0.855 | 0.847 | 0.840 | 0.833 |
| PER. 3 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.903 | 0.891 | 0.879 | 0.867 | 0.855 | 0.844 | 0.832 | 0.822 | 0.811 | 0.800 | 0.790 | 0.780 | 0.770 | 0.761 |
| PER. 4 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.873 | 0.857 | 0.842 | 0.826 | 0.812 | 0.797 | 0.783 | 0.769 | 0.756 | 0.743 | 0.731 | 0.718 | 0.706 | 0.694 |
| PER. 5 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.844 | 0.829 | 0.806 | 0.788 | 0.770 | 0.753 | 0.737 | 0.721 | 0.705 | 0.690 | 0.675 | 0.661 | 0.647 | 0.634 |
| PER. 6 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.816 | 0.794 | 0.772 | 0.751 | 0.731 | 0.712 | 0.693 | 0.675 | 0.658 | 0.641 | 0.624 | 0.609 | 0.593 | 0.579 |
| PER. 7 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.789 | 0.764 | 0.740 | 0.716 | 0.694 | 0.673 | 0.652 | 0.632 | 0.613 | 0.595 | 0.577 | 0.560 | 0.544 | 0.528 |
| PER. 8 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.763 | 0.735 | 0.708 | 0.683 | 0.659 | 0.636 | 0.613 | 0.592 | 0.572 | 0.552 | 0.534 | 0.516 | 0.499 | 0.482 |
| PER. 9 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.738 | 0.707 | 0.679 | 0.651 | 0.625 | 0.601 | 0.577 | 0.555 | 0.533 | 0.513 | 0.493 | 0.475 | 0.457 | 0.440 |
| PER.10 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.713 | 0.681 | 0.650 | 0.621 | 0.593 | 0.567 | 0.543 | 0.519 | 0.497 | 0.476 | 0.456 | 0.437 | 0.419 | 0.402 |
| PER.11 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.689 | 0.655 | 0.623 | 0.592 | 0.563 | 0.536 | 0.511 | 0.486 | 0.464 | 0.442 | 0.422 | 0.402 | 0.384 | 0.367 |
| PER.12 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.666 | 0.630 | 0.596 | 0.564 | 0.535 | 0.507 | 0.480 | 0.456 | 0.432 | 0.410 | 0.390 | 0.370 | 0.352 | 0.335 |
| PER.13 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.644 | 0.606 | 0.571 | 0.538 | 0.507 | 0.479 | 0.452 | 0.427 | 0.403 | 0.381 | 0.360 | 0.341 | 0.323 | 0.306 |
| PER.14 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.623 | 0.583 | 0.547 | 0.513 | 0.482 | 0.452 | 0.425 | 0.400 | 0.376 | 0.354 | 0.333 | 0.314 | 0.296 | 0.279 |
| PER.15 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.602 | 0.561 | 0.524 | 0.487 | 0.457 | 0.427 | 0.400 | 0.374 | 0.351 | 0.329 | 0.308 | 0.289 | 0.271 | 0.255 |
| PER.16 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.582 | 0.540 | 0.502 | 0.467 | 0.434 | 0.404 | 0.376 | 0.351 | 0.327 | 0.305 | 0.285 | 0.266 | 0.249 | 0.233 |
| PER.17 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.563 | 0.520 | 0.481 | 0.445 | 0.412 | 0.382 | 0.354 | 0.328 | 0.305 | 0.283 | 0.263 | 0.245 | 0.228 | 0.212 |
| PER.18 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.544 | 0.500 | 0.460 | 0.424 | 0.391 | 0.361 | 0.333 | 0.308 | 0.284 | 0.263 | 0.243 | 0.225 | 0.209 | 0.194 |
| PER.19 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.52 | 0.481 | 0.441 | 0.404 | 0.371 | 0.341 | 0.313 | 0.288 | 0.265 | 0.244 | 0.225 | 0.208 | 0.192 | 0.177 |
| PER.20 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.508 | 0.463 | [illegible] | 0.386 | 0.352 | 0.322 | 0.295 | 0.270 | 0.247 | 0.227 | 0.208 | 0.191 | 0.176 | 0.162 |
| PER.21 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.491 | 0.446 | [illegible] | 0.368 | 0.334 | 0.304 | 0.277 | 0.253 | 0.231 | 0.210 | 0.192 | 0.176 | 0.161 | 0.147 |
| PER.22 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.475 | 0.429 | 0.388 | 0.350 | 0.317 | 0.287 | 0.261 | 0.237 | 0.215 | 0.195 | 0.178 | 0.162 | 0.148 | 0.135 |
| PER.23 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.459 | 0.413 | 0.371 | 0.334 | 0.301 | 0.272 | 0.245 | 0.222 | 0.200 | 0.181 | 0.164 | 0.149 | 0.135 | 0.123 |
| PER.24 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.444 | 0.397 | 0.356 | 0.319 | 0.286 | 0.257 | 0.231 | 0.208 | 0.187 | 0.169 | 0.152 | 0.137 | 0.124 | 0.112 |
| PER.25 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.429 | 0.382 | 0.341 | 0.304 | 0.271 | 0.243 | 0.217 | 0.194 | 0.174 | 0.156 | 0.141 | 0.126 | 0.114 | 0.102 |
| PER.26 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.415 | 0.368 | 0.326 | 0.290 | 0.258 | 0.229 | 0.204 | 0.182 | 0.163 | 0.145 | 0.130 | 0.116 | 0.104 | 0.093 |
| PER.27 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.401 | 0.354 | 0.312 | 0.276 | 0.245 | 0.217 | 0.192 | 0.171 | 0.152 | 0.135 | 0.120 | 0.107 | 0.094 | 0.085 |
| PER.28 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.386 | 0.340 | 0.299 | 0.263 | 0.232 | 0.204 | 0.181 | 0.160 | 0.141 | 0.125 | 0.111 | 0.099 | 0.088 | 0.078 |
| PER.29 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.375 | 0.328 | 0.287 | 0.251 | 0.220 | 0.193 | 0.170 | 0.150 | 0.132 | 0.116 | 0.103 | 0.091 | 0.080 | 0.071 |
| PER.30 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.362 | 0.315 | 0.275 | 0.239 | 0.209 | 0.183 | 0.160 | 0.140 | 0.123 | 0.108 | 0.095 | 0.084 | 0.074 | 0.065 |
| PER.31 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.350 | 0.303 | 0.263 | 0.228 | 0.198 | 0.173 | 0.150 | 0.131 | 0.115 | 0.100 | 0.088 | 0.077 | 0.067 | 0.059 |
| PER.32 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.337 | 0.292 | 0.252 | 0.219 | 0.188 | 0.163 | 0.141 | 0.123 | 0.107 | 0.093 | 0.081 | 0.071 | 0.062 | 0.054 |
| PER.33 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.327 | 0.281 | 0.242 | 0.208 | 0.179 | 0.154 | 0.133 | 0.115 | 0.100 | 0.086 | 0.075 | 0.065 | 0.057 | [illegible] |
| PER.34 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.317 | 0.270 | [illegible] | [illegible] | 0.170 | 0.146 | 0.125 | 0.108 | 0.093 | 0.080 | 0.069 | 0.060 | 0.052 | 0.045 |
| PER.35 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.306 | [illegible] | [illegible] | [illegible] | 0.161 | 0.138 | 0.118 | 0.101 | 0.087 | 0.074 | 0.064 | 0.055 | 0.045 | 0.041 |
| PER.36 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.296 | 0.250 | [illegible] | 0.180 | 0.153 | 0.130 | 0.111 | 0.095 | 0.081 | 0.069 | 0.059 | 0.051 | 0.044 | 0.038 |
| PER.37 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.286 | 0.241 | 0.203 | 0.171 | 0.145 | 0.123 | 0.104 | 0.089 | 0.075 | 0.064 | 0.055 | 0.047 | 0.040 | 0.034 |
| PER.38 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.277 | 0.232 | 0.194 | 0.164 | 0.138 | 0.116 | 0.098 | 0.083 | 0.070 | 0.060 | 0.051 | 0.043 | 0.037 | 0.031 |
| PER.39 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.267 | 0.223 | 0.186 | 0.156 | 0.131 | 0.110 | 0.092 | 0.078 | 0.066 | 0.055 | 0.047 | 0.040 | 0.034 | 0.029 |
| PER.40 | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | [illegible] | 0.258 | 0.215 | 0.178 | 0.149 | 0.124 | 0.104 | 0.087 | 0.073 | 0.061 | 0.051 | 0.043 | 0.037 | 0.031 | 0.026 |
| [illegible] | | | [illegible] | [illegible] | [illegible] | 0.303 | 0.250 | [illegible] | | | | [illegible] | 0.082 | 0.068 | 0.057 | 0.048 | 0.041 | 0.034 | 0.028 | 0.024 |
| | | | | | [illegible] | 0.294 | [illegible] | | | | | [illegible] | 0.077 | 0.064 | 0.053 | 0.044 | 0.037 | 0.031 | 0.026 | 0.022 |
| | | | | | | | | | | | | | [illegible] | 0.060 | 0.050 | 0.041 | 0.034 | 0.028 | 0.024 | 0.020 |
| | | | | | | | | | | | | | | | [illegible] | | | | [illegible] | 0.018 |

FIG. 58 "PROFIT" DISCOUNT FACTORS.

LOSS FACTORS.

| | 1% | 2% | 3% | 4% | 5% | 6% | 7% | 8% | 9% | 10% | 11% | 12% | 13% | 14% | 15% | 16% | 17% | 18% | 19% | 20% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PER.-1 | 0.99 | 0.99 | 0.98 | [illegible] | 0.97 | 0.97 | 0.96 | 0.96 | 0.95 | 0.95 | 0.94 | 0.94 | 0.93 | 0.93 | 0.92 | 0.92 | 0.91 | 0.91 | 0.90 | 0.89 |
| PER. 0 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| PER. 1 | 1.01 | 1.01 | 1.02 | 1.02 | 1.03 | 1.03 | 1.04 | 1.04 | 1.05 | 1.05 | 1.06 | 1.07 | 1.07 | 1.08 | 1.08 | 1.09 | 1.10 | 1.10 | 1.11 | 1.12 |
| PER. 2 | 1.01 | 1.02 | 1.03 | 1.04 | 1.05 | 1.06 | 1.08 | 1.09 | 1.10 | 1.11 | 1.12 | 1.14 | 1.15 | 1.16 | 1.18 | 1.19 | 1.20 | 1.22 | 1.23 | 1.25 |
| PER. 3 | 1.02 | 1.03 | 1.05 | 1.06 | 1.09 | 1.10 | 1.12 | 1.13 | 1.15 | 1.17 | 1.19 | 1.21 | 1.23 | 1.25 | 1.28 | 1.30 | 1.32 | 1.35 | 1.37 | 1.40 |
| PER. 4 | 1.02 | 1.04 | 1.06 | 1.07 | 1.11 | 1.13 | 1.16 | 1.18 | 1.21 | 1.23 | 1.26 | 1.29 | 1.32 | 1.35 | 1.38 | 1.42 | 1.45 | 1.49 | 1.52 | 1.56 |
| PER. 5 | 1.03 | 1.05 | 1.09 | 1.11 | 1.14 | 1.17 | 1.20 | 1.23 | 1.27 | 1.30 | 1.34 | 1.38 | 1.42 | 1.46 | 1.50 | 1.55 | 1.59 | 1.64 | 1.65 | 1.75 |
| PER. 6 | 1.03 | 1.06 | 1.10 | 1.13 | 1.17 | 1.20 | 1.24 | 1.28 | 1.33 | 1.37 | 1.42 | 1.47 | 1.52 | 1.57 | 1.63 | 1.69 | 1.75 | 1.81 | 1.88 | 1.95 |
| PER. 7 | 1.04 | 1.07 | 1.11 | 1.15 | 1.20 | 1.24 | 1.29 | 1.34 | 1.39 | 1.45 | 1.50 | 1.56 | 1.63 | 1.70 | 1.77 | 1.84 | 1.92 | 2.00 | 2.09 | 2.18 |
| PER. 8 | 1.04 | 1.09 | 1.13 | 1.18 | 1.23 | 1.28 | 1.34 | 1.40 | 1.46 | 1.52 | 1.59 | 1.67 | 1.75 | 1.83 | 1.92 | 2.01 | 2.11 | 2.21 | 2.32 | 2.44 |
| PER. 9 | [illegible] | 1.10 | 1.15 | 1.20 | 1.26 | 1.32 | 1.39 | 1.46 | 1.53 | 1.61 | 1.69 | 1.78 | 1.87 | 1.97 | 2.08 | 2.19 | 2.31 | 2.44 | 2.58 | 2.73 |
| PER.10 | 1.05 | 1.11 | 1.16 | 1.23 | 1.29 | 1.36 | 1.44 | 1.52 | 1.60 | 1.67 | [illegible] | 1.89 | 2.01 | 2.13 | 2.25 | 2.39 | 2.54 | 2.70 | 2.87 | 3.05 |
| PER.11 | 1.06 | 1.12 | 1.18 | 1.25 | 1.33 | 1.41 | 1.49 | 1.58 | 1.68 | 1.79 | 1.90 | 2.02 | 2.15 | 2.29 | 2.44 | 2.61 | 2.79 | 2.99 | 3.19 | 3.41 |
| PER.12 | 1.06 | 1.13 | 1.21 | 1.28 | 1.36 | 1.45 | 1.55 | 1.65 | 1.76 | 1.88 | 2.01 | 2.15 | 2.31 | 2.47 | 2.65 | 2.85 | 3.06 | 3.29 | 3.54 | 3.81 |
| PER.13 | 1.07 | 1.14 | [illegible] | 1.33 | 1.40 | 1.50 | 1.60 | 1.72 | 1.85 | 1.98 | 2.13 | 2.30 | 2.47 | 2.67 | 2.88 | 3.11 | 3.38 | 3.63 | 3.93 | 4.20 |
| PER.14 | 1.07 | 1.15 | [illegible] | 1.33 | 1.43 | 1.54 | 1.66 | 1.79 | 1.94 | 2.04 | 2.26 | 2.45 | 2.65 | 2.87 | 3.12 | 3.39 | 3.69 | 4.01 | 4.37 | 4.77 |
| PER.15 | [illegible] | 1.15 | 1.26 | 1.36 | 1.47 | 1.59 | 1.72 | 1.87 | 2.03 | 2.20 | 2.40 | 2.61 | 2.84 | 3.10 | 3.38 | 3.70 | 4.04 | 4.43 | 4.86 | 5.33 |
| PER.16 | [illegible] | 1.18 | 1.29 | 1.37 | 1.51 | 1.64 | 1.79 | 1.95 | 2.13 | 2.32 | 2.54 | 2.78 | 3.05 | 3.34 | 3.67 | 4.03 | 4.44 | 4.89 | 5.40 | 5.96 |
| PER.17 | [illegible] | 1.19 | 1.30 | 1.41 | 1.55 | 1.67 | 1.85 | 2.03 | 2.23 | 2.43 | 2.69 | 2.96 | 3.27 | 3.60 | 3.98 | 4.42 | 4.87 | 5.40 | 6.00 | 6.66 |
| PER.18 | 1.09 | 1.20 | 1.32 | 1.44 | 1.59 | 1.75 | 1.92 | 2.12 | 2.34 | 2.58 | 2.85 | 3.16 | 3.50 | 3.89 | 4.32 | 4.80 | 5.35 | 5.97 | 6.66 | 7.45 |
| PER.19 | 1.10 | 1.21 | 1.34 | 1.47 | 1.63 | 1.80 | 1.99 | 2.21 | 2.45 | 2.72 | 3.03 | 3.37 | 3.75 | 4.19 | 4.68 | 5.26 | 5.87 | 6.59 | 7.40 | 8.33 |
| PER.20 | 1.11 | 1.22 | 1.36 | 1.50 | 1.67 | 1.86 | 2.07 | 2.30 | 2.57 | 2.87 | 3.21 | 3.59 | 4.03 | 4.52 | 5.08 | 5.72 | 6.44 | 7.28 | 8.23 | 9.31 |
| PER.21 | 1.11 | 1.24 | 1.39 | 1.54 | 1.71 | 1.91 | 2.14 | 2.40 | 2.69 | 3.02 | 3.40 | 3.83 | 4.32 | 4.87 | 5.51 | 6.24 | 7.07 | 8.03 | 9.14 | 10.41 |
| PER.22 | 1.12 | 1.25 | 1.40 | 1.57 | 1.76 | [illegible] | 2.22 | 2.50 | 2.82 | 3.17 | 3.60 | 4.09 | 4.63 | 5.25 | 5.98 | 6.81 | 7.76 | 8.87 | 10.15 | 11.64 |
| PER.23 | 1.12 | 1.26 | 1.42 | 1.60 | 1.80 | 2.04 | 2.30 | 2.61 | 2.96 | 3.36 | 3.82 | 4.35 | 4.98 | 5.67 | 6.48 | 7.43 | 8.52 | 9.80 | 11.28 | 13.02 |
| PER.24 | 1.13 | 1.27 | 1.44 | 1.63 | 1.85 | [illegible] | 2.39 | 2.72 | 3.10 | 3.54 | 4.05 | 4.64 | 5.32 | 6.11 | 7.03 | 8.10 | 9.36 | 10.82 | 12.54 | 14.55 |
| PER.25 | 1.13 | [illegible] | 1.46 | 1.67 | 1.90 | 2.17 | 2.48 | 2.84 | 3.25 | 3.71 | 4.29 | 4.96 | 5.70 | 6.59 | 7.63 | 8.86 | 10.27 | 11.95 | 13.93 | 16.27 |
| PER.26 | 1.14 | 1.30 | 1.49 | 1.70 | 1.93 | 2.24 | 2.57 | 2.96 | 3.41 | 3.91 | 4.55 | 5.27 | 6.11 | 7.16 | 8.27 | 9.65 | 11.27 | 13.20 | 15.48 | [illegible] |
| PER.27 | 1.15 | 1.31 | 1.51 | 1.74 | 2.00 | 2.31 | 2.66 | 3.08 | 3.57 | 4.19 | 4.87 | 5.62 | 6.55 | 7.66 | 8.97 | 10.55 | 12.37 | 14.57 | 17.20 | [illegible] |
| PER.28 | 1.15 | 1.33 | 1.53 | 1.77 | 2.05 | 2.38 | 2.76 | 3.21 | 3.74 | 4.37 | 5.11 | 5.99 | 7.03 | 8.26 | 9.71 | 11.48 | 13.58 | 16.09 | 19.11 | 22.74 |
| PER.29 | 1.16 | 1.34 | 1.56 | 1.81 | 2.10 | 2.45 | 2.86 | 3.35 | 3.93 | 4.61 | 5.47 | 6.38 | 7.53 | 8.91 | 10.55 | 12.53 | 14.91 | 17.77 | 21.29 | 25.42 |
| PER.30 | 1.16 | 1.35 | 1.58 | 1.86 | 2.16 | 2.53 | 2.97 | 3.49 | 4.12 | 4.86 | 5.74 | 6.80 | 8.08 | 9.61 | 11.49 | 13.67 | 16.36 | 19.62 | 23.94 | 28.42 |
| PER.31 | 1.17 | 1.37 | 1.60 | 1.89 | 2.21 | 2.61 | 3.08 | 3.64 | 4.31 | 5.12 | 6.09 | 7.25 | 8.66 | 10.36 | 12.42 | 14.92 | 17.96 | 21.67 | 26.21 | 31.76 |
| PER.32 | 1.17 | 1.38 | 1.63 | 1.92 | 2.27 | 2.69 | 3.19 | 3.80 | 4.52 | 5.40 | 6.45 | 7.73 | 9.28 | 11.17 | 13.47 | 16.28 | 19.71 | 23.93 | 29.12 | 35.53 |
| PER.33 | 1.18 | 1.40 | 1.65 | 1.96 | 2.33 | 2.78 | 3.31 | 3.96 | 4.74 | 5.65 | 6.84 | 8.24 | 9.95 | 12.04 | 14.61 | 17.78 | 21.68 | 26.43 | 32.36 | 39.72 |
| PER.34 | 1.19 | 1.41 | 1.68 | [illegible] | [illegible] | 2.86 | 3.43 | 4.13 | 4.97 | 6.03 | 7.25 | 8.79 | 10.67 | 12.99 | 15.85 | 19.38 | 23.75 | 29.19 | 35.99 | 44.41 |
| PER.35 | 1.19 | 1.42 | [illegible] | 2.04 | 2.45 | 2.95 | 3.56 | 4.30 | 5.21 | 6.32 | 7.69 | 9.37 | 11.55 | 14.00 | 17.29 | 21.14 | 26.07 | 32.23 | 39.55 | 45.65 |
| PER.36 | [illegible] | 1.44 | 1.73 | 2.09 | 2.52 | 3.05 | 3.67 | 4.49 | 5.46 | 6.66 | 8.15 | 9.98 | 12.28 | 15.10 | 18.64 | 23.07 | 28.62 | 35.59 | 44.39 | 55.51 |
| PER.37 | [illegible] | 1.45 | 1.74 | 2.13 | 2.58 | 3.14 | 3.83 | 4.68 | 5.72 | 7.02 | 8.64 | 10.85 | 13.19 | 16.27 | 20.22 | 25.17 | 31.41 | 39.30 | 49.32 | 62.06 |
| PER.38 | 1.21 | 1.47 | 1.78 | 2.17 | 2.65 | 3.24 | 3.97 | 4.88 | 6.00 | 7.40 | 9.15 | 11.35 | 14.10 | 17.56 | 21.93 | 27.48 | 34.43 | 43.40 | 54.80 | 69.39 |
| PER.39 | 1.22 | 1.48 | [illegible] | 2.22 | 2.72 | 3.34 | 4.12 | 5.08 | 6.29 | 7.80 | 9.70 | 12.07 | 15.11 | 18.94 | 23.79 | 29.96 | 37.86 | 47.93 | 60.88 | 77.58 |
| PER.40 | [illegible] | 1.50 | [illegible] | 2.26 | 2.79 | 3.45 | 4.27 | 5.30 | 6.59 | 8.23 | 10.28 | 12.69 | 16.20 | 20.42 | 25.80 | 32.69 | 41.56 | 52.93 | 67.46 | 86.74 |
| PER.41 | 1.23 | 1.51 | [illegible] | 2.31 | 2.86 | 3.56 | 4.43 | 5.53 | 6.91 | 8.67 | 10.90 | 13.76 | 17.37 | 22.02 | 27.98 | 35.67 | 45.59 | 58.45 | 75.17 | 96.97 |
| PER.42 | 1.23 | 1.53 | 1.90 | 2.35 | 2.94 | 3.67 | 4.59 | 5.76 | 7.25 | 9.14 | 11.56 | 14.65 | 18.62 | 23.74 | 30.39 | 38.92 | 50.06 | 64.55 | 83.52 | ***** |
| PER.43 | 1.24 | 1.54 | 1.92 | 2.41 | 3.01 | 3.78 | 4.76 | 6.01 | 7.60 | 9.63 | 12.25 | 15.62 | 19.97 | 25.60 | 32.92 | 42.46 | 54.93 | 71.29 | 92.56 | ***** |
| PER.44 | [illegible] | 1.56 | 1.95 | 2.45 | 3.09 | 3.90 | 4.94 | 6.26 | 7.96 | 10.15 | 12.98 | 16.65 | 21.41 | 27.61 | 35.71 | 46.35 | 60.30 | 78.72 | ***** | ***** |
| [illegible] | | | 1.91 | 2.51 | 3.17 | 4.02 | 5.12 | [illegible] | | | [illegible] | 17.75 | 22.95 | 29.77 | 38.73 | 50.95 | 66.18 | 86.93 | ***** | ***** |
| | | | | [illegible] | 3.25 | [illegible] | | | | | | | 24.61 | 32.10 | 42.01 | 55.15 | 72.64 | 96.00 | ***** | ***** |
| | | | | | | | | | | | | | | 34.62 | 45.57 | 60.18 | 79.74 | ***** | ***** | ***** |
| | | | | | | | | | | | | | | | | | | | [illegible] | ***** |

FIG. 5.9 "LOSS" DISCOUNT FACTORS.

```
PRINT OUT OF SIMULATION PARAMETERS
**********************************
**********************************

STOCK TURN -------------------------->   4.5

AVERAGE DEBTOR MONTHS --------------->   2.2

AVERAGE CREDITOR MONTHS ------------->   1.5

RAW MATERIAL INVESTMENT YEAR 0      500000.00

PURCHASES AS % OF COST OF PRODUCTION   40.00

% REINVESTMENT RATE ----------------->  15.0

NORMAL CORPORATE TAX % RATE --------->  40.0

PLANT & EQUIPMENT
-----------------
      INITIAL ALLOWANCE -------------> 15.0%
      INVESTMENT ALLOWANCE ----------> 15.0%
      WEAR & TEAR ALLOWANCE ---------> 17.5%
      SALVAGE VALUE AS % OF BOOK VALUE  10.0


BUILDINGS
---------
      INVESTMENT ALLOWANCE ----------> 10.0%
      WEAR & TEAR ALLOWANCE --------->  7.0%
      SALVAGE VALUE AS % OF BOOK VALUE  25.0


FURNITURE & FITTINGS
--------------------
      WEAR & TEAR ALLOWANCE --------->  5.0%
      SALVAGE VALUE AS % OF BOOK VALUE  10.0


MOTOR VEHICLES
--------------
      WEAR & TEAR ALLOWANCE ---------> 20.0%
      SALVAGE VALUE AS % OF BOOK VALUE  10.0


OTHER ASSETS
------------
      WEAR & TEAR ALLOWANCE ---------> 10.0%
      SALVAGE VALUE AS % OF BOOK VALUE   5.0
```

FIG. 5·10 PARAMETER INPUT CONTROL.

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PRINT OUT OF SIMULATION PARAMETERS
**********************************
**********************************

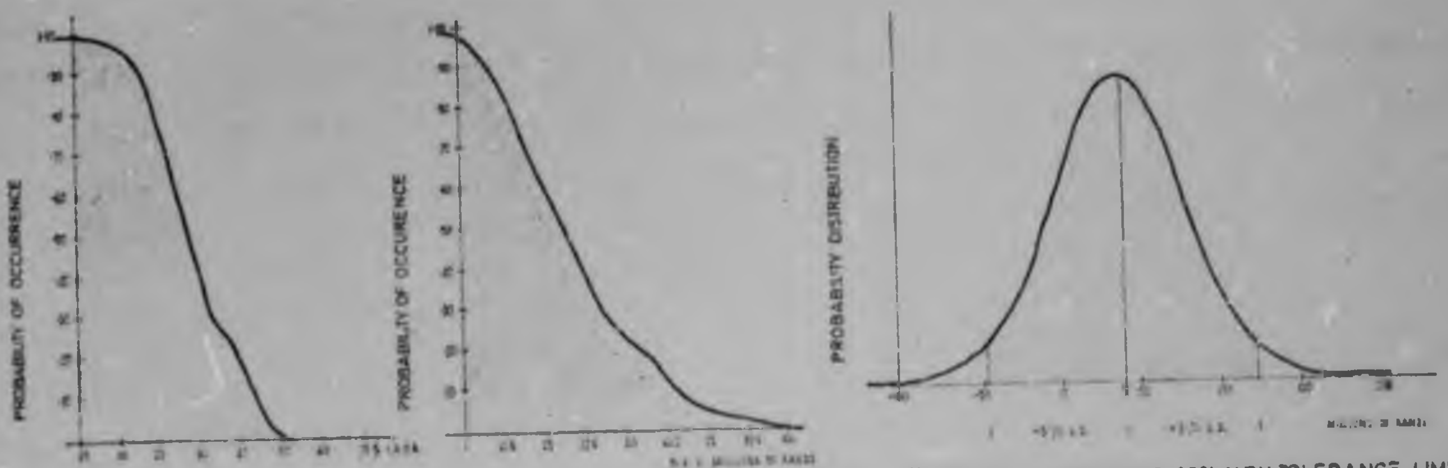
LIQUID ASSETS - % SALVAGE VALUE ----->   90.0
INVENTORY - % SALVAGE VALUE --------->   4[illegible]

ANALYSIS OF INITIAL INVESTMENT
******************************
     % PLANT & EQUIPMENT ->   90.70
     % BUILDINGS --------->    9.30
     % MOTOR VEHICLES --->     0.00
     % FURNITURE & FITTINGS    0.00
     % OTHER ASSETS ------>    0.00

RAW MAT. & W.I.P. AS % OF FINISHED STK. 33.[illegible]

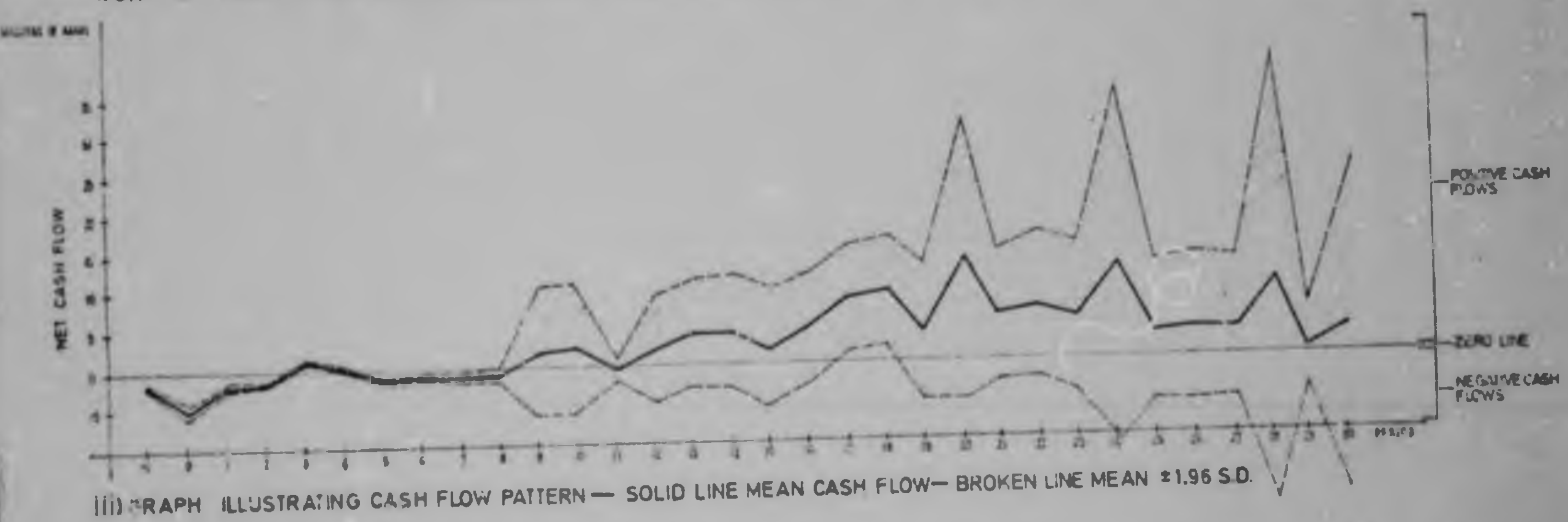
                             ************
                             END OF JOB.
                             ************
```

FIG. 5.10 PARAMETER INPUT CONTROL




i) GRAPHS ILLUSTRATING SAMPLE PROBABILITY OF ACHIEVING A VALUE > X

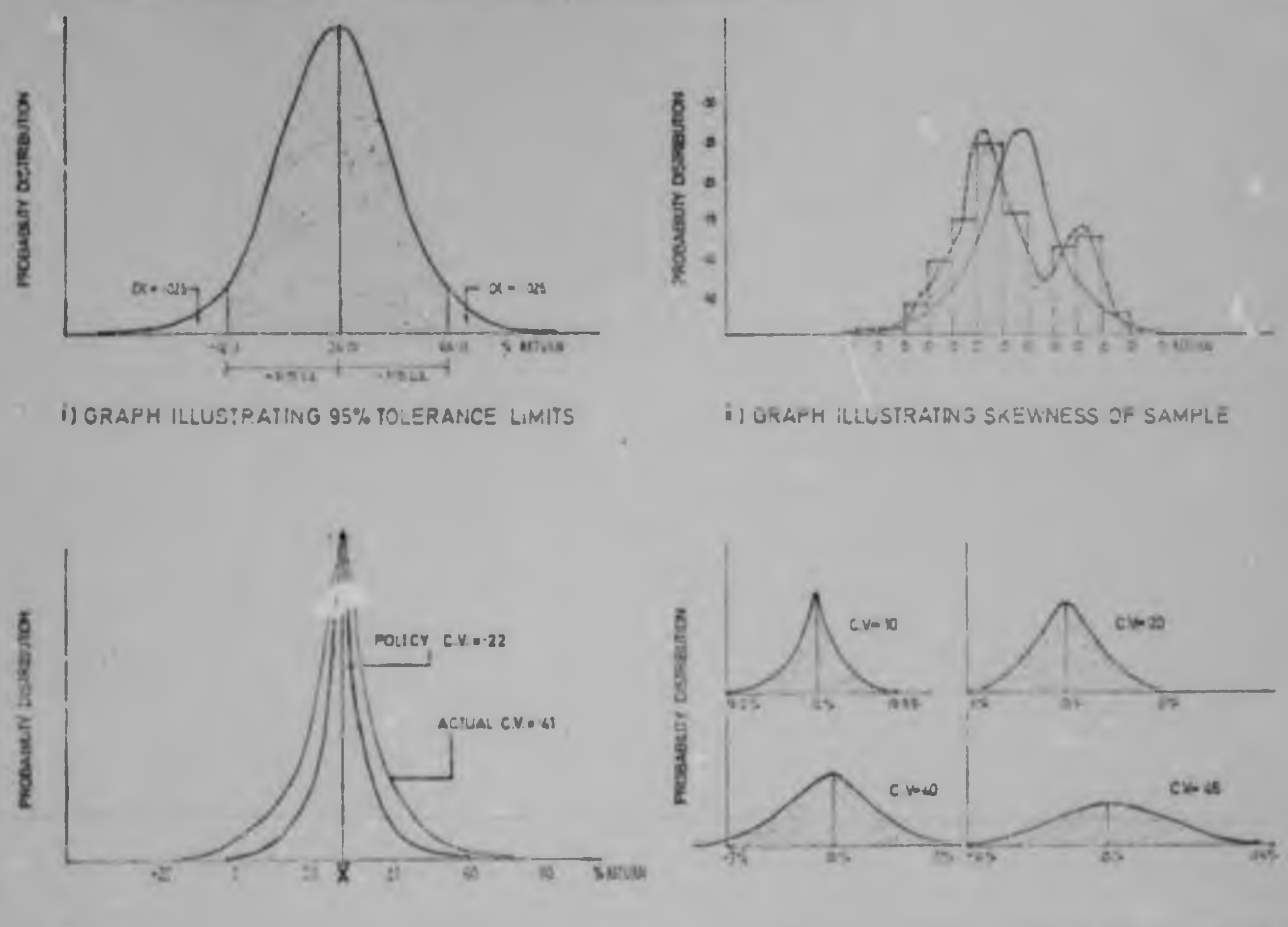
ii) GRAPH ILLUSTRATING 95% NPV TOLERANCE LIMITS




iii) GRAPH ILLUSTRATING CASH FLOW PATTERN — SOLID LINE MEAN CASH FLOW— BROKEN LINE MEAN ±1.96 S.D.

FIG. 5.11 GRAPHICAL ILLUSTRATIONS OF RESULTS

GRAPHIC ILLUSTRATIONS OF PROJECTS I.R.O.R. RESULTS




i) GRAPH ILLUSTRATING 95% TOLERANCE LIMITS

ii) GRAPH ILLUSTRATING SKEWNESS OF SAMPLE

iii) GRAPH ILLUSTRATING ACTUAL AND POLICY RISK PROFILES

iv) GRAPHS ILLUSTRATING VARYING POLICY RISK PROFILES

FIG. 5.12 GRAPHICAL ILLUSTRATIONS OF RESULTS choose to rely heavily on the distribution of simulation results rather than on tolerance limits. Another interesting consideration is skewness, as the tolerance limits have been established under the assumption of normality. Figure 5 : 12 (ii) indicates that the distribution of possible results could be slightly skewed to the left, which implies that the minimum return of -14,11 percent established with central limits may be too low. Having considered the range of likely returns, one is now interested in appraising this relative to the Policy Risk Profiles[62] given in figure 5 : 12 (iv). These selected profiles indicate the acceptable maximum risk standards for given expected values of I.R.O.R., and as such can be used to plot an "efficient frontier".

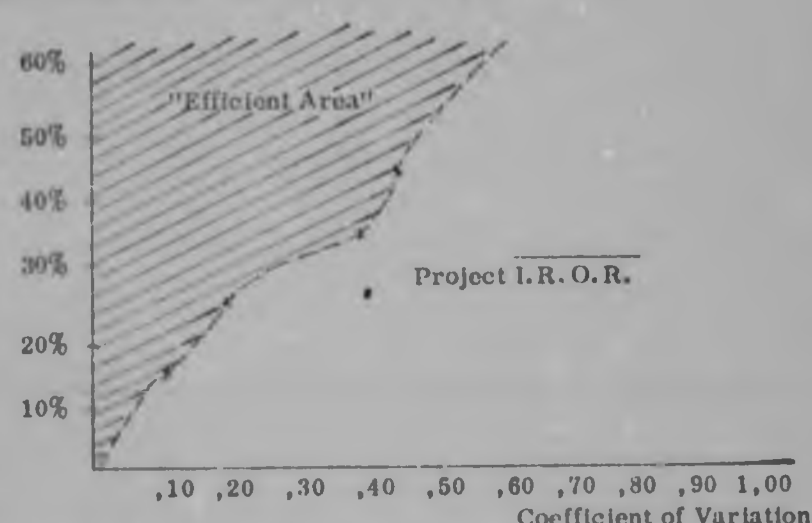



Fig. 5 : 13 - Efficient Frontier and the Expected Value of I.R.O.R. for the Project.

From the above it is clear that, while the project is expected to earn a substantial return, this return is inadequate relative to the project's risk profile. According to the "efficient frontier" projects yielding the same return are available at a coefficient of variation of only approximately twenty-

62. These are established by top management with due cognizance to the firm's objectives and task and potential environment. They are set on the bases of expected sample values of I.R.O.R.

two percent. Another way of highlighting the same fact is to compare the Probability Distribution of I.R.O.R. for the project against the policy profile as shown in figure 5 : 12 (iii). Because the policy profile is inside the project's profile, the project should be dismissed as its return is inadequate relative to risk.

From the above the conclusion that should be drawn is that the project should not be approved as it has an inadequate return relative to risk. If, however, new information makes it possible to reduce some of the uncertainty over certain strategic elements, the simulation should be rerun in order to requantify return and risk. Even if, however, return relative to risk had been satisfactory, the adverse cash flow pattern for the project may have still rendered the project unfeasible. This conclusion highlights the point raised by Lerner & Rappaport in "Limit D.C.F. in Capital Budgeting."

Before closing this chapter, advantage can be taken of the simulation's results to illustrate the point made previously that yield on an investment is meaningless and deceptive without the quantification of risk. In this case the mean yield is expected to be twenty-six percent and yet when one quantifies the project's risk one finds that the yield is inadequate. In fact, the "Efficient Frontier" in figure 5 : 13 indicates that for the same risk level, the firm can undertake investments with a mean yield of at least thirty-five percent per annum. The spread of likely results thus becomes a key issue in evaluating any project.

CHAPTER 6

## SUGGESTED IMPROVEMENTS TO THE PROBABILISTIC SIMULATION MODEL

Before handling the improvements, two corrections should be mentioned. One involves the over statement of the maximum number of years in the project by one year (see figure 5 : ), and the other involves a spelling error in the "Parameter Control" tabulation (see figure 5 : 10). Both of these will naturally be corrected at the time of including any improvements.

Initial Investment Variable

This strategic variable is included as one globular amount and is subsequently broken down by means of a percentage analysis. This approach may be considered restrictive because the elements of the investment are fixed, whereas in practice some uncertainty may exist over the elements of the total investment. Thus, one could have an initial investment with possibly two or more feasible break downs relative to the elements :

1) Buildings,
2) Plant and Equipment,
3) Vehicles,
4) Furniture,
5) Other.

This suggests therefore, that one improvement would be to allow for each category of investment to be a separate strategic variable instead of one globular amount, which is subsequently broken down according to a percentage analysis.

Random Number Generator

At one stage in the development of the simulation suite, the random number generator was suspect, but a chi-squared test ultimately proved that the random numbers were satisfactory. The chi-squared test, which is included in Appendix III, gave the following results :

$$\chi^2_{observed} = 7,02$$

$$\chi^2_{expected} = 16,90 \quad \text{at} \quad \alpha = 0,05$$

Growth and Inflation Factors

These are treated as constant for all simulations, and therefore the inherent uncertainty involved in these estimates of growth and inflation is not quantified. One can easily conceive of management wishing to express these factors by means of probability statements, as was done with the other strategic variables. In short, the suite could be improved by providing for random sampling of the growth and inflation factor distributions. The one complication is, however, whether one could use the same distributions throughout the life of the project. Because of the product life cycle effects this may not be feasible in which case one would have to consider different distributions for different periods. This would become an unfeasible modification as one would have to increase the probability distributions to be sampled by several hundred. Possibly one solution would be to provide only for distributions per time period for selected variables, for instance market size, market share, market price , variable cost of production etc.

The tentative conclusion to be drawn is that some form of sampling of the growth and inflation factor distributions seems justifiable, particularly on a selective basis.

## Parameter Inputs

These are fed into the simulation once, and are treated as constant for all periods. It is possible that a change in parameters can be forecast from time to time in which case the ability to change certain parameters is desirable. Take for instance the tax rate, one could predict, in five yearly cycles, that the rate will change. This suggests that an improvement can be obtained by allowing for parameters to change.

## Project Budget

Although this aspect is not really part of the simulation suite, it is an addition which could have much practical value. One would use the simulation data to project a budget for the project, so that actual performance can be monitored for effectiveness. By means of this budget, management should be able to efficiently and effectively control the project's implementation and its contribution to the firm's worth.

Finally, it should be mentioned that the above improvements are in the main feasible and should not pose any major programming difficulty.

# CHAPTER 7

## SURVEY INTO SOUTH AFRICAN CAPITAL BUDGETING PRACTICES

The sixty-seven companies, given in Appendix II, were drawn from the population of South African firms situated in Johannesburg. The selection was taken from the Business School's[63] mailing list, with due cognizance being given to obtaining a good cross-section of firms. Of the sixty-seven firms requested for an interview, thirty-nine percent granted an interview and were interviewed, sixteen percent refused interviews, thirty-three percent did not reply, and twelve percent agreed to be interviewed but for practical reasons, were not.[64] Appendix II contains full details of the firms include in the survey.

The survey questionnaire, a specimen of which is also included in Appendix II, was administered at interviews conducted by the writer with a financial executive of each firm. The detailed results of the survey are given in Appendix II and in this chapter a summary of these will be furnished and discussed. In the discussion, perspective will be drawn on the implications of the survey, as to :

1) the reality of the model's assumptions, its practicability and its usefulness,
2) possible barriers to implementation of the model,

and 3) the need for educational programmes in order to render the simulation technique effective.

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63. University of the Witwatersrand.
64. For instance, the reply was either received too late or the interview was granted outside the Johannesburg area.

The mean score and standard deviation to question one[65] are respectively 6,15 and 1,12. This indicates that most financial executives are aware of the importance of capital investment decisions to the overall long term success of their firms. Notwithstanding this however, the mean score on question two[66] was lower at 5,61, which implies that investment analysis is found to be important but some scepticism possibly exists on how meaningful and effective analysis is. One recalls on this point the statement made by the president of a large international company, reported in Chapter two. The mean score of 4,35 for question three[67] indicates that the above conclusion of scepticism may be valid, as most financial executives find their appraisal techniques inadequate to some degree. When questioned[68] on the adequacy of their present appraisal techniques, the lack of risk quantification was highlighted as significant. The responses were as follows :

| | Mean | Standard Dev. |
|---|---|---|
| i) Consistency in application of techniques | 5,3 | 1,7 |
| ii) Use of Discounting techniques | 4,6 | 2,1 |
| iii) Inclusion of Risk Considerations | 3,7 | 2,1 |
| iv) Quantification of Risk | 2,1 | 1,4 |

From the above score it is interesting to observe that present value techniques are not as widely used as might be expected. The high standard

65. What is the importance of Capital Investment decisions to the overall long term success of your company ? (Scale 1 - 7); 7 = Extremely important.
66. How important is Investment Analysis to proper appraisal of your capital projects ? (Scale 1 - 7 ); 7 = Extremely important.
67. How adequate do you find your present methods of investment Analysis ? (Scale 1 - 7); 7 = Highly adequate.
68. In what areas do you find your present methods inadequate (if any) ? (Scale 1 - 7); 7 = High/Good.

deviation suggests that some firms never utilise present value techniques, while others only utilise them occassionally. Question five[69] indicates that while most firms are aware of "Book return", "Payback", "Present Value Techniques", "Degree of Necessity", only sixty-two percent know of the "Profitability Index" and only fifty-four percent know of "Probabilistic Discounted Cash Flow Techniques". Responses to question five (part a) indicate that all the firms use two or more capital productivity measures, with "Payback", "Present Value", "Book return" and "Degree of Necessity" being the most popular with respectively eighty-one percent, seventy-seven percent, sixty-nine percent and sixty-five percent of the firms interviewed. The response to the "Probabilistic Discounted Cash Flow Techniques" was most disappointing, with only eight percent of those interviewed having ever used some approach at quantifying risk. Of those that did, most of them used the technique of the "Worst, Expected and Best" estimates of return.

Question six[70] queried the feasibility of allocating probabilities to key variables, and the affirmative response was ninety-six percent. This is heartening as one of the major criticisms raised against the probabilistic

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69. a) What are your present methods of appraisal (Blocks A) ?
    b) What other methods of appraisal are known by you (Blocks B) ?

70. Do you think it is practically feasible to allocate probabilities to estimates of key factors such as :

    Total Market Size
    Market Share
    Selling Price
    Marketing Costs (except Selling)
    Selling Costs (including Dist. Costs)
    Fixed Manufacturing Costs
    Variable Manufacturing Costs
    Investment Costs
    Life of Product
    Life of Plant

simulation technique is that firms would find this task impossible. The survey indicates that this criticism is unfounded. Question seven[71] indicates, with a mean score of 5,3, that the quantification of risk by means of probability limits would be useful. The low score suggests, however, that the exact meaning of this information may not be understood. Question eight[72] produced some surprises. The mean score to part (a) was 6,1 which suggests that most firms are aware of the importance of inflation and yet only forty-six percent do anything about it. Of these, most of them employ inflation factors to the various components of cost. The response to part (b) suggests that the major portion of the firms interviewed do not know how to provide for the "inflation" contingency. The response to question nine[73] reveals that most firms do take into account, where appropriate, an initial period of low profitability. Question ten[74] reveals that most firms use I.R.O.R. or the

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71. If the results of the simulation were discounted on a present value basis and risk was quantified, would you find it useful ?
    Example of what is meant : You will be told that the Internal Rate of Return at 95 % probability limits, will be less than x % but greater than y %, with an expected rate of z %. (scale 1 - 7); 7 = Very useful.
72. a) Do you consider inflation an important element when evaluating capital projects ? (Scale 1 - 7): 7 = Very important.
    b) If so, how do you provide for it ?
73. When evaluating a project do you allow for an initial period of product establishment ? For example, do you allow for sales to build up over a period of say 6 - 24 months ?
74. When selecting between alternative projects, which are at acceptable levels of profitability, do you choose the one which has ?
    The higher rate of return ,
    The one with the longer life,
    The one which, although lower in return, has more constant annual cash flows,
    The one which, although lower in return, has a quicker payback,
    Other (please specify)

duration of a project when selecting between mutually exclusive alternatives. This response was, however, quite academic because most firms admit that they rarely generate alternatives. This practice must surely be sub-optimal to a country like South Africa, where investment plays such an important part in its economic development. Question eleven[75] highlighted the confusion which exists between N. P. V. and I. R. O. R. as selection measures. Thirty-eight percent of the firms were not sure of the complication caused by the "re-investment rate" while sixty-two percent implied that they did. On no occassion, however, did any financial executive query the relationship between the firm's cost of capital and its re-investment rate, before answering this question. This suggests that this issue is not well understood. Eighty-five percent of the firms stated , in response to question twelve[76], that they use a "Cut-off" rate to appraise the suitability of an investment. The determination of this rate was, however, in many instances intuitive. Fortunately, some enlightenment on the part of the larger firms did exist and it was interesting to note that in these cases it was quite common to relate the "Cut-off" rate to the firm's long term earnings and growth objectives, whether they be explicit or implicit. Another interesting point raised by this question was that some companies use the cost of capital as the "Cut-off" rate which implies that funding of all investment opportunities is possible. This attitude concerning availability of funds is quite rife with South African business as is conveyed by the response to question thirteen[77]. Forty-two percent of the firms consider that they do not have a capital rationing constraint. One questions the

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75. When appraising projects do you think it is more correct to use the N. P. V. + Profitability Index than the Internal Rate of Return because of the complication caused by the re-investment rate ?
76. Does your company use a "Cut-off" rate of return and if so, how does it determine this rate ?
77. Does your company fix an annual amount for capital expenditure ?

realism of this assumption and its possible adverse effects on the investment decision. Of the firms that do recognise the capital rationing constraint, most of these allocate funds in one of two ways[78]. One, replacements then expansions or two, according to a subjective scale of necessity. The first approach has one serious defect, it does not recognise the decline stage of a product line. There is no reason, in the writer's opinion, to assume that a viable business will continue to be so, and therefore economic appraisal of replacements should not be considered an unnecessary task. The inadequacy of the "degree of necessity" approach has previously been dealt with, and it suffices to state that it should be dispensed with. The use of a ranking system according to "terminal value" should be used for rationing purposes for all projects that can be economically quantified. "Degree of necessity" should only be used for those investments that cannot be economically quantified. Question fifteen[79] raised the important issue of management's reception to the designed probabilistic simulation model. Thirty-one percent of the firms believed their directors would be "sceptical", fifty-four percent believed their directors would be "impressed", while fifteen percent thought their directors would be "very impressed". This favourable response could

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78. Question 14 : If your company does fix an annual Capital Budget, how does it ration out this amount ?

79. How do you think your Board of Directors will react to a Probabilistic Capital Budgeting technique, once they are well informed on the technique ?

Will your Directors be : i) Sceptical
ii) Impressed
iii) Very Impressed.

and will they find the technique

i) too sophisticated and practically unfeasible,
ii) O.K. but still not as meaningful as the present techniques used by your company,
iii) a worthwhile improvement,
iv) a very significant improvement which will go a long way to assist management in making sound investment decisions.

be interpreted to mean that most firms are conscious of their inadequacy at quantifying risk and that they would welcome any new techniques that may help in this area. The sceptical thirty-one percent, however, cannot be ignored, for they signal the need for an educational programme as part of the implementation scheme.

At the end of every interview each respondent was requested to comment on any aspect which he considered fundamentally important to successful capital budgeting. The comments were most enlightening and the following were the most significant, in the writer's opinion.

The Group Financial Manager of a large firm stated : ".... one of the greatest problems is the starting point of a projection. A person too easily assumes that growth will take place from the present level. Perhaps the present level is artificially too high and therefore a drop must be expected before growth will be achieved." Diagrammatically, the question posed by this individual was :

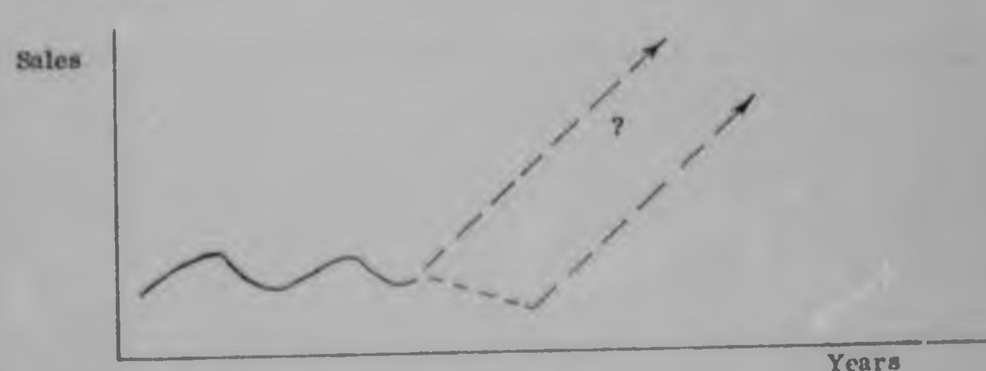


Fig. 7 : 1 - Illustrating the Base Year Dilemma.

The Group Controller of a large firm made the following scathing comments : "Many investment appraisals are a farce because data is built up to support a decision already taken. Alternatively, emotional involvement in trying to please the 'Boss' renders many appraisals suspect." When questioned on how to overcome these difficulties, the individual replied : "Somehow one must get to know the people involved in making forecasts and the basis of their estimates. In this way one can make allowance where necessary. Ideally, of course, objectivity should be striven for; possibly one should consider employing outside investment analysts. This will also assist in doing away with pre-conceived opinions." Finally, this individual spoke on the lack of exposure of mistakes : "Unless a big blunder is made, silence reigns on the actual results achieved by an investment. With big blunders, however, we spend considerable effort and money trying to convert them into profitable investments."

The Chief Accountant of a large investment firm stated : "One of the greatest obstacles to objective assessment of investment opportunities is the lack of business statistics in South Africa."

The Financial Manager of a large manufacturing firm said : "One of our dilemmas is obtaining information about our market environment and its future needs."

The Financial Director of a large merchandising organisation admitted : "If one is truthful, one of the major obstacles to good investment decisions is simply ignorance. Too many executives are taking investment decisions without really understanding the economics of an investment opportunity."

The survey has given some insights into South African Capital Budgeting practices and its major deficiencies. It has confirmed that the generation of probability distributions for strategic variables is feasibo and that management would find probability limits of I.R.O.R. and N.P.V. useful. It has also raised the "human side" of the capital budgeting process as a major obstacle on three fronts, subjectivity, scepticism and ignorance. With these insights one can now proceed to devise an implementation scheme for the simulation model.

# CHAPTER 8

## DESIGN OF AN IMPLEMENTATION SCHEME FOR THE PROBABILISTIC SIMULATION MODEL

Although this simulation model may be considered well designed and effective in the academic sense, its practical success will be measured by its usefulness to management. If the model assists management to better evaluate an investment opportunity and thus reduces the number of wrong decisions made, then the model will be both academically and practically successful. Much of the practical success will depend on how well the model is implemented. For implementation to be effective it must inform the "Users" of why this approach is preferable to others presently used, what facilities this approach offers, how the model operates and what inputs are required, and finally, the limitations of the model. The need for a sound educational programme is quite obvious from the above communication specification. A major consideration in the implementation scheme is therefore one of education. The next consideration is how this model is to be fitted into the Capital Expenditure Control process of a firm. The final consideration is a technical one, the installation of and testing of the simulation suite.

### Educational Programme

Owing to the general confusion that appears to exist over capital productivity measurement, the educational programme should include a general run through both capital productivity measurement and risk quantification. The review given in Chapter Two could serve this purpose, with appropriately selected cases being used to emphasise the various points made in the chapter. Once a firm grasp has been obtained of this area, the Probabilistic Simulation Model developed in this dissertation should be discussed at length. Particular attention should be given to what facilities and advantages this model offers and what are its limitations. The one limitation that must be stressed is that the model is an information tool and not a panacea to all capital investment problems and errors. Nor can it replace judgement as the paramount element in investment decision making.

When understanding has reached a reasonable level, the executives must be given an opportunity to experiment individually or in groups with the simulation technique. This should not only obtain deeper understanding but also commitment to the simulation technique. Furthermore, during these experiments improvements might be forthcoming. Finally, the educational programme must be seen as an on-going process and a contact point must be established in the Management Services Department for all queries on the scheme.

The scheduling of the educational programme should be, in the writer's opinion, over a period of a week or two, in order to allow participants sufficient time to interact over the points raised at the seminars. The programme could be arranged to cover the pertinent aspects as follows :

1) Seminar I - "Review of Capital Budgeting Techniques Part I" (90 minutes) - Question Time (30minutes)
2) Seminar II - "Review of Capital Budgeting Techniques Part II" (90 minutes) - Question Time (30 minutes)
3) Seminar III - "The Importance of Risk Quantification" (60 minutes) - Question Time (30 minutes)
4) Seminar IV - "Methods of Risk Quantification" (90 minutes) - Question Time (30 minutes)
5) Seminar V - "The Probabilistic Simulation Technique" (90 minutes) - Question Time (30 minutes)
6) Group Exercise I - "An Experience in Running the Simulation Part I" (Loading the data) (45 minutes)
7) Group Exercise II - "An Experience in Running the Simulation Part II" (Discussion of results with each group) (45 minutes)

## The Simulation Model as a sub-system of the Capital Expenditure Control Process

The Capital Expenditure Control process is responsible for developing investment opportunities and for their evaluation, implementation and control. As part of the evaluation process, investments must be appraised and it is to this activity, technically termed Capital Budgeting, that the Simulation Model belongs. Naturally, the simulation model will only suit a certain category of investments, namely large investments of critical importance to a firm's long term survival. For new investments and replacements which are small in value, a simpler appraisal technique is recommended, namely the use of N.P.V. and I.R.O.R. In the case of non-quantifiable strategic investments, economic justification will not be possible and therefore a subjective scale of "necessity" will have to be developed to ensure that such investments are essential and properly scheduled. Schematically, this Capital Budgeting System can be represented as follows :

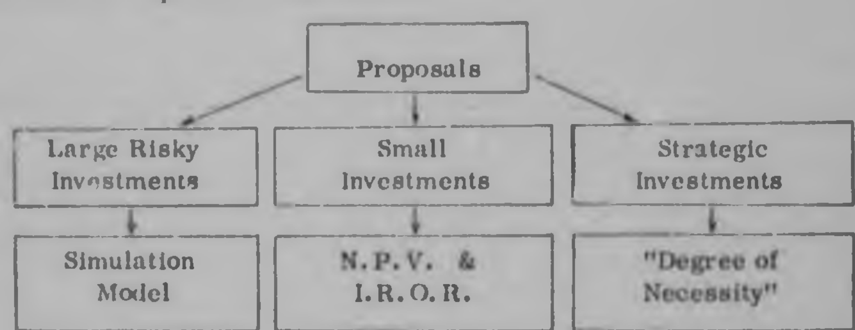


Fig. 8 : 1 - Capital Budgeting System.

In order to give effect to the above Capital Budgeting System, management should send out a directive defining each category of investment and it should instruct the Capital Expenditure Committee to ensure that all proposals are evaluated according to this system, except under extenuating circumstances.

Installation and Testing of Simulation Suite

The installation of the simulation suite should not pose any major difficulty as it has been written in Fortran IV, which is common to most computers. Naturally, minor changes will be necessary as each computer installation has its own idiosyncrasies. Once installation has been effected, two tests will be necessary. A chi-squared test to check the randomness of the random number generator and a specimen run to test the functioning of the suite. The specimen run can be verified by comparison with the run given in this dissertation as the latter has been manually audited.

CHAPTER 9

## SUMMARY AND CONCLUSION

The dissertation began by stressing the importance of sound investment decisions with the point that bad investment decisions can not only cripple a firm but hamper a nation's economic development. Britain is a case in point; evidence[80] suggests that its low growth rate since the war is not due to the lack of investments but to their quality. This perspective on capital investment gave one a sense of urgency to develop tools by which to make better decisions. In quest of these tools, much research has taken place and in Chapter Two the research was reviewed in order to draw insight into the present state of the "art". The different capital productivity measures were examined and most of them were found to be deficient in at least one major respect, the time value of money. The use of present value techniques like N.P.V. and I.R.O.R. were found to be superior and they were endorsed as the most effective yardsticks of capital productivity. The confusion between N.P.V. and I.R.O.R. was clarified and the complementary nature of the two measures was stressed. In fact the two measures were still found to lack in one important dimension, the "re-investment consideration" and therefore a new measure was introduced to quantify the effects of re-investment, the measure was defined as the Overall Rate of Return. At that stage of the review it was clear that all the academic standards for capital productivity measurement had been satisfied and that further developments in this area were unnecessary. One had reached the ultimate for practical purposes.

Notwithstanding this however, one became despondent because presidents of large firms were unhappy about the actual pay off of their investment decisions. The problem became quite clear, risk was not being quantified and

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80. P.E.P. - . cit.

therefore a given return was quite meaningless. The question posed was how to quantify risk. A review, of the important developments in this area, took place. Many of the approaches were dismissed as either impractical or inadequate. The "Hertz type" simulation was, however, one exception and it was substantiated as affording much of the needed information in the area of risk quantification. The approach appeared to make a major break-through and it was adopted as the best approach available so far, and as such, the dissertation settled on applying, with modification, the simulation technique for the quantification of risk under South African conditions.

In Chapter Three a systems design was developed for a model to evaluate risky investments which would incorporate the best techniques raised in the previous chapter. Chapter Three also discussed the principles of cash flow generation. In the following chapter the designed simulation suite was discussed and full displays of the programmes were given. A specimen run of the suite was then examined and an interpretation of the results was given. The results showed that notwithstanding a mean I.R.O.R. of twenty-six percent, the project was not acceptable because its return was too low for the risk involved. The project's cash flow pattern was also criticised.

Chapter Six suggested possible improvements to the simulation suite. Chapter Seven reported the findings of the survey into "South African Capital Budgeting Practices", and drew from these findings important conclusions for the implementation scheme discussed in the following chapter. The proposed implementation scheme was then examined, and the educational programme was found to be the most important element to successful implementation.

By way of conclusion to this dissertation, one might find it appropriate to ask : "And where to from here?" In the writer's opinion, the proper measurement of return and a means of quantifying risk are now both possible. What is now required is concentration on improving, not technology as such but data inputs and the spreading of education on the sound practices of capital budgeting. While the latter is not easy, it can be achieved by concerted effort. The former, however, is extremely difficult because it deals with the ultimate challenge "the future". Undoubtedly one will never be able to remove the uncertainty caused by the future, but as accurate information on past and present trends is man's major clue to the future, it is important that this information at least be available. In South Africa this is perhaps the major deficiency. Many of the financial executives interviewed raised the lack of business statistics as a very real problem. They contrasted the availability of information in South Africa to that available in the U.S.A. Although this comparison is possibly unfair, it does highlight the inadequacy of business statistics in South Africa. One reason for this appears to rest on the belief that secrecy is a wiser course to disclosure. One questions the validity of this in view of the results obtained in the U.S.A. under a system of disclosure. In future one can expect, in the writer's opinion, greater emphasis being placed on obtaining business statistics be it on a routine basis or by means of special research conducted locally or overseas. The quality of input data will ultimately dictate how effective investment analysis will be.

Another significant development in investment policy will be, in the [illegible] opinion, the more conscious attention given to investment as a strate- [illegible]ideration. As firms become more conscious of strategy and business [illegible], so they will view investment opportunities and their appraisal as fundamental to long term survival. Concommitant with this will be their desire to reduce the area of speculation by adopting schemes similar to that developed in this dissertation. Any analysis which aids in reducing the unknowns, or quantifying the sensitivity of a proposal's return to different variables, will be exploited to the full, particularly now that computers afford many man years of calculation to be performed in a few hours.

## APPENDIX I

## DETAILS OF INPUT REQUIREMENTS

CONTENTS :

PROBABILITY DATA INPUT DOCUMENT - PROGRAMME RRJSO1

1. COMPLETING FORMS

a) Each block of data (e.g. Market Size) comprises twelve fields for figures, and three fields for the probability estimate. The first two fields from the extreme right of the twelve field block are understood decimals. Example : if market size of 100 000,11 units is estimated to have a probability of fifteen percent, one would fill in the block as indicated in figure A1/1. Note,probability is quoted without decimals or percentage sign.

b) If any block is not used, the block must be filled with a zero and 100 as indicated under 'Other Fixed Expenses'.

c) On completion of the form, one should find that each probability set has a combined probability of 1,00.

2. PUNCHING DATA

a) Please note that one must punch the data on sheet RRJSO1/2 immediately after completing all the data on RRJSO1/1, no space must be left between the end of the data on sheet RRJSO1/1 and the beginning of the data on RRJSO1/2. Furthermore, column 1 of RRJSO1/2 must be aligned with column 1 of RRJSO1/1.

3. RUNNING PROGRAMME

To action programme RRJSO1 , one carries out the following :

/Input

/Include RRJSO1

/Data

'detail data - Two rows of six blocks (each block has fifteen fields)'

/end run.

## 4. STORAGE OF OUTPUT OF RRJSO1

Once the computer has completed the programme run, one must store the output file. This file will be subsequently used when processing programme RRJSO2.

## PROBABILITY DATA – INPUT DOCUMENT

RRJS01/1

| MARKET SIZE IN UNITS | MARKET SHARE AS PERCENTAGE | MARKET PRICE OF PRODUCT | AVERAGE VARIABLE PRODUCTION COSTS | TOTAL FIXED PRODUCTION COSTS | TOTAL MARKETING COSTS | CONTROL TOTALS |
|---|---|---|---|---|---|---|
| | | | | | | |

FIELDS

CONTROL TOTALS

DECIMALS

FIG. A1/1 INPUT DOCUMENT FOR PROGRAMME RRJS01

## PROBABILITY DATA-INPUT DOCUMENT CONTINUED RRJS01/2

| | TOTAL SELLING COSTS | OTHER FIXED EXPENSES | OTHER VARIABLE EXPENSES RELATIVE TO UNIT SALES | PRODUCT LIFE IN YEARS | PLANT LIFE IN YEARS | INVESTMENT | CONTROL TOTALS SHEETS 1/2 |
|---|---|---|---|---|---|---|---|
| FIELDS | | | | | | | |
| CONTROL TOTALS | | | | | | | |
| DECIMALS | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

FIG. AI/1 INPUT DOCUMENT FOR PROGRAMME RRJS01

## RANDOM NUMBER GENERATOR INPUT

In order to action the random number programme, one must feed in two integers in the first two fields. It is suggested that the selected integers be taken from a book of random two figure tables. For example, to run programme RRJSO3 one instructs as follows :

/Input
/Include RRJSO3
/Data
'detail any two digit integer'
/end run.

Once the computer has finished the programme run, the output file must be stored as this file will subsequently be used when processing programme RRJSO2.

## COMPOUND GROWTH AND INFLATION FACTORS AND CONDITIONAL STATEMENTS OF PROBABILITY - PROGRAMME RRJS04

### 1. COMPLETING FORMS

a) Growth Factors : Growth factors are used to create projections for the different variables. They are compounded and therefore they are applied to the previously determined value in series. If there is no growth, one must still fill in the form RRJS04/1 with '100' for the number of years the simulation is to be run. For example, if market size is expected to grow at two percent for five years and five percent for another five years; market share is expected to increase by three percent per annum for the years two to ten; and market price is expected to remain constant for the ten year duration, one would fill in the form RRJS04/1 as indicated in figure A1/2. Please note that in this case the filling in of growth factors for only ten years implies that the project is expected to last for ten years.

b) Inflation Factors : So often capital appraisals ignore the very important aspect of inflation and thus imply that all future price trends will bear the same relationships as exist at the present time. Clearly, this assumption is wanting and for this reason the simulation provides for inflation factors for each variable. Once again if inflation is not expected for any one variable the column must be filled in with '100'. For example, if we expect market price to inflate for ten years at one percent, and we do not expect selling costs to inflate for the first three years and after that, to inflate at two percent, we would fill in form RRJS04/2 as indicated in figure A1/2.

c) Conditional Statements : By means of this facility one can change certain data on file, after the file has been extended by the growth factors but before the inflation factors have been applied. The conditional statements specify exactly the changes needed and add great flexibility to the suite of programmes.

Form RRJS04/3 must be complete with strict observance of the conditional statement and variable codes given on the next page RRJSO4/B. For example, if one wished to put into effect the following statements, one could fill in the form RRJSO4/3 as indicated in figure AI/3 :

a) If market size is less than or equal to 50 000 units and greater than 40 000 units, market price will be R1.00.

b) If market price is equal to R1.00, then marketing costs will be R100 000.

## 2. PUNCHING DATA

Please punch data in the following sequence :

i) Growth factors,

ii) Inflation factors,

iii) Conditional statements.

Please note that the first line of both the Growth and Inflation data must be filled with zeros (see forms RRJSO4/1 & 2). Also the control limits for the factors and statements must be filled in.

## 3. RUNNING PROGRAMME

To run the programme one must bring together programme RRJSO4 and the above data :

```
/Input
/Include RRJSO4
/Data
'Growth Factors'
'Inflation Factors'
'Conditional Statements'
'Output of Programme RRJSO2'
/end run.
```

## CONDITIONAL STATEMENTS - RRJS04/B

| Statement Code | Single Conditional Statements |
|---|---|
| 100 | If independent variable less than a given value, dependent variable = |
| 101 | If independent variable less than or equal to a given value, dependent variable = |
| 102 | If independent variable equal to a given value, dependent variable = |
| 103 | If independent variable not equal to a given value, dependent variable = |
| 104 | If independent variable greater than a given value, dependent variable = |
| 105 | If independent variable greater than or equal to a given value, dependent variable = |

### Double Conditional Statements

| | |
|---|---|
| 106 | If independent variable 'one' is greater than or equal to a given value and independent variable 'two' is less than another given value, dependent variable = |
| 107 | If independent variable 'one' is less than or equal to a given value and independent variable 'two' is greater than another given value, dependent variable = |

| Code | Variables | Code | Variables |
|---|---|---|---|
| 01 | Market Size | 02 | Market Share |
| 03 | Market Price | 04 | Manufacturing Variable Costs |
| 05 | Manufacturing Fixed Costs | 06 | Marketing Costs |
| 07 | Selling Costs | 08 | Other Fixed |
| 09 | Other Variable | | |

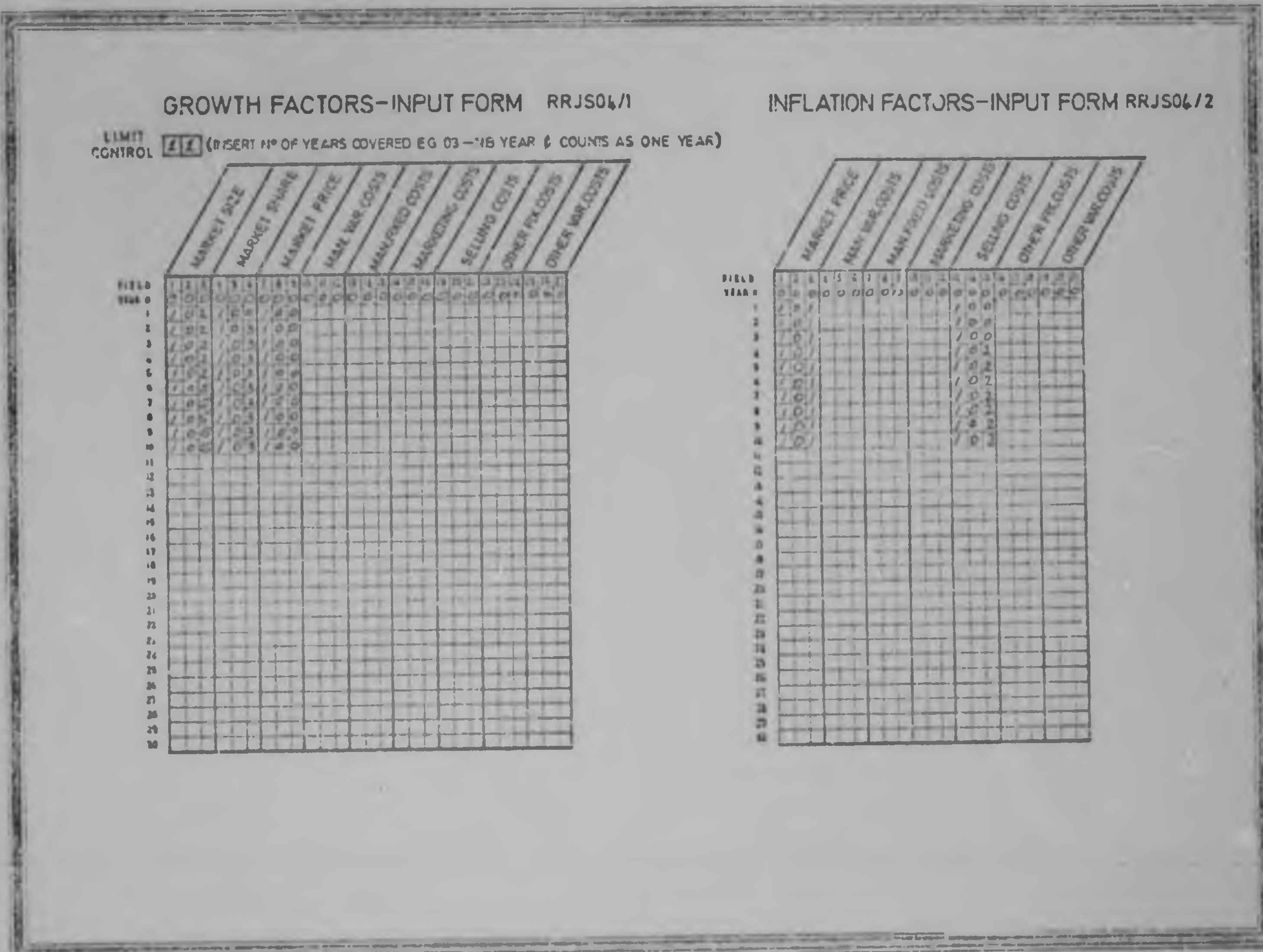


FIG. AI/2 INPUT DOCUMENT FOR PROGRAMME RRJS04

## CONDITIONAL PROBABILITY INPUT FORM

RRJS04/3

Ø2 (NUMBER OF CONDITIONAL STATEMENTS)

| FIELD NUMBER | [illegible] | [illegible] | GIVEN VALUE | [illegible] | ANOTHER GIVEN VALUE FOR DOUBLE STATEMENT | [illegible] | VALUE TO BE GIVEN TO DEP VARIABLE |
|---|---|---|---|---|---|---|---|
| | 107 | 01 | 5000000 | 01 | 4000000 | 03 | 100 |
| | 102 | 03 | 100 | | | 06 | 10000000 |

FIG. [redacted] A1/3 INPUT DOCUMENT FOR PROGRAMME RRJS04

## INPUT DOCUMENT FOR PARAMETERS, PROJECT INVESTMENTS DURING YEARS ONE TO THREE ETC. - PROGRAMME RRJSO5

### 1. COMPLETING FORM

The first item to be filled in is the maximum life of the project, year zero being counted as one year. The parameters come next with understood decimals as indicated on the document (see figure AI/4). Take for instance "Stock turn", this is a four figure field with two decimal places. Decimal points are understood and must not, therefore, be filled in. Next come the Investments during the years one to three for each category of investment. The field specification is twelve figures with two understood decimals. Finally, one has to fill in the Cost of Capital factors, which comprise two fields both of which are understood decimals.

### 2. PUNCHING DATA

Please punch data, beginning in column 1 as follows :

a) Maximum number of years in simulation,

b) Parameters,

c) Project Investments,

d) Cost of Capital Factors.

### 3. RUNNING PROGRAMME

To run this programme the following are required in the order given :

```
/Input
/Include Programme RRJSO5
/Data
'data from input document described above'
'output from programme RRJSO4'
/end run.
```

# GENERAL INPUT DOCUMENT RRJ S05

## A) PARAMETERS

punching row no

1 NUMBER OF YEARS IN EACH SIMULATION

| | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | PLANT | BUILDINGS | MOTOR VEHICLES | FURNITURE | OTHER | PLANT | BUILDINGS | MOTOR VEHICLES | FURNITURE | OTHER | | | | | | PLANT | BUILDINGS | MOTOR VEHICLES | FURNITURE | OTHER | SHORT TERM ASSETS | INVENTORY |
| fields | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| understood decimals | 2 | 4 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 3 | 0 |

SALVAGE VALUE AS % OF BOOK VALUE

## B) PROJECT INVESTMENTS DURING YEARS 1 TO 3

| | PLANT | BUILDINGS | MOTOR VEHICLES | FURNITURE | OTHER |
|---|---|---|---|---|---|
| fields | | | | | |
| period 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |

## C) COST OF CAPITAL FACTORS

| year | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| fields | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

FIG. VI/4 INPUT DOCUMENT FOR PROGRAMME RRJS05

# APPENDIX II

## SURVEY DETAILS

CONTENTS :

## SURVEY DOCUMENTS

### QUESTIONNAIRE

1. What is the importance of Capital Investment decisions to the overall long term success of your company ?

   Not important 1 2 3 4 5 6 7 Extremely important

2. How important is Investment Analysis to proper appraisal of your capital projects ?

   Not important 1 2 3 4 5 6 7 Extremely important

3. How adequate do you find your present methods of Investment Analysis ?

   Inadequate 1 2 3 4 5 6 7 Highly adequate

4. In what areas do you find your present methods inadequate (if any) ?

| | low/poor | | | | | high/good | |
|---|---|---|---|---|---|---|---|
| In their lack of consistency | 1 | 2 | 3 | 4 | 5 | 6 | 7 Consistency |
| In their exclusion of the Time Value of Money | 1 | 2 | 3 | 4 | 5 | 6 | 7 Time Value |
| In their exclusion of Risk considerations | 1 | 2 | 3 | 4 | 5 | 6 | 7 Risk considerations |
| In their inability to quantify risk | 1 | 2 | 3 | 4 | 5 | 6 | 7 Quantification of Risk |

   Others (please specify) ________________________________

   ________________________________

   ________________________________

5. a) What are your present methods of appraisal (Blocks A) ?

   b) What other methods of appraisal are known by you (Blocks B) ?

| | A | B |
|---|---|---|
| Average Book Return | | |
| Payback Period | | |
| Internal Rate of Return | | |
| Net Present Value | | |
| Net Present Value + Profitability Index | | |
| Degree of Necessity | | |
| Probabilistic D. C. F. | | |

Other (please specify) ______________________________

______________________________

______________________________

6. Do you think it is practically feasible to allocate probabilities to estimates of key factors such as ?

| | YES | NO | NOT SURE |
|---|---|---|---|
| Total Market Size | | | |
| Market Share | | | |
| Selling Price | | | |
| Marketing Costs (except Selling) | | | |
| Selling Costs (including Dist. Costs) | | | |
| Fixed Manufacturing Costs | | | |
| Variable Manufacturing Costs | | | |
| Investment Costs | | | |
| Life of Product | | | |
| Life of Plant | | | |

| | | | |
|---|---|---|---|
| <u>EXAMPLE</u> : | <u>Market Size</u>: | 100 000 tons | 10 % |
| | | 220 000 tons | 55 % |
| | | 270 000 tons | 35 % |

7. If the results of the simulation were discounted on a present value basis and risk was quantified, would you find it useful ?

<u>Example of what is meant</u> : You will be told that the Internal Rate of Re-

turn at 95 % probability limits, will be less than x % but greater than y % with an expected rate of z %.

Not useful 1 2 3 4 5 6 7 Very useful

8. a) Do you consider inflation an important element when evaluating capital projects ?

Not important 1 2 3 4 5 6 7 Very important

b) If so, how do you provide for it ?

Do not provide ☐

Remarks : ______________________________

______________________________

______________________________

9. When evaluating a project do you allow for an initial period of product establishment ? For example, do you allow for sales to build up over a period of say 6 - 24 months ?

YES ☐ NO ☐

10. When selecting between alternative projects, which are at acceptable levels of profitability, do you choose the one which has ?

The higher rate of return ☐

The one with the longer life ☐

The one which, although lower in return, has more constant annual cash flows ☐

The one which, although lower in return, has a quicker payback ☐

Other (please specify) ______________________________

______________________________

11. When appraising projects do you think it is more correct to use the N. P. V. + Profitability Index than the Internal Rate of Return because of the complication caused by the re-investment rate ?

YES ☐ NO ☐ NOT SURE ☐

12. Does your company use a "Cut - off" rate of return and if so, how does it determine this rate ?

YES ☐ NO ☐

______________________________
______________________________
______________________________

13. Does your company fix an annual amount for capital expenditure ?

YES ☐ NO ☐

14. If your company does fix an annual Capital Budget, how does it ration out this amount ?

______________________________
______________________________
______________________________

15. How do you think your Board of Directors will react to a Probabilistic Capital Budgeting technique, once they are well informed on the technique?

Will your Directors be :
i) Sceptical ☐
ii) Impressed ☐
iii) Very Impressed ☐

and will they find the technique :
i) too sophisticated and practically unfeasible ☐

ii) O.K. but still not as meaningful as the present techniques used by your company ☐

iii) a worthwhile improvement ☐

iv) a very significant improvement which will go a long way to assist management in making sound investment decisions ☐

16. Other Remarks : ________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

## INTERVIEW DETAILS

NAME OF COMPANY : ____________________

ADDRESS : ____________________

____________________

____________________

### PERSON INTERVIEWED

NAME : ____________________

POSITION : ____________________

DATE AND TIME OF INTERVIEW : ____________________

DURATION OF INTERVIEW : ____________________

REMARKS (if any) : ____________________

____________________

____________________

____________________

____________________

____________________

____________________

____________________

____________________

____________________

## LIST OF COMPANIES INCLUDED IN SAMPLE

| | Type of Response | | | |
|---|---|---|---|---|
| | Affirmative | Refusal | None | Other |
| Abercom Investments Ltd. | | | X | |
| Acrow Engineers (Pty) Ltd. | | X | | |
| A E & C I Ltd. | X | | | |
| African Cables Ltd. | | | | X |
| African Cons. Investment Corp. Ltd. | | | X | |
| African Oxygen Group | X | | | |
| Amalgamated Hotels Ltd. | | X | | |
| Am[illegible] Ltd. | X | | | |
| Afri[illegible] Steel Furniture Manufacturers | | | X | |
| Anglo - Alpha Cement | X | | | |
| Anglo - Tvl. Con. Inv. Co. Ltd. | | X | | |
| Automotive Products | X | | | |
| Baird & Tatlock Manu. Co. | | | X | |
| Barlow - Rand | | X | | |
| Edward L. Bateman | | X | | |
| Bencor | | | X | |
| Bradlows Stores | | | | X |
| Bruynzeel Plywood | X | | | |
| Carborundum, Universal S.A. | | | | X |
| Claude Neon Lights | X | | | |
| C.N.A. Investments | X | | | |
| Coca Cola Bottling Co. | X | | | |
| Consolidated Glass Works | | X | | |
| The Corner House Investment Co. | | X | | |
| Diesel - Electric | | X | | |
| Dorman Long | X | | | |
| Dryden Engineering | | | X | |
| Dunswart Iron & Steel | | | X | |
| Edgars Stores | | | X | |

| | Type of Response | | | |
|---|---|---|---|---|
| | Affirmative | Refusal | None | Other |
| Everite Ltd. | X | | | |
| Fibreglass S.A. | | | X | |
| General Mining & Finance Corp. | | | X | |
| Greatermans Stores | X | | | |
| Gundle Plastics | | | X | |
| Hume Ltd. | X | | | |
| Hunts, Leuchars & Hepburn | | | X | |
| Industrial Development Corp. | X | | | |
| International Harvestor Co. | | | X | |
| Johannesburg Consolidated Invest. | X | | | |
| Litemaster Industries | | X | | |
| Malcomess Ltd. | | | | X |
| McKinnon Chain | X | | | |
| Marley S.A. | X | | | |
| Metal Box Co. | X | | | |
| Midas Chemicals | | | X | |
| Minnesota Mining & Manufacturing | | | X | |
| Murray & Roberts Holdings | X | | | |
| National Amalgamated Packaging | | | X | |
| National Bolts & Rivets | X | | | |
| O.K. Bazaars | X | | | |
| Pfizer Laboratories | X | | | |
| Plascon & Evans Paints | | | X | |
| Premier Milling | | | | X |
| Reunert & Lenz | | | | X |
| Russell Holdings | X | | | |
| Schlesinger Organisation | | X | | |
| Shoe Corp. of Africa | X | | | |
| S.A. Breweries | X | | | |
| Southern Cross Steel Co. | | | X | |
| Southern Sun Hotel Corp. | | | X | |

| | Type of Response | | | |
|---|---|---|---|---|
| | Affirmative | Refusal | None | Other |
| Tiger Oats & National Milling | | | | X |
| Toyota S.A. | | | | X |
| Union Steel Corporation | | | X | |
| United Tobacco Co. | X | | | |
| Whitehall Products | | | X | |
| Wispeco Holdings | | X | | |
| Wit Industrial | | | X | |
| | 26 | 11 | 22 | 8 |

## SUMMARY OF RESULTS

| Question Number | Mean | Standard Deviation | % Positive Reply | |
|---|---|---|---|---|
| 1 | 6,154 | 1,1202 | | |
| 2 | 5,615 | 1,2672 | | |
| 3 | 4,346 | 1,5476 | | |
| 4 (1) | 5,346 | 1,7082 | | |
| 4 (2) | 4,577 | 2,0874 | | |
| 4 (3) | 3,654 | 2,0773 | | |
| 4 (4) | 2,077 | 1,3543 | | |
| 5 (A) | | | | |
| 1 | | | 69,23 | |
| 2 | | | 80,77 | |
| 3 | | | 53,85 | 76,9 |
| 4 | | | 57,69 | |
| 5 | | | 26,92 | |
| 6 | | | 65,38 | |
| 7 | | | 7,69 | |
| 5 (B) | | | | |
| 1 | | | 100,00 | |
| 2 | | | 88,46 | |
| 3 | | | 84,62 | |
| 4 | | | 96,15 | |
| 5 | | | 61,54 | |
| 6 | | | 92,31 | |
| 7 | | | 53,85 | |
| 6 | | | | |
| Yes | | | 96,15 | |
| No | | | 3,85 | |
| Not Sure | | | - | |
| 7 | 5,308 | 1,4758 | | |
| 8 (a) | 6,077 | 1,5473 | | |

| Question Number | Mean | Standard Deviation | % Positive Reply |
|---|---|---|---|
| 8 (b) | | | |
| Provides | | | 46,15 |
| Does Not Provide | | | 53,85 |
| 9 | | | |
| Yes | | | 100,00 |
| No | | | 0,00 |
| 10 | | | |
| 1 | | | 45,83 |
| 2 | | | 37,50 |
| 3 | | | 25,00 |
| 4 | | | 16,67 |
| 11 | | | |
| Yes | | | 61,54 |
| No | | | 0,00 |
| Not Sure | | | 38,46 |
| 12 | | | |
| Yes | | | 84,62 |
| No | | | 15,38 |
| 13 | | | |
| Yes | | | 57,69 |
| No | | | 42,31 |
| 15 | | | |
| (i) | | | 30,77 |
| (ii) | | | 53,85 |
| (iii) | | | 15,38 |
| (i) | | | 23,08 |
| (ii) | | | 11,54 |
| (iii) | | | 38,46 |
| (iv) | | | 26,92 |

## DETAILED SURVEY RESULTS

| Company Code | Question Number 1 | 2 | 3 | 4(1) | 4(2) | 4(3) | 4(4) | 5(A) 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 38 | 7 | 5 | 5 | 6 | 6 | 5 | 3 | x | x | x | x |  | x |  |  |
| 31 | 6 | 6 | 4 | 5 | 6 | 3 | 2 | x | x | x | x |  |  |  |  |
| 54 | 7 | 6 | 5 | 5 | 7 | 6 | 1 | x | x | x | x |  |  |  |  |
| 9 | 3 | 3 | 6 | 6 | 6 | 6 | 1 | x |  | x | x |  | x |  |  |
| 62 | 7 | 4 | 5 | 6 | 7 | 4 | 1 | x |  |  | x | x |  |  |  |
| 45 | 5 | 6 | 4 | 7 | 2 | 4 | 1 | x | x |  |  |  | x |  |  |
| 39 | 7 | 5 | 4 | 4 | 1 | 4 | 2 | x | x |  |  |  | x |  |  |
| 14 | 7 | 7 | 5 | 7 | 2 | 1 | 1 | x | x |  |  |  |  |  |  |
| 30 | 7 | 6 | 5 | 5 | 4 | 7 | 3 | x | x | x |  |  |  | x |  |
| 66 | 5 | 7 | 4 | 6 | 6 | 3 | 4 | x | x | x |  |  | x |  |  |
| 3 | 6 | 7 | 4 | 1 | 6 | 2 | 1 | x | x | x | x |  | x |  |  |
| 51 | 7 | 7 | 7 | 7 | 7 | 7 | 1 |  | x | x | x | x |  |  |  |
| 61 | 7 | 5 | 4 | 5 | 4 | 1 | 1 | x |  |  | x |  | x |  |  |
| 67 | 5 | 3 | 6 | 6 | 6 | 7 | 6 | x | x |  |  |  | x |  |  |
| 50 | 7 | 7 | 6 | 3 | 7 | 1 | 3 | x | x | x |  |  | x |  |  |
| 5 | 6 | 6 | 5 | 5 | 3 | 5 | 4 |  | x |  |  |  | x |  |  |
| 53 | 7 | 4 | 3 | 2 | 6 | 2 | 2 |  |  |  | x | x |  |  |  |
| 59 | 7 | 4 | 3 | 6 | 3 | 2 | 1 | x | x | x | x | x | x |  |  |
| 60 | 7 | 7 | 5 | 4 | 5 | 3 | 2 |  | x | x |  |  | x |  |  |
| 47 | 5 | 6 | 5 | 5 | 7 | 5 | 3 | x | x | x | x |  | x |  |  |
| 36 | 5 | 5 | 1 | 1 | 1 | 1 | 1 |  |  | x |  |  | x |  |  |
| 25 | 7 | 7 | 2 | 6 | 6 | 3 | 1 | x | x |  |  |  | x |  |  |
| 42 | 6 | 6 | 1 | 6 | 6 | 2 | 3 | x | x |  | x |  | x |  |  |
| 19 | 4 | 5 | 3 | 3 | 1 | 1 | 1 |  | x |  | x | x |  |  |  |
| 55 | 7 | 7 | 7 | 6 | 6 | 6 | 1 |  | x | x | x | x | x | x |  |
| 35 | 6 | 5 | 4 | 5 | 4 | 6 | 4 |  | x |  | x | x |  |  |  |

| Company Code | Question Number 5 (b) 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 6 Yes | No | N.S[1] | 7 | 8(a) Score | 8(b) P. | DNP[2] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 38 | x | x | x | x | | x | | | x | | | 6 | 6 | x | |
| 31 | x | x | x | x | x | x | x | | x | | | 5 | 3 | | x |
| 54 | x | x | x | x | | x | | | x | | | 5 | 7 | x | |
| 9 | x | x | x | x | | x | | | x | | | 7 | 7 | | x |
| 62 | x | x | x | x | x | x | x | | x | | | 5 | 7 | x | |
| 45 | x | x | x | x | x | x | x | | x | | | 7 | 7 | | x |
| 39 | x | x | x | x | | x | | | x | | | 5 | 7 | | x |
| 14 | x | x | x | x | | x | x | | x | | | 7 | 7 | | x |
| [illegible] | x | x | x | x | x | x | x | | x | | | 7 | 7 | x | |
| [illegible] | x | x | x | x | | x | | | x | | | 5 | 7 | x | |
| [illegible] | x | x | x | x | x | x | x | | x | | | 4 | 6 | x | |
| [illegible] | x | x | x | x | x | | x | | x | | | 3 | 7 | x | |
| [illegible] | x | | x | x | x | x | x | | x | | | 3 | 6 | | x |
| 67 | x | x | | | | x | | | x | | | 2 | 7 | | x |
| 50 | x | x | x | x | x | x | | | x | | | 6 | 7 | | x |
| 5 | x | x | x | x | x | x | x | | x | | | 5 | 7 | x | |
| 53 | x | | | x | x | | | | x | | | 7 | 7 | | x |
| 69 | x | x | x | x | x | x | x | | x | | | 7 | 5 | x | |
| 60 | x | x | x | x | x | x | x | | x | | | 7 | 7 | x | |
| 47 | x | x | x | x | x | x | x | | x | | | 3 | 7 | | x |
| 36 | x | | x | x | | x | | | x | | | 6 | 1 | | x |
| 25 | x | x | x | x | | x | x | | x | | | 6 | 4 | | x |
| 42 | x | x | | x | | x | | | x | | | 6 | 4 | x | |
| 19 | x | x | | x | x | x | | | x | | | 5 | 5 | | x |
| 55 | x | x | x | x | x | x | x | | | x | | 7 | 7 | | x |
| 35 | x | x | x | x | x | x | | | x | | | 6 | 6 | x | |

Notes : 1. Not sure
2. Does Not Provide

| | Question Number | | |
|---|---|---|---|
| Company | 8 | 9 | |
| Code | Remarks | Yes | No |
| 36 | Inflation factor used | x | |
| 31 | | x | |
| 54 | Inflation factors used on limited variables | x | |
| 9 | Overall % used - sometimes economic forecasts | x | |
| 62 | Variable Cost of Capital | x | |
| 45 | | x | |
| 39 | | x | |
| 14 | | x | |
| 30 | Inflation factors used | x | |
| 66 | Inflation factors used | x | |
| 3 | Inflation factors used | x | |
| 51 | Inflation factors used | x | |
| 61 | | x | |
| 67 | | x | |
| 50 | | x | |
| 5 | Inflation factors used | x | |
| 53 | | x | |
| 59 | Inflation factors used | x | |
| 60 | Build in inflation factors | x | |
| 47 | Only in respect of replacements | x | |
| 36 | Expect all items to move in sympathy | x | |
| 25 | | x | |
| 42 | Overall factor applied | x | |
| 19 | | x | |
| 55 | | x | |
| 35 | Inflation factors used | x | |

Question Number

| Company Code | 10: 1 | 10: 2 | 10: 3 | 10: 4 | 11: Yes | 11: No | 11: N.S | 12: Yes | 12: No | 13: Yes | 13: No |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 38 | x | x | | | x | | | x | | | x |
| 31 | | x | | | x | | | x | | x | |
| 54 | x | | | | x | | | x | | | x |
| 9 | x | | | | x | | | x | | | x |
| 62 | x | | | | x | | | x | | x | |
| 45 | x | | | | x | | | | x | | x |
| 39 | | x | | | | | x | x | | x | |
| 14 | x | | | | x | | | x | | x | |
| 30 | | | x | | x | | | x | | x | |
| 66 | | x | | | x | | | x | | x | |
| 3 | x | x | x | | x | | | | x | x | |
| 51 | 0 | 0 | 0 | 0 | x | | | x | | | x |
| 61 | | x | | | x | | | x | | | x |
| 67 | 0 | 0 | 0 | 0 | | | | x | | x | |
| 50 | | x | | | x | | | x | | x | |
| 5 | | x | x | x | | | x | x | | x | |
| 53 | | | x | | | | x | x | | | x |
| 59 | x | | | | | | x | x | | | x |
| 60 | | | x | | x | | | x | | | x |
| 47 | | | | x | | | x | x | | x | |
| 36 | | x | | | | | x | x | | | x |
| 25 | | | x | | | | x | x | | x | |
| 42 | x | | | | | | x | | x | x | |
| 19 | | | | x | | | x | | x | x | |
| 55 | x | | | | x | | | x | | | x |
| 35 | x | | | x | x | | | x | | x | |

| Company Code | Question Number 12 Remarks |
|---|---|
| 38 | 17½ % before tax (Book return). |
| 31 | Profit target based on growth objective. |
| 54 | 15 % before tax - intuitively. |
| 9 | Return based on economic conditions etc. |
| 62 | 15,4 % after tax. |
| 45 | |
| 39 | 25 % before tax (merchandising); 20 % before tax (steel) - intuitive. |
| 14 | 25 % before tax - experience. |
| 30 | Profit objective determines return. |
| 66 | Risk adjusted rate. |
| 3 | Not defined. |
| 51 | Cost of capital + Premium (intuitive). |
| 61 | Intuitively. |
| 67 | A rate to which we have become accustomed. |
| 50 | Intuitive growth rate. |
| 5 | Intuitive. |
| 53 | 20 % - intuitive. |
| 59 | Weighted cost of capital. |
| 60 | 15 % after tax. |
| 47 | Modigliani & Miller. |
| 36 | 15 % before tax - instructions from overseas. |
| 25 | Intuitive ( based on present trading results). |
| 42 | Positive N. P. V. accepted |
| 19 | |
| 55 | Compare with rate of similar industries. |
| 35 | Target rate - long term loan interest rates. |

| Company Code | Question Number 14 Remarks |
|---|---|
| 38 | |
| 31 | Return or motivation. |
| 54 | |
| 9 | |
| 62 | Replacements, then expansions relative to return. |
| 45 | |
| 39 | Replacements, improved operations, social requirements, and new activities. |
| 14 | Replacements, then new projects (return and size of project used on new project). |
| 30 | Good long term return - cash flow pattern. |
| 66 | Degree of necessity once company is fully established. |
| 3 | Necessity, return and risk. |
| 51 | |
| 61 | |
| 67 | Machine replacements, then degree of necessity. |
| 50 | Degree of necessity. |
| 5 | Replacements, then I.R.O.R. |
| 53 | |
| 59 | |
| 60 | |
| 47 | I.R.O.R. and degree of necessity. |
| 36 | |
| 25 | Cash flow pattern. |
| 42 | Degree of necessity. |
| 19 | Degree of necessity. |
| 55 | |
| 35 | National spread and best return in shortest time. |

| Company | | | | Question Number 15 | | | |
|---|---|---|---|---|---|---|---|
| Code | (i) | (ii) | (iii) | (i) | (ii) | (iii) | (iv) |
| 38 | | x | | | | x | |
| 31 | x | | | x | | | |
| 54 | | x | | | | x | |
| 9 | | | x | | | x | |
| 62 | | | x | | | | x |
| 45 | | x | | | | x | |
| 39 | x | | | | x | | |
| 14 | | x | | | | | x |
| 30 | | x | | | | | x |
| 66 | x | | | x | | | |
| 3 | x | | | x | | | |
| 51 | | x | | | | x | |
| 61 | x | | | x | | | |
| 67 | | x | | | x | | |
| 50 | | | x | | | | x |
| 5 | | x | | | | x | |
| 53 | x | | | | x | | |
| 59 | | x | | | | x | |
| 60 | | x | | | | | x |
| 47 | | x | | | | x | |
| 3[illegible] | | x | | | | | x |
| 25 | x | | | x | | | |
| 42 | | | x | | | | x |
| 19 | | x | | | | x | |
| 55 | x | | | x | | | |
| 35 | | x | | | | x | |

| Company Code | Question Number 16 Other Remarks |
|---|---|
| 38 | |
| 31 | |
| 54 | |
| 9 | |
| 62 | Planning is inadequate. |
| 45 | |
| 39 | |
| 14 | Education for new system important. |
| 30 | Important to examina base year and government spending. |
| 66 | Lack of statistics a problem. |
| 3 | Sceptical until usefulness experienced. |
| 51 | Have used discounted cash flows since 193[illegible] |
| 61 | |
| 67 | |
| 50 | |
| 5 | |
| 53 | Old and tested techniques still the best. |
| 59 | |
| 60 | Alternatives always a problem. |
| 47 | Input data a problem. |
| 36 | |
| 25 | Serious problems concerning the human side of investments. |
| 42 | Education poor! |
| 19 | |
| 55 | |
| 35 | |

APPENDIX III

# CHI - SQUARED TEST ON RANDOM NUMBER GENERATOR

| CONTENTS : | PAGE |
|---|---|
|  |

Chi-squared Test on Random Numbers Generated by Programme RRJSO[illegible] - Input Integer 33

| Class Interval | Tally Stroke Totals | $f_o$ | $f_e$ | $(f_o - f_e)^2$ | $(f_o - f_e)^2 / f_e$ | |
|---|---|---|---|---|---|---|
| 1 - 10 | 17 13 13 8 2 10 | 63 | 60 | 9 | 0,15 | |
| 11 - 20 | 6 13 5 12 9 7 | 52 | 60 | 64 | 1,07 | |
| 21 - 30 | 5 15 8 10 15 13 | 66 | 60 | 36 | 0,60 | |
| 31 - 40 | 14 6 15 6 7 8 | 56 | 60 | 16 | 0,27 | |
| 41 - 50 | 9 10 7 10 15 13 | 64 | 60 | 16 | 0,27 | |
| 51 - 60 | 12 12 8 11 7 12 | 62 | 60 | 4 | 0,07 | |
| 61 - 70 | 8 9 12 10 10 7 | 56 | 60 | 16 | 0,27 | |
| 71 - 80 | 5 5 7 6 17 11 | 51 | 60 | 81 | 1,35 | |
| 81 - 90 | 9 8 12 15 9 4 | 57 | 60 | 9 | 0,15 | |
| 91 - 100 | 15 9 13 12 9 15 | 73 | 60 | 169 | 2,82 | |
| | | 600 | 600 | | 7,02 | $X^2_{\text{Observed}}$ |

Prob. ( $X^2_e \leqslant$ 16,9 ) 0,95

0,50 $<$ Prob. ( $X^2_{obs.}$ = 7,02 / D.F. = 9 ) $<$ 0,90

CONCLUSION : Randomness is Satisfactory

APPENDIX IV

## AUDIT OF SPECIMEN RUN

CONTENTS : PAGE

## MANUAL AUDIT OF SIMULATION NUMBER ONE

| | Market Size | Market Share | Market Price | Man. Var. Costs | Man. Fixed Costs | Marketing Costs | Selling Costs | Other Fixed Costs | Other Var. Costs | Product Life | Plant Life | Investment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. Selection of Variable Data | | | | | | | | | | | | |
| Random Numbers ex RRJSO3 | 1 | 1 | 3 | 11 | 41 | 47 | 14 | 62 | 47 | 23 | 15 | 83 |
| Variables Selected ex RRJSO2 | 170 000 | 0,4000 | 135.00 | 104.00 | 550 000 | 140 000 | 500 000 | 200 000 | 2.00 | 12 | 10 | 7 000 000 |
| 2. Annual Variable Data | | | | | | | | | | | | |
| Applying Growth Factors | | | | | | | | | | | | |
| Year | | | | | | | | | | | | |
| 0 | - | - | - | - | - | - | - | - | - | 12 | 10 | 7 000 000 |
| 1 | 102 000 | 0,4000 | 135.00 | 104.00 | 550 000 | 140 000 | 500 000 | 200 000 | 2.00 | | | |
| 2 | 112 200 | 0,4000 | 135.00 | 104.00 | 550 000 | 140 000 | 1000 000 | 200 000 | 2.00 | | | |
| 3 | 201 960 | 0,4000 | 135.00 | 104.00 | 550 000 | 140 000 | 1750 000 | 200 000 | 2.00 | | | |
| 4 | 333 234 | 0,4040 | 135.00 | 104.00 | 577 500 | 140 000 | 2625 000 | 200 000 | 2.00 | | | |
| 5 | 383 219 | 0,4080 | 135.00 | 104.00 | 577 500 | 133 000 | 2887 500 | 150 000 | 2.00 | | | |
| 6 | 402 380 | 0,4121 | 135.00 | 104.00 | 577 500 | 126 350 | 3176 250 | 112 500 | 2.00 | | | |
| 7 | 423 499 | 0,4162 | 148.50 | 104.00 | 606 375 | 151 620 | 3176 250 | 61 875 | 2.00 | | | |
| 8 | 443 624 | 0,4204 | 148.50 | 96.80 | 606 375 | 136 456 | 3176 250 | 9 281 | 2.00 | | | |
| 9 | 465 805 | 0,4216 | 148.50 | 91.98 | 636 694 | 122 812 | 3176 250 | - | 2.00 | | | |
| 10 | 489 095 | 0,4331 | 148.50 | 90.05 | 636 694 | 98 250 | 3176 250 | - | 2.00 | | | |
| Applying Inflation Factors | | | | | | | | | | | | |
| Year | | | | | | | | | | | | |
| 0 | - | - | - | - | - | - | - | - | - | 12 | 10 | 7 000 000 |
| 1 | | 0,40 | 135.00 | 104.00 | 550 000 | 140 000 | 500 000 | 200 000 | 2.00 | | | |
| 2 | | 0,40 | 137.70 | 112.32 | 550 000 | 144 200 | 1010 000 | 200 000 | 2.02 | | | |
| 3 | As | 0,40 | 137.70 | 115.69 | 550 000 | 148 129 | 1785 118 | 200 000 | 2.04 | | | |
| 4 | Above | 0,40 | 140.45 | 116.85 | 577 500 | 152 982 | 2704 540 | 200 000 | 2.06 | | | |
| 5 | | 0,41 | 140.45 | 118.01 | 577 500 | 149 893 | 3004 744 | 150 000 | 2.08 | | | |
| 6 | | 0,41 | 140.45 | 120.37 | 606 375 | 146 474 | 3338 271 | 112 500 | 2.10 | | | |
| 7 | | 0,42 | 157.59 | 122.78 | 636 694 | 181 012 | 3371 653 | 61 875 | 2.14 | | | |
| 8 | | 0,42 | 157.59 | 114.90 | 636 694 | 167 826 | 3405 370 | 9 281 | 2.19 | | | |
| 9 | | 0,42 | 157.59 | 112.86 | 668 529 | 153 875 | 3439 423 | - | 2.23 | | | |
| 10 | | 0,43 | 160.74 | 112.42 | 668 529 | 128 194 | 3473 816 | - | 2.28 | | | |

| Conditional Statements Year | Market Size | Market Share | Market Price | Man. Var. Costs | Man. Fixed Costs | Marketing Costs | Selling Costs | Other Fixed Costs | Other Var. Costs | Product Life | Plant Life | Investment |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | | | - | | | | | | | | | |
| 1 | | | 135.00 | | | | | | | | | |
| 2 | | | 137.70 | | | | | | | | | |
| 3 | As | As | 145.00 | As | As | As | As | As | As | As | As | As |
| 4 | Above | Above | 145.00 | Above | Above | Above | Above | Above | Above | Above | Above | Above |
| 5 | | | 145.00 | | | | | | | | | |
| 6 | | | 145.00 | | | | | | | | | |
| 7 | | | 157.59 | | | | | | | | | |
| 8 | | | 157.59 | | | | | | | | | |
| 9 | | | 157.59 | | | | | | | | | |
| 10 | | | 160.74 | | | | | | | | | |

3. Cash Flow Data

| Basic Data Year | Unit Sales | Units for Stock | Production in units | Turnover (000) | Cost of Production | Average Unit Cost | Total Other Var. Exp. | Investment: Stock | Investment: Debtors | Investment: Creditors |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | - | - | - | - | - | - | - | 500 000 | - | - |
| 1 | 49 900 | 8 500 | 49 300 | 5 508 | 5 677 300 | 115.16 | 81 600 | 1 305 069 | 1 009 800 | 283 860 |
| 2 | 44 880 | 9 350 | 45 730 | 6 180 | 5 888 393 | 122.91 | 90 658 | 1 533 196 | 1 132 998 | 284 326 |
| 3 | 80 784 | 16 820 | 88 264 | 11 714 | 10 761 262 | 142.02 | 164 799 | 2 738 030 | 2 147 508 | 538 362 |
| 4 | 133 294 | 27 770 | 144 234 | 19 329 | 17 431 242 | 120.96 | 274 585 | 4 479 312 | 3 543 398 | 871 502 |
| 5 | 137 120 | 32 733 | 162 043 | 22 782 | 19 704 914 | 121.49 | 326 810 | 5 302 100 | 4 176 373 | 979 216 |
| 6 | 164 976 | 34 370 | 166 613 | 23 922 | 20 661 581 | 123.60 | 346 450 | 5 663 942 | 4 385 812 | 1 033 079 |
| 7 | 177 449 | 36 969 | 180 048 | 27 964 | 22 742 986 | 125.88 | 379 741 | 6 204 877 | 5 126 767 | 1 137 149 |
| 8 | 196 322 | 38 117 | 188 170 | 29 362 | 23 025 159 | 122.94 | 409 045 | 6 362 918 | 5 283 121 | 1 181 280 |
| 9 | 195 839 | 40 758 | 197 579 | 30 831 | 22 987 293 | 117.34 | 436 273 | 6 276 204 | 5 652 275 | 1 146 285 |
| 10 | 214 311 | 43 815 | 213 368 | 33 806 | 24 710 795 | 116.18 | 479 809 | 6 786 991 | 6 197 684 | [illegible] |
| Formulae | Mkt. Size $\times$ Mkt. Share | Unit Sales $\div$ Stk. Turn | Unit Sales + units for stk. less - opening stk. | Unit Sales x Mkt. Price | Prod. in units x M. V. C. + M. F. C. | (opening stk. value + cost of prod.) $\div$ (opening stk. units + units produced) | Other Var. costs x unit sales | Units for stk. x average unit cost x (r. m. + W. I. P. %) | Turnover $\div$ 12 x Debtor's Period | Cost of Prod. x Purch. % $\div$ 12 x Creditor's Period |

A. Cash Flows and Calculation of Internal Rate of Return and Net Present Value for Simulation Number One

| Year | Cost of Production | Turnover | Cost of Sales | Profit before Dep. & Tax | Tax Payable | Debtors Creditors Etc. | Inventory Investment | Cash Flow Mid-Year | Cash Flow Year-End |
|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 500 000 | - 1 750 000 | - 5 750 000 |
| 1 | 5 677 200 | 5 508 000 | 4 889 363 | - 111 964 | - 1 448 416 | 725 940 | 1 305 069 | - 1 831 487 | - 1 331 487 |
| 2 | 1 686 393 | 6 179 978 | 5 516 021 | - 780 903 | - 793 916 | 846 675 | 1 532 190 | 1 557 241.5 | 158 825.5 |
| 3 | 10 761 282 | 11 713 690 | 9 858 941 | - 441 761 | - 653 003 | 1 609 448 | 2 738 030 | - 1 461 724.5 | - 807 224.5 |
| 4 | 17 431 242 | 19 327 630 | 16 125 241 | - 129 718 | - 828 186 | 2 671 836 | 4 479 313 | - 1 391 107.5 | - 1 140 194.5 |
| 5 | 19 704 914 | 22 712 100 | 18 067 580 | 63 273 | - 460 989 | 3 191 527 | 5 302 100 | - 500 326.5 | - 375 509.5 |
| 6 | 20 861 561 | 23 921 820 | 20 390 208 | - 412 383 | - 530 594 | 3 352 533 | 5 663 949 | - 319 321.5 | - 242 124.5 |
| 7 | 22 742 948 | 27 961 187 | 22 337 280 | 1 632 590 | 630 846 | 3 989 618 | 6 204 877 | 572 193.5 | 492 588.5 |
| 8 | 23 025 159 | 29 362 483 | 22 906 613 | 2 465 348 | 980 631 | 4 231 863 | 6 362 918 | - 444 335 | 717 107 |
| 9 | 22 987 293 | 30 830 592 | 22 956 749 | 3 812 572 | 1 551 521 | 4 503 910 | 6 376 904 | 938 171 | 1 287 954 |
| 10 | 24 740 705 | 33 805 390 | 24 433 090 | 5 290 780 | 63 466 | 4 980 619 | 6 786 991 | 846 341.5 | 10 067 418 |

B. Determination of Cash Flow per Six-monthly Period (Brackets represent inflows)

| Period | -1 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Profit (as above) | - | - | 55 982.5 | 55 982.5 | 390 451.5 | 390 451.5 | 220 880.5 | 220 880.5 | 64 858.0 | 64 858.0 | (31 636.5) |
| Provisional Tax | - | - | - | - | (724 208.0) | (724 208.0) | (396 958.0) | (396 958.0) | (326 501.5) | (326 501.5) | (264 092.0) |
| Tax Adjustments | - | - | - | - | (1 448 416.0) | | 654 500 | | 140 912 | | 124 817 |
| Total | - | - | 55 982.5 | 55 982.5 | (1 782 172.5) | (333 756.5) | 478 422.5 | (176 077.5) | (120 729.5) | (261 642.5) | (170 912.5) |
| Short Term Assets | | | | | | | | | | | |
| Debtors/Creditors | - | - | 362 970 | 362 970 | 61 367.5 | 61 367.5 | 380 368 | 380 368 | 531 195.5 | 531 195.5 | 259 845.5 |
| Inventory | - | 500 000 | 402 534.5 | 402 534.5 | 113 563.5 | 113 563.5 | 602 917 | 602 917 | 870 641.5 | 870 641.5 | 411 398.5 |
| Total | - | 500 000 | 821 487 | 821 487 | (1 607 241.5) | (158 825.5) | 1 461 724.5 | 807 224.5 | 1 281 107.5 | 1 140 194.5 | 500 326.5 |
| Long Term Assets | 1 750 000 | 5 250 000 | 1 010 000 | 510 000 | 50 000 | | | | | | |
| Terminal Salvage Value | | | | | | | | | | | |
| Total | 1 750 000 | 5 750 000 | 1 831 487 | 1 331 487 | (1 557 241.5) | (158 825.5) | 1 461 724.5 | 807 224.5 | 1 281 107.5 | 1 140 194.5 | 500 326.5 |

5. Determination of Cash Flow — Six-monthly Period (Brackets represent Inflows) (continued)

| Period | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Profit (as above) | (31 636.5) | 206 191.5 | 206 191.5 | (816 298.0) | (816 298.0) | (1 232 674.7) | (1 232 474.0) | (1 921 286.0) | (1 921 286.0) | (2 645 390.0) | (2 645 390.0) |
| Provisional Tax | (264 093.0) | (225 494.5) | (225 494.5) | (265 297.0) | (265 297.0) | 315 424.0 | 315 424.0 | 490 315.5 | 490 315.6 | 765 760.5 | 765 760.5 |
| Tax Adjustments | | 77 197.0 | | (79 823.0) | | 1 101 442.5 | | 345 763.0 | | 550 890.0 | (1 499 855.0) |
| Total | (295 729.5) | 57 894.0 | (19 303.0) | (1 161 200.0) | (1 081 [illegible]) | 344 [illegible] | (917 250.0) | (1 081 187.5) | (1 430 970.5) | (1 [illegible] 739.5) | (2 347 684.5) |
| Short Term Assets | | | | | | | | | | | |
| Debtors/Creditors | 259 845.5 | 80 503.0 | 80 503.0 | 318 543.5 | 319 542.5 | 121 122.5 | 121 122.5 | 136 023.5 | 136 023.5 | 228 354.5 | 228 384.5 |
| Inventory | 411 393.5 | 180 924.5 | 180 924.5 | 270 461.0 | 270 464.0 | 79 020.5 | 79 020.5 | 6 993.0 | 6 993.0 | 205 043.5 | 205 043.5 |
| Total | 375 509.5 | 319 321.5 | 242 124.5 | (272 [illegible]) | (492 588.5) | 444 335.0 | (717 107.0) | (936 171.0) | (1 287 964.0) | (895 341.5) | (2 914 [illegible]) |
| Long Term Assets | | | | | | | | | | | |
| Terminal Salvage Value | | | | | | | | | | | (7 153 120.5) |
| Total | 375 509.5 | 319 321.5 | 242 124.5 | (272 195.5) | (492 588.5) | 444 335.0 | (717 107.0) | (936 171.0) | (1 287 964.0) | (895 341.5) | (10 067 415.0) |

| Tax Allowance | Plant & Equipment | | Buildings | | Motor Vehicles | | Furniture | | Other | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | B.K.V. | Allowance | B.K.V. | Allowance | B.K.V. | Allowance | B.K.V. | Allowance | B.K.V. | Allowance | Allowance |
| 0 | 6 349 000 | 2 849 112 | 651 000 | 64 100 | | | | | | | |
| 1 | 1 500 000 | 680 156 | | 13 020 | 10 000 | 1 500 | 5 000 | 82 | 5 000 | 125 | 2 589 075 |
| 2 | 50 000 | 1 188 117 | | 13 020 | | 2 000 | | 250 | | 500 | 1 2[illegible]2 887 |
| 3 | | 1 174 [illegible] | | 13 020 | | 2 000 | | 250 | | 500 | 1 190 748 |
| 4 | | 1 174 976 | | 13 020 | | 2 000 | | 250 | | 500 | 1 180 748 |
| 5 | | 1 174 976 | | 13 020 | | 2 000 | | 250 | | 500 | 1 190 748 |
| 6 | | 899 731 | | 13 020 | | 500 | | 250 | | 500 | 914 101 |
| 7 | | 41 706 | | 13 020 | | | | 250 | | 500 | 55 476 |
| 8 | | | | 13 020 | | | | 250 | | 500 | 13 778 |
| 9 | | | | 13 020 | | | | 250 | | 500 | 13 778 |
| 10 | | | | 13 020 | | | | 250 | | 500 | 13 778 |
| Net B.K.V. | 7 [illegible] 000 | 2 [illegible] | 651 000 | 1[illegible] | 10 000 | 10 000 | 5 000 | 2 312 | 5 000 | 4 [illegible] | 9 2[illegible] 087 |
| Terminal B.K.V. | NIL | | 520 800 | | NIL | | 2 888 | | 375 | | |

| Salvage Values and Tax Allowance on Liquidation of Assets | Plant | Buildings | Motor Vehicles | Furniture | Other | Inventory | Debtors/Creditors | Total |
|---|---|---|---|---|---|---|---|---|
| Cash Realised | - | 130 200 | - | 288,8 | 18,75 | 3 854 148 | 3 968 495 | 7 153 126.50 |
| Tax Allowance | | 156 240 | | 987,7 | 142,50 | 1 493 138 | 394 835 | 2 047 339,23 |
| Salvage Rate | 10% | 25% | 10% | 10% | 5% | 45% | 80% | |

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6. Calculation of Net Present Value and Internal Rate of Return.

| Period | Cash Flows | N.P.V. Factors | | N.P.V. | -1% Factor | Present Value | -½% Factor | Present Value |
|---|---|---|---|---|---|---|---|---|
| -1 | -1 750 000 | 1,030 | | - 818 250 | 0,99 | -1 732 500 | 0,9975 | -1 745 636 |
| 0 | -5 750 000 | 1,000 | | -5 750 000 | 1,00 | -5 750 000 | 1,0000 | -5 750 000 |
| 1 | -1 831 487 | 0,962 | | -1 761 890 | 1,01 | -1 849 802 | 1,0025 | -1 836 066 |
| 2 | -1 331 487 | 0,926 | 8% | -1 232 957 | 1,01 | -1 344 802 | 1,0050 | -1 338 144 |
| 3 | 1 557 341.5 | 0,891 | | 1 387 502 | 1,02 | 1 588 388 | 1,0075 | 1 568 021 |
| 4 | 150 825.5 | 0,857 | | 136 113 | 1,02 | 162 002 | 1,0100 | 169 414 |
| 5 | -1 461 724.5 | 0,806 | | -1 179 150 | 1,03 | -1 505 576 | 1,0126 | -1 480 142 |
| 6 | - 807 224.5 | 0,772 | | - 623 177 | 1,03 | - 831 441 | 1,0151 | - 819 414 |
| 7 | -1 281 107.5 | 0,740 | | - 948 020 | 1,04 | -1 332 352 | 1,0176 | -1 303 658 |
| 8 | -1 140 194.5 | 0,708 | | - 807 258 | 1,04 | -1 185 802 | 1,0202 | -1 163 226 |
| 9 | - 500 326.5 | 0,670 | 9% | - 339 722 | 1,05 | - 525 343 | 1,0227 | - 511 684 |
| 10 | - 375 509.5 | 0,650 | | - 244 081 | 1,05 | - 391 298 | 1,0253 | - 385 010 |
| 11 | - 319 321.5 | 0,623 | | - 198 937 | 1,06 | - 338 481 | 1,0278 | - 328 199 |
| 12 | - 242 124.5 | 0,596 | | - 144 306 | 1,06 | - 256 652 | 1,0304 | - 249 495 |
| 13 | 572 193.5 | 0,538 | | 307 840 | 1,07 | 612 247 | 1,0330 | 591 076 |
| 14 | 492 398.5 | 0,513 | | 252 698 | 1,07 | 527 870 | 1,0356 | 510 125 |
| 15 | - 444 335 | 0,489 | | - 217 280 | 1,08 | - 479 882 | 1,0382 | - 461 309 |
| 16 | 717 107 | 0,467 | | 334 889 | 1,08 | 774 476 | 1,0408 | 746 368 |
| 17 | 938 171 | 0,445 | 10% | 417 486 | 1,09 | 1 022 606 | 1,0434 | 978 898 |
| 18 | 1 287 854 | 0,424 | | 546 092 | 1,09 | 1 403 870 | 1,0460 | 1 347 206 |
| 19 | 895 341.5 | 0,404 | | 361 718 | 1,10 | 984 876 | 1,0486 | 938 856 |
| 20 | 10 067 418 | 0,386 | | 3 886 022 | 1,11 | 11 174 830 | 1,0512 | 10 582 506 |
| | - 548 083 | | | -7 633 668 | | 723 445 | | 82 740 |

On the basis of the above calculations one can state :

1) Internal Rate of Return is greater than -½% and less than zero%

2) Net Present Value is : - 7 633 668

The results produced by the Programme were :

1) Internal Rate of Return is between : -0,01% and -0,99%

2) Net Present Value is : - 7 838 184

Therefore, Except For Rounding Errors, Answers Check.

Calculation of Net Present Value and Internal Rate of Return for Simulation Number Two

| Period | Cash Flows | N.P.V. Factors | N.P.V. | 32% Factor | Present Value | 31% Factor | Present Value |
|---|---|---|---|---|---|---|---|
| -1 | -1 500 000 | 1,030 | -1 65[illegible] 500 | 1,145 | -1 723 500 | 1,145 | -1 717 500 |
| 0 | -5 000 000 | 1,000 | -5 000 000 | 1,000 | -5 000 000 | 1,000 | -5 000 000 |
| 1 | -1 766 372 | 0,962 8% | -1 699 442 | 0,870 | -1 536 918 | 0,874 | -1 543 984 |
| 2 | -1 266 572 | 0,926 | -1 172 846 | 0,758 | - 960 062 | 0,753 | - 964 394 |
| 3 | 1 063 218 | 0,891 | 944 216 | 0,659 | 701 318 | 0,667 | 709 831 |
| 4 | 385 547 | 0,857 | 330 448 | 0,574 | 221 327 | 0,583 | 224 797 |
| 5 | -1 344 294 | 0,804 | -1 083 501 | 0,500 | - 672 147 | 0,508 | - 684 246 |
| 6 | - 803 [illegible] | 0,772 | - 620 138 | 0,435 | - 349 430 | 0,445 | - 357 463 |
| 7 | -1 003 13[illegible] | 0,740 | - 742 323 | 0,[illegible] | - 379 187 | 0,389 | - 390 221 |
| 8 | - 734 510 | 0,708 | - 520 033 | 0,32[illegible] | - 241 654 | 0,340 | - 249 733 |
| 9 | - 327 437.5 | 0,679 9% | - 222 330 | 0,287 | - 33 875 | 0,297 | - 97 249 |
| 10 | 455 220 | 0,650 | 295 893 | 0,250 | 113 805 | 0,259 | 117 902 |
| 11 | 376 658.5 | 0,623 | 234 658 | 0,217 | 81 734 | 0,226 | 85 174 |
| 12 | 642 358 | 0,596 | 382 844 | 0,189 | 121 405 | 0,198 | 127 196 |
| 13 | 9 969 619 | 0,538 | 5 363 116 | 0,165 | 1 644 822 | 0,173 | 1 724 871 |
| 14 | 9 921 597 | 0,513 | 5 089 779 | 0,143 | 1 418 788 | 0,151 | 1 498 161 |
| 15 | - 590 903 | 0,489 | - 288 952 | 0,125 | - 73 863 | 0,132 | - 77 999 |
| 16 | 8 701 161 | 0,467 | 4 063 582 | 0,108 | 939 754 | 0,115 | 1 000 668 |
| 17 | 8 820 903 | 0,412 10% | 3 925 301 | 0,094 | 829 165 | 0,101 | 890 911 |
| 18 | 10 031 930 | 0,424 | 4 253 496 | 0,082 | 822 610 | 0,088 | 882 801 |
| 19 | 9 089 754 | 0,404 | 3 672 261 | 0,072 | 654 162 | 0,077 | 699 911 |
| 20 | 10 427 640 | 0,386 | 4 024 837 | 0,062 | 646 476 | 0,067 | 698 612 |
| 21 | 9 354 970 | 0,334 | 3 124 560 | 0,054 | 505 168 | 0,059 | 551 943 |
| 22 | 10 500 710 | 0,317 11% | 3 [illegible] 725 | 0,047 | 493 533 | 0,051 | 535 536 |
| 23 | 10 0[illegible] 190 | 0,301 | 3 03[illegible] | 0,041 | 413 710 | 0,045 | 454 072 |
| 24 | 31 387 020 | 0,286 | 8 974 688 | 0,036 | 1 129 933 | 0,039 | 1 224 094 |
| | | | 38 143 870 | | - 292 725 | | 341 330 |

On the basis of the above calculations one can state :

1) Internal Rate of Return is greater than 31% and less than 32%

2) Net Present Value is 38 143 870

The results produced by the Programme were :

1) Internal Rate of Return is between 31% and 31,99%

2) Net Present Value : 38 142 220

Therefore, Except For Rounding Errors, Answers Check.

Validation of Expected Return on Total Funds

| Period | 15% Factors | Cash Flows | | |
|---|---|---|---|---|
| -1 | 1,000 | -1 497 500 | -1 497 500 | |
| 0 | 0,933 | -4 992 450 | -4 657 956 | |
| 1 | 0,870 | -1 890 574 | -1 644 799 | |
| 2 | 0,811 | -1 390 574 | 1 127 756 | |
| 3 | (1,07238) | 1 113 026 | | |
| 4 | | 221 856 | | |
| 5 | 0,658 | -1 473 064 | - 969 270 | -11 993 400 |
| 6 | 0,613 | - 932 799,6 | 584 059 | |
| 7 | 0,572 | -1 298 829 | - 742 970 | |
| 8 | 0,533 | -1 111 193 | - 592 266 | |
| 9 | | 1 731 050 | | |
| 10 | | 2 241 880 | | |
| 11 | 0,432 | - 419 314 | - 178 82[illegible] | |
| 12 | | 1 645 762 | | |
| 13 | | 4 180 119 | | |
| 14 | | 4 214 061 | | |
| 15 | | 1 899 700 | | |
| 16 | | 4 435 088 | | |
| 17 | | 8 350 433 | | |
| 18 | | 9 109 747 | | |
| 19 | | 4 010 1[illegible]5 | | |
| 20 | | 13 546 690 | | |
| 21 | | 6 034 217 | | |
| 22 | | 6 760 120 | | |
| 23 | | 8 398 162 | | |
| 24 | | 12 198 390 | | |
| 25 | | 3 536 905 | | |
| 26 | | 3 783 589 | | |
| 27 | | 3 549 218 | | |
| 28 | | 9 929 92[illegible] | | |
| 29 | | 979 143 | | |
| 30 | | 4 057 190 | 235 043 470 | |

$P.V. (1 + m)^n = T.V.$ where : P.V. = Present Value

T.V. = Terminal Value

n = 31

$$(1 + m)^{31} = \frac{235\ 043\ 470}{11\ 993\ 400}$$

$$(1 + m) = 31 \quad 19,597734$$

$$\log (1 + m) = 1,29224 \div 31$$

$$= 0,0416851$$

$$(1 + m) = 1,1007$$

$$m = 0,1007$$

$$r = 21,15\ \%$$

As per Computer Programme :

1) Initial Investment : 11 969 350
2) Terminal Value : 235 043 500
3) Expected Return on Total Funds : 21,2 % per annum

Therefore, with the exception of rounding errors

Computer Output Validated

## MANUAL AUDIT OF I.R.O.R. STATISTICS

Mean I.R.O.R. $= \sum_{i=1}^{n} x_i f_i \Big/ \sum_{i=1}^{n} f_i$

$= 2\,600 / 100$

$= \underline{26{,}00 \text{ percent}}$

Standard Deviation $= \sqrt{\left(\sum_{i=1}^{n} x_i f_i / N - \bar{x}^2\right) \dfrac{N}{N-1}}$

$= \sqrt{114{,}39}$

$= \underline{10{,}695 \text{ percent}}$

Coefficient of Variation $= 10{,}695 / 26{,}00 \times 100$

$= \underline{41{,}13 \text{ percent}}$

"Results agree with Simulation's Output"

## MANUAL AUDIT OF N.P.V. STATISTICS

**Mean N.P.V.**

$$= \sum_{i=1}^{n} x_i \; f_i \Big/ \sum_{i=1}^{n} f_i$$

$$= 2\ 816\ 197\ 500 \ / \ 100$$

$$= \underline{\underline{28\ 161\ 975}}$$

**Standard Deviation**

$$= \sqrt{\left(\sum_{i=1}^{n} x_i \; f_i / N \; - \; \bar{x}^2\right) \frac{N}{N-1}}$$

$$= \sqrt{44\ 929{,}97} \quad \times \quad 10^5$$

$$= 211{,}96690 \quad \times \quad 10^5$$

$$= \underline{\underline{21\ 196\ 690}}$$

**Coefficient of Variation**

$$= 21\ 196\ 690 \ / \ 28\ 161\ 975 \quad \times \quad 100$$

$$= \underline{\underline{75.27 \text{ percent}}}$$

**Profitability Index**

$$= \frac{28\ 161\ 975 \ + \ 1{,}039(1\ 497\ 500) \ + \ 4\ 992\ 450}{1{,}039(1\ 497\ 500) \ + \ 4\ 992\ 450}$$

$$= \underline{\underline{5{,}30}}$$

"Results agree with Simulation's Output"

## MANUAL AUDIT OF CASH FLOW STATISTICS

**Proof for Period 5**

Mean $= \dfrac{111\ 307\ 334}{100}$

$= \underline{\underline{1\ 113\ 073,34}}$

Standard Deviation $= \sqrt{\left(\sum_{i=1}^{n} x_i^2 / N - \bar{x}^2\right) \dfrac{N}{N-1}}$

$= \sqrt{(1\ 272\ 866,58 - 1\ 238\ 931,5)\ \dfrac{10^8}{99}}$

$= 10^4 \sqrt{342,7777}$

$= \underline{\underline{185\ 142}}$

"With the exception of Rounding Errors, Results agree with Simulation's Output"

# BIBLIOGRAPHY


Ansoff, H.I. editor - Business Strategy; Penguin Books Ltd., Harmondsworth, Middlesex, England, 1972.

Bierman, H. Jr. and Smidt, S. - The Capital Budgeting Decision; 2nd. ed., The Macmillan Coy : New York, 1967.

Drucker, P.F. - The Practice of Management; 3rd Printing, Pan Books Ltd., London, 1970.

Livingstone, J.L. and Burns, T.J. editors - Income Theory and Rate of Return; 1st Printing, Ohio State University : Ohio, 1971.

McCracken, D.D. - A Guide to FORTRAN IV Programming; John Wiley and Sons, Inc : New York, 1965.

Merret, A.J. and Sykes, A. - The Finance and Analysis of Capital Projects; New Impression, Longman Group Ltd : London, 1971.

Silke, A.S. - Silke on South African Income Tax; 4th ed., Juta & Co. Ltd : Cape Town, 1965.

Spiegel, M.R. - Theory and Problems of Statistics; Schaum Publishing Coy : New York, 1961.

Solomon, E. editor - The Management of Corporate Capital; Seventh Printing, The Free Press : New York, 1967.

Van Horne, J.C. - Financial Management and Policy; 2nd ed., Prentice - Hall Inc., Englewood Cliffs, New Jersey, 1971.

Waterman, M.H. et al. - Essays on Business Finance; 4th ed., Masterco Press : Ann Arbor, Michigan, 1963.

Weston, J.F. and Brigham, E.F. - Essentials of Managerial Finance; Holt, Rinehart and Winston, Inc : New York, 1968.

Weston, J.F. and Brigham, E.F. - Managerial Finance; 3rd ed., Holt, Rinehart and Winston, Inc : New York, 1969.

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