6-30-1974

The determination of an optimum plant capacity in a dynamic economy

Frederick Louis Monesmith
New Jersey Institute of Technology

Copyright Warning & Restrictions

The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted material.

Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One of these specified conditions is that the photocopy or reproduction is not to be "used for any purpose other than private study, scholarship, or research." If a, user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use" that user may be liable for copyright infringement,

This institution reserves the right to refuse to accept a copying order if, in its judgment, fulfillment of the order would involve violation of copyright law.

Please Note: The author retains the copyright while the New Jersey Institute of Technology reserves the right to distribute this thesis or dissertation

Printing note: If you do not wish to print this page, then select "Pages from: first page # to: last page #" on the print dialog screen

THE DETERMINATION OF AN OPTIMUM PLANT CAPACITY IN A DYNAMIC ECONOMY

BY

FREDERICK LOUIS MONESMITH

A THESIS

PRESENTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE

OF

MASTER OF SCIENCE IN CHEMICAL ENGINEERING

AT

NEWARK COLLEGE OF ENGINEERING

Newark, New Jersey
1974

ABSTRACT

A Monte Carlo computer program has been developed in which the optimum plant capacity is determined by comparing calculated profitability criterions for various plant capacities. The estimates for input variables are developed into probability distributions. This data is then used to calculate a probability distribution for a profitability criterion. In this thesis approximately thirty input variables are developed into beta distributions. Each variable must be estimated with a ninety percent probability estimate, a most likely probability estimate and a ten percent probability estimate. The three level estimates for each variable completely describe the beta distribution. Approximately half of the beta distributions are used to generate time dependent models described by equations for industry demand, market share, selling price, plant learning, and variable costs. These models follow continuous exponential curves. The remaining distributions are used in determining investments, manufacturing costs and working capital. The procedure followed in the Monte Carlo program is choosing randomly selected values from each distribution and using these values to calculate profitability criterions. This procedure is repeated a large number of times resulting in a probability distribution for each profitability criterion. The profitability distributions are developed for various plant capacities and therefore, the optimum plant capacity is determined.

APPROVAL OF THESIS

THE DETERMINATION OF AN OPTIMUM PLANT CAPACITY IN A DYNAMIC ECONOMY

BY

FREDERICK LOUIS MONESMITH

FOR

DEPARTMENT OF CHEMICAL ENGINEERING

NEWARK COLLEGE OF ENGINEERING

BY

FACULTY COMMITTEE

APPROVED:

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

INTRODUCTION

Statement of Problem

A problem that corporate executives frequently face is selecting information that is needed to clarify the key differences among various capital allocation alternatives. These alternatives may include decisions between various plant locations or plant capacities, new product ventures or expansions in an established market.

The corporate decision maker must obtain information regarding the uncertainty of key economic variables such as markets, prices and costs. The generally accepted method of calculating the profitability of a venture is to estimate a single, most probable value of each economic variable and to calculate a yearly profit until the end of the project life. However, the single profitability measure calculated in this manner does not inform the corporate decision maker of any uncertainties in estimating the key economic variables or the effect of these uncertainties upon the profitability of the venture.

The element of risk in the key economic variables is present regardless of the following profitability methods used:

1. Return on original investment.
2. Return on average investment.
3. Payout time.
4. Payout time including interest.

5. Present worth.

6. Interest or discounted rate of return

These and other methods are discussed in literature which include recommendations for the method which should be used and the strengths and weaknesses of each method. Generally, each company has established one or more of these profitability criterions as acceptable for its use. The corporate decision maker can use any profitability method he wishes but none of the methods include allowances for uncertainty.

One aid in evaluating the effect of uncertainty of key economic variables is sensitivity analysis. This technique can be described as a method in which important economic variables are changed and the effect of the change on standard calculated profitability measure is determined.

The sensitivity analysis method does not do the following, as stated by G. L. Smith:

"1. Show the probability or chances of a change taking place.
2. Consider simultaneous changes in more than one input variable.
3. Handle inter-relationships among variables."[1]

In review, the corporate executive needs to know more about

[1] G. L. Smith, "Monte Carlo Simulation — A Tool For Combating Uncertainty In Economic Analysis," A Paper Presented at the Tenth Annual Meeting; AIChE, (June 20, 1966), p. 2.

the alternatives that are availabe to him. He needs to know not only the profitability of a venture but also the likelihood of a certain outcome. This thesis will present a method, in which the optimum plant capacity for a given company can be selected, based on estimates of key economic variables and their uncertainties.

Discussion of Solution

The solution to the corporate uncertainty problem is not new. The Monte Carlo simulation, as a numerical analysis tool, has been advocated for a number of years. Any discussion of the Monte Carlo simulation method should begin with an explanation of the origin of the name. The term "Monte Carlo" comes from the world famous gambling casino of the same name because chance or risk is a basic ingredient of the method. Many, including the writer, have found that assigning numerical values for uncertainties in key economic variables and simultaneously allowing for these variables to change with time is a difficult task for a financial analyst to perform.

The traditional manner of calculating the profitability of an investment is to estimate a best guess for the various economic factors and to calculate a single profitability value. This thesis uses a beta distribution for thirty-four economic variables. The following estimates are made for each variable: high (90% probability), most likely, and low (10% probability). These estimates are used to develop a probability distribution for each input variable. Some of these distributions are used to

generate time related models as described in the following list:

1. The selling price model is formed by summing a price floor and a margin over the price floor. The model assumes that both the price floor and the price margin continuously decrease with time, following an exponential decay. In the case of the selling price model, the input data required are the high, most likely and low estimates for the initial price floor, the price floor at some future time, the initial selling price, and the selling price at some future time.
2. A total industry market demand model is based on the assumption that high growth rates will gradually decay toward a long-run limit. The required input data are the high, most likely and low estimates for the initial demand, the demand at two other times in the future and a long-run demand growth rate.
3. A market share model is based on the assumption that an initial market share will gradually change toward a long-run value. Three level estimates (high, most likely and low) for the initial market share, the market share at some time in the future and in the long-run market share are required to describe the model.
4. A plant capacity learning curve model is used. The plant capacity is assumed to continuously increase above its original design capacity because of learning. The required input data are the three level estimates for the learning ratio at some time in the future and the learning ratio in

the long-run.

5. The variable cost model is defined as the sum of raw material cost and other variable cost. Both of these costs are estimated initially and at some time in the future.
6. A yearly fixed cost is determined from estimates of an initial fixed cost and a yearly inflation rate.
7. An investment model contains four different types of invest - ments. The first type is the initial capital investment which is assumed to be made at year zero. The second type is the start-up cost which is also assumed to be made at year zero. The third investment is an annual sustaining investment to maintain competitive product quality. This investment is estimated as a percentage of the original investment. The last investment is a yearly debottlenecking investment needed to allow the plant capacity to increase as projected in the learning curve model. Once the yearly capacity increase has been determined by the learning curve model, its associated cost is determined from estimates of a fraction of the original investment per pound of production.

The remaining beta distributions are used for variables such as plant life, maintenance, taxes and insurance, federal tax rate, and six estimates to determine working capital.

A Monte Carlo computer program is used to randomly select a value from each distribution and to calculate a profitability value for a given set of variables. When this procedure is

followed a vast number of times, a probability distribution can be made for the profitability of a venture. When the Monte Carlo simulation method is used for ventures competing for the same capital, then the uncertainty of each venture can be compared and this information can be used by the corporate decision maker.

Strengths and Limitations

Every method used in solving problems has strengths as well as limitations. The writer feels that the strengths of the Monte Carlo simulation far outweigh the limitations of the method, but a comparison of both sides would be appropriate at this time.

In the writer's opinion, the statements by G. L. Smith best describe the strengths and limitations of the Monte Carlo technique.

The Strengths of Monte Carlo are:

"1. It recognizes that profitability measures are estimates, that the input information such as capital required, costs and sales are also estimates.
2. It forces an estimate of the reliability of each bit of input information, and makes an estimate of the reliability of the answer.
3. It expresses results as probability distribution rather than single number, giving business management more information in the calculation process.
4. It can utilize more information in the calculation process.
5. It can handle inter-related variables; it does not assume that they act independently.
6. Judgement is applied early in the process, to individual variables in forming their probability distributions. Monte Carlo itself combines these judgement factors giving the correct weighing to each."[2]

[2] Ibid., p. 14.

The Limitations of Monte Carlo are:

1. "The major disadvantage for Monte Carlo is that it uses subjective probabilities which are only estimates of what the actual probabilities may be.
2. Answers still depend on judgement and can be no better than that judgement.
3. Formation of the subjective probabilities is itself not a simple task; it requires work, experience, and training for people to think in terms of distributions.
4. Perhaps adjustments to allow for uncertainty can be challenged as nothing more than guesses which must be made, and will be made, either explicitly or implicitly.
5. Another drawback to Monte Carlo is its complexity of calculations; a computer is a necessity."[3]

The above comments refer to the Monte Carlo method. Some additional comments concerning the computer program used in this thesis should be noted. The main problem with this type of program is that the program is only as useful as the data is meaningful. The greatest strength of this particular program is that the user is not required to estimate vast quantities of data without realizing the meaning of his estimates. With the models used for key economic variables, the amount of data needed is reduced. The overall effect of the estimates can be shown graphically as will be demonstrated later in this thesis.

One limitation of the Monte Carlo method is that it does not take into account inflation; except for an inflation factor used to increase yearly fixed cost. The basic assumption

[3] Ibid., passim, p. 16.

is that any gross increase in costs due to inflation will be cancelled because the selling price will be equally inflated.

Case Study

To illustrate the methods described in this thesis, an example case study has been devised. A given company is planning to enter into a new marketing area. The company has some potential customers and has estimated the expected industry demand and the selling price. The company must determine the design capacity of the new plant. Small capacity plants will undoubtably be inefficient and not too profitable. However, a large plant will be more efficient but the risks must be considered. The expected markets may not develop and a large investment may become a substantial loss.

For this case study all input data have been contrived by the writer and the product is a fictitious chemical. The fixed capital investment is estimated for a 75 million pounds per year plant. For the other plant capacities of 25, 50, 100, and 125 million pounds per year, the capital cost estimates are made by applying a 0.6 exponential factor on the high, most likely and low estimates for the 75 million pounds per year base case.

The type of results calculated in the program are as follows:

1. All beta distributions are presented graphically.
2. A set of intermediate and final results are presented for constant probability levels of 10%, 30%, 50%, 70%, and 90%.
3. Graphs of the selling price, the industry demand, the market

share, the firm's demand, and the plant learning are presented at different probability levels.

4. For the base case (75 million pounds per year) for each Monte Carlo run, a list of profitability values is presented which includes the plant life, the year in which the plant capacity is reached, the present worth over a 10% cost of capital and the breakeven year, the present worth over a 0% cost of capital and the breakeven year, and the yield (commonly referred to as the discounted rate of return).
5. Graphs and histograms are presented for each plant capacity showing the probability of an expected present worth and yield.

THEORY

Monte Carlo Technique

Normally key economic variables are estimated and used in calculating profitability criterions such as the return on investment. In the Monte Carlo method, a random value is chosen for each key economic variable based upon the probability distribution specified. That group of variables is then used to calculate a profitability criterion. If the above sequence is repeated many times, then a probability distribution of a profitability criterion can be developed. This distribution will show the range of possible values as well as the likelihood of achieving or failing to obtain any possible value.

Beta Distribution

What characteristics should a distribution have when used to describe uncertainties? Because of the nature of the estimates, the distribution should easily be described in simple terms. The type of distribution needed should be a bell type curve which can permit unsymmetrical probability distributions.

The modified beta distribution is selected for the following reasons:

1. Only three estimates are required for each distribution.
2. The range has been set by analogy to the normal distribution, in which 99.7% of all possible values lie in a band that is six standard deviations wide.

3. This distribution has an upper and lower limit.

4. This distribution can be either symmetrical or skewed to either side.

According to Malloy,[4] two parameters, the degree of asymmetry and the range are sufficient to define the modified beta distribution. The degree of asymmetry is defined by a ratio of the portion of the range above the most likely value and the portion below the most likely value.

$$R = \frac{U - M}{M - L} \tag{1}$$

where: U = the upper limit

M = the most likely value, the top of the distribution

L = the lower limit

The numerical value of R is 1.0 for summetrical distribution, greater than 1.0 for skewed distribution and less than 1.0 for lower skewed distribution.

Also according to Malloy, the cumulative probability under the lower tail of the beta distribution is given by:

$$\text{Probability under Lower Tail} = \frac{\int_0^x x^{p-1}\,(1-x)^{q-1}\,dx}{\int_0^1 x^{p-1}\,(1-x)^{q-1}\,dx} \tag{2}$$

If the range of the beta distribution is set at six standard deviations, the values of p and q are given by:

[4] J. B. Malloy, "Risk Analysis of Chemical Plants," Chemical Engineering Progress, Vol. 67, No. 10, (October 1971), p. 70.

$$p = 3.8578 + 4.4352R - 7.1639R^2 + 2.8790R^3 \quad (3)$$

$$q = 0.9970 + 2.9399R + 4.0186R^2 - 6.4084R^3 + 2.5281R^4 \quad (4)$$

The absolute values of U and L are difficult to estimate. The writer has determined a relationship between R and r; a modified asymmetry ratio defined by:

$$r = \frac{u - M}{M - l} \quad (5)$$

where: u = the upper 90% limit

M = the most likely value

l = the lower 10% limit

In order to completely describe the modified beta distribution from an estimate of u, M and l, the writer has determined a relationship between r and the following two ratios.

$$\text{RATIO1} = \frac{M - l}{M - L} \quad (6)$$

$$\text{RATIO2} = \frac{u - M}{U - M} \quad (7)$$

From the two ratios, the absolute lower and upper limit can be determined. A series of equations R, RATIO1 and RATIO2 with r are as follows:

$$R = .03676065 + .5544066r + .207795r^2 + .212011r^3 \quad (8)$$

$$\text{RATIO1} = .439488 - .139630r + .167078r^2 - .022398r^3 \quad (9)$$

$$\text{RATIO2} = .4824025 + .4322292r - .9310103r^2 + .4589393r^3 \quad (\text{for } 0 \leq r \leq 0.2469) \quad (10)$$

$$\text{RATIO2} = -.00592139 + .1313115E02r - .2304106E03r^2 + .2922765E04r^3 - .2184090E05r^4 + .8339572E05r^5 - .1249429E06r^6 \quad (\text{for } 0.2469 < r \leq 1) \qquad (11)$$

In review, the procedure to completely describe the modified beta distribution from estimates of u, M and l are as follows:

1. Calculate r from equation 5.
2. If $0 \leq r \leq 1.0$ (lower skewed distribution), then calculate R from equation 8 and RATIO1 from equation 9.
3. If $0 \leq r \leq 0.2469$ then calculate RATIO2 from equation 11. If $0.2469 < r \leq 1.0$ then calculate RATIO2 from equation 10.
4. Calculate values of L and M from equations 6 and 7 respectively.
5. Calculate R from equation 1.
6. Calculate values of p and q from equations 3 and 4 respectively.
7. Calculate the probability under the lower tail from equation 2.
8. If $r > 1.0$ (upper skewed distribution) then let $r = 1/r$ and follow steps 2 through 7 remembering that the curve calculated is lower skewed and must be transformed back to its complementary upper skewed curve.

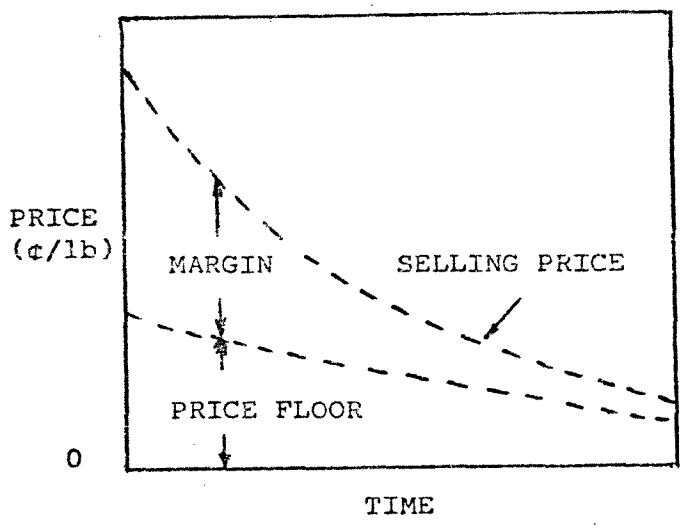
This approach is applied to all input variables.

Selling Price Model

The selling price model, first introduced by Twaddle and Malloy,[5] is formed by summing the price floor and a margin over the price floor. Both the price floor and the margin decrease with time following an exponential decay as demonstrated in the figure below.

FIGURE 1

TYPICAL SELLING PRICE CURVES
SHOWING MARGIN AND PRICE FLOOR



The margin decays because of competitive pressures, whereas the selling price decays because of technological improvements and the trend towards larger more efficient plants. The selling price model is given by equation number 12.

[5] W. W. Twaddle and J. B. Malloy, "Evaluating and Sizing New Chemical Plants," Chemical Engineering Progress, Vol. 62, No. 7, (July 1966), p. 92.

$$Price = (Mo)\exp(-Km(t)) + (PFo)\exp(-Kpf(t)) \qquad (12)$$

where: Price = Selling price (cent/pound)

Mo = Initial price margin (cent/pound)

Km = Rate constant for margin

PFo = Initial price floor (cent/pound)

Kpf = Rate constant for price floor

All the variables in equation 12 can be determined from equations 13 and 14 and the high, most likely and low estimates of the following values:

PFo = Initial price floor (cent/pound)
(Beta distribution #1)

PFt = Price floor at some time t_1 in the future (cent/pound)
(Beta distribution #2)

SPo = Initial selling price (cent/pound)
(Beta distribution #3)

SPt = Selling price at some time t_2 in the future (cent/pound)
(Beta distribution #4)

$$Kpf = \frac{\ln(PFo) - \ln(PFt)}{t_1} \qquad (13)$$

$$Km = \frac{\ln(SPo - PFo) - \ln(SPt - (PFo)\exp(-Kpf(t_2)))}{t_2} \qquad (14)$$

The following steps are the procedure used to develop the selling price model:

1. The high, most likely and low estimates of PFo, PFt, SPo, and SPt are developed into beta distributions.
2. For a given Monte Carlo trial a probability level is randomly selected. The value for each of the above four estimates can be selected by entering the beta distributions with the same random number.
3. The selected values of PFo, PFt, SPo, and SPt can then be used in equations 13 and 14 to determine Km and Kpf.
4. Since the initial price margin (Mo) is the difference between the initial selling price (SPo) and the initial price floor (PFo), the selling price can be calculated from equation 12 for any year t.

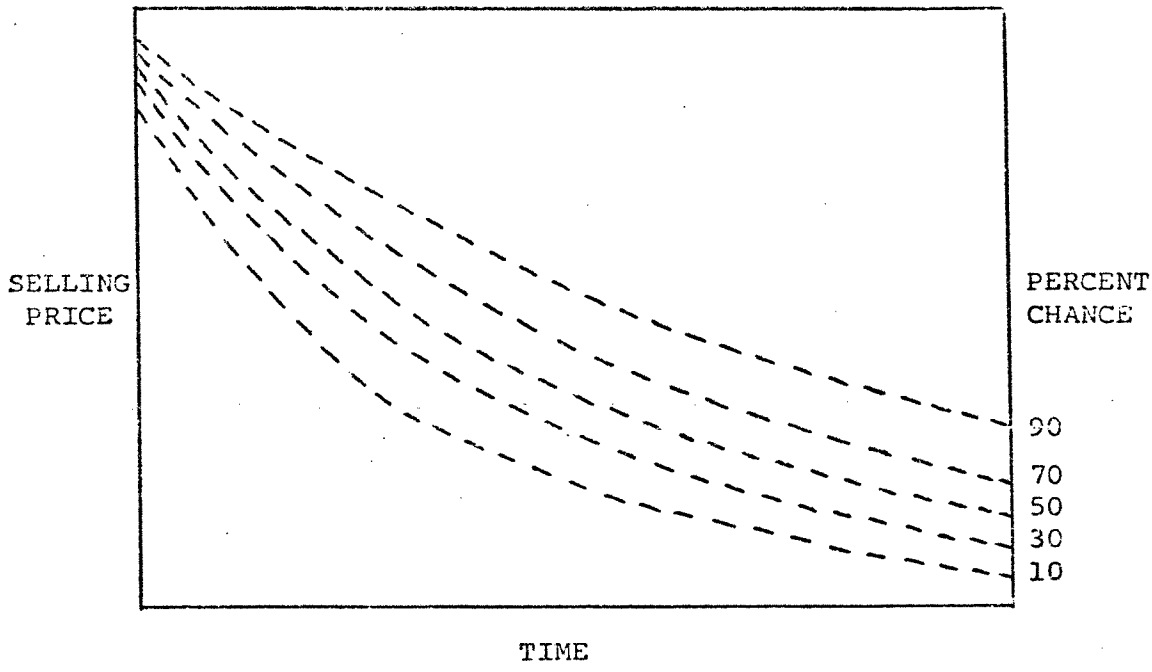
The selling price model assumes that the price floor and the selling price decay exponentially and that the margin is always positive. Therefore, care must be made that the estimates of PFo, PFt, SPo, and SPt are consistent with the assumptions in the model at each probability level (low, most likely and high estimate). For each Monte Carlo run a value for each of the four estimates will be selected at the same probability level by entering the beta distributions with the same random number. This linking will insure that a low initial selling price is not used with a higher selling price at some later time which together would violate the selling price model.

A typical sketch of the selling price curve at various

probability levels is given below. A similar curve for the case study is included in the section on results.

FIGURE 2

TYPICAL SELLING PRICE CURVES
AT VARIOUS PROBABILITY LEVELS



Total Industry Demand Model

As in the case of the selling price model, the total industry demand model was first introduced by Twaddle and Malloy. The demand model is based on the assumption that high growth rates will gradually decay toward a long-run limit. The following model was suggested by Twaddle and Malloy:[6]

[6] Idem

$$D = Do \exp (Rf(t) + (Ro - Rf)(1-\exp(-Kd(t)))/Kd) \quad (15)$$

where: D = Market demand (units/time)

Do = Initial demand (units/time)

Ro = Initial growth rate

Rf = long-run growth rate

Kd = Demand rate constant

The variables in the above equation are determined from estimates of the following four values:

Do = Initial demand

Dt = Demand at time t

D2t = Demand at time twice t

Rf = Long-run growth rate (%/yr)

The values for Kd and Ro are calculated from equations 16 and 17:

$$Kd = -\frac{1}{t} \ln \frac{\ln(D2t/Dt) - (Rf)(t)}{\ln(Dt/Do) - (Rf)(t)} \quad (16)$$

$$Ro = Rf + \frac{\ln(Dt/Do) - Rf(t)}{(1 - \exp(-Kd(t)))/kd} \quad (17)$$

The following steps are the procedure used in developing the total industry demand model:

1. The three level estimates (high, most likely and low) of the variables Do, Dt, D2t, and Rf are developed into beta distributions.
2. For a given Monte Carlo trial, a probability level is

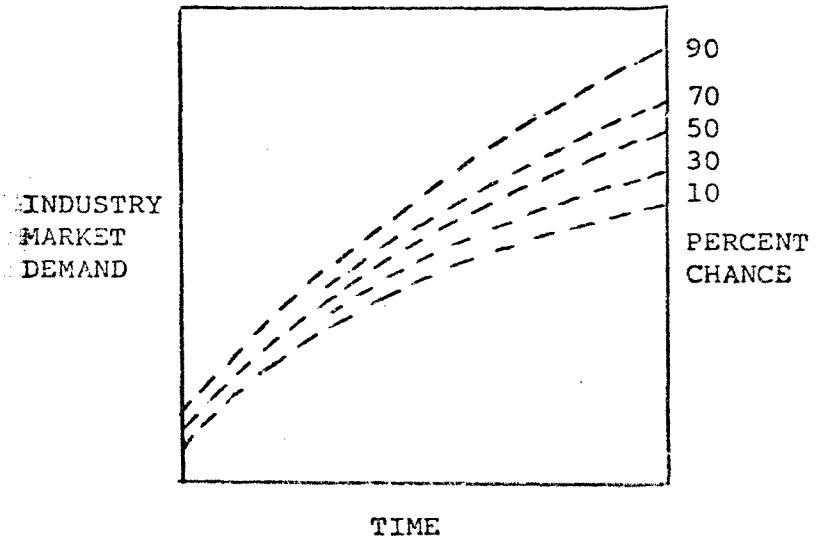
randomly selected. The value for each of the above four estimates is selected by entering the beta distributions with the same random number.

3. The selected values of Do, Dt, D2t, and Rf are then used in equations 16 and 17 to calculate Kd and Ro.
4. All of the variables in equation number 15 are now defined. Therefore, the total industry market demand is calculated for any year t.

For each Monte Carlo trial, a value for each of the above variables is selected at the same probability level. This linking insures that the growth rate will gradually decay toward a long-run limit and that the model will not be violated. The figure below demonstrates demand curves at various probability levels:

FIGURE 3

TYPICAL INDUSTRY MARKET DEMAND CURVES
AT VARIOUS PROBABILITY LEVELS



The selling price and the total industry market demand do not fluctuate independently but a low selling price is likely to be associated with a high market demand and vice versa. Therefore, a linking between the demand projection and the price projection is accomplished by entering the beta distribution for the demand variables, Do, Dt, D2t, and Rf, with a random number P and by entering the beta distribution for the selling price variables, Fo, Ft, SPo, and SPt, with a complementary number 1 - P.

Market Share

The market share is defined as that fraction of the industry demand which belongs to a given company. The market share is used to determine the company's demand.

The market share model is based on the assumption that an initial market share gradually changes towards a long-run value. The following model was suggested by Twaddle and Malloy.[7]

$$F = Fo + (Ff - Fo)\ (1. - \exp(-Kf(t))) \qquad (18)$$

where: F = Market share (percent)

Fo = Initial market share (percent)

Ff = Long-run market share (percent)

Kf = Market share rate constant

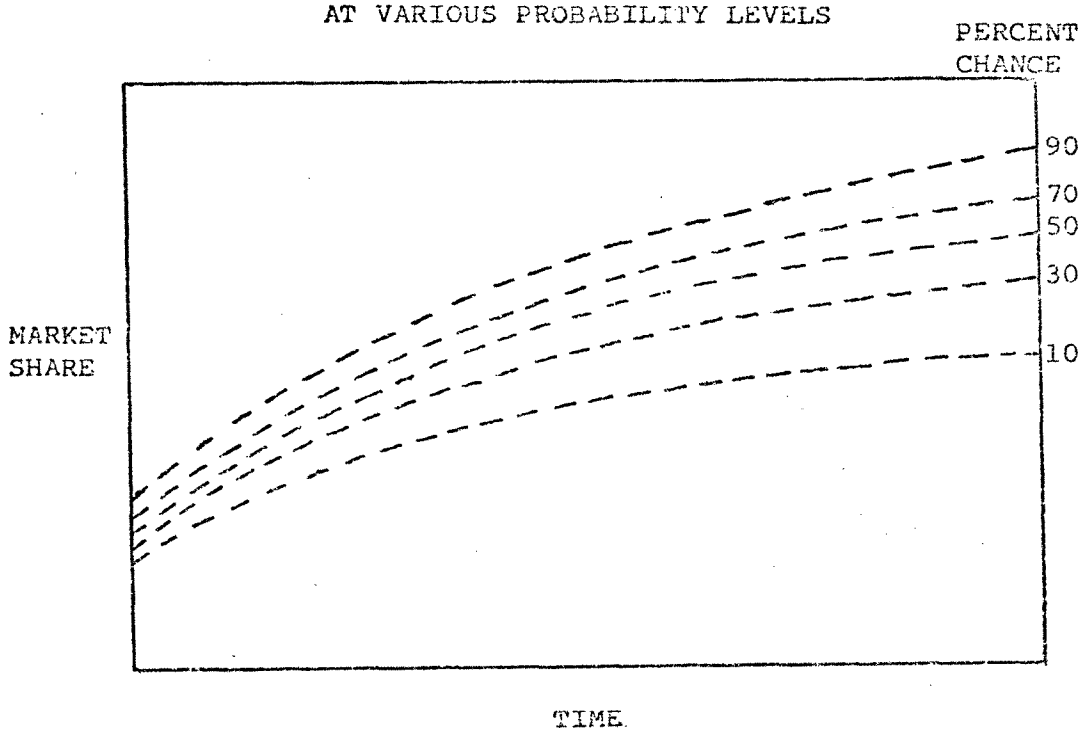
The variables which are estimated and developed into beta distributions are the initial market share (Fo), the market

[7] Idem

share (Ft) at some time in the future, and the long-run market share (Ff). Care must be made that the three level estimates (high, most likely and low) of the market share variables, Fo, Ft and Ff, are consistent with the assumption that the market share gradually changes towards a long-run limit. Similar to the other models, the same random number is used to select values from the three distributions. This linking insures that a low initial market share is not used with a higher long-run market share which would violate the model. The values selected from the three probability distributions are then used in equation number 18 which defines the market share rate constant. The figure below demonstrates a typical market share curve at various probability levels.

FIGURE 4

TYPICAL MARKET SHARE CURVES
AT VARIOUS PROBABILITY LEVELS



Learning Curve Model

Chemical plants often produce more than the original design capacity and gradually increase toward a long-run limit. A learning curve model presented by Twaddle and Malloy[8] is given in equation number 19.

$$R = 1 + (Rf - 1)\ (1. - \exp(K1(t))) \qquad (19)$$

where: R = Ratio of actual to design capacity

Rf = Long-run ratio

K1 = Rate constant for learning

The variables which are estimated and developed into beta distributions are the long-run learning ratio (Rf) and the learning ratio (Rt) at some time in the future. Care must be made that the three level estimates (high, most likely and low) of the variables, Rt and Rf are consistent with the assumption that the learning ratio increases from an initial value of unity to a long-run value. The same random number is used to select values from both distributions. These values are used in equation number 20 to determine K1, the rate constant for the learning curve model.

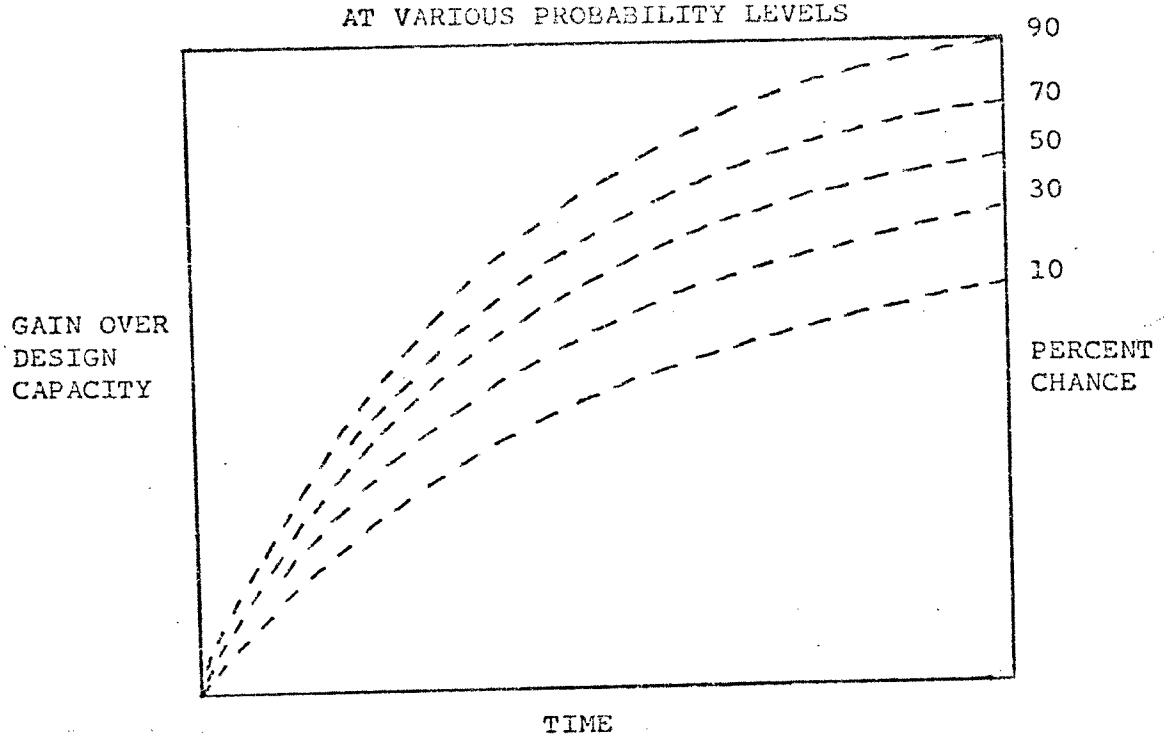
$$K1 = -(1./tr)\ \ln\ (1. - \frac{(Rt - 1.)}{(Rf - 1.)}) \qquad (20)$$

The figure on the following page demonstrates a set of learning curves at various probability levels.

[8] Idem

FIGURE 5

TYPICAL LEARNING CURVES
AT VARIOUS PROBABILITY LEVELS



Investment Model

An investment model contains four different types of investments; two initial investments and two yearly investments. The initial investments are assumed to be made at year zero and are comprised of fixed capital and start-up cost. These investments are estimated and beta distributions are developed for each. For each Monte Carlo trial, a new fixed capital and start-up cost are randomly selected from their beta distributions. The yearly investments are an annual sustaining investment to maintain competitive product quality and a yearly debottlenecking investment needed to allow the plant capacity to increase as projected in the learning curve model. The yearly sustaining investment is estimated as a percentage of the original investment, whereas,

the yearly debottlenecking investment is estimated as a percentage of the original investment per pound of production. These estimates are developed into beta distributions. For a given Monte Carlo trial, values are randomly selected from the beta distributions for each year until the end of the project.

Variable Cost Model

The variable cost is a combination of raw material costs and other costs. Each part is estimated seperately and the total variable cost is defined by equation number 21.

$$VC = (RMo)\exp(+Krm(t)) + (Co)\exp(+Kc(t)) \qquad (21)$$

where: VC = Total variable cost (cent/pound)

RMo = Initial raw material cost (cent/pound)

Krm = Rate constant for raw material cost

Co = Initial other variable cost (cent/pound)

Kc = Rate constant for other variable cost

The variables which are estimated and developed into beta distributions are initial raw material cost (RMo), raw material cost at some time in the future (RMt), initial other variable cost (Co), and other variable cost at some time in the future (Ct).

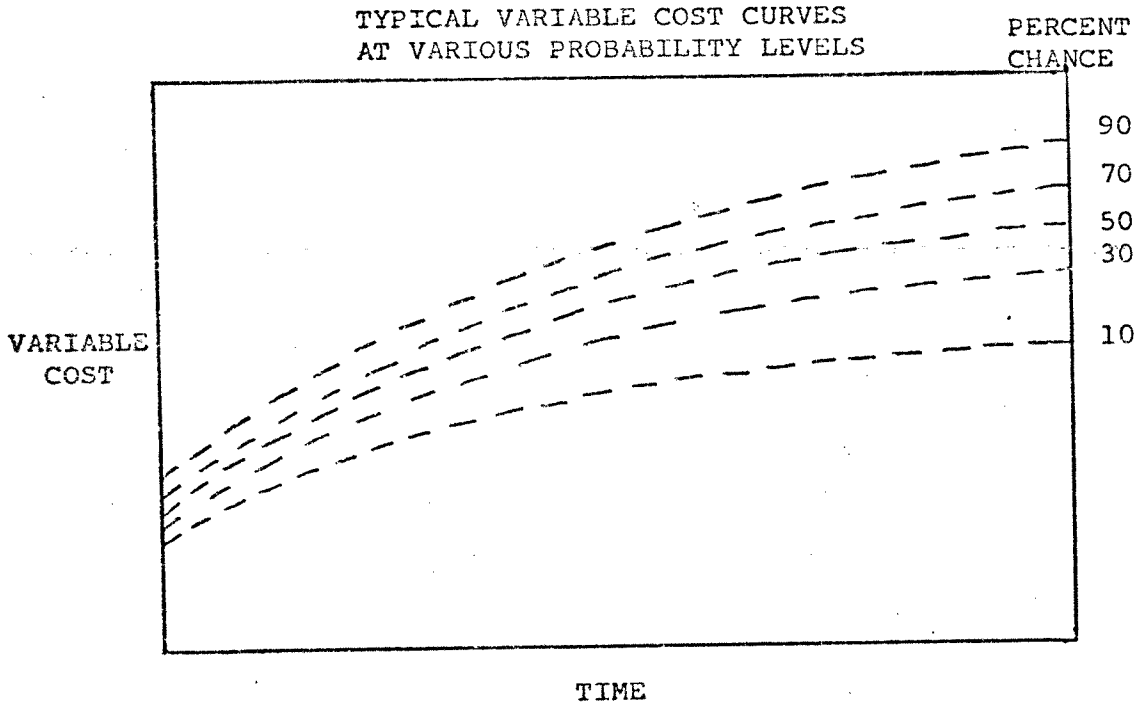
Values of the four input variables are randomly selected from the four beta distributions and are used to calculate Krm and Kc from the equations 22 and 23 which are on the following page:

$$Krm = \left(\frac{1}{trm}\right) \ln \left(\frac{RMt}{RMo}\right) \quad (22)$$

$$Kc = \left(\frac{1}{tc}\right) \ln \left(\frac{Ct}{Co}\right) \quad (23)$$

The figure below demonstrates a typical set of variable cost curves at various probability levels.

FIGURE 6



Fixed Cost Model

The yearly fixed cost is determined from estimates of an initial fixed cost and a yearly inflation rate. Beta distributions are made for the initial fixed cost and the yearly inflation rate. For a given Monte Carlo trial, a value for the initial fixed cost is randomly selected from its beta distribu-

tion. For each subsequent year, a new randomly selected inflation rate is chosen and multiplied times the previous year's fixed cost. In this manner, the fixed cost is determined by year for the entire project life.

Other Variables

The remaining beta distributions are used for variables such as plant life, maintenance, taxes and insurance, Federal tax rate, and six estimates to determine working capital. Three level estimates (high, most likely and low) are determined for all of the above variables. The estimations are further discussed below:

1. Plant life is estimated in years.
2. The yearly maintenance cost is estimated as a percentage of the original investment.
3. The yearly taxes and insurance cost is estimated as a percentage of the original investment.
4. The Federal tax rate is estimated as a percentage of profits.
5. Receivables are estimated as months of product sales.
6. Feed inventories are estimated as months of raw material cost.
7. Product inventories are estimated as months of product sales.
8. Cash is estimated as months of processing cost, excluding raw material cost.
9. Spares are estimated as a percentage of the original investment.
10. Payables are estimated as months of processing cost.

The plant life and the Federal tax rate are randomly selected from their distributions only once during a given Monte Carlo trial. Values for the remaining variables are randomly selected from their distributions for each year during a given Monte Carlo trial. A fixed royalty charge may be used. It is estimated as a constant charge in cents per pound of product. The manufacturing cost, determined yearly, is the sum of the variable cost, fixed cost, taxes and insurance, maintenance, and royalties.

Profitability Measure

The profitability criterions mentioned in this thesis are discussed below.

1. The term present worth is defined as the current value of all cash flows. It is calculated by discounting all cash flows at a set interest rate back to the present time. This thesis refers to the term, present worth, at a zero percent or a ten percent cost of capital but any other percentage could be used according to acceptable practices. Commonly used terms for present worth are present value or venture worth.
2. The term yield is defined as the set interest rate at which the present worth is equal to zero. Commonly used terms for yield are interest rate of return, investor's method, profitability index, or discounted rate of return.
3. The term breakeven year refers to that year when the net positive cash flows equal the net negative cash flows.

RESULTS

Results of the Case Study

To illustrate the methods described in this thesis, an example case study was devised. This case study employed the methods described in the theory section to determine the optimum plant capacity for a company considering a new market venture. A computer program was developed in which the Monte Carlo simulation was applied. The computer program is documented in Appendix A which includes a list of input data for the case study, a list of symbols used in the program and a Fortran source program.

The results or listing of the print out from the computer program are included in Appendix B. The following list summarizes the information that is included in the print out.

1. Page 69 lists the 0, 10, 20, 30, 40, 50, 60, 70, 80, 90, and 100 percent probability values for the thirty-four beta distributions.
2. Pages 70 through 78 contain a list of data for the curves and profitability calculations for a constant probability of 10, 30, 50, 70, and 90 percent. The symbols on these and other pages are described in Table III (Appendix A).
3. Pages 79 through 86 list the results of the five hundred Monte Carlo runs for the 75 million pounds per year plant capacity. Listed from left to right are:

A. Run number

B. Plant life in years

C. The year in which the sales reach the plant capacity

D. Present worth above a 10% return

E. Breakeven year for D

F. Present worth above a 0% return

G. Breakeven year for F

H. Yield or discounted rate of return

4. The remaining printed data lists the present worth above a 10% return and the yield at various probability levels for various plant capacities.

Additional data is printed out on magnetic tape and is used to plot approximately forty graphs on a computer plotter. These graphs are included and supply the primary source of information for the discussion which follows. The thirty-four beta distributions, which are generated in the program from their respective three input estimates, are graphed on figures 14 through 33 (Appendix B). These graphs can be reviewed by the program user to insure that the uncertainty in each variable is reflected by the shape of the distribution.

The selling price, industry market demand, firm's market demand, market share, and plant learning are variables which strongly affect the financial potential of a project. The range and likelihood of the above variables at various times in the

future are plotted in figures 7 through 11 which immediately follow this section. These graphs are probably the most useful and important of all the input data graphs. These graphs coupled with the fixed capital investment distribution enable a user to completely review the meaning of one's numerous input estimates.

The probabilities of projected profitabilities calculated by the computer program for the various plant capacities are presented as histograms and cumulative probability graphs. Ten histograms, which were constructed for present worth and yield regarding five plant capacities, are included in Appendix B. The results in histogram form may be more readily understood than the cumulative or "S" shaped probability graphs. The results of the cumulative probability graphs for present worth and yield at various plant capacities are presented in figures 12 and 13 respectively. These two figures would enable a financial analyst to review the impact of plant capacity on the cash flow of a venture.

Inspection of figure 12 shows that the characteristic "S" curve changes shape and flattens out as the design capacity is increased. The change in the curve demonstrates that as increased money is invested, additional uncertainty is introduced in regards to the dollars of cash flow. Inspection of figures 12 and 13 shows that the 25MM plant capacity appears to be a poor investment compared to the other plant capacities. The 75MM plant capacity

has a higher yield than the other plant capacities as demonstrated in figure 13. The 75MM plant capacity appears to have a definite advantage over the 50MM plant capacity as far as higher present worth is concerned. The 100MM and 125MM plant capacities demonstrate a tendency to possibly make more money than the 75MM plant capacity but this is offset by what appears to be an even greater tendency to possibly lose more money than the 75MM plant capacity. It appears that the 75MM plant capacity will minimize the risk of losing money and will simultaneously maximize the dollars of cash flow and the expected yield on the capital invested.

FIGURE 7

SELLING PRICE AT VARIOUS PROBABILITY LEVELS VERSUS TIME

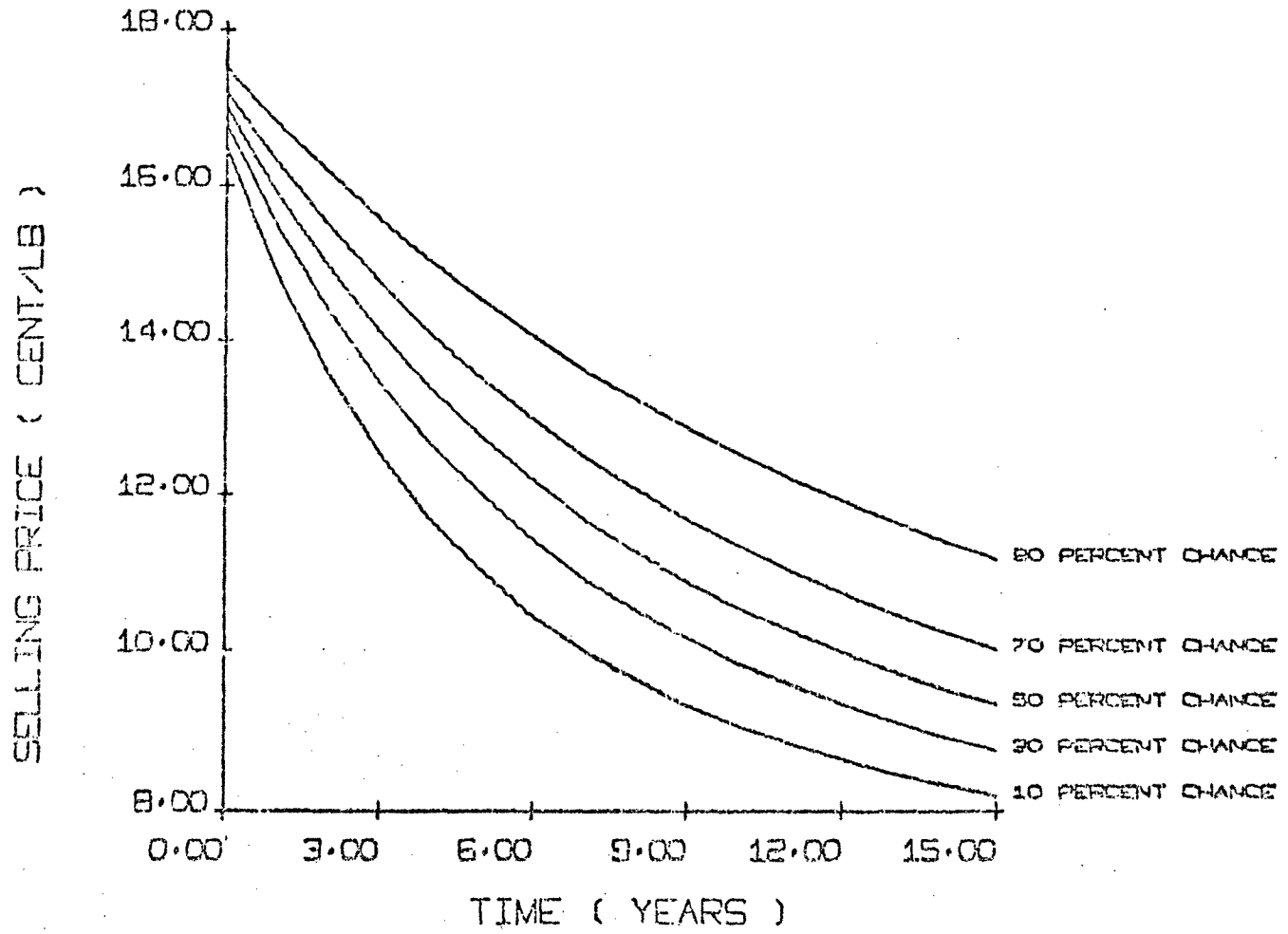


FIGURE 8

INDUSTRY MARKET DEMAND AT VARIOUS PROBABILITY LEVELS VERSUS TIME

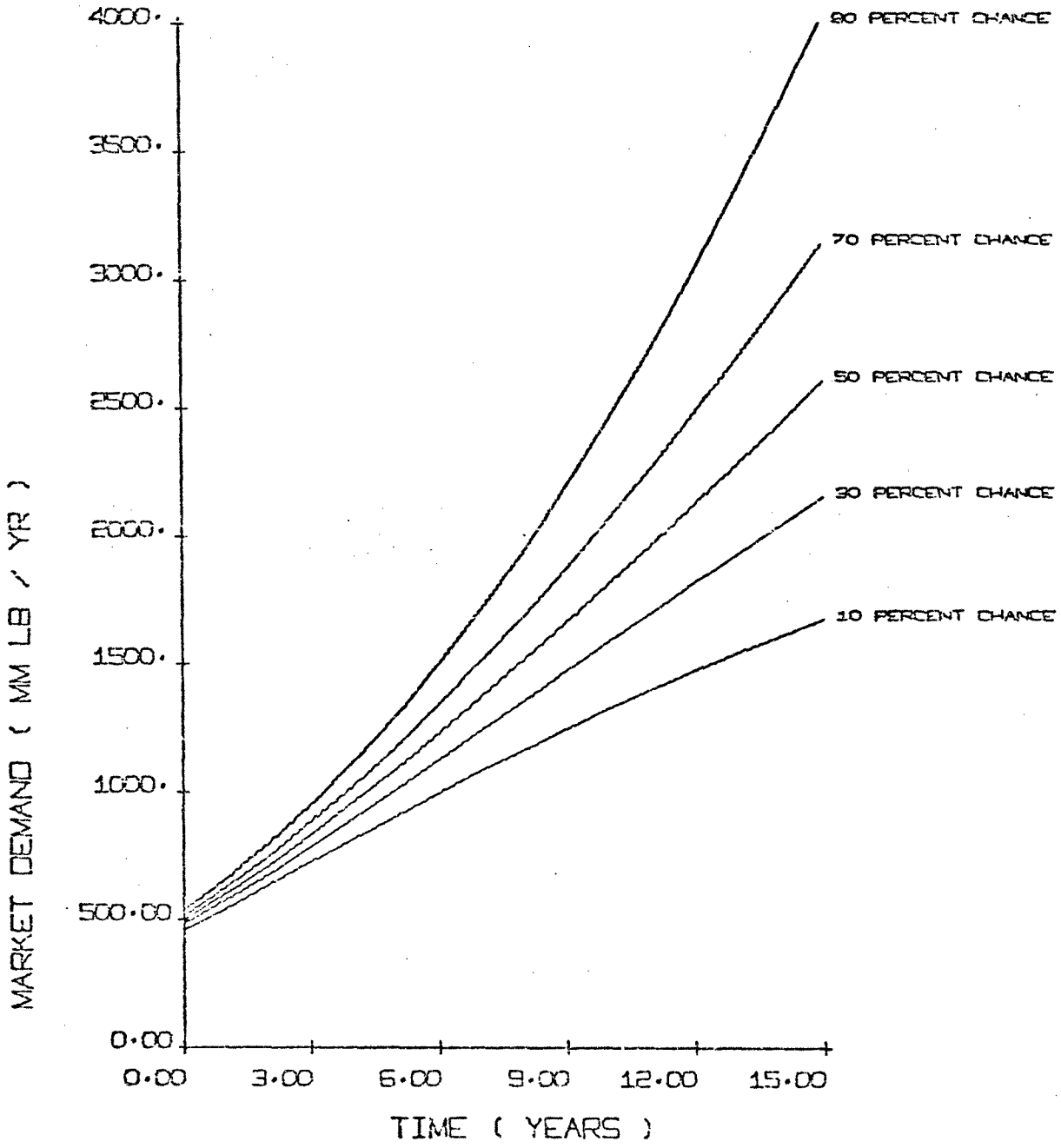


FIGURE 9

MARKET SHARE AT VARIOUS PROBABILITY LEVELS VERSUS TIME

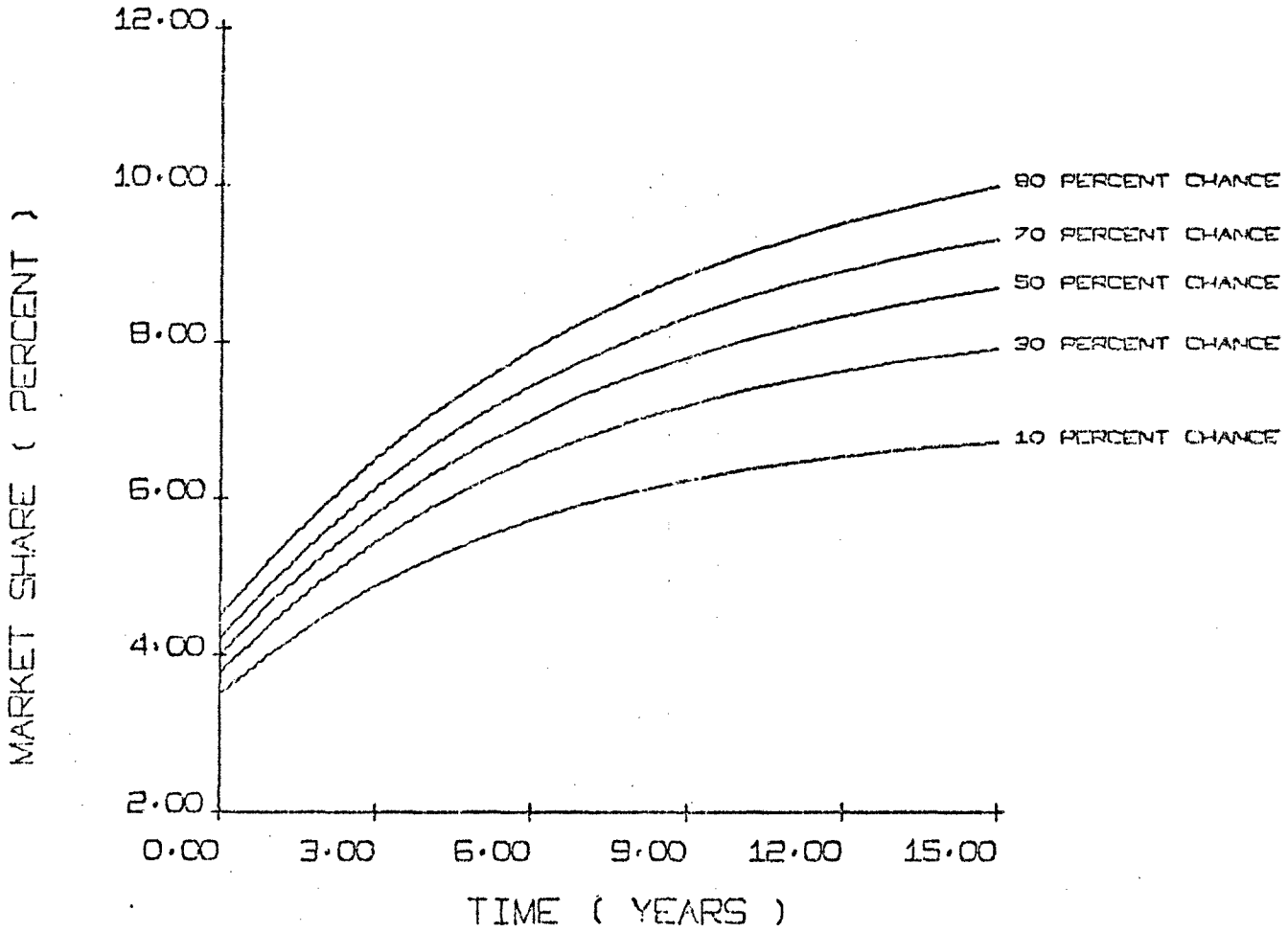


FIGURE 10

FIRM'S DEMAND AT VARIOUS PROBABILITY LEVELS VERSUS TIME

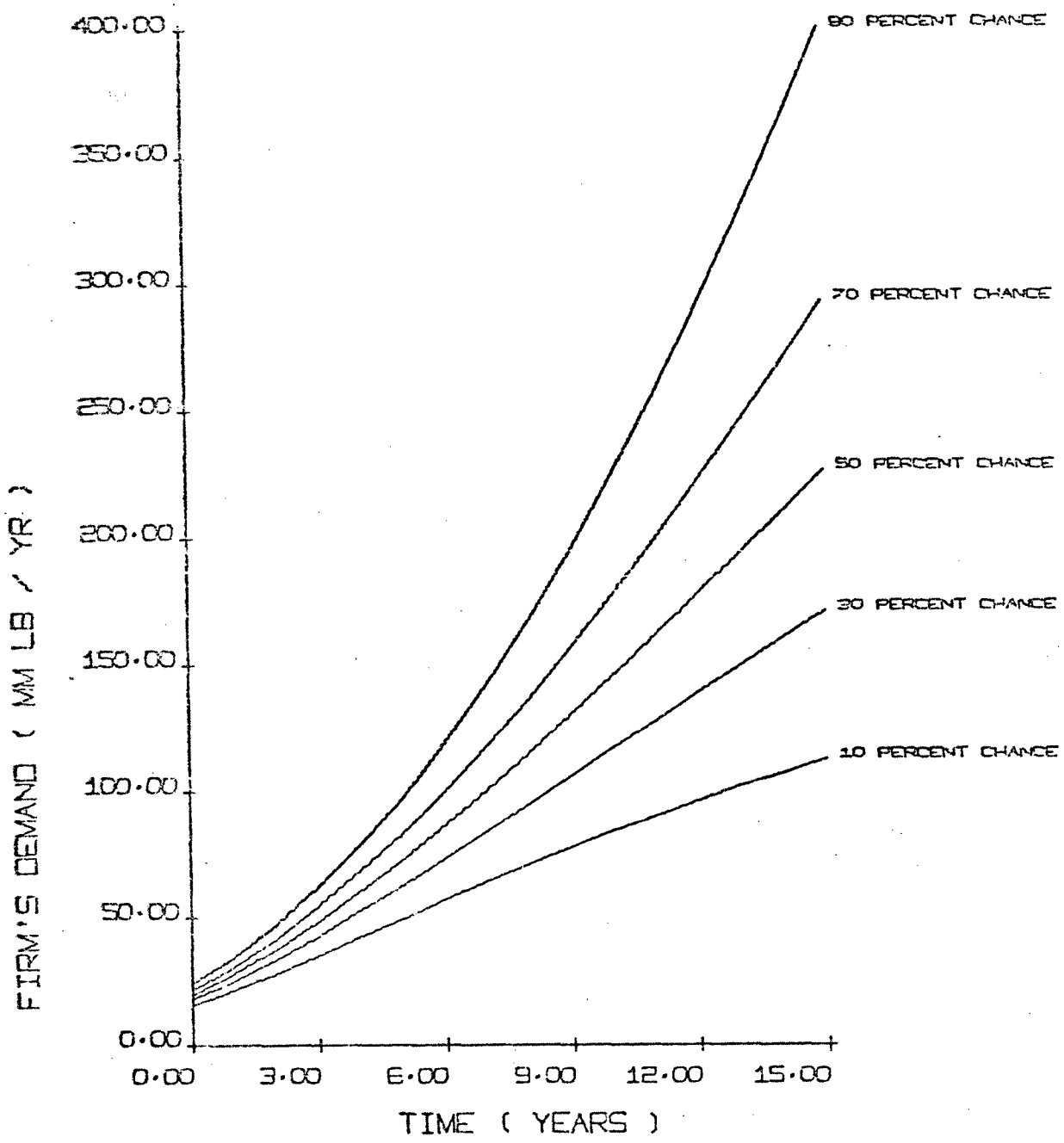


FIGURE 11

LEARNING OVER DESIGN CAPACITY AT VARIOUS PROBABILITY LEVELS VERSUS TIME

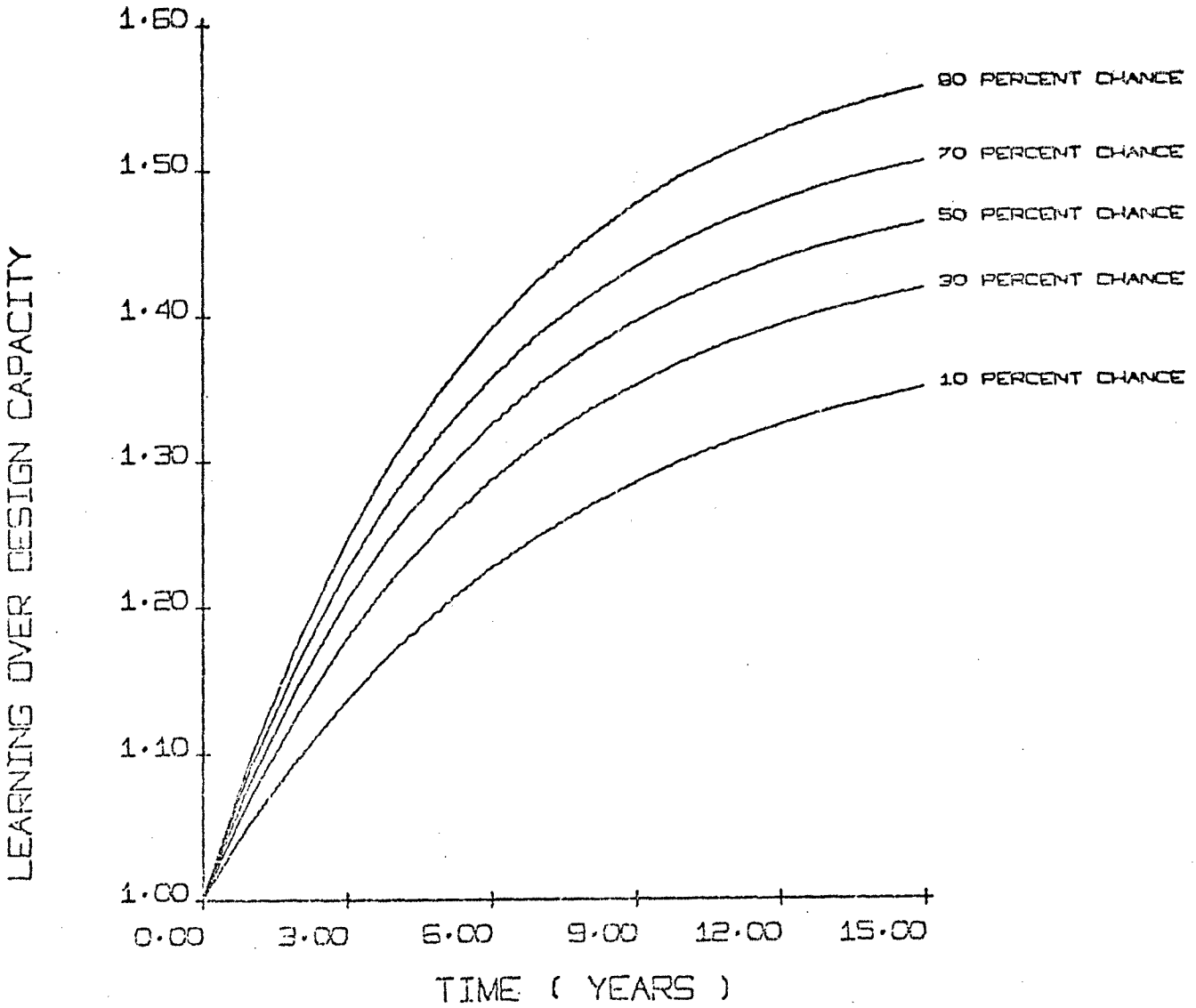


FIGURE 12

PROBABILITY OF PRESENT WORTHS ABOVE A TEN PERCENT RETURN AT VARIOUS PLANT CAPACITIES

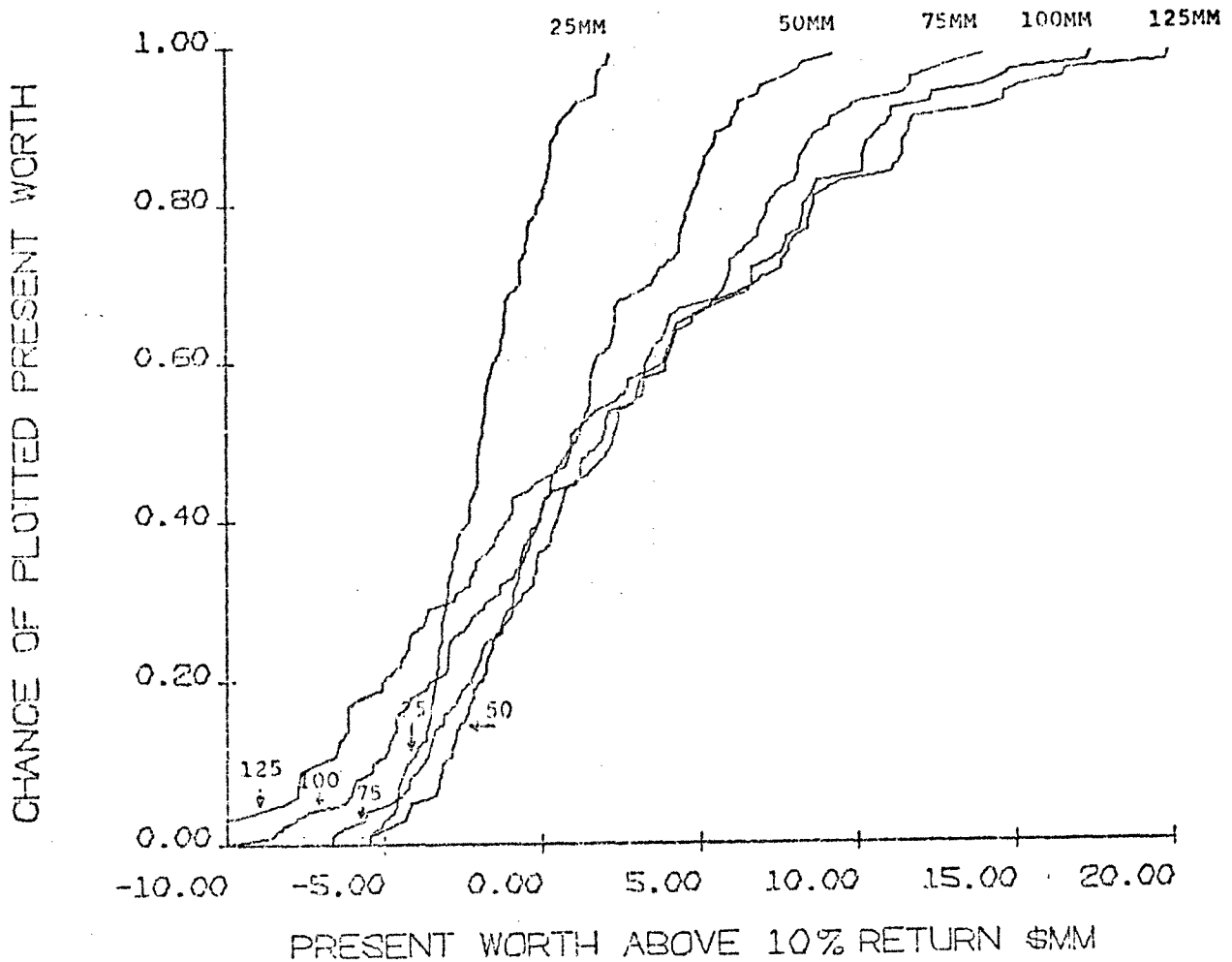
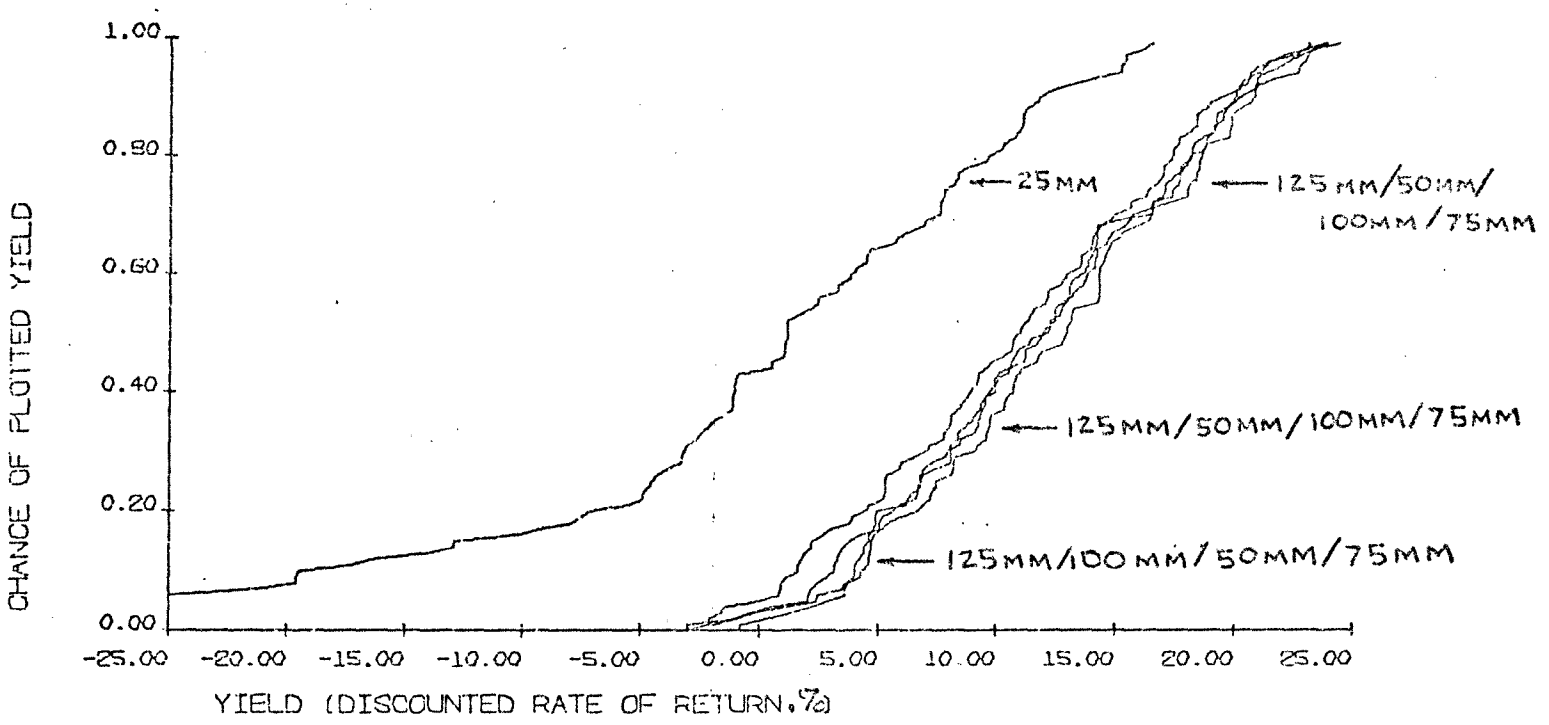


FIGURE 13

PROBABILITY OF YIELD AT VARIOUS PLANT CAPACITIES



CONCLUSIONS

1. The use of equations to represent the change of key economic variables with time is fundamental in order to simplify the input data. The use of equations also allows for the opportunity to inspect the overall meaning of one's estimates to insure that the estimates reflect one's best judgement.

2. The Monte Carlo technique is suitable in quantifying the combined uncertainty of many variables.

3. The Monte Carlo method distinguishes between capital investment alternatives with either a narrow or a high range of possible outcome.

4. The superior alternative determined from the best guess approach is not necessarily the best alternative when uncertainty is considered. The Monte Carlo technique allows for the comparison of various alternatives at different probability levels.

RECOMMENDATIONS

1. Presently, the models for key economic variables are limited because the variables are assumed to either continuously increase or decrease with time. This restriction should be removed and new, more flexible equations should be employed.

2. Currently, the initial investment is assumed to be made at year zero. The investment model could be changed to allow the capital expenditures to be spent continuously over a given period of time. This could be implemented if more precise numbers were required.

3. The probability distribution for capital cost is often a substantial part of the total project uncertainty. This input data should be generated by using the Monte Carlo method. Estimates for the major portions of the total cost should be made by estimating either a dollar figure or a number of units for an item with its unit cost.

4. In this work the Monte Carlo method is used to decide between different plant capacities for a proposed plant. It is recommended that this method be used to compare profitability between alternatives with different processes, locations or products.

5. It is recommended that the section of the computer program that develops the input data into graphical form be separated

from the section of the program that calculates the profitability of the venture. If the above is accomplished, then a user can develop the input data, review the graphical output of the input data, and then, if necessary, refine the input data without being biased by the profitability calculations. A system structured in this manner will less likely allow a user the opportunity to glance at the results and then to modify the input data. This should reduce the possibility of bias entering into the results of the program and should improve the credibility and usefulness of the computer program.

APPENDIX A

TABLE I

INPUT DATA CONTROL CARD

SYMBOL	VALUE	COLUMNS	DESCRIPTION
XMONT	500.0	1 - 10	Number of runs in Monte Carlo simulation
DESIGN	75000.	11 - 20	Design capacity of base case (M lb/yr)
ROYAL	0.0	21 - 30	Royalty (¢/lb)
DEPNY	11.0	31 - 40	Number of years for sum of the years digits depreciation
FRSALV	0.1	41 - 50	Fraction of investment for salvage after end of depreciation period
X	0.1	51 - 60	Discount rate for present worth calculations
PRT	1.0	61 - 70	Print out control for intermed - iate results 0. for supressing, 1. for print out

TABLE II

PROBABILITY DISTRIBUTION INPUT DATA

75 MM LB/YR PLANT

DIST. NO.	DESCRIPTION	ESTIMATES			TIME IN YRS.
		LOW 10%	MOST LIKELY	HIGH 90%	
01	Initial price floor (¢/lb)	9.5	10.0	10.5	
02	Price floor at T (¢/lb)	8.0	8.5	9.5	15.
03	Initial selling price (¢/lb)	16.5	17.	17.5	
04	Selling price at T (¢/lb)	11.0	12.7	14.5	5.
05	Initial market demand (MM lb/yr)	460.	500.	540.	
06	Market demand at T (MM lb/yr)	730.	830.	950	3.
07	Market demand at 2T (MM lb/yr)	1000.	1200.	1500.	6.
08	Long-run growth in market demand (%/yr)	2.	4.	6.	
09	Initial market share (%)	3.5	4.	4.5	
10	Market share at T (%)	5.5	7.	7.5	5.
11	Long-run market share (%)	7.	10.	11.	
12	Learning ratio at T	1.2	1.32	1.35	5.
13	Long-run learning ratio	1.4	1.5	1.6	
14	Initial variable cost excluding raw materials (¢/lb)	2.8	2.875	2.975	

TABLE II (CONTINUED)

PROBABILITY DISTRIBUTION INPUT DATA

75 MM LB/YR PLANT

DIST. NO.	DESCRIPTION	ESTIMATES			TIME IN YRS.
		LOW 10%	MOST LIKELY	HIGH 90%	
15	Variable cost at T (¢/lb)	2.65	2.725	2.825	15.
16	Initial raw material cost (¢/lb)	2.8	2.875	2.975	
17	Raw material cost at T (¢/lb)	2.65	2.725	2.825	15.
18	Initial investment (MM$)	9.3	10.	11.8	
19	Sustaining investment (% of initial investment/yr)	0.5	1.0	1.5	
20	Debottlenecking cost (% of initial investment/annual lb increase)	20.	33.	60.	
21	Maintenance (% of investment/yr)	3.	4.	5.	
22	Taxes and insurance (% of investment/yr	0.75	1.0	1.5	
23	Receivables (months)	0.8	1.0	2.0	
24	Feed inventories (months)	0.5	0.7	1.0	
25	Product inventories (months)	0.7	1.0	1.5	
26	Cash (cost excluding raw materials, months)	0.7	1.0	1.5	
27	Spares (% of investment)	1.5	2.0	2.5	

TABLE II (CONTINUED)

PROBABILITY DISTRIBUTION INPUT DATA

75 MM LB/YR PLANT

DIST. NO.	DESCRIPTION	ESTIMATES			TIME IN YRS.
		LOW 10%	MOST LIKELY	HIGH 90%	
28	Payables (processing cost, months)	0.8	1.0	1.2	
29	Inflation of fixed cost (%/yr)	2.0	3.0	4.0	
30	Open variable	---	---	---	
31	Start-up cost (MM$)	0.25	0.5	1.0	
32	Other fixed cost (MM$/yr)	0.8	1.0	1.2	
33	Federal tax rate (%)	48.0	50.0	52.0	
34	Project life (yrs)	12.0	15.0	18.0	

TABLE III

LIST OF SYMBOLS FOR THE COMPUTER PROGRAM

SYMBOLS	DESCRIPTION
AA	Ranking of profitability index from lowest to highest
APLOT	Present worth results
ATP	After tax profit by year ($/yr)
A1	Firm's demand (MM lb/yr)
A2	Yearly sustaining investment ($/yr)
A3	Yearly debottlenecking investment ($/yr)
A4	Yearly raw material cost ($/yr)
A5	Yearly variable cost excluding raw materials ($/yr)
A6	Yearly cost of taxes and insurance ($/yr)
A7	Yearly maintenance cost ($/yr)
A8	Yearly cost for royalties ($/yr)
A9	Working capital for spares ($)
A10	Working capital for receivables ($)
A11	Working capital for feed inventories ($)
A12	Working capital for product inventories ($)
A13	Working capital for cash ($)
A14	Working capital for payables ($)
A15	Yearly receipts from sales ($/yr)
BPLOT	Yield results
BTP	Before tax profit by year ($/yr)
BV	Book value of investment ($)

TABLE III (CONTINUED)

LIST OF SYMBOLS FOR THE COMPUTER PROGRAM

SYMBOLS	DESCRIPTION
B2	Name of array containing all distributions (N = 1 thru 34)
B2 (N, 1)	Low 10% estimate for distribution N
B2 (N, 2)	Most likely estimate for distribution N
B2 (N, 3)	High 90% estimate for distribution N
B2 (N, 5)	Year which estimate applies
B2 (N, 10 thru B2 (N, 110)	100 values of distribution N as generated in Beta subroutine
C	Variable cost (excluding raw material) by year (¢/lb)
CAPT	Initial investment (MM$)
CASH	Working capital for cash (cost excluding raw materials, months)
CF	Yearly cash flow ($/yr)
CMAIN	Yearly maintenance cost (% of investment/yr)
CMANF	Yearly manufacturing cost ($/yr)
CO	Initial variable cost (excluding raw materials) (¢/lb)
CT	Variable cost (excluding raw materials) at time T (¢/lb)
D	Yearly depreciation charge ($/yr)
DEBOT	Debottlenecking cost (% of initial investment/ annual lb increase)
DESIGN	Design capacity of base case (M lb/yr)
DEM	Yearly market demand (MM lb/yr)

TABLE III (CONTINUED)

LIST OF SYMBOLS FOR THE COMPUTER PROGRAM

SYMBOLS	DESCRIPTION
DEMO	Initial market demand (MM lb/yr)
DEMT	Market demand at T = TDEM (MM lb/yr)
DEM2T	Market demand at T = T2DEM (MM lb/yr)
DEPNY	Number of years for sum of the years digits depreciation
DGRLR	Market demand long-run growth (%/yr)
DISCFI	Yearly discounted cash flow ($/yr)
DISWC	Yearly discounted working capital ($/yr)
DMED	Middle points in histograms of results
F	Yearly market share (%)
FEEDI	Feed inventories in months
FCINF	Yearly inflation on fixed costs (%/yr)
FLR	Firm's long-run market share (%)
FIXCT	Other fixed costs (MM$/yr)
FIXCY	Yearly fixed costs ($/yr)
FO	Initial market share (%)
FRSALV	Fraction of investment for salvage
FT	Market share at T = TF (%)
HISTO	Number of occurences data for histograms
IC (N, 1)	Distribution number
IC (N, 2)	Distribution type - 0 for dollars or other value, 1 for $ per unit, 2 for number of units
IC (N, 3)	Related to distribution number

TABLE III (CONTINUED)

LIST OF SYMBOLS FOR THE COMPUTER PROGRAM

SYMBOLS	DESCRIPTION
IC (N, 4)	Type of dependency - 0 for none, 1 for direct, 2 for inverse
IC (N, 5)	Dependent on distribution number
INVEST	Sum of yearly sustaining and debottlenecking investment ($/yr)
LEARN	Plant capacity because of learning (lb/yr)
LOAD	Year that the plant is sold out
MONTE	Number of runs in Monte Carlo simulation
MRUN	Run number during simulation
NPY	Number of years for plant
NORMI	A counter when abnormal data is encountered in Monte Carlo run
NORMO	Same as NORMI
NRUN	A counter for various plant capacities
PAYAB	Working capital associated with accounts payable (processing costs, months)
PCT	A constant value used as a random variable
PFO	Initial price floor (¢/lb)
PFT	Price floor at time TPF (¢/lb)
PROD	Firm's production (lb/yr)
PRODI	Product inventory (months)
PRT	A print out control for intermediate results, 0. for supressing, 1. for print out
PWO	Present worth at 0% discount factor ($)

TABLE III (CONTINUED)

LIST OF SYMBOLS FOR THE COMPUTER PROGRAM

SYMBOLS	DESCRIPTION
PW1	Present worth at X% discount factor ($)
R	Yearly learning curve ratio (actual capacity/ design capacity)
RECEV	Receivable (months)
RLR	Long-run learning ratio
RMC	Raw material cost (¢/lb)
RMCO	Initial raw material cost (¢/lb)
RMCT	Raw material cost at time TRMC (¢/lb)
ROYAL	Royalty
RT	Learning ratio at time TR
SAL	Yearly salvage credit ($)
SCAPT	Sustaining investment (% of initial investment/yr)
SP	Selling price at each year (¢/lb)
SPARE	Spares (% of investment)
SPO	Initial selling price (¢/lb)
SPT	Selling price at time TSP (¢/lb)
SR	Modified asymmetry ratio
START	Start up cost (MM$)
SUMINV	Sum of investments to date ($)
TAXIN	Taxes and insurance (% of initial investments/yr)
TAXRT	Feseral tax rate (%)

TABLE III (CONTINUED)

LIST OF SYMBOLS FOR THE COMPUTER PROGRAM

SYMBOLS	DESCRIPTION
TC	Year for CT estimate
TDEM	Year for DEMT estimate
T2DEM	Year for DEM2T estimate
TF	Year for FT estimate
TPF	Year for PFT estimate
TR	Year for RT estimate
TRMC	Year for RMCT estimate
TSP	Year for SPT estimate
WC	Yearly working capital ($)
X	Discount rate for present worth calculations
XAXIS	Array of distribution X-axis data
XHST	Highest value in distribution
XL	10% lower value
XLST	Lowest value in distribution
XMONT	Number of Monte Carlo runs
XU	90% upper value
YAXIS	Array of distribution Y-axis data
YIELD2	Project financial yield %
YLEARN	Yearly increase in learning (lb/yr)
YPWO	Break even year for PWO
YPW1	Break even year for PW1

TABLE IV

COMPUTER PROGRAM LIST

```
FORTRAN IV REV I          4/11/74          PAGE    1

      REAL INVEST(30)
      DIMENSION PW1(510),YPW1(510),PWO(510),YPWO(510),YIELD2(510)
      COMMON B2(35,111),IC(35,6)
      COMMON/SRS/AA(510)
      COMMON/SR/ CF(30),WC(30),INVEST
      IX=12345
      IB=0
      DO 1 I=1,35
      DO 1 J=1,110
    1 B2(I,J)=0.0
      DO 5 I=1,35
      DO 5 J=1,6
    5 IC(I,J)=0
      REWIND8
      REWIND9
      REWIND10
      REWIND11
      READ(2,2) XMONT,DESIGN,ROYAL,DEPNY,FRSALV,X,PRT
    2 FORMAT(8F10.0)
      NT=34
      DO 3 NN=1,NT
    3 READ(2,12) IC(NN,1),
     1B2(NN,1),B2(NN,2),B2(NN,3),B2(NN,5)
   12 FORMAT(I2,18X,4F10.0)
      XX=1.23
      X=X/100.
      DESIGN=DESIGN*10.**3
      MONTE=XMONT
      MONT1=MONTE+1
      MONT2=MONTE/100
      NDEP=DEPNY
      NRUN=0
      CALL BETA(NT,IB)
  500 NRUN=NRUN+1
      NORMI=0
      GO TO (501,502,503,504,505,506),NRUN
  502 B2(18,1)=( 50./75.)**0.6*9.3
      B2(18,2)=( 50./75.)**0.6*10.
      B2(18,3)=( 50./75.)**0.6*11.8
      DESIGN= 50.*10.**6
      PRT=0.0
      GO TO 501
  503 B2(18,1)=(100./75.)**0.6*9.3
      B2(18,2)=(100./75.)**0.6*10.
      B2(18,3)=(100./75.)**0.6*11.8
      DESIGN=100.*10.**6
      PRT=0.0
      GO TO 501
  504 B2(18,1)=(125./75.)**0.6*9.3
      B2(18,2)=(125./75.)**0.6*10.
      B2(18,3)=(125./75.)**0.6*11.8
      DESIGN=125.*10.**6
      PRT=0.0
      GO TO 501
  505 B2(18,1)=( 25./75.)**0.6*9.3
      B2(18,2)=( 25./75.)**0.6*10.
      B2(18,3)=( 25./75.)**0.6*11.8
      DESIGN=25.*10.**6
      PRT=0.0
  501 CONTINUE
```

```
      IB=18
      CALL BETA(NT,IB)
      IF(PRT.EQ.0.0) GO TO 209
      WRITE(3,215)
  215 FORMAT(1H1)
      DO 202 I=1,NT
  202 WRITE(3,203) I,B2(I,10),B2(I,20),B2(I,30),B2(I,40),B2(I,50),
     1B2(I,60),B2(I,70),B2(I,80),B2(I,90),B2(I,100),B2(I,110)
  203 FORMAT(    4X,I2,4X,11(1X,E9.3))
  209 CONTINUE
      MRUN=0
      IF(PRT.EQ.0.0) GO TO 210
C     DETERMINATION OF CURVES AND CASH FLOWS AT 10,30,50,70,AND90 PERCENT OF
C     DISTRIBUTION VALUES
      PCT=0.1
  201 WRITE(3,204) PCT
  204 FORMAT('1'////10X,'VALUES USING A CONSTANT RANDOM VARIABLE = ',
     1F6.3///13X     ,'SP(I)',7X,'DEM(I)',7X,'F(I)',8X,'R(I)',
     210X,'C(I)',7X,'RMC(I)',5X,'PROD(I)',4X,'LEARN(I)'//)
      CALL UNFRM(NT,PCT,XX,IX)
      CALL       CURVES(DESIGN,ROYAL,DEPNY,FRSALV,START,CAPT,NPY,LOAD,
     1NORMI,NORMO,MRUN,PCT,IX)
      CALL       PWORTH(START,CAPT,0.0,NPY,PW,NPWZ)
      WRITE(3,205)  PW,NPWZ
  205 FORMAT(10X,'NET PRESENT WORTH OVER ZERO PERCENT COST OF CAPITAL =
     1 ',E15.7/10X,'BREAKEVEN YEAR = ',I2)
      CALL       PWORTH(START,CAPT,X  ,NPY,PW,NPWZ)
      WRITE(3,206) PW,NPWZ
  206 FORMAT(10X,'NET PRESENT WORTH OVER 10 PERCENT COST OF CAPITAL =
     1 ',E15.7/10X,'BREAKEVEN YEAR = ',I2)
      CALL       YIELD(START,CAPT,NPY,YIELD1,YPWZ,MRUN)
      WRITE(3,207) YIELD1
  207 FORMAT(10X,'DISCOUNTED RATE OF RETURN = ',E15.7)
      PCT=PCT+0.2
      IF(PCT.GT.1.0) GO TO 200
      GO TO 201
  200 PCT=0.0
  210 CONTINUE
C     SETTING OF DEPENDENCIES OF ONE VARIABLE ON ANOTHER
      IC( 2,4)=1
      IC( 3,4)=1
      IC( 4,4)=1
      IC( 5,4)=1
      IC( 6,4)=1
      IC( 7,4)=1
      IC( 8,4)=1
      IC(10,4)=1
      IC(11,4)=1
      IC(13,4)=1
      IC(15,4)=1
      IC(17,4)=1
      IC( 2,5)=1
      IC( 3,5)=1
      IC( 4,5)=1
      IC( 5,5)=3
      IC( 6,5)=5
      IC( 7,5)=5
      IC( 8,5)=5
      IC(10,5)=9
      IC(11,5)=9
```

```
      IC(13,5)=12
      IC(15,5)=14
      IC(17,5)=16
      IF(PRT.EQ.0.0) GO TO 400
      WRITE(3,299)
  299 FORMAT( 1H1,40X,'PROFITABILITY VALUES FOR EACH MONTE CARLO RUN'//
     1 1X,'MRUN',4X,'NPY',3X,'LOAD',15X,'PW1',13X,'YPW1',14X,'PWO',
     2 13X,'YPWO',11X,'YIELD2'///)
  400 CONTINUE
    6 MRUN=MRUN+1
C     UNFRM SETS WHICH VALUE OF EACH DISTRIBUTION WILL BE USED ON THAT RUN
      CALL UNFRM(NT,PCT,XX,IX)
C     CALCULATE MARKET DATA CURVES AND CASH FLOWS
      CALL       CURVES(DESIGN,ROYAL,DEPNY,FRSALV,START,CAPT,NPY,LOAD,
     1NORMI,NORMO,MRUN,PCT,IX)
      IF(NORMI.EQ.NORMO)GO TO 60
      NORMI=NORMO
      IF(NORMI.GT.50) GO TO 75
      MRUN=MRUN-1
      GO TO 6
   60 CONTINUE
C     CALCULATE PRESENT WORTH AT X PERCENT
      CALL       PWORTH(START,CAPT,X  ,NPY,PW,NPWZ)
      PW1(MRUN)=PW
      YPW1(MRUN)=NPWZ
C     CALCULATE PRESENT WORTH AT ZERO PERCENT
      XO=0.0
      CALL       PWORTH(START,CAPT,XO ,NPY,PW,NPWZ)
      PWO(MRUN)=PW
      YPWO(MRUN)=NPWZ
C     CALCULATE YIELD (DISCOUNTED RATE OF RETURN)
      CALL       YIELD(START,CAPT,NPY,YIELD1,YPWZ,MRUN)
      YIELD2(MRUN)=YIELD1
      IF(PRT.EQ.0.0) GO TO 401
      WRITE(3,999) MRUN,NPY,LOAD,PW1(MRUN),YPW1(MRUN),PWO(MRUN),
     1YPWO(MRUN),YIELD2(MRUN)
  999 FORMAT(1X,I3,5X,I3,5X,I3,1X,4(2X,F15.0),2X,F15.6)
  401 CONTINUE
      IF(MONTE-MRUN)15,15,6
   15 CONTINUE
      DO 666 I=1,MONT1
      PW1(I)=PW1(I)/10.**6
      PWO(I)=PWO(I)/10.**6
  666 YIELD2(I)=YIELD2(I)*100.
C     RANKING AND PRINT OUT OF PRESENT WORTH AT X PERCENT
      CALL SRANK(MONTE,PW1)
      X=X*100.
      WRITE(3,40)DESIGN,X
   40 FORMAT('1',///2X,'DESIGN CAPACITY (LB/YR) =',F12.0//
     1              2X,'PROBABILITY    PRESENT WORTH'/16X,'AT',F5.1,'PER
     2CENT'//)
      X=X/100.
      PT=20.
      YAX=0.0
      WRITE(3,50) YAX,AA(1)
      MN=XMONT/PT
      DO 41 I=MN,MONTE,MN
      YAX=YAX+1./PT
      WRITE(3,50) YAX,AA(I)
   41 CONTINUE
```

```
FORTRAN IV REV I              4/11/74            PAGE    4

      YX=0.0
      DO 1013 I=1,MONT1,MONT2
      WRITE(10,706) YX,AA(I)
  706 FORMAT(1X,2E11.4)
 1013 YX=YX+0.01
   50 FORMAT(2E14.7)
C     RANKING AND PRINT OUT OF YIELDS
      CALL SRANK(MONTE,YIELD2)
      WRITE(3,51) DESIGN
   51 FORMAT('1',///2X,'DESIGN CAPACITY
     1             2X,'PROBABILITY
      PT=20.
      YAX=0.0
      WRITE(3,50)YAX,AA(1)
      MN=XMONT/PT
      DO 53 I=MN,MONTE,MN
      YAX=YAX+1./PT
      WRITE(3,50) YAX,AA(I)
   53 CONTINUE
      YX=0.0
      DO 1014 I=1,MONT1,MONT2
      WRITE(10,706) YX,AA(I)
 1014 YX=YX+0.01
      GO TO 77
   75 WRITE(3,76)MRUN
   76 FORMAT(' DATA ENCOUNTERED IN CURVES THAT VIOLATES ASSUMPTIONS IN',
     1'MODEL'/' LIMIT EXCEEDED IN RUN NUMBER ',I4)
   77 CONTINUE
      GO TO 500
  506 CONTINUE
      ENDFILE 8
      ENDFILE 9
      ENDFILE 10
      ENDFILE 11
      STOP
      END
```

```
      SUBROUTINE BETA(NT,IB)
      REAL N
      DIMENSION F(1055)
      COMMON B2(35,111),IC(35,6)
      NN=0
   50 NN=NN+1
      IF(IB.NE.0) NN=IB
      N=1000.
      M=IFIX(N+1.)
      IF(IC(NN,6))102,102,101
  101 DO 103 J=10,110
  103 B2(NN,J)=B2(NN,2)
      NX=0
      GO TO 100
  102 CONTINUE
      XL=B2(NN,1)
      XM=B2(NN,2)
      XU=B2(NN,3)
      II=0
      DX=1./N
      X=DX
      F(1)=0.0
      SR=(XU-XM)/(XM-XL)
      IF(SR-1.0) 15,15,16
   16 SR=1./SR
      DUM=XL
      XL=XU
      XU=DUM
      II=1
   15 CONTINUE
      R=.03676065+.5544066*SR+.207795*SR**2.+.212011*SR**3.
      RATL=.439488-.139630*SR+.167078*SR**2.-.022398*SR**3.
      IF(SR-.2469) 18,17,17
   17 XRATU=.4824025+.4322292*SR-.9310103*SR**2.+.4589393*SR**3.
      GO TO 19
   18 XRATU=-.00592139+.1313115E02*SR-.2304106E03*SR**2.+.2922765E04
     1*SR**3.-.2184090E05*SR**4.+.8339572E05*SR**5.-.1249429E06*SR**6.
   19 CONTINUE
      XLST=XM-(XM-XL)/RATL
      XHST=XM+(XU-XM)/XRATU
      RANGE=ABS(XHST-XLST)
      P=3.8578+4.4352*R-7.1639*R*R+2.8790*R**3.
      Q=0.9970+2.9399*R+4.0186*R*R-6.4804*R**3.+2.5281*R**4.
      DO 1 I=2,M
      F(I)=X**(P-1.)*(1.-X)**(Q-1.)
    1 X=X+DX
      A=0.0
      B=0.0
      MM=N-1.
      DO 10 I=1,MM,2
   10 A=A+F(I)+4.*F(I+1)+F(I+2)
      A=A*DX/3.
      PROB=.01
      J=11
      I=1
    3 Y=A*PROB*FLOAT(J-10)
    4 DB=(F(I)+4.*F(I+1)+F(I+2))*DX/3.
      IF(Y-(B+DB)) 22,22,20
   20 B=B+DB
      I=I+2
```

```
      GO TO 4
   22 FRACT=(Y-(B-DB))/DB
      IF(II-1) 27,26,27
   26 JJ=121-J-1
      B2(NN,JJ)=DX*FLOAT(I-2)+FRACT*DX
      B2(NN,JJ)=XLST-B2(NN,JJ)*RANGE
      GO TO 30
   27 B2(NN, J)=DX*FLOAT(I-2)+FRACT*DX
      B2(NN,J)=XLST+B2(NN,J)*RANGE
   30 J=J+1
      B=B+DB
      I=I+2
      IF(ABS(A-Y)-(A*.00001))5,5,3
    5 CONTINUE
      IF(II-1) 31,32,31
   32 SR=1.0/SR
      DUM=XL
      XL=XU
      XU=DUM
      R=1.0/R
      DUM=RATL
      RATL=XRATU
      XRATU=DUM
      DUM=XLST
      XLST=XHST
      XHST=DUM
      B2(NN,110)=XHST
      B2(NN,9)=XHST
      B2(NN,10)=XLST
      GO TO 33
   31 CONTINUE
      B2(NN,9)=XHST
      B2(NN,10)=XLST
   33 CONTINUE
C     DETERMINE LARGEST F(I)
      FLARG=F(1)
      N1=IFIX(N)
      DO 214 J=2,N1
      IF(FLARG-F(J)) 213,214,214
  213 DUM=FLARG
      FLARG=F(J)
      F(J)=DUM
  214 CONTINUE
      NX=0
      DO 29 I=1,M,10
      NX=NX+1
      IF(II-1) 36,37,36
   36 DDX=DX*FLOAT(I)
      XAXIS=DDX*RANGE+XLST
      YAXIS=F(I)/FLARG
      GO TO 29
   37 DDX=DX*(N-FLOAT(I))
      XAXIS=DDX*RANGE+XLST
      YAXIS=F(I)/FLARG
   29 WRITE(8,41) XAXIS,YAXIS
   41 FORMAT(1X,2E11.4)
      IF(IB.NE.0)  GO TO 100
      IF(NN.EQ.NT) GO TO 100
      GO TO 50
  100 CONTINUE
```



```
      RETURN
      END
```

```
FORTRAN IV REV I                4/11/74              PAGE    8

      SUBROUTINE CURVES(DESIGN,ROYAL,DEPNY,FRSALV,START,CAPT,NPY,LOAD,
     1NORMI,NORMO,MRUN,PCT,IX)
      REAL INVEST(30),LEARN(30)
      REAL KC,KD,KF,KL,KM,KPF,KRM
      DIMENSION SP(30),DEM(30),F(30),R(30),C(30),SCAPT(30),DEBOT(30),
     1 CMAIN(30),TAXIN(30),RECEV(30),FEEDI(30),PRODI(30),CASH(30),
     2SPARE(30),PAYAB(30),FCINF(30),PROD(30),SAL(30),FIXCY(30),CMANF(30)
     3,RMC(30),SUMINV(30),ATP(30),BTP(30),          YLEARN(30),DEPF(30)
     4,SDEPF(30),D(30,31),BV(30,31)
     5,A1(30),A2(30),A3(30),A4(30),A5(30),A6(30),A7(30),A8(30),
     6A9(30),A10(30),A11(30),A12(30),A13(30),A14(30),A15(30)
      COMMON B2(35,111),IC(35,6)
      COMMON/SR/ CF(30),WC(30),INVEST
C     GENERATE YEARLY VALUES
      NORMO=NORMI
      START=B2(31,9)
      CAPT=B2(18,9)
      NPY=IFIX(B2(34,9)+.5)
      IF(NPY.GE.30)NPY=30
      IF(PCT.EQ.0.0) GO TO 3000
      NPY=15
 3000 CONTINUE
C     SELLING PRICE MODEL
      PFO=B2(1,9)
      PFT=B2(2,9)
      IF(PFO.LE.PFT) GO TO 400
      TPF=B2(2,5)
      SPO=B2(3,9)
      SPT=B2(4,9)
      IF(SPO.LE.SPT) GO TO 400
      TSP=B2(4,5)
      PMO=SPO-PFO
      KPF=PFO/PFT
      IF( KPF.LE.0.0) GO TO 400
      KPF=ALOG(KPF)
      KPF=KPF/TPF
      CON=SPT-PFO*EXP(-(KPF)*TSP)
      IF( CON.LE.0.0) GO TO 400
      CON=ALOG(CON)
      IF( PMO.LE.0.0) GO TO 400
      KM=ALOG(PMO)
      KM=(KM-CON)/TSP
      DO 1 I=1,NPY
    1 SP(I)=PMO*EXP(-KM*FLOAT(I))+PFO*EXP(-KPF*FLOAT(I))
C     DEMAND FORECAST MODEL
      DEMO=B2(5,9)
      DEMT=B2(6,9)
      TDEM=B2(6,5)
      DEM2T=B2(7,9)
      T2DEM=B2(7,5)
      DGRLR=B2(8,9)*.01
      IF (DGRLR.LE.0.0) GO TO 400
      IF(DEMO.GE.DEMT.OR.DEMT.GE.DEM2T) GO TO 400
      CON1=DGRLR*TDEM
      CON2=DEMT/DEMO
      IF(CON2.LE.0.0) GO TO 400
      CON2=ALOG(CON2)
      CON3=DEM2T/DEMT
      IF(CON3.LE.0.0) GO TO 400
      CON3=ALOG(CON3)
```

```
      CON4=(CON3-CON1)/(CON2-CON1)
      IF(CON4.LE.0.0) GO TO 400
      KD=ALOG(CON4)
      KD=KD/(-TDEM)
      DGRO=DGRLR+(CON2-CON1)*KD/(1.-EXP(-KD*TDEM))
      DO 2 I=1,NPY
      AA=-KD*FLOAT(I)
      CC=1.-EXP(AA)
      EE=(DGRO-DGRLR)*CC/KD
      DD=DGRLR*FLOAT(I)+EE
      DEM(I)=DEMO*EXP(DD)*10.**6
    2 CONTINUE
C     MARKET SHARE MODEL
      FO=B2(9,9)
      FT=B2(10,9)
      TF=B2(10,5)
      FLR=B2(11,9)
      CON1=(FT-FO)/(FLR-FO)
      KF=1.-CON1
      IF(FO.GE.FT.OR.FT.GE.FLR) GO TO 400
      IF(  KF.LE.0.0) GO TO 400
      KF=ALOG(KF)
      KF=KF/(-TF)
      DO 3 I=1,NPY
    3 F(I)=FO+(FLR-FO)*(1.-EXP(-KF*FLOAT(I)))
C     LEARNING CURVE MODEL
      RT=B2(12,9)
      TR=B2(12,5)
      RLR=B2(13,9)
      CON1=(RT-1.)/(RLR-1.)
      KL=1.-CON1
      IF(RT.GE.RLR) GO TO 400
      IF(  KL.LE.0.0) GO TO 400
      KL=ALOG(KL)
      KL=KL/(-TR)
      DO 4 I=1,NPY
    4 R(I)=1.+(RLR-1.)*(1.-EXP(-KL*FLOAT(I)))
C     VARIABLE COSTS (EXCLUDING RAW MATERIALS)
      CO=B2(14,9)
      CT=B2(15,9)
      TC=B2(15,5)
      KC=CT/CO
      IF(  KC.LE.0.0) GO TO 400
      KC=ALOG(KC)
      KC=KC/TC
      DO 5 I=1,NPY
    5 C(I)=CO*EXP(KC*FLOAT(I))
C     RAW MATERIAL COSTS
      RMCO=B2(16,9)
      RMCT=B2(17,9)
      TRMC=B2(17,5)
      KRM=RMCT/RMCO
      IF( KRM.LE.0.0) GO TO 400
      KRM=ALOG(KRM)
      KRM=KRM/TRMC
      DO 7 I=1,NPY
    7 RMC(I)=RMCO*EXP(KRM*FLOAT(I))
C     ASSIGN YEARLY CASH FUNDS  ( NO DEPENDENCY )
      NI=0
    6 NI=NI+1
```

```
      SCAPT(NI)=B2(19,9)
      DEBOT(NI)=B2(20,9)
      CMAIN(NI)=B2(21,9)
      RECEV(NI)=B2(22,9)
      TAXIN(NI)=B2(23,9)
      FEEDI(NI)=B2(24,9)
      PRODI(NI)=B2(25,9)
      CASH (NI)=B2(26,9)
      SPARE(NI)=B2(27,9)
      PAYAB(NI)=B2(28,9)
      FCINF(NI)=B2(29,9)
      IF(NPY-NI)10,10,11
   11 DO 12 NN=19,30
      IF(PCT.EQ.0.0) GO TO 220
      B2(NN,6)=PCT
      GO TO 221
  220 CALL RANDU(IX,IY,YFL)
      B2(NN,6)=YFL
      IX=IY
  221 Y2=B2(NN,6)*100.
      IL=IFIX(Y2)+10
      IH=IFIX(Y2+1.0)+10
      B2(NN,9)=B2(NN,IL)+(Y2-FLOAT(IL-10))*(B2(NN,IH)-B2(NN,IL))
   12 CONTINUE
      GO TO 6
   10 CONTINUE
C DETERMINATION OF PLANT PRODUCTION
      JJ=0
      DO 20 I=1,NPY
      PROD(I)=DEM(I)*F(I)*.01
      A1(I)=PROD(I)
      LEARN(I)=DESIGN*R(I)
      IF(LEARN(I)-PROD(I))51,51,20
   51 PROD(I)=LEARN(I)
      IF (JJ-0)101,101,20
  101 JJ=I
   20 CONTINUE
      LOAD=JJ
C     YEARLY INCREASE IN PLANT LEARNING
      YLEARN(1)=LEARN(1)-DESIGN
      DO 19 I=2,NPY
   19 YLEARN(I)=LEARN(I)-LEARN(I-1)
C     DETERMINATION OF NEW CAPITAL INVESTMENT BY YEAR
      DO 22 I=1,NPY
      A2(I)=SCAPT(I)*CAPT*10.**4
      A3(I)=DEBOT(I)*YLEARN(I)*CAPT*10.**4/DESIGN
   22 INVEST(I)=A2(I)+A3(I)
C     DETERMINATION OF TOTAL INVESTMENT TO DATE
      SUMINV(1)=(CAPT+START)*10.**6.+INVEST(1)
      DO 21 I=2,NPY
   21 SUMINV(I)=SUMINV(I-1)+INVEST(I)
C     DETERMINATION OF FIXED COSTS BY YEAR
      FIXCT=B2(32,9)
      FIXCY(1)=FIXCT*10.**6
      DO 23 I=2,NPY
   23 FIXCY(I)=FIXCY(I-1)*(1.+FCINF(I)/100.)
C     DETERMINATION OF MANUFACTURING COSTS
      DO 24 I=1,NPY
      A4(I)=RMC(I)*PROD(I)/100.
      A5(I)=C(1)*PROD(I)/100.
```

```
      A6(I)=TAXIN(I)*SUMINV(I)/100.
      A7(I)=CMAIN(I)*SUMINV(I)/100.
      A8(I)=ROYAL*PROD(I)/100.
   24 CMANF(I)=A4(I)+A5(I)+A6(I)+A7(I)+A8(I)+FIXCY(I)
C     DETERMINATION OF WORKING CAPITAL BY YEAR
      DO 25 I=1,NPY
      A9(I)=SPARE(I)*CAPT*10.**6/100.
      A10(I)=RECEV(I)*PROD(I)*SP(I)/100./12.
      A11(I)=FEEDI(I)*PROD(I)*RMC(I)/100./12.
      A12(I)=PRODI(I)*PROD(I)*SP(I)/100./12.
      A13(I)=CASH(I)*PROD(I)*C(I)/100./12.
      A14(I)=PAYAB(I)*CMANF(I)/12.
   25 WC(I)=A9(I)+A 10(I)+A11(I)+A12(I)+A13(I)-A14(I)
      DO 1001 I=1,15
      DEPF(I)=0.0
 1001 SDEPF(I)=0.0
      DO 1002 I=1,15
      DO 1002 J=1,16
      D(I,J)=0.0
 1002 BV(I,J)=0.0
      DEPF(1)=(DEPNY+1.-1.)/(DEPNY*(DEPNY+1.)/2.)
      SDEPF(1)=DEPF(1)
      DO 27 I=2,NPY
      DEPF(I)=(DEPNY+1.-FLOAT(I))/(DEPNY*(DEPNY+1.)/2.)
   27 SDEPF(I)=DEPF(I)+SDEPF(I-1)
      D(1,1)=DEPF(1)*(CAPT+START)*10.**6.*(1.-FRSALV)
      BV(1,1)=(CAPT+START)*10.**6.-D(1,1)
      N5=IFIX(DEPNY+.00001)
      DO 28 J=2,N5
      D(J,1)=DEPF(J)*(CAPT+START)*10.**6.*(1.-FRSALV)
   28 BV(J,1)=BV(J-1,1)-D(J,1)
      DO 1008 NY=2,NPY
      I=1
      D(NY,NY)=DEPF(I)*INVEST(NY-1)*(1.-FRSALV)
      BV(NY,NY)=INVEST(NY-1)-D(NY,NY)
      IF(NY-NPY) 1006,1008,1006
 1006 N1=NY+1
      N2=NY+(N5-1)
      IF(NPY-N2) 1005,1004,1004
 1005 N2=NPY
 1004 DO 1003 NI=N1,N2
      I=I+1
      D(NI,NY)=DEPF(I)*INVEST(NY-1)*(1.-FRSALV)
      BV(NI,NY)=INVEST(NY-1)-D(NI,NY)
 1003 CONTINUE
 1008 CONTINUE
      DO 1007 NI=1,NPY
      DO 1007 NY=1,NPY
      D(NI,16)=D(NI,NY)+D(NI,16)
 1007 BV(NI,16)=BV(NI,NY)+BV(NI,16)
C     DETERMINATION OF SALVAGE VALUE BY YEAR
      DO 149 I=1,NPY
  149 SAL(I)=0.0
      I3=IFIX(DEPNY+.0001)
      IF(I3-NPY) 150,151,151
  150 SAL(I3)=(CAPT+START)*10.**6.*FRSALV
      I3=I3+1
      N3=0
      N4=NPY-1
      DO 152 J=I3,N4
```

```
      N3=N3+1
  152 SAL(J)=INVEST(N3)*FRSALV
      SAL(NPY)=BV(NPY,16)
      GO TO 153
  151 SAL(NPY)=SUMINV(NPY)*FRSALV
  153 CONTINUE
C     DETERMINATION OF CASH FLOW BY YEARS
      TAXRT=G2(33,9)
      DO 30 I=1,NPY
      A15(I)=PROD(I)*SP(I)/100.
      BTP(I)=A15(I)-CMANF(I)
      ATP(I)=(BTP(I)-D(I,16))*(1.-TAXRT/100.)
   30 CF(I)=ATP(I)+D(I,16)+SAL(I)
      GO TO 401
  877 FORMAT(3X,I2,2X,3(5X,E15.7))
  400 CONTINUE
      NORMO=NORMI+1
  401 CONTINUE
      IF(MRUN.EQ.0) GO TO 206
      GO TO 205
  206 NPY=15
      DO 201 I=1,NPY
  201 WRITE(3,202) I,SP(I),DEM(I),F(I),R(I),C(I),RMC(I),PROD(I),LEARN(I)
  202 FORMAT(4X,I2,4X,8(1X,E11.5))
      WRITE(3,203)
  203 FORMAT(///12X     ,'INVEST(I)',3X,'SUMINV(I)',4X,'SAL(I)',6X,'BTP(
     1I)',6X,'ATP(I)',6X,'CF(I)',7X,'WC(I)'//)
      DO 204 I=1,NPY
  204 WRITE(3,202)I,INVEST(I),SUMINV(I),SAL(I),BTP(I),ATP(I),CF(I),WC(I)
      WRITE(3,209)
  209 FORMAT(1H1,//5X,'I',6X,'LEARN(I)',5X,'A1(I)',7X,'A2(I)',7X,'A3(I)'
     1',5X,'D(I,16)',7X,'BV(I,16)')
      DO 210 I=1,NPY
  210 WRITE(3,202) I,LEARN(I),A1(I),A2(I),A3(I),D(I,16),BV(I,16)
      WRITE(3,211)
  211 FORMAT(/5X,'I',6X,'FIXCY(I)',5X,'A4(I)',7X,'A5(I)',7X,'A6(I)',7X,
     1'A7(I)',7X,'A8(I)',6X,'CMANF(I)')
      DO 212 I=1,NPY
  212 WRITE(3,202) I,FIXCY(I),A4(I),A5(I),A6(I),A7(I),A8(I),CMANF(I)
      WRITE(3,213)
  213 FORMAT(/5X,'I',7X,'A9(I)',7X,'A10(I)',6X,'A11(I)',6X,'A12(I)'
     1,6X,'A13(I)',6X,'A14(I)',6X,'WC(I)')
      DO 214 I=1,NPY
  214 WRITE(3,202) I,A9(I),A10(I),A11(I),A12(I),A13(I),A14(I),WC(I)
      WRITE(3,208) CAPT,START
  208 FORMAT(/10X,'INITIAL INVESTMENT MM$ = ',E15.7/
     110X,'START-UP INVESTMENT MM$ = ',E15.7/)
C     CARD PUNCH DATA FOR CURVES
      TO=0.
      AO=DEMO*FO
      RO=1.0
      WRITE(9,902)     TO,SPO,DEMO,FO,AO,RO,PCT
  902 FORMAT(1X,7E11.4)
      DO 903 I=1,NPY
      DEM(I)=DEM(I)/10.**6
      A1(I)=A1(I)/10.**6
      T=FLOAT(I)
  903 WRITE(9,902)    T,SP(I),DEM(I),F(I),A1(I),R(I),PCT
  205 CONTINUE
      RETURN
```



```
      END
```

```
FORTRAN IV REV I              4/11/74              PAGE   14

      SUBROUTINE PWORTH(START,CAPT,X   ,NPY,PW,NPWZ)
      REAL INVEST(30)
      DIMENSION DISCF(30),DISWC(30)
      COMMON B2(35,111),IC(35,6)
      COMMON/SR/ CF(30),WC(30),INVEST
      NPWZ=0
      DO 1 J=1,NPY
      DISCF (J)=(CF(J)-INVEST(J))*(1.0+X)**(-J)
    1 DISWC(J)=X*WC(J)*(1.0+X)**(-J)
      SUM=0.0
      AINV=(START+CAPT)*10.**6
      DO 2 J=1,NPY
      FX=DISCF (J)-DISWC(J)
      SUM=SUM+FX
      IF(NPWZ.GE.1) GO TO 2
      IF(SUM-AINV)2,4,4
    4 NPWZ=J
    2 CONTINUE
      PW=SUM-AINV
      RETURN
      END
```

```
      SUBROUTINE YIELD(START,CAPT,NPY,YIELD1,YPWZ,MRUN)
      REAL INVEST(30)
      DIMENSION DISCF(30),DISWC(30),Y(41),XL(40),XR(40)
      COMMON B2(35,111),IC(35,6)
      COMMON/SR/ CF(30),WC(30),INVEST
C      HALF INTERVAL METHOD CONVERGENCE FOR YIELD DETERMINATION
      E=0.001
      XL(1)=-1.0
      XR(1)=1.0
      K=1
      Y(K)=XL(1)
   56 Y(K+1) = (XL(K)+XR(K))/2.
      K=K+1
      IF(40-(K+1))101,101,102
  102 IF(Y(K).EQ.0.0) GO TO 60
      GO TO 61
   60 IF(ABS(Y(K)-Y(K-1))-E) 54,50,50
   61 IF(ABS((Y(K)-Y(K-1))/Y(K))-E) 54,50,50
   50 CONTINUE
C      EVALUATION OF FUNCTION AT Y(K)
      SUM=0.0
      DO 52 J=1,NPY
      FACT=(1.0+Y(K))**(-J)
      DIF=CF(J)-INVEST(J)
      DISCF (J)=DIF*FACT
      DISWC(J)=Y(K)*WC(J)*(1.0+Y(K))**(-J)
      FX=DISCF (J)-DISWC(J)
      SUM=SUM+FX
   52 CONTINUE
      AINV=(START+CAPT)*10.**6
      PW=SUM-AINV
      IF (ABS(PW)-25000.)54,54,57
   57 CONTINUE
      IF(PW)55,54,53
   53 XL(K)=Y(K)
      XR(K)=XR(K-1)
      GO TO 56
   55 XR(K)=Y(K)
      XL(K)=XL(K-1)
      GO TO 56
   54 SUM=0.0
      YPWZ=NPY
      YN=YPWZ
      DO 2 J=1,NPY
      DISCF (J)=(CF(J)-INVEST(I))*(1.0+Y(K))**(-J)
      DISWC(J)=Y(K)*WC(J)*(1.0+Y(K))**(-J)
      FX=DISCF (J)-DISWC(J)
      SUM=SUM+FX
      IF(YPWZ-YN)2,3,3
    3 CONTINUE
      IF(SUM-AINV)2,4,4
    4 YPWZ=J
    2 CONTINUE
      YIELD1=Y(K)
      RETURN
  101 CONTINUE
      YIELD1=Y(K)
      RETURN
      END
```

```
      SUBROUTINE SRANK (N,A)
      DIMENSION A(510), HISTO(25),DMED(25),CON(25)
      COMMON B2(35,111),IC(35,6)
      COMMON/SRS/AA(510)
      M=N-1
      DO 14 I=1,M
      K=I+1
      DO 14 J=K,N
      IF (A(I).LE.A(J)) GO TO 14
      DUM =A(I)
      A(I)=A(J)
      A(J)=DUM
   14 CONTINUE
      DO 15 I=1,N
   15 AA(I)=A(I)
      DO 16 I=1,25
   16 HISTO(I)=0.
C     DETERMINE HISTOGRAM DATA
      RANGE=A(N)-A(1)
      DX=RANGE/25.
      DMED(1)=A(1)+.5*DX
      CON(1)=A(1)+DX
      DO 17 I=2,25
      DMED(I)=DMED(I-1)+DX
      CON(I)=CON(I-1)+DX
   17 CONTINUE
      IN=1
      DO 22 NN=1,N
   23 IF(A(NN).GE.CON(IN)) GO TO 20
      HISTO(IN)=HISTO(IN)+1.0
      GO TO 22
   20 IN=IN+1
      GO TO 23
   22 CONTINUE
      DO 35 I=1,25
   35 WRITE(11,36) HISTO(I),DMED(I)
   36 FORMAT(1X,2E11.4)
      RETURN
      END
```

```
      SUBROUTINE UNFRM(NT,PCT,XX,IX)
      COMMON B2(35,111),IC(35,6)
      NN=1
    4 CONTINUE
      IF(PCT.EQ.0.0) GO TO 20
      B2(NN,6)=PCT
      GO TO 21
   20 CALL RANDU(IX,IY,YFL)
      B2(NN,6)=YFL
      IX=IY
      XX=1.+B2(NN,6)
   21 Y2=B2(NN,6)*100.
      IL=IFIX(Y2)+10
      IH=IFIX(Y2+1.0)+10
      B2(NN,9)=B2(NN,IL)+( Y2-FLOAT(IL-10))*(B2(NN,IH)-B2(NN,IL))
    7 NN=NN+1
      IF(NT-NN+1) 11,11,8
    8 INT=IC(NN,4)+1
      IF(PCT.NE.0.0) GO TO 4
      GO TO (4,10,9),INT
    9 I9=IC(NN,5)
      B2(NN,6)=1.0-B2(I9,6)
      Y2=B2(NN,6)*100.
      IL=IFIX(Y2)+10
      IH=IFIX(Y2+1.0)+10
      B2(NN,9)=B2(NN,IL)+( Y2-FLOAT(IL-10))*(B2(NN,IH)-B2(NN,IL))
      GO TO 7
   10 I10=IC(NN,5)
      B2(NN,6)=B2(I10,6)
      Y2=B2(NN,6)*100.
      IL=IFIX(Y2)+10
      IH=IFIX(Y2+1.0)+10
      B2(NN,9)=B2(NN,IL)+( Y2-FLOAT(IL-10))*(B2(NN,IH)-B2(NN,IL))
      GO TO 7
   11 CONTINUE
      RETURN
      END
```

```
FORTRAN IV REV I              4/11/74              PAGE   18

        SUBROUTINE RANDU(IX,IY,YFL)                                  RANDU  1
        IY=IX*899                                                    RANDU  2
        IF(IY)5,6,6                                                  RANDU  3
      5 IY=IY+32767+1                                                RANDU  4
      6 YFL=IY                                                       RANDU  5
        YFL=YFL/32767.                                               RANDU  6
        RETURN                                                       RANDU  7
        END                                                          RANDU  8
$WEOF SO
$ASS SI DSB 80 DSA
$NOTE START ASSEMBLY  10:30:20
$EXE MAC,,NOLO,NOSC
```

APPENDIX B

TABLE V

COMPUTER PROGRAM PRINT OUT FOR CASE STUDY

1	0.888E+01	0.950E+01	0.966E+01	0.978E+01	0.989E+01	0.100E+02	0.101E+02	0.102E+02	0.103E+02	0.105E+02	0.110E+02
2	0.754E+01	0.800E+01	0.819E+01	0.835E+01	0.851E+01	0.866E+01	0.882E+01	0.900E+01	0.921E+01	0.950E+01	0.109E+02
3	0.159E+02	0.165E+02	0.167E+02	0.168E+02	0.169E+02	0.170E+02	0.171E+02	0.172E+02	0.173E+02	0.175E+02	0.180E+02
4	0.890E+01	0.110E+02	0.116E+02	0.120E+02	0.124E+02	0.127E+02	0.131E+02	0.135E+02	0.139E+02	0.145E+02	0.168E+02
5	0.410E+03	0.460E+03	0.473E+03	0.483E+03	0.492E+03	0.500E+03	0.508E+03	0.517E+03	0.527E+03	0.540E+03	0.583E+03
6	0.613E+03	0.730E+03	0.763E+03	0.789E+03	0.813E+03	0.835E+03	0.859E+03	0.884E+03	0.912E+03	0.950E+03	0.111E+04
7	0.794E+03	0.100E+04	0.107E+04	0.113E+04	0.118E+04	0.123E+04	0.128E+04	0.134E+04	0.141E+04	0.150E+04	0.192E+04
8	-.499E+00	0.200E+01	0.264E+01	0.313E+01	0.358E+01	0.399E+01	0.441E+01	0.484E+01	0.534E+01	0.593E+01	0.813E+01
9	0.268E+01	0.350E+01	0.366E+01	0.378E+01	0.389E+01	0.400E+01	0.410E+01	0.421E+01	0.434E+01	0.450E+01	0.503E+01
10	0.335E+01	0.550E+01	0.592E+01	0.622E+01	0.646E+01	0.668E+01	0.688E+01	0.708E+01	0.728E+01	0.759E+01	0.792E+01
11	0.270E+01	0.700E+01	0.784E+01	0.843E+01	0.893E+01	0.936E+01	0.977E+01	0.102E+02	0.106E+02	0.110E+02	0.118E+02
12	0.105E+01	0.120E+01	0.123E+01	0.126E+01	0.127E+01	0.129E+01	0.131E+01	0.132E+01	0.133E+01	0.135E+01	0.138E+01
13	0.120E+01	0.140E+01	0.143E+01	0.146E+01	0.148E+01	0.150E+01	0.152E+01	0.154E+01	0.157E+01	0.160E+01	0.171E+01
14	0.272E+01	0.280E+01	0.283E+01	0.285E+01	0.286E+01	0.288E+01	0.290E+01	0.292E+01	0.294E+01	0.297E+01	0.311E+01
15	0.257E+01	0.265E+01	0.268E+01	0.270E+01	0.271E+01	0.273E+01	0.275E+01	0.277E+01	0.279E+01	0.282E+01	0.296E+01
16	0.272E+01	0.280E+01	0.283E+01	0.285E+01	0.286E+01	0.288E+01	0.290E+01	0.292E+01	0.294E+01	0.297E+01	0.311E+01
17	0.257E+01	0.265E+01	0.268E+01	0.270E+01	0.271E+01	0.273E+01	0.275E+01	0.277E+01	0.279E+01	0.282E+01	0.296E+01
18	0.870E+01	0.930E+01	0.959E+01	0.985E+01	0.101E+02	0.103E+02	0.106E+02	0.109E+02	0.113E+02	0.118E+02	0.146E+02
19	-.125E+00	0.499E+00	0.660E+00	0.783E+00	0.894E+00	0.998E+00	0.110E+01	0.121E+01	0.134E+01	0.150E+01	0.203E+01
20	0.828E+01	0.200E+02	0.251E+02	0.293E+02	0.335E+02	0.375E+02	0.418E+02	0.465E+02	0.522E+02	0.600E+02	0.991E+02
21	0.175E+01	0.300E+01	0.332E+01	0.357E+01	0.379E+01	0.400E+01	0.420E+01	0.442E+01	0.467E+01	0.499E+01	0.606E+01
22	0.522E+00	0.752E+00	0.847E+00	0.927E+00	0.100E+01	0.108E+01	0.116E+01	0.125E+01	0.135E+01	0.150E+01	0.222E+01
23	0.625E+00	0.803E+00	0.921E+00	0.103E+01	0.114E+01	0.126E+01	0.140E+01	0.155E+01	0.173E+01	0.200E+01	0.339E+01
24	0.294E+00	0.501E+00	0.571E+00	0.628E+00	0.680E+00	0.732E+00	0.784E+00	0.843E+00	0.909E+00	0.100E+01	0.142E+01
25	0.407E+00	0.702E+00	0.811E+00	0.899E+00	0.982E+00	0.106E+01	0.115E+01	0.124E+01	0.135E+01	0.150E+01	0.222E+01
26	0.407E+00	0.702E+00	0.811E+00	0.899E+00	0.982E+00	0.106E+01	0.115E+01	0.124E+01	0.135E+01	0.150E+01	0.222E+01
27	0.875E+00	0.150E+01	0.166E+01	0.178E+01	0.189E+01	0.200E+01	0.210E+01	0.221E+01	0.234E+01	0.250E+01	0.303E+01
28	0.550E+00	0.800E+00	0.864E+00	0.913E+00	0.958E+00	0.999E+00	0.104E+01	0.108E+01	0.113E+01	0.120E+01	0.141E+01
29	0.750E+00	0.200E+01	0.228E+01	0.257E+01	0.279E+01	0.300E+01	0.320E+01	0.342E+01	0.367E+01	0.399E+01	0.506E+01
30	0.775E+00	0.900E+00	0.932E+00	0.957E+00	0.979E+00	0.100E+01	0.102E+01	0.104E+01	0.107E+01	0.110E+01	0.121E+01
31	0.221E-01	0.252E+00	0.347E+00	0.427E+00	0.504E+00	0.580E+00	0.661E+00	0.749E+00	0.855E+00	0.100E+01	0.172E+01
32	0.550E+00	0.800E+00	0.864E+00	0.913E+00	0.958E+00	0.999E+00	0.104E+01	0.108E+01	0.113E+01	0.120E+01	0.141E+01
33	0.455E+02	0.480E+02	0.486E+02	0.491E+02	0.496E+02	0.500E+02	0.504E+02	0.508E+02	0.513E+02	0.520E+02	0.541E+02
34	0.625E+01	0.120E+02	0.130E+02	0.137E+02	0.144E+02	0.150E+02	0.156E+02	0.163E+02	0.170E+02	0.100E+02	0.212E+02

VALUES USING A CONSTANT RANDOM VARIABLE = 0.100

	SP(I)	DEM(I)	F(I)	R(I)	C(I)	RMC(I)	PROD(I)	LEARN(I)
1	0.14653E+02	0.54743E+09	0.40451E+01	0.10510E+01	0.27896E+01	0.27896E+01	0.22144E+08	0.70882E+08
2	0.13546E+02	0.63782E+09	0.45062E+01	0.10968E+01	0.27794E+01	0.27794E+01	0.28742E+08	0.82261E+08
3	0.12504E+02	0.72957E+09	0.48954E+01	0.11360E+01	0.27692E+01	0.27692E+01	0.35716E+08	0.85203E+08
4	0.11669E+02	0.82139E+09	0.52239E+01	0.11702E+01	0.27590E+01	0.27590E+01	0.42909E+08	0.87764E+08
5	0.10996E+02	0.91221E+09	0.55012E+01	0.11999E+01	0.27489E+01	0.27489E+01	0.50183E+08	0.89993E+08
6	0.10450E+02	0.10012E+10	0.57353E+01	0.12256E+01	0.27388E+01	0.27388E+01	0.57423E+08	0.91939E+08
7	0.10002E+02	0.10878E+10	0.59322E+01	0.12483E+01	0.27288E+01	0.27288E+01	0.64539E+08	0.93623E+08
8	0.96314E+01	0.11716E+10	0.60996E+01	0.12679E+01	0.27188E+01	0.27188E+01	0.71466E+08	0.95094E+08
9	0.93217E+01	0.12525E+10	0.62404E+01	0.12850E+01	0.27088E+01	0.27088E+01	0.78159E+08	0.96374E+08
10	0.90595E+01	0.13302E+10	0.63592E+01	0.12996E+01	0.26989E+01	0.26989E+01	0.84592E+08	0.97489E+08
11	0.88347E+01	0.14049E+10	0.64595E+01	0.13128E+01	0.26890E+01	0.26890E+01	0.90752E+08	0.98459E+08
12	0.86392E+01	0.14767E+10	0.65442E+01	0.13240E+01	0.26792E+01	0.26792E+01	0.96640E+08	0.99304E+08
13	0.84669E+01	0.15458E+10	0.66156E+01	0.13339E+01	0.26694E+01	0.26694E+01	0.10004E+09	0.10004E+09
14	0.83128E+01	0.16123E+10	0.66760E+01	0.13424E+01	0.26596E+01	0.26596E+01	0.10068E+09	0.10068E+09
15	0.81732E+01	0.16765E+10	0.67269E+01	0.13496E+01	0.26498E+01	0.26498E+01	0.10124E+09	0.10124E+09

	INVEST(I)	SUMINV(I)	SAL(I)	BTP(I)	ATP(I)	CF(I)	WC(I)
1	0.14287E+06	0.96926E+07	0.00000E+00	0.80560E+06	-.36717E+06	0.12245E+07	0.43979E+06
2	0.13037E+06	0.98230E+07	0.00000E+00	0.11069E+07	-.18929E+06	0.12815E+07	0.50566E+06
3	0.11950E+06	0.99425E+07	0.00000E+00	0.12781E+07	-.35000E+05	0.13105E+07	0.56740E+06
4	0.11004E+06	0.10053E+08	0.00000E+00	0.14049E+07	0.99947E+05	0.13166E+07	0.62510E+06
5	0.10130E+06	0.10154E+08	0.00000E+00	0.15079E+07	0.22023E+06	0.13046E+07	0.67928E+06
6	0.94522E+05	0.10249E+08	0.00000E+00	0.15827E+07	0.32953E+06	0.12766E+07	0.72998E+06
7	0.88377E+05	0.10337E+08	0.00000E+00	0.16395E+07	0.43088E+06	0.12418E+07	0.77745E+06
8	0.82940E+05	0.10420E+08	0.00000E+00	0.16827E+07	0.52646E+06	0.11969E+07	0.82194E+06
9	0.78209E+05	0.10498E+08	0.00000E+00	0.17156E+07	0.61763E+06	0.11454E+07	0.86356E+06
10	0.74089E+05	0.10573E+08	0.00000E+00	0.17402E+07	0.70594E+06	0.10887E+07	0.90245E+06
11	0.70502E+05	0.10643E+08	0.00000E+00	0.17580E+07	0.79146E+06	0.10275E+07	0.93873E+06
12	0.67379E+05	0.10710E+08	0.00000E+00	0.17696E+07	0.87470E+06	0.96230E+06	0.97250E+06
13	0.64655E+05	0.10775E+08	0.00000E+00	0.17760E+07	0.95643E+06	0.92669E+06	0.98383E+06
14	0.62296E+05	0.10837E+08	0.00000E+00	0.17780E+07	0.77508E+06	0.85269E+06	0.96905E+06
15	0.60236E+05	0.10898E+08	0.62133E+06	0.14402E+07	0.71070E+06	0.18056E+07	0.95585E+06

I	LEARN(I)	A1(I)	A2(I)	A3(I)	O(I,16)	RV(I,16)
1	0.76002E+00	0.22144E+06	0.46386E+05	0.94879E+05	0.15916E+07	0.79581E+07
2	0.82761E+00	0.28742E+06	0.46386E+05	0.83949E+05	0.14737E+07	0.66303E+07
3	0.85203E+00	0.35716E+06	0.46386E+05	0.73115E+05	0.13456E+07	0.54388E+07
4	0.87764E+00	0.42909E+06	0.46386E+05	0.63649E+05	0.12167E+07	0.43450E+07
5	0.89993E+00	0.50183E+06	0.46386E+05	0.55409E+05	0.10844E+07	0.34698E+07
6	0.91934E+00	0.57423E+06	0.46386E+05	0.48236E+05	0.94905E+06	0.26941E+07
7	0.93623E+00	0.64539E+06	0.46386E+05	0.41991E+05	0.81096E+06	0.20586E+07
8	0.95094E+00	0.71466E+06	0.46386E+05	0.36553E+05	0.67041E+06	0.15641E+07
9	0.96374E+00	0.78159E+06	0.46386E+05	0.31823E+05	0.52760E+06	0.12111E+07
10	0.97489E+00	0.84592E+06	0.46386E+05	0.27703E+05	0.38276E+06	0.10000E+07
11	0.98459E+00	0.90752E+06	0.46386E+05	0.24116E+05	0.23604E+06	0.93147E+06
12	0.99304E+00	0.96640E+06	0.46386E+05	0.20993E+05	0.87597E+05	0.10057E+07
13	0.10004E+09	0.10226E+09	0.46386E+05	0.18276E+05	0.62262E+05	0.93556E+06
14	0.10068E+09	0.10763E+09	0.46386E+05	0.15910E+05	0.77617E+05	0.87450E+06
15	0.10124E+09	0.11270E+09	0.46386E+05	0.13849E+05	0.73574E+05	0.82133E+06

I	FIXCY(I)	A4(I)	A5(I)	A6(I)	A7(I)	A8(I)	CMANF(I)
1	0.79956E+06	0.61773E+06	0.61773E+06	0.77873E+05	0.29056E+06	0.00000E+00	0.24035E+07
2	0.81556E+06	0.79803E+06	0.79883E+06	0.78920E+05	0.29447E+06	0.00000E+00	0.27866E+07
3	0.83182E+06	0.98903E+06	0.98903E+06	0.79880E+05	0.29805E+06	0.00000E+00	0.31678E+07
4	0.84844E+06	0.11839E+07	0.11839E+07	0.80764E+05	0.30135E+06	0.00000E+00	0.35963E+07
5	0.86539E+06	0.13795E+07	0.13795E+07	0.81582E+05	0.30440E+06	0.00000E+00	0.40103E+07
6	0.88268E+06	0.15727E+07	0.15727E+07	0.82342E+05	0.30724E+06	0.00000E+00	0.44177E+07
7	0.90031E+06	0.17612E+07	0.17612E+07	0.83052E+05	0.30989E+06	0.00000E+00	0.48156E+07
8	0.91830E+06	0.19430E+07	0.19430E+07	0.83715E+05	0.31238E+06	0.00000E+00	0.52005E+07
9	0.93664E+06	0.21172E+07	0.21172E+07	0.84347E+05	0.31472E+06	0.00000E+00	0.55701E+07
10	0.95535E+06	0.22831E+07	0.22831E+07	0.84942E+05	0.31694E+06	0.00000E+00	0.59234E+07
11	0.97444E+06	0.24404E+07	0.24404E+07	0.85509E+05	0.31906E+06	0.00000E+00	0.62597E+07
12	0.99391E+06	0.25891E+07	0.25891E+07	0.86050E+05	0.32107E+06	0.00000E+00	0.65793E+07
13	0.10138E+07	0.27304E+07	0.27304E+07	0.86570E+05	0.32301E+06	0.00000E+00	0.67841E+07
14	0.10340E+07	0.28776E+07	0.28776E+07	0.87073E+05	0.32488E+06	0.00000E+00	0.68812E+07
15	0.10547E+07	0.28826E+07	0.28826E+07	0.87554E+05	0.32669E+06	0.00000E+00	0.68341E+07

I	A9(I)	A10(I)	A11(I)	A12(I)	A13(I)	A14(I)	WC(I)
1	0.13936E+06	0.20611E+06	0.25802E+05	0.19250E+06	0.36155E+05	0.16014E+06	0.43979E+06
2	0.13936E+06	0.24397E+06	0.33366E+05	0.22787E+06	0.46754E+05	0.18567E+06	0.50566E+06
3	0.13936E+06	0.27986E+06	0.41310E+05	0.26136E+06	0.57886E+05	0.21240E+06	0.56740E+06
4	0.13936E+06	0.31377E+06	0.49440E+05	0.29306E+06	0.69290E+05	0.23975E+06	0.62518E+06
5	0.13936E+06	0.34580E+06	0.57619E+05	0.32297E+06	0.80739E+05	0.26721E+06	0.67928E+06
6	0.13936E+06	0.37601E+06	0.65690E+05	0.35120E+06	0.92049E+05	0.29435E+06	0.72996E+06
7	0.13936E+06	0.40451E+06	0.73561E+05	0.37781E+06	0.10308E+06	0.32086E+06	0.77745E+06
8	0.13936E+06	0.43133E+06	0.81157E+05	0.40286E+06	0.11372E+06	0.34651E+06	0.82194E+06
9	0.13936E+06	0.45656E+06	0.88433E+05	0.42642E+06	0.12392E+06	0.37114E+06	0.86356E+06
10	0.13936E+06	0.48024E+06	0.95360E+05	0.44854E+06	0.13362E+06	0.39467E+06	0.90245E+06
11	0.13936E+06	0.50242E+06	0.10193E+06	0.46926E+06	0.14283E+06	0.41708E+06	0.93873E+06
12	0.13936E+06	0.52318E+06	0.10814E+06	0.48865E+06	0.15154E+06	0.43838E+06	0.97250E+06
13	0.13936E+06	0.53076E+06	0.11154E+06	0.49575E+06	0.15629E+06	0.45069E+06	0.98303E+06
14	0.13936E+06	0.52446E+06	0.11124E+06	0.48984E+06	0.15672E+06	0.45316E+06	0.96905E+06
15	0.13936E+06	0.51851E+06	0.11205E+06	0.48428E+06	0.15701E+06	0.45535E+06	0.95585E+06

INITIAL INVESTMENT MM$ = 0.9297878E+01
START-UP INVESTMENT MM$ = 0.2519759E+00

NET PRESENT WORTH OVER ZERO PERCENT COST OF CAPITAL = 0.6866184E+07
BREAKEVEN YEAR = 9
NET PRESENT WORTH OVER 10 PERCENT COST OF CAPITAL = -0.1618336E+07
BREAKEVEN YEAR = 0
DISCOUNTED RATE OF RETURN = 0.7128996E-01

VALUES USING A CONSTANT RANDOM VARIABLE = 0.300

	SP(I)	DEM(I)	F(I)	R(I)	C(I)	RMC(I)	PROD(I)	LEARN(I)
1	0.15466E+02	0.57940E+09	0.44238E+01	0.10691E+01	0.28360E+01	0.28360E+01	0.25631E+08	0.80184E+08
2	0.14361E+02	0.68208E+09	0.49760E+01	0.11278E+01	0.28258E+01	0.28258E+01	0.33940E+08	0.84564E+08
3	0.13431E+02	0.78944E+09	0.54522E+01	0.11776E+01	0.28156E+01	0.28156E+01	0.43041E+08	0.88318E+08
4	0.12646E+02	0.90026E+09	0.58628E+01	0.12198E+01	0.28055E+01	0.28055E+01	0.52780E+08	0.91486E+08
5	0.11981E+02	0.10135E+10	0.62168E+01	0.12557E+01	0.27954E+01	0.27954E+01	0.63007E+08	0.94175E+08
6	0.11415E+02	0.11282E+10	0.65221E+01	0.12861E+01	0.27853E+01	0.27853E+01	0.73584E+08	0.96457E+08
7	0.10932E+02	0.12437E+10	0.67854E+01	0.13119E+01	0.27753E+01	0.27753E+01	0.84390E+08	0.98394E+08
8	0.10517E+02	0.13594E+10	0.70124E+01	0.13338E+01	0.27653E+01	0.27653E+01	0.95324E+08	0.10004E+09
9	0.10156E+02	0.14748E+10	0.72081E+01	0.13524E+01	0.27553E+01	0.27553E+01	0.10143E+09	0.10143E+09
10	0.98466E+01	0.15897E+10	0.73769E+01	0.13682E+01	0.27454E+01	0.27454E+01	0.10261E+09	0.10261E+09
11	0.95738E+01	0.17040E+10	0.75224E+01	0.13816E+01	0.27355E+01	0.27355E+01	0.10362E+09	0.10362E+09
12	0.93332E+01	0.18175E+10	0.76479E+01	0.13930E+01	0.27256E+01	0.27256E+01	0.10447E+09	0.10447E+09
13	0.91195E+01	0.19303E+10	0.77561E+01	0.14026E+01	0.27158E+01	0.27158E+01	0.10519E+09	0.10519E+09
14	0.89282E+01	0.20425E+10	0.78494E+01	0.14108E+01	0.27060E+01	0.27060E+01	0.10581E+09	0.10581E+09
15	0.87554E+01	0.21542E+10	0.79299E+01	0.14177E+01	0.26963E+01	0.26963E+01	0.10633E+09	0.10633E+09

	INVEST(I)	SUMINV(I)	SAL(I)	BTP(I)	ATP(I)	CF(I)	WC(I)
1	0.27686E+06	0.10551E+08	0.00000E+00	0.11118E+07	-.30549E+06	0.14069E+07	0.65423E+06
2	0.24663E+06	0.10798E+08	0.00000E+00	0.15227E+07	-.40785E+05	0.15621E+07	0.78425E+06
3	0.22097E+06	0.11019E+08	0.00000E+00	0.18896E+07	0.20627E+06	0.16904E+07	0.91331E+06
4	0.19920E+06	0.11218E+08	0.00000E+00	0.22110E+07	0.43464E+06	0.17920E+07	0.10400E+07
5	0.18072E+06	0.11399E+08	0.00000E+00	0.24914E+07	0.64490E+06	0.18685E+07	0.11635E+07
6	0.16504E+06	0.11564E+08	0.00000E+00	0.27324E+07	0.83861E+06	0.19223E+07	0.12832E+07
7	0.15174E+06	0.11716E+08	0.00000E+00	0.29395E+07	0.10178E+07	0.19563E+07	0.13990E+07
8	0.14045E+06	0.11856E+08	0.00000E+00	0.31175E+07	0.11846E+07	0.19732E+07	0.15108E+07
9	0.13086E+06	0.11987E+08	0.00000E+00	0.30445E+07	0.12259E+07	0.18604E+07	0.15466E+07
10	0.12273E+06	0.12110E+08	0.00000E+00	0.27656E+07	0.11643E+07	0.16410E+07	0.15131E+07
11	0.11583E+06	0.12225E+08	0.00000E+00	0.25123E+07	0.11174E+07	0.14330E+07	0.14820E+07
12	0.10997E+06	0.12335E+08	0.00000E+00	0.22813E+07	0.10834E+07	0.12348E+07	0.14532E+07
13	0.10500E+06	0.12440E+08	0.00000E+00	0.20694E+07	0.58139E+06	0.11215E+07	0.14263E+07
14	0.10078E+06	0.12541E+08	0.00000E+00	0.18739E+07	0.88678E+06	0.10174E+07	0.14011E+07
15	0.97204E+05	0.12638E+08	0.13998E+07	0.16923E+07	0.79849E+06	0.23208E+07	0.13776E+07

I	LEARN(I)	A1(I)	A2(I)	A3(I)	D(I,16)	BV(I,16)
1	0.80154E+00	0.25631E+08	0.77139E+05	0.19972E+06	0.17124E+07	0.85621E+07
2	0.84584E+00	0.33940E+08	0.77139E+05	0.16919E+06	0.16029E+07	0.72360E+07
3	0.88318E+00	0.43041E+08	0.77139E+05	0.14383E+06	0.14841E+07	0.60447E+07
4	0.91480E+00	0.52780E+08	0.77139E+05	0.12206E+06	0.13573E+07	0.49914E+07
5	0.94175E+00	0.63007E+08	0.77139E+05	0.10359E+06	0.12236E+07	0.40769E+07
6	0.96457E+00	0.73504E+08	0.77139E+05	0.87906E+05	0.10837E+07	0.33095E+07
7	0.98394E+00	0.84390E+08	0.77139E+05	0.74598E+05	0.93853E+06	0.26860E+07
8	0.10004E+01	0.95324E+08	0.77139E+05	0.63306E+05	0.78061E+06	0.22093E+07
9	0.10143E+01	0.10631E+09	0.77139E+05	0.53724E+05	0.63451E+06	0.18011E+07
10	0.10263E+01	0.11727E+09	0.77139E+05	0.45592E+05	0.47668E+06	0.17028E+07
11	0.10362E+01	0.12818E+09	0.77139E+05	0.38692E+05	0.31552E+06	0.16754E+07
12	0.10447E+01	0.13900E+09	0.77139E+05	0.32833E+05	0.15134E+06	0.17997E+07
13	0.10519E+01	0.14972E+09	0.77139E+05	0.27865E+05	0.14011E+06	0.16440E+07
14	0.10581E+01	0.16034E+09	0.77139E+05	0.23645E+05	0.13059E+06	0.15119E+07
15	0.10633E+01	0.17083E+09	0.77139E+05	0.20065E+05	0.12249E+06	0.13998E+07

I	FIXCY(I)	A4(I)	A5(I)	A6(I)	A7(I)	A8(I)	CMANF(I)
1	0.91353E+06	0.72691E+06	0.72691E+06	0.10867E+06	0.37633E+06	0.00000E+00	0.28523E+07
2	0.93677E+06	0.95909E+06	0.95909E+06	0.11142E+06	0.38513E+06	0.00000E+00	0.33515E+07
3	0.96082E+06	0.12119E+07	0.12119E+07	0.11370E+06	0.39301E+06	0.00000E+00	0.38913E+07
4	0.98548E+06	0.14807E+07	0.14807E+07	0.11575E+06	0.40011E+06	0.00000E+00	0.44628E+07
5	0.10108E+07	0.17613E+07	0.17613E+07	0.11762E+06	0.40656E+06	0.00000E+00	0.50575E+07
6	0.10367E+07	0.20495E+07	0.20495E+07	0.11932E+06	0.41244E+06	0.00000E+00	0.56675E+07
7	0.10633E+07	0.23420E+07	0.23420E+07	0.12086E+06	0.41786E+06	0.00000E+00	0.62862E+07
8	0.10906E+07	0.26360E+07	0.26360E+07	0.12233E+06	0.42287E+06	0.00000E+00	0.69078E+07
9	0.11186E+07	0.27948E+07	0.27948E+07	0.12368E+06	0.42753E+06	0.00000E+00	0.72593E+07
10	0.11473E+07	0.28172E+07	0.28172E+07	0.12495E+06	0.43191E+06	0.00000E+00	0.73385E+07
11	0.11766E+07	0.28345E+07	0.28345E+07	0.12615E+06	0.43604E+06	0.00000E+00	0.74079E+07
12	0.12070E+07	0.28475E+07	0.28475E+07	0.12728E+06	0.43996E+06	0.00000E+00	0.74692E+07
13	0.12379E+07	0.28569E+07	0.28569E+07	0.12836E+06	0.44371E+06	0.00000E+00	0.75238E+07
14	0.12697E+07	0.28632E+07	0.28632E+07	0.12940E+06	0.44730E+06	0.00000E+00	0.75729E+07
15	0.13023E+07	0.28669E+07	0.28669E+07	0.13041E+06	0.45077E+06	0.00000E+00	0.76174E+07

I	A9(I)	A10(I)	A11(I)	A12(I)	A13(I)	A14(I)	WC(I)
1	0.17561E+06	0.30624E+06	0.38055E+05	0.29697E+06	0.54455E+05	0.21709E+06	0.65423E+06
2	0.17561E+06	0.37653E+06	0.50210E+05	0.36514E+06	0.71840E+05	0.25509E+06	0.78425E+06
3	0.17561E+06	0.44657E+06	0.63444E+05	0.43306E+06	0.90786E+05	0.29617E+06	0.91331E+06
4	0.17561E+06	0.51561E+06	0.77519E+05	0.50001E+06	0.11093E+06	0.33967E+06	0.10400E+07
5	0.17561E+06	0.58314E+06	0.92206E+05	0.56551E+06	0.13194E+06	0.38493E+06	0.11635E+07
6	0.17561E+06	0.64888E+06	0.10730E+06	0.62926E+06	0.15354E+06	0.43136E+06	0.12852E+07
7	0.17561E+06	0.71267E+06	0.12261E+06	0.69111E+06	0.17545E+06	0.47844E+06	0.13990E+07
8	0.17561E+06	0.77444E+06	0.13800E+06	0.75102E+06	0.19747E+06	0.52576E+06	0.15108E+07
9	0.17561E+06	0.79596E+06	0.14631E+06	0.77136E+06	0.20936E+06	0.55251E+06	0.15466E+07
10	0.17561E+06	0.78053E+06	0.14748E+06	0.75692E+06	0.21104E+06	0.55854E+06	0.15131E+07
11	0.17561E+06	0.76633E+06	0.14839E+06	0.74315E+06	0.21234E+06	0.56363E+06	0.14820E+07
12	0.17561E+06	0.75322E+06	0.14907E+06	0.73044E+06	0.21331E+06	0.56849E+06	0.14532E+07
13	0.17561E+06	0.74107E+06	0.14956E+06	0.71865E+06	0.21402E+06	0.57264E+06	0.14263E+07
14	0.17561E+06	0.72975E+06	0.14989E+06	0.70768E+06	0.21449E+06	0.57638E+06	0.14011E+07
15	0.17561E+06	0.71916E+06	0.15009E+06	0.69741E+06	0.21477E+06	0.57976E+06	0.13773E+07

INITIAL INVESTMENT MM$ = 0.9047584E+01
START-UP INVESTMENT MM$ = 0.4269851E+00

NET PRESENT WORTH OVER ZERO PERCENT COST OF CAPITAL = 0.1216196E+08
BREAKEVEN YEAR = 7
NET PRESENT WORTH OVER 10 PERCENT COST OF CAPITAL = 0.1755360E+06
BREAKEVEN YEAR = 15
DISCOUNTED RATE OF RETURN = 0.1025391E+00

VALUES USING A CONSTANT RANDOM VARIABLE = 0.500

	SP(I)	DEM(I)	F(I)	R(I)	C(I)	RMC(I)	PROD(I)	LEARN(I)
1	0.15890E+02	0.60372E+09	0.46929E+01	0.10600E+01	0.28726E+01	0.28726E+01	0.28332E+08	0.80999E+08
2	0.14929E+02	0.71614E+09	0.52976E+01	0.11472E+01	0.28624E+01	0.28624E+01	0.37930E+08	0.86037E+08
3	0.14095E+02	0.83612E+09	0.58241E+01	0.12036E+01	0.28522E+01	0.28522E+01	0.48696E+08	0.90269E+08
4	0.13369E+02	0.96270E+09	0.62823E+01	0.12510E+01	0.28420E+01	0.28420E+01	0.60980E+08	0.93625E+08
5	0.12735E+02	0.10950E+10	0.66812E+01	0.12906E+01	0.28319E+01	0.28319E+01	0.73156E+08	0.96808E+08
6	0.12180E+02	0.12320E+10	0.70284E+01	0.13242E+01	0.28219E+01	0.28219E+01	0.86594E+08	0.99316E+08
7	0.11694E+02	0.13733E+10	0.73307E+01	0.13523E+01	0.28118E+01	0.28118E+01	0.10067E+09	0.10142E+09
8	0.11265E+02	0.15180E+10	0.75938E+01	0.13759E+01	0.28018E+01	0.28018E+01	0.10319E+09	0.10319E+09
9	0.10887E+02	0.16658E+10	0.78229E+01	0.13957E+01	0.27919E+01	0.27919E+01	0.10468E+09	0.10468E+09
10	0.10551E+02	0.18162E+10	0.80223E+01	0.14123E+01	0.27819E+01	0.27819E+01	0.10592E+09	0.10592E+09
11	0.10253E+02	0.19691E+10	0.81958E+01	0.14263E+01	0.27720E+01	0.27720E+01	0.10697E+09	0.10697E+09
12	0.99852E+01	0.21243E+10	0.83469E+01	0.14380E+01	0.27622E+01	0.27622E+01	0.10785E+09	0.10785E+09
13	0.97450E+01	0.22818E+10	0.84784E+01	0.14479E+01	0.27524E+01	0.27524E+01	0.10859E+09	0.10859E+09
14	0.95280E+01	0.24417E+10	0.85929E+01	0.14562E+01	0.27426E+01	0.27426E+01	0.10921E+09	0.10921E+09
15	0.93311E+01	0.26039E+10	0.86926E+01	0.14631E+01	0.27328E+01	0.27328E+01	0.10974E+09	0.10974E+09

	INVEST(I)	SUMINV(I)	SAL(I)	BTP(I)	ATP(I)	CF(I)	WC(I)
1	0.41359E+06	0.11343E+08	0.00000E+00	0.12783E+07	-.27164E+06	0.15499E+07	0.86467E+06
2	0.36392E+06	0.11706E+08	0.00000E+00	0.18470E+07	0.61109E+05	0.17859E+07	0.10636E+07
3	0.32220E+06	0.12029E+08	0.00000E+00	0.23930E+07	0.38975E+06	0.20034E+07	0.12689E+07
4	0.28716E+06	0.12316E+08	0.00000E+00	0.29078E+07	0.70904E+06	0.21990E+07	0.14776E+07
5	0.25773E+06	0.12574E+08	0.00000E+00	0.33868E+07	0.10158E+07	0.23713E+07	0.16879E+07
6	0.23301E+06	0.12807E+08	0.00000E+00	0.38283E+07	0.13084E+07	0.25203E+07	0.18978E+07
7	0.21225E+06	0.13019E+08	0.00000E+00	0.42329E+07	0.15865E+07	0.26469E+07	0.21063E+07
8	0.19481E+06	0.13214E+08	0.00000E+00	0.39186E+07	0.15087E+07	0.24103E+07	0.20752E+07
9	0.18016E+06	0.13394E+08	0.00000E+00	0.35812E+07	0.14224E+07	0.21592E+07	0.20299E+07
10	0.16786E+06	0.13562E+08	0.00000E+00	0.32662E+07	0.13500E+07	0.19166E+07	0.19864E+07
11	0.15753E+06	0.13719E+08	0.00000E+00	0.29726E+07	0.12907E+07	0.16823E+07	0.19440E+07
12	0.14885E+06	0.13868E+08	0.00000E+00	0.26989E+07	0.12434E+07	0.14559E+07	0.19052E+07
13	0.14156E+06	0.14010E+08	0.00000E+00	0.24435E+07	0.11244E+07	0.13194E+07	0.18675E+07
14	0.13543E+06	0.14145E+08	0.00000E+00	0.22045E+07	0.10122E+07	0.11925E+07	0.18317E+07
15	0.13029E+06	0.14275E+08	0.19484E+07	0.19800E+07	0.90616E+06	0.30225E+07	0.17977E+07

I	LEARN(I)	A1(I)	A2(I)	A3(I)	D(I,16)	BV(I,16)
1	0.80999E+08	0.28332E+08	0.10331E+06	0.31028E+06	0.10215E+07	0.91075E+07
2	0.86037E+08	0.37938E+08	0.10331E+06	0.26061E+06	0.17248E+07	0.77962E+07
3	0.90269E+08	0.48696E+08	0.10331E+06	0.21890E+06	0.16136E+07	0.66154E+07
4	0.93823E+08	0.60460E+08	0.10331E+06	0.18386E+06	0.14900E+07	0.55710E+07
5	0.96800E+08	0.73186E+08	0.10331E+06	0.15442E+06	0.13556E+07	0.46678E+07
6	0.99316E+08	0.86594E+08	0.10331E+06	0.12970E+06	0.12119E+07	0.39101E+07
7	0.10142E+09	0.10067E+09	0.10331E+06	0.10894E+06	0.10602E+07	0.33012E+07
8	0.10319E+09	0.11527E+09	0.10331E+06	0.91503E+05	0.90158E+06	0.28442E+07
9	0.10468E+09	0.13031E+09	0.10331E+06	0.76855E+05	0.73680E+06	0.25514E+07
10	0.10592E+09	0.14570E+09	0.10331E+06	0.64554E+05	0.56662E+06	0.23950E+07
11	0.10697E+09	0.16139E+09	0.10331E+06	0.54219E+05	0.39166E+06	0.24066E+07
12	0.10785E+09	0.17732E+09	0.10331E+06	0.45539E+05	0.21243E+06	0.25778E+07
13	0.10859E+09	0.19346E+09	0.10331E+06	0.38251E+05	0.19496E+06	0.23305E+07
14	0.10921E+09	0.20981E+09	0.10331E+06	0.32127E+05	0.18029E+06	0.21228E+07
15	0.10974E+09	0.22634E+09	0.10331E+06	0.26995E+05	0.16797E+06	0.19484E+07

I	FIXCY(I)	A4(I)	A5(I)	A6(I)	A7(I)	A8(I)	CMANF(I)
1	0.99928E+06	0.81386E+06	0.81386E+06	0.14339E+06	0.45329E+06	0.00000E+00	0.32237E+07
2	0.10292E+07	0.10859E+07	0.10859E+07	0.14799E+06	0.46784E+06	0.00000E+00	0.38169E+07
3	0.10601E+07	0.13889E+07	0.13889E+07	0.15206E+06	0.48071E+06	0.00000E+00	0.44706E+07
4	0.10918E+07	0.17109E+07	0.17109E+07	0.15569E+06	0.49219E+06	0.00000E+00	0.51774E+07
5	0.11245E+07	0.20717E+07	0.20717E+07	0.15895E+06	0.50249E+06	0.00000E+00	0.59294E+07
6	0.11582E+07	0.24435E+07	0.24435E+07	0.16190E+06	0.51180E+06	0.00000E+00	0.67190E+07
7	0.11929E+07	0.28306E+07	0.28306E+07	0.16456E+06	0.52029E+06	0.00000E+00	0.75391E+07
8	0.12287E+07	0.28912E+07	0.28912E+07	0.16704E+06	0.52807E+06	0.00000E+00	0.77063E+07
9	0.12655E+07	0.29224E+07	0.29224E+07	0.16932E+06	0.53527E+06	0.00000E+00	0.78150E+07
10	0.13034E+07	0.29468E+07	0.29468E+07	0.17145E+06	0.54198E+06	0.00000E+00	0.79104E+07
11	0.13425E+07	0.29653E+07	0.29653E+07	0.17344E+06	0.54827E+06	0.00000E+00	0.79949E+07
12	0.13827E+07	0.29791E+07	0.29791E+07	0.17532E+06	0.55422E+06	0.00000E+00	0.80705E+07
13	0.14241E+07	0.29889E+07	0.29889E+07	0.17711E+06	0.55986E+06	0.00000E+00	0.81389E+07
14	0.14668E+07	0.29953E+07	0.29953E+07	0.17882E+06	0.56529E+06	0.00000E+00	0.82015E+07
15	0.15108E+07	0.29989E+07	0.29989E+07	0.18047E+06	0.57050E+06	0.00000E+00	0.82595E+07

I	A9(I)	A10(I)	A11(I)	A12(I)	A13(I)	A14(I)	WC(I)
1	0.20680E+06	0.40511E+06	0.45649E+05	0.39936E+06	0.72195E+05	0.26845E+06	0.86467E+06
2	0.20680E+06	0.50967E+06	0.66246E+05	0.50243E+06	0.96330E+05	0.31785E+06	0.10636E+07
3	0.20680E+06	0.61763E+06	0.84725E+05	0.60866E+06	0.12321E+06	0.37229E+06	0.12669E+07
4	0.20680E+06	0.72756E+06	0.10468E+06	0.71722E+06	0.15247E+06	0.43114E+06	0.14778E+07
5	0.20680E+06	0.83833E+06	0.12638E+06	0.82642E+06	0.18378E+06	0.49376E+06	0.16879E+07
6	0.20680E+06	0.94910E+06	0.14907E+06	0.93562E+06	0.21676E+06	0.55952E+06	0.18978E+07
7	0.20680E+06	0.10593E+07	0.17268E+06	0.10443E+07	0.25110E+06	0.62781E+06	0.21063E+07
8	0.20680E+06	0.10461E+07	0.17630E+06	0.10312E+07	0.25647E+06	0.64173E+06	0.20752E+07
9	0.20680E+06	0.10255E+07	0.17020E+06	0.10109E+07	0.25924E+06	0.65078E+06	0.20299E+07
10	0.20680E+06	0.10057E+07	0.17976E+06	0.99144E+06	0.26140E+06	0.65872E+06	0.19864E+07
11	0.20680E+06	0.98691E+06	0.18090E+06	0.97299E+06	0.26305E+06	0.66576E+06	0.19448E+07
12	0.20680E+06	0.96909E+06	0.18174E+06	0.95532E+06	0.26427E+06	0.67206E+06	0.19052E+07
13	0.20680E+06	0.95226E+06	0.18233E+06	0.93873E+06	0.26513E+06	0.67775E+06	0.18675E+07
14	0.20680E+06	0.93638E+06	0.18272E+06	0.92308E+06	0.26570E+06	0.68296E+06	0.18317E+07
15	0.20680E+06	0.92141E+06	0.18294E+06	0.90852E+06	0.26602E+06	0.68780E+06	0.17977E+07

INITIAL INVESTMENT MM$ = 0.1034925E+02
START-UP INVESTMENT MM$ = 0.5798271E+00

NET PRESENT WORTH OVER ZERO PERCENT COST OF CAPITAL = 0.1595978E+08
BREAKEVEN YEAR = 7
NET PRESENT WORTH OVER 10 PERCENT COST OF CAPITAL = 0.1294136E+07
BREAKEVEN YEAR = 12
DISCOUNTED RATE OF RETURN = 0.1166992E+00

VALUES USING A CONSTANT RANDOM VARIABLE = 0.700

	SP(I)	DEM(I)	F(I)	R(I)	C(I)	RMC(I)	PROD(I)	LEARN(I)
1	0.16285E+02	0.62808E+09	0.49440E+01	0.10886E+01	0.29107E+01	0.29107E+01	0.31052E+08	0.81643E+08
2	0.15461E+02	0.75063E+09	0.55867E+01	0.11627E+01	0.29005E+01	0.29005E+01	0.41935E+08	0.87201E+08
3	0.14726E+02	0.88397E+09	0.61501E+01	0.12247E+01	0.28903E+01	0.28903E+01	0.54364E+08	0.91051E+08
4	0.14079E+02	0.10275E+10	0.66439E+01	0.12765E+01	0.28802E+01	0.28802E+01	0.60266E+08	0.95741E+08
5	0.13484E+02	0.11806E+10	0.70769E+01	0.13199E+01	0.28701E+01	0.28701E+01	0.83547E+08	0.90996E+08
6	0.12958E+02	0.13426E+10	0.74565E+01	0.13562E+01	0.28600E+01	0.28600E+01	0.10011E+09	0.10172E+09
7	0.12487E+02	0.15130E+10	0.77892E+01	0.13866E+01	0.28500E+01	0.28500E+01	0.10400E+09	0.10400E+09
8	0.12063E+02	0.16914E+10	0.80809E+01	0.14120E+01	0.28400E+01	0.28400E+01	0.10590E+09	0.10590E+09
9	0.11680E+02	0.18773E+10	0.83366E+01	0.14333E+01	0.28300E+01	0.28300E+01	0.10750E+09	0.10750E+09
10	0.11335E+02	0.20705E+10	0.85608E+01	0.14511E+01	0.28201E+01	0.28201E+01	0.10883E+09	0.10883E+09
11	0.11022E+02	0.22707E+10	0.87573E+01	0.14660E+01	0.28102E+01	0.28102E+01	0.10995E+09	0.10995E+09
12	0.10739E+02	0.24780E+10	0.89295E+01	0.14784E+01	0.28004E+01	0.28004E+01	0.11088E+09	0.11088E+09
13	0.10480E+02	0.26923E+10	0.90806E+01	0.14886E+01	0.27905E+01	0.27905E+01	0.11166E+09	0.11166E+09
14	0.10244E+02	0.29136E+10	0.92130E+01	0.14976E+01	0.27807E+01	0.27807E+01	0.11232E+09	0.11232E+09
15	0.10027E+02	0.31420E+10	0.93290E+01	0.15048E+01	0.27710E+01	0.27710E+01	0.11286E+09	0.11286E+09

	INVEST(I)	SUMINV(I)	SAL(I)	BTP(I)	ATP(I)	CF(I)	WC(I)
1	0.58273E+06	0.12258E+08	0.00000E+00	0.14332E+07	-.25202E+06	0.16939E+07	0.11210E+07
2	0.50915E+06	0.12767E+08	0.00000E+00	0.21674E+07	0.14810E+06	0.20142E+07	0.14089E+07
3	0.44758E+06	0.13215E+08	0.00000E+00	0.29146E+07	0.56497E+06	0.23302E+07	0.17166E+07
4	0.39608E+06	0.13611E+08	0.00000E+00	0.36608E+07	0.99021E+06	0.26366E+07	0.20401E+07
5	0.35299E+06	0.13964E+08	0.00000E+00	0.43954E+07	0.14173E+07	0.29295E+07	0.23761E+07
6	0.31694E+06	0.14281E+08	0.00000E+00	0.51106E+07	0.18413E+07	0.32061E+07	0.27219E+07
7	0.28677E+06	0.14568E+08	0.00000E+00	0.48615E+07	0.17965E+07	0.30029E+07	0.27185E+07
8	0.26154E+06	0.14829E+08	0.00000E+00	0.45019E+07	0.17030E+07	0.27405E+07	0.26687E+07
9	0.24043E+06	0.15070E+08	0.00000E+00	0.41530E+07	0.16165E+07	0.24789E+07	0.26175E+07
10	0.22277E+06	0.15293E+08	0.00000E+00	0.38173E+07	0.15443E+07	0.22200E+07	0.25661E+07
11	0.20799E+06	0.15500E+08	0.00000E+00	0.34962E+07	0.14804E+07	0.19650E+07	0.25152E+07
12	0.19563E+06	0.15696E+08	0.00000E+00	0.31900E+07	0.14268E+07	0.17143E+07	0.24653E+07
13	0.18528E+06	0.15881E+08	0.00000E+00	0.28986E+07	0.12960E+07	0.15581E+07	0.24169E+07
14	0.17663E+06	0.16058E+08	0.00000E+00	0.26212E+07	0.11701E+07	0.14110E+07	0.23700E+07
15	0.16939E+06	0.16227E+08	0.26199E+07	0.23570E+07	0.10469E+07	0.38920E+07	0.23248E+07

I	LEARN(I)	A1(I)	A2(I)	A3(I)	D(I,16)	BV(I,16)
1	0.81643E+08	0.31052E+08	0.13231E+06	0.45042E+06	0.19459E+07	0.97296E+07
2	0.87201E+08	0.41935E+08	0.13231E+06	0.37684E+06	0.18661E+07	0.84462E+07
3	0.91851E+08	0.54364E+08	0.13231E+06	0.31526E+06	0.17653E+07	0.72872E+07
4	0.95741E+08	0.66266E+08	0.13231E+06	0.26577E+06	0.16464E+07	0.62615E+07
5	0.98996E+08	0.83547E+08	0.13231E+06	0.22068E+06	0.15122E+07	0.53766E+07
6	0.10172E+09	0.10011E+09	0.13231E+06	0.18463E+06	0.13648E+07	0.46387E+07
7	0.10400E+09	0.11785E+09	0.13231E+06	0.15446E+06	0.12061E+07	0.40529E+07
8	0.10590E+09	0.13668E+09	0.13231E+06	0.12923E+06	0.10375E+07	0.36238E+07
9	0.10750E+09	0.15650E+09	0.13231E+06	0.10812E+06	0.86034E+06	0.33549E+07
10	0.10883E+09	0.17725E+09	0.13231E+06	0.90458E+05	0.67572E+06	0.32492E+07
11	0.10995E+09	0.19885E+09	0.13231E+06	0.75678E+05	0.48452E+06	0.33094E+07
12	0.11088E+09	0.22127E+09	0.13231E+06	0.63317E+05	0.28748E+06	0.35375E+07
13	0.11166E+09	0.24447E+09	0.13231E+06	0.52974E+05	0.26213E+06	0.31757E+07
14	0.11232E+09	0.26843E+09	0.13231E+06	0.44319E+05	0.24092E+06	0.28731E+07
15	0.11286E+09	0.29314E+09	0.13231E+06	0.37078E+05	0.22318E+06	0.26199E+07

I	FIXCY(I)	A4(I)	A5(I)	A6(I)	A7(I)	A8(I)	CMANF(I)
1	0.10844E+07	0.90304E+06	0.90304E+06	0.38957E+06	0.54204E+06	0.00000E+00	0.36237E+07
2	0.11215E+07	0.12163E+07	0.12163E+07	0.19744E+06	0.56455E+06	0.00000E+00	0.43161E+07
3	0.11598E+07	0.15713E+07	0.15713E+07	0.20436E+06	0.58435E+06	0.00000E+00	0.50912E+07
4	0.11995E+07	0.19662E+07	0.19662E+07	0.21049E+06	0.60186E+06	0.00000E+00	0.59443E+07
5	0.12406E+07	0.23979E+07	0.23979E+07	0.21595E+06	0.61747E+06	0.00000E+00	0.68697E+07
6	0.12830E+07	0.28631E+07	0.28631E+07	0.22085E+06	0.63148E+06	0.00000E+00	0.78616E+07
7	0.13269E+07	0.29639E+07	0.29639E+07	0.22526E+06	0.64416E+06	0.00000E+00	0.81242E+07
8	0.13723E+07	0.30076E+07	0.30076E+07	0.22933E+06	0.65573E+06	0.00000E+00	0.82727E+07
9	0.14193E+07	0.30422E+07	0.30422E+07	0.23305E+06	0.66636E+06	0.00000E+00	0.84031E+07
10	0.14679E+07	0.30692E+07	0.30692E+07	0.23649E+06	0.67621E+06	0.00000E+00	0.85109E+07
11	0.15181E+07	0.30898E+07	0.30898E+07	0.23971E+06	0.68541E+06	0.00000E+00	0.86227E+07
12	0.15700E+07	0.31051E+07	0.31051E+07	0.24273E+06	0.69406E+06	0.00000E+00	0.87176E+07
13	0.16238E+07	0.31160E+07	0.31160E+07	0.24560E+06	0.70225E+06	0.00000E+00	0.88036E+07
14	0.16793E+07	0.31232E+07	0.31232E+07	0.24833E+06	0.71006E+06	0.00000E+00	0.88842E+07
15	0.17368E+07	0.31274E+07	0.31274E+07	0.25095E+06	0.71755E+06	0.00000E+00	0.89601E+07

I	A9(I)	A10(I)	A11(I)	A12(I)	A13(I)	A14(I)	WC(I)
1	0.24157E+06	0.52648E+06	0.63463E+05	0.52348E+06	0.93550E+05	0.32745E+06	0.11210E+07
2	0.24157E+06	0.67501E+06	0.85405E+05	0.67106E+06	0.12589E+06	0.39002E+06	0.14089E+07
3	0.24157E+06	0.83349E+06	0.11033E+06	0.82366E+06	0.16264E+06	0.46006E+06	0.17166E+07
4	0.24157E+06	0.99999E+06	0.13806E+06	0.99819E+06	0.20351E+06	0.53715E+06	0.20401E+07
5	0.24157E+06	0.11720E+07	0.16837E+06	0.11663E+07	0.24819E+06	0.62078E+06	0.23761E+07
6	0.24157E+06	0.13506E+07	0.20194E+06	0.13427E+07	0.29834E+06	0.71041E+06	0.27218E+07
7	0.24157E+06	0.13519E+07	0.20811E+06	0.13441E+07	0.30677E+06	0.73413E+06	0.27183E+07
8	0.24157E+06	0.13360E+07	0.21118E+06	0.13222E+07	0.31130E+06	0.74755E+06	0.26687E+07
9	0.24157E+06	0.13072E+07	0.21361E+06	0.12995E+07	0.31488E+06	0.75934E+06	0.26175E+07
10	0.24157E+06	0.12803E+07	0.21550E+06	0.12762E+07	0.31767E+06	0.76980E+06	0.25661E+07
11	0.24157E+06	0.12617E+07	0.21695E+06	0.12543E+07	0.31980E+06	0.77918E+06	0.25152E+07
12	0.24157E+06	0.12396E+07	0.21802E+06	0.12328E+07	0.32136E+06	0.78770E+06	0.24653E+07
13	0.24157E+06	0.12163E+07	0.21878E+06	0.12112E+07	0.32251E+06	0.79552E+06	0.24162E+07
14	0.24157E+06	0.11976E+07	0.21930E+06	0.11908E+07	0.32326E+06	0.80281E+06	0.23700E+07
15	0.24157E+06	0.11782E+07	0.21959E+06	0.11714E+07	0.32370E+06	0.80967E+06	0.23246E+07

INITIAL INVESTMENT MMS = 0.1092636E+02
START-UP INVESTMENT MMS = 0.7493315E+00

NET PRESENT WORTH OVER ZERO PERCENT COST OF CAPITAL = 0.1956557E+06
BREAKEVEN YEAR = 6
NET PRESENT WORTH OVER 10 PERCENT COST OF CAPITAL = 0.2120412E+07
BREAKEVEN YEAR = 11
DISCOUNTED RATE OF RETURN = 0.1240236E+00

VALUES USING A CONSTANT RANDOM VARIABLE = 0.900

	SP(I)	DEM(I)	P(I)	R(I)	C(I)	RMC(I)	PROD(I)	LEARN(I)
1	0.16790E+02	0.66099E+09	0.52552E+01	0.10965E+01	0.29646E+01	0.29646E+01	0.34736E+08	0.82236E+08
2	0.16142E+02	0.79768E+09	0.59261E+01	0.11774E+01	0.29544E+01	0.29544E+01	0.47271E+08	0.88306E+08
3	0.15548E+02	0.94992E+09	0.65187E+01	0.12453E+01	0.29442E+01	0.29442E+01	0.61923E+08	0.93400E+08
4	0.15001E+02	0.11178E+10	0.70423E+01	0.13023E+01	0.29341E+01	0.29341E+01	0.78720E+08	0.97673E+08
5	0.14499E+02	0.13014E+10	0.75040E+01	0.13504E+01	0.29240E+01	0.29240E+01	0.97668E+08	0.10126E+09
6	0.14037E+02	0.15007E+10	0.79135E+01	0.13902E+01	0.29139E+01	0.29139E+01	0.10427E+09	0.10427E+09
7	0.13611E+02	0.17158E+10	0.82744E+01	0.14239E+01	0.29039E+01	0.29039E+01	0.10679E+09	0.10679E+09
8	0.13218E+02	0.19466E+10	0.85933E+01	0.14521E+01	0.28939E+01	0.28939E+01	0.10891E+09	0.10891E+09
9	0.12855E+02	0.21933E+10	0.88750E+01	0.14758E+01	0.28839E+01	0.28839E+01	0.11068E+09	0.11068E+09
10	0.12520E+02	0.24561E+10	0.91239E+01	0.14956E+01	0.28740E+01	0.28740E+01	0.11217E+09	0.11217E+09
11	0.12210E+02	0.27352E+10	0.93437E+01	0.15123E+01	0.28641E+01	0.28641E+01	0.11342E+09	0.11342E+09
12	0.11922E+02	0.30310E+10	0.95380E+01	0.15263E+01	0.28542E+01	0.28542E+01	0.11447E+09	0.11447E+09
13	0.11655E+02	0.33438E+10	0.97095E+01	0.15380E+01	0.28444E+01	0.28444E+01	0.11535E+09	0.11535E+09
14	0.11407E+02	0.36742E+10	0.98611E+01	0.15479E+01	0.28346E+01	0.28346E+01	0.11609E+09	0.11609E+09
15	0.11177E+02	0.40229E+10	0.99950E+01	0.15561E+01	0.28249E+01	0.28249E+01	0.11671E+09	0.11671E+09

	INVEST(I)	SUMINV(I)	SAL(I)	BTP(I)	ATP(I)	CF(I)	WC(I)
1	0.85955E+06	0.13658E+08	0.00000E+00	0.16192E+07	-.24674E+06	0.18864E+07	0.15467E+07
2	0.74957E+06	0.14408E+08	0.00000E+00	0.25838E+07	0.24075E+06	0.23232E+07	0.19896E+07
3	0.65728E+06	0.15065E+08	0.00000E+00	0.36319E+07	0.78337E+06	0.27838E+07	0.24831E+07
4	0.57986E+06	0.15645E+08	0.00000E+00	0.47580E+07	0.13715E+07	0.32632E+07	0.30236E+07
5	0.51491E+06	0.16160E+08	0.00000E+00	0.59179E+07	0.19964E+07	0.37565E+07	0.36074E+07
6	0.46041E+06	0.16620E+08	0.00000E+00	0.59394E+07	0.20794E+07	0.36882E+07	0.37188E+07
7	0.41469E+06	0.17035E+08	0.00000E+00	0.56259E+07	0.20096E+07	0.34503E+07	0.36855E+07
8	0.37633E+06	0.17411E+08	0.00000E+00	0.52983E+07	0.19400E+07	0.31980E+07	0.36424E+07
9	0.34415E+06	0.17755E+08	0.00000E+00	0.49639E+07	0.18733E+07	0.29359E+07	0.35924E+07
10	0.31715E+06	0.18072E+08	0.00000E+00	0.46281E+07	0.18112E+07	0.26674E+07	0.35377E+07
11	0.29450E+06	0.18367E+08	0.00000E+00	0.42947E+07	0.17549E+07	0.23949E+07	0.34803E+07
12	0.27549E+06	0.18642E+08	0.00000E+00	0.39661E+07	0.17050E+07	0.21203E+07	0.34211E+07
13	0.25955E+06	0.18902E+08	0.00000E+00	0.36440E+07	0.15688E+07	0.19456E+07	0.33614E+07
14	0.24617E+06	0.19148E+08	0.00000E+00	0.33292E+07	0.14331E+07	0.17777E+07	0.33016E+07
15	0.23495E+06	0.19383E+08	0.37657E+07	0.30222E+07	0.12987E+07	0.53819E+07	0.32424E+07

I	LEARN(I)	A1(I)	A2(I)	A3(I)	D(I,16)	BV(I,16)
1	0.62236E+08	0.34736E+08	0.17647E+06	0.68308E+06	0.21331E+07	0.10665E+08
2	0.88306E+08	0.47271E+08	0.17647E+06	0.57310E+06	0.20824E+07	0.94426E+07
3	0.93400E+08	0.61923E+08	0.17647E+06	0.48082E+06	0.20004E+07	0.83350E+07
4	0.97673E+08	0.78720E+08	0.17647E+06	0.40339E+06	0.18917E+07	0.73558E+07
5	0.10126E+09	0.97668E+08	0.17647E+06	0.33844E+06	0.17601E+07	0.65159E+07
6	0.10427E+09	0.11876E+09	0.17647E+06	0.28394E+06	0.16068E+07	0.58246E+07
7	0.10679E+09	0.14197E+09	0.17647E+06	0.23822E+06	0.14407E+07	0.52096E+07
8	0.10891E+09	0.16728E+09	0.17647E+06	0.19980E+06	0.12580E+07	0.49174E+07
9	0.11068E+09	0.19466E+09	0.17647E+06	0.16768E+06	0.10626E+07	0.47135E+07
10	0.11217E+09	0.22410E+09	0.17647E+06	0.14068E+06	0.85619E+06	0.46823E+07
11	0.11342E+09	0.25557E+09	0.17647E+06	0.11803E+06	0.64003E+06	0.48278E+07
12	0.11447E+09	0.28909E+09	0.17647E+06	0.99020E+05	0.41520E+06	0.51531E+07
13	0.11535E+09	0.32467E+09	0.17647E+06	0.83079E+05	0.37683E+06	0.56075E+07
14	0.11609E+09	0.36232E+09	0.17647E+06	0.69702E+05	0.34457E+06	0.61998E+07
15	0.11671E+09	0.40209E+09	0.17647E+06	0.58476E+05	0.31750E+06	0.37657E+07

I	FIXCY(I)	A4(I)	A5(I)	A6(I)	A7(I)	A8(I)	CMANF(I)
1	0.11983E+07	0.10298E+07	0.10298E+07	0.27527E+06	0.68175E+06	0.00000E+00	0.42129E+07
2	0.12461E+07	0.13966E+07	0.13966E+07	0.20826E+06	0.71917E+06	0.00000E+00	0.50467E+07
3	0.12959E+07	0.18231E+07	0.18231E+07	0.30141E+06	0.75198E+06	0.00000E+00	0.59956E+07
4	0.13476E+07	0.23097E+07	0.23097E+07	0.31502E+06	0.78092E+06	0.00000E+00	0.70610E+07
5	0.14014E+07	0.28550E+07	0.28550E+07	0.32832E+06	0.80662E+06	0.00000E+00	0.82429E+07
6	0.14573E+07	0.30302E+07	0.30302E+07	0.33253E+06	0.82960E+06	0.00000E+00	0.86959E+07
7	0.15155E+07	0.31010E+07	0.31010E+07	0.34083E+06	0.85030E+06	0.00000E+00	0.89037E+07
8	0.15760E+07	0.31516E+07	0.31516E+07	0.34636E+06	0.86909E+06	0.00000E+00	0.90967E+07
9	0.16389E+07	0.31920E+07	0.31920E+07	0.35524E+06	0.88627E+06	0.00000E+00	0.92644E+07
10	0.17043E+07	0.32238E+07	0.32238E+07	0.36159E+06	0.90210E+06	0.00000E+00	0.94157E+07
11	0.17724E+07	0.32485E+07	0.32485E+07	0.36748E+06	0.91680E+06	0.00000E+00	0.95537E+07
12	0.18431E+07	0.32673E+07	0.32673E+07	0.37209E+06	0.93055E+06	0.00000E+00	0.96812E+07
13	0.19167E+07	0.32811E+07	0.32811E+07	0.37626E+06	0.94350E+06	0.00000E+00	0.98005E+07
14	0.19932E+07	0.32907E+07	0.32907E+07	0.38041E+06	0.95579E+06	0.00000E+00	0.99135E+07
15	0.20727E+07	0.32963E+07	0.32963E+07	0.38781E+06	0.96752E+06	0.00000E+00	0.10022E+08

I	A9(I)	A10(I)	A11(I)	A12(I)	A13(I)	A14(I)	WC(I)
1	0.29445E+06	0.72948E+06	0.85378E+05	0.72691E+06	0.12871E+06	0.42070E+06	0.15467E+07
2	0.29445E+06	0.95442E+06	0.11646E+06	0.95366E+06	0.17455E+06	0.50396E+06	0.19896E+07
3	0.29445E+06	0.12042E+07	0.15204E+06	0.12042E+07	0.22786E+06	0.59871E+06	0.24831E+07
4	0.29445E+06	0.14776E+07	0.19261E+06	0.14765E+07	0.28867E+06	0.70510E+06	0.30236E+07
5	0.29445E+06	0.17712E+07	0.23815E+06	0.17696E+07	0.35692E+06	0.82313E+06	0.36074E+07
6	0.29445E+06	0.18336E+07	0.25336E+06	0.18291E+07	0.37972E+06	0.86837E+06	0.37108E+07
7	0.29445E+06	0.18160E+07	0.25860E+06	0.18166E+07	0.38757E+06	0.88962E+06	0.36855E+07
8	0.29445E+06	0.18005E+07	0.26282E+06	0.17991E+07	0.39389E+06	0.90839E+06	0.36428E+07
9	0.29445E+06	0.17796E+07	0.26619E+06	0.17783E+07	0.39894E+06	0.92513E+06	0.35924E+07
10	0.29445E+06	0.17566E+07	0.26884E+06	0.17562E+07	0.40292E+06	0.94024E+06	0.35377E+07
11	0.29445E+06	0.17321E+07	0.27090E+06	0.17308E+07	0.40601E+06	0.95402E+06	0.34803E+07
12	0.29445E+06	0.17070E+07	0.27247E+06	0.17057E+07	0.40836E+06	0.96676E+06	0.34211E+07
13	0.29445E+06	0.16816E+07	0.27362E+06	0.16802E+07	0.41007E+06	0.97867E+06	0.33614E+07
14	0.29445E+06	0.16564E+07	0.27442E+06	0.16551E+07	0.41126E+06	0.98995E+06	0.33016E+07
15	0.29445E+06	0.16315E+07	0.27493E+06	0.16303E+07	0.41205E+06	0.10000E+07	0.32424E+07

INITIAL INVESTMENT MM$ = 0.1179777E+02
START-UP INVESTMENT MM$ = 0.1000940E+01

NET PRESENT WORTH OVER ZERO PERCENT COST OF CAPITAL = 0.2418998E+08
BREAKEVEN YEAR = 6
NET PRESENT WORTH OVER 10 PERCENT COST OF CAPITAL = 0.2754928E+07
BREAKEVEN YEAR = 11
DISCOUNTED RATE OF RETURN = 0.1259766E+00

PROFITABILITY VALUES FOR EACH MONTE CARLO RUN

MRUN	NPY	LOAD	PW1	YPW1	PWO	YPWO	YIELD2
1	12	8	1851140.	11.	16356172.	7.	0.123647
2	12	8	545504.	12.	12991640.	7.	0.107422
3	15	6	3773100.	9.	20910336.	6.	0.146884
4	13	6	7559168.	7.	27293416.	5.	0.191406
5	13	9	-1552762.	0.	8135356.	8.	0.075684
6	17	8	3473404.	9.	21552056.	6.	0.142578
7	15	6	4072336.	9.	22130464.	6.	0.147461
8	12	11	-2964364.	0.	485623b.	10.	0.049805
9	13	9	-2665672.	0.	6032724.	9.	0.057617
10	15	7	6607648.	7.	27086368.	6.	0.179688
11	17	6	17819024.	5.	56055184.	3.	0.269531
12	18	8	6920780.	7.	20797536.	5.	0.184570
13	15	7	2863992.	10.	19235008.	6.	0.135742
14	15	8	96620.	15.	13248356.	7.	0.101563
15	13	7	-267724.	0.	11243796.	7.	0.094191
16	13	8	-161828.	0.	32786912.	7.	0.097656
17	12	8	-1898696.	0.	9056660.	8.	0.074707
18	13	11	-3085328.	0.	4605872.	10.	0.047852
19	14	11	-6650264.	0.	-789300.	0.	-0.007813
20	18	9	2312503.	8.	17559456.	6.	0.143555
21	14	6	6342640.	7.	24724624.	5.	0.180664
22	8	6	-2654908.	0.	3932084.	7.	0.051270
23	15	8	346876.	15.	14653928.	7.	0.104492
24	17	7	3493372.	7.	18220048.	5.	0.153320
25	13	7	7588092.	7.	26488696.	5.	0.199219
26	15	11	-1273756.	0.	9597192.	8.	0.081055
27	14	6	2867972.	10.	18523696.	6.	0.129883
28	17	11	634652.	17.	15261736.	7.	0.108398
29	18	7	12490256.	6.	45645280.	4.	0.227539
30	15	12	-5616694.	0.	5534004.	12.	0.036133
31	14	14	-5571988.	0.	1362964.	14.	0.012695
32	19	7	5265092.	8.	19371048.	5.	0.155508
33	15	7	5971272.	9.	29450312.	6.	0.150180
34	9	9	-2498866.	0.	3107236.	8.	0.046490
35	14	8	-170320.	0.	12499696.	7.	0.097656
36	17	7	18105724.	6.	36049568.	5.	0.210938
37	15	5	11568112.	6.	37364608.	4.	0.230469
38	15	7	4113524.	9.	21665992.	6.	0.151367
39	10	0	-3925876.	0.	2347220.	9.	0.028320
40	14	9	-1243140.	0.	9701648.	8.	0.062031
41	18	9	2316628.	9.	17193744.	6.	0.132813
42	14	8	3320660.	9.	19371136.	6.	0.143555
43	12	6	6614348.	7.	23436272.	5.	0.187500
44	14	14	-4209014.	0.	4397896.	12.	0.037598
45	15	14	-6349270.	0.	361812.	15.	0.003174
46	15	8	1452940.	12.	17197400.	7.	0.117676
47	16	8	9795624.	6.	35686864.	5.	0.208984
48	13	6	6429152.	7.	31711664.	5.	0.185547
49	16	9	678892.	16.	14279844.	6.	0.109375
50	15	9	-3474282.	0.	5076272.	10.	0.043945
51	14	10	-3397312.	0.	5085028.	10.	0.046875
52	18	9	6054876.	7.	34314544.	5.	0.184570
53	15	8	5906156.	8.	27692520.	6.	0.166016
54	11	7	3249820.	8.	17529536.	6.	0.142578
55	16	9	3933184.	9.	23696568.	6.	0.145996
56	16	7	11776604.	6.	39403632.	5.	0.231445

57	15	7	4451552.	[illegible]	24582504.	6.	0.144456
58	16	7	6911624.	7.	27141064.	5.	0.186523
59	15	5	13189772.	6.	42473744.	4.	0.233398
60	15	8	-4850080.	0.	2278452.	11.	0.022461
61	12	9	-986152.	0.	8114076.	8.	0.087496
62	18	6	8185368.	6.	28449280.	4.	0.216797
63	19	7	7199620.	6.	20056064.	5.	0.198242
64	15	7	5770880.	8.	25138048.	6.	0.171875
65	12	10	-3615318.	0.	5122404.	10.	0.046387
66	17	7	7025752.	6.	25895696.	5.	0.199219
67	14	6	7185464.	7.	27250136.	5.	0.188477
68	19	7	9197976.	7.	36470224.	5.	0.199219
69	11	7	2143528.	9.	13793052.	6.	0.131836
70	13	8	-1998256.	0.	8352660.	8.	0.071777
71	12	8	771488.	12.	12589164.	7.	0.111328
72	11	7	2229068.	9.	15916760.	6.	0.128418
73	19	6	8273928.	7.	34250352.	5.	0.185547
74	15	11	-587764.	0.	13071204.	8.	0.092773
75	13	9	298672.	13.	14191972.	7.	0.103516
76	15	8	2404540.	11.	19719496.	7.	0.127930
77	11	7	1718260.	10.	15786324.	6.	0.121094
78	12	8	-637440.	0.	10575108.	7.	0.090820
79	21	6	9243068.	5.	34765904.	4.	0.208984
80	16	10	5852116.	9.	28092936.	6.	0.164551
81	15	8	-2725820.	0.	6773952.	9.	0.059570
82	14	11	-2131654.	0.	7339740.	9.	0.066406
83	18	8	3838700.	9.	23350656.	6.	0.143555
84	17	6	8732436.	5.	31209816.	5.	0.207031
85	15	7	-120152.	0.	11794932.	7.	0.098145
86	12	10	-4430240.	0.	5290980.	10.	0.042480
87	18	6	14092984.	5.	46466992.	4.	0.245117
88	13	8	524056.	13.	12591204.	7.	0.107422
89	19	7	3220892.	8.	19197296.	5.	0.143555
90	15	8	-1181480.	0.	9215180.	7.	0.082031
91	17	8	1039896.	10.	11007492.	6.	0.118164
92	14	8	-3537900.	0.	7216336.	9.	0.054688
93	16	8	7425356.	7.	30642728.	5.	0.181641
94	13	6	3530868.	6.	19314984.	5.	0.143555
95	16	10	1952896.	10.	14619436.	6.	0.131836
96	18	7	8543500.	6.	31859680.	5.	0.202125
97	14	9	-3760710.	0.	4655272.	10.	0.042480
98	19	14	263708.	19.	14029940.	7.	0.103516
99	12	9	-1724516.	0.	7352428.	8.	0.072266
100	19	10	-2201708.	0.	6825456.	7.	0.066848
101	12	6	5496180.	7.	20288864.	5.	0.180664
102	13	7	-267724.	0.	11241796.	7.	0.095191
103	13	8	-161628.	0.	12786912.	7.	0.097656
104	12	8	-1898696.	0.	9056660.	8.	0.074707
105	13	11	-3085328.	0.	4685872.	10.	0.047852
106	14	11	-6655264.	0.	-789308.	0.	-0.007813
107	18	9	2912508.	8.	17659456.	6.	0.143555
108	14	6	6342640.	7.	24724624.	5.	0.180664
109	8	6	-2654908.	0.	3932084.	7.	0.051270
110	15	8	346876.	15.	14653928.	7.	0.104492
111	17	7	3493372.	7.	18220848.	5.	0.153320
112	13	7	7588092.	7.	26408696.	5.	0.199219
113	15	11	-1273756.	0.	9587192.	8.	0.081055
114	14	6	2467972.	10.	18523696.	6.	0.129883
115	17	11	634652.	17.	15261736.	7.	0.108398
116	18	7	12498256.	6.	43645280.	4.	0.227539
117	15	12	-5610694.	0.	5534004.	12.	0.036133
118	14	14	-5571980.	0.	1362964.	14.	0.012695
119	19	7	3265092.	8.	19371048.	5.	0.145508
120	15	7	5971272.	9.	29450312.	6.	0.159180
121	9	9	-2495366.	0.	3107236.	8.	0.045898
122	14	8	-170320.	0.	12499696.	7.	0.097656
123	17	7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

123	17	7	10103724.	8.	38049568.	5.	0.210730
124	15	5	11568112.	6.	37304688.	4.	0.230469
125	15	7	4113524.	9.	21665992.	6.	0.151367
126	10	0	-3925876.	0.	2347220.	9.	0.020320
127	14	9	-1243140.	0.	9701048.	8.	0.082031
128	18	9	2310628.	9.	17193744.	6.	0.132813
129	14	8	3320860.	9.	19371136.	6.	0.148555
130	12	6	5619308.	7.	26436272.	5.	0.187500
131	14	14	-4209014.	0.	4397696.	12.	0.037598
132	13	14	-6349270.	0.	361812.	15.	0.003174
133	15	8	1453940.	12.	17197400.	7.	0.117676
134	16	8	9795624.	6.	35646864.	5.	0.258984
135	13	6	6429152.	7.	31711664.	5.	0.185547
136	16	9	678032.	16.	14279844.	6.	0.109375
137	15	9	-3474282.	0.	8076272.	10.	0.045450
138	14	10	-3397312.	0.	5065028.	10.	0.044675
139	18	9	8054876.	7.	34314964.	5.	0.164570
140	15	8	5980156.	8.	27692520.	6.	0.166016
141	11	7	3249820.	8.	17229536.	6.	0.102578
142	16	9	3933184.	9.	23696568.	6.	0.135956
143	16	7	11776604.	8.	39403832.	5.	0.251945
144	15	7	4431552.	9.	24262304.	6.	0.148438
145	16	7	6911624.	7.	27141064.	5.	0.166523
146	15	5	13189772.	6.	42473760.	4.	0.253758
147	15	8	-4050080.	0.	2278452.	11.	0.022461
148	12	9	-986152.	0.	8114076.	8.	0.063496
149	18	6	8185360.	6.	29449280.	4.	0.216797
150	19	7	7199620.	6.	28056064.	5.	0.198242
151	15	7	5770880.	8.	25138048.	6.	0.171875
152	12	10	-3615318.	0.	5122404.	10.	0.046387
153	17	7	7029752.	6.	25895696.	5.	0.199219
154	14	6	7189464.	7.	27250136.	5.	0.188477
155	15	7	9197976.	7.	30470224.	5.	0.199219
156	11	7	2145528.	9.	13793052.	6.	0.131836
157	13	8	-1998256.	0.	8352660.	8.	0.071777
158	12	8	771488.	12.	12589164.	7.	0.111328
159	11	7	2229064.	9.	15916760.	6.	0.120410
160	19	6	8273928.	7.	24250352.	5.	0.165547
161	15	11	-567764.	0.	13071264.	8.	0.092773
162	13	9	294672.	13.	14191972.	7.	0.103516
163	15	8	2403548.	11.	19719496.	7.	0.127930
164	11	7	1718260.	10.	15746324.	6.	0.121094
165	12	8	-637440.	0.	10575108.	7.	0.090820
166	21	6	9243068.	6.	34765904.	4.	0.208984
167	16	10	5852116.	8.	28092936.	6.	0.164551
168	15	8	-2725820.	0.	6773952.	9.	0.059570
169	14	11	-2131654.	0.	7339740.	9.	0.064406
170	18	8	3836700.	9.	23350656.	6.	0.143555
171	17	6	8732436.	6.	31209816.	5.	0.207031
172	15	7	-120152.	0.	11794932.	7.	0.098145
173	12	10	-4436240.	0.	5290980.	10.	0.042480
174	18	6	14092984.	5.	46466992.	4.	0.245117
175	13	8	524056.	13.	12591204.	7.	0.107422
176	19	7	3220892.	8.	19197296.	5.	0.143555
177	15	8	-1181480.	0.	9215180.	7.	0.082031
178	17	8	1039896.	10.	11807492.	6.	0.118164
179	14	8	-3537900.	0.	7216336.	9.	0.054688
180	16	8	7425356.	7.	30642728.	5.	0.181641
181	13	6	3530868.	8.	19314984.	5.	0.143555
182	16	10	1952896.	10.	14619436.	6.	0.131836
183	18	7	8543500.	6.	31859680.	5.	0.203125
184	14	9	-3760710.	0.	4655272.	10.	0.042480
185	19	14	263788.	19.	14029940.	7.	0.103516
186	12	9	-1724516.	0.	7252428.	8.	0.072266
187	19	10	-2201748.	0.	8825456.	7.	0.088943
188	12	6	5496180.	7.	20288864.	5.	0.180664

189	13	7	-267724.	0.	11241795.	7.	0.095191
190	13	8	-161828.	0.	12786912.	7.	0.097656
191	12	8	-1898696.	0.	9056660.	8.	0.074707
192	13	11	-3085328.	0.	4685872.	10.	0.047852
193	14	11	-6655264.	0.	-709308.	0.	-0.007816
194	18	9	2912508.	8.	17859956.	6.	0.143555
195	14	6	6342640.	7.	24724624.	5.	0.180664
196	8	6	-2654908.	0.	3932084.	7.	0.051270
197	15	8	346876.	15.	14653928.	7.	0.104492
198	17	7	3493372.	7.	18220848.	5.	0.153320
199	13	7	7588092.	7.	26488696.	5.	0.199219
200	15	11	-1273756.	0.	9587192.	8.	0.061035
201	14	6	2467972.	10.	18523696.	6.	0.129883
202	17	11	634652.	17.	15261736.	7.	0.108398
203	18	7	12498256.	6.	43645200.	4.	0.227539
204	15	12	-5610694.	0.	5534004.	12.	0.046133
205	14	14	-5571988.	0.	1362964.	14.	0.022695
206	19	7	3265092.	8.	19371048.	5.	0.145508
207	15	7	5971272.	9.	29450312.	6.	0.159180
208	9	9	-2498366.	0.	3107256.	8.	0.046898
209	14	8	-170520.	0.	12499696.	7.	0.097656
210	17	7	10105724.	6.	36049568.	5.	0.210938
211	15	5	11568112.	6.	37304688.	4.	0.230469
212	15	7	4113524.	9.	21665992.	6.	0.151367
213	10	0	-3925876.	0.	2347220.	9.	0.026320
214	14	9	-1243140.	0.	9701848.	8.	0.082031
215	18	9	2310628.	9.	17193744.	6.	0.142813
216	14	8	3320860.	9.	19371136.	6.	0.143555
217	12	6	6614348.	7.	23430272.	5.	0.187500
218	14	14	-4209014.	0.	4397896.	12.	0.037598
219	15	14	-6349270.	0.	361012.	15.	0.003174
220	15	6	1453940.	12.	17197400.	7.	0.117676
221	16	6	9795624.	12.	35646864.	5.	0.208984
222	13	6	8429152.	7.	31711664.	5.	0.185547
223	16	9	678892.	16.	14279844.	6.	0.109375
224	15	9	-3474282.	0.	5076272.	10.	0.045898
225	14	10	-3397312.	0.	5085028.	10.	0.046875
226	18	9	8054676.	7.	33314944.	5.	0.194570
227	15	8	5986156.	8.	27692520.	6.	0.166016
228	11	7	3249820.	8.	17329536.	6.	0.142578
229	16	9	3935184.	9.	23696568.	6.	0.145996
230	16	7	11776604.	6.	39403632.	5.	0.231445
231	15	7	4431552.	9.	24302304.	6.	0.148438
232	16	7	6911624.	7.	27141064.	5.	0.186523
233	15	5	13189772.	6.	42473744.	4.	0.233398
234	15	8	-4850090.	0.	2278452.	11.	0.022461
235	12	9	-986152.	0.	8114076.	8.	0.053995
236	18	6	8185368.	6.	28449280.	4.	0.216797
237	19	7	7199620.	6.	25956064.	5.	0.198242
238	15	7	5770880.	8.	25138048.	6.	0.171875
239	12	10	-3615318.	0.	5122404.	10.	0.046387
240	17	7	7025752.	6.	25695696.	5.	0.199219
241	14	6	7189464.	7.	27250136.	5.	0.188477
242	19	7	9197976.	7.	36470224.	5.	0.199219
243	11	7	2143528.	9.	13793052.	6.	0.131836
244	13	8	-1990256.	0.	8352660.	8.	0.071777
245	12	8	771468.	12.	12589164.	7.	0.111328
246	11	7	2229064.	9.	15916760.	6.	0.126418
247	19	6	8273928.	7.	34250352.	5.	0.185547
248	15	11	-587764.	0.	13071284.	6.	0.092773
249	13	9	294672.	13.	14191972.	7.	0.103516
250	15	8	2403548.	11.	19719496.	7.	0.127930
251	11	7	1718260.	10.	15706324.	6.	0.121094
252	12	8	-637440.	0.	10575108.	7.	0.090820
253	21	6	9243068.	6.	34765904.	4.	0.208984
254	15	10	5852116.	8.	28092936.	6.	0.164551

255	15	6	-2723820.	0.	6773952.	9.	0.059570
256	14	11	-2131654.	0.	7339740.	9.	0.066406
257	18	8	3838700.	9.	23350656.	6.	0.143555
258	17	6	8732436.	6.	31209816.	5.	0.207031
259	15	7	-120152.	0.	11794932.	7.	0.098145
260	12	10	-4430240.	0.	5290980.	10.	0.042480
261	18	6	14092904.	5.	46466992.	4.	0.245117
262	13	8	524056.	13.	12591204.	7.	0.107422
263	19	7	3220892.	6.	19197296.	5.	0.143555
264	15	8	-1181480.	0.	9215180.	7.	0.082031
265	17	8	1039896.	10.	11807492.	6.	0.118164
266	14	8	-3567900.	0.	7216336.	9.	0.054688
267	16	8	7425356.	7.	30642728.	5.	0.191691
268	13	6	3830868.	8.	19314984.	5.	0.143555
269	16	10	1952896.	10.	14619436.	6.	0.131836
270	18	7	8543500.	6.	31859680.	5.	0.203125
271	14	9	-3760710.	0.	4655272.	10.	0.042480
272	19	14	263768.	19.	14025940.	7.	0.103516
273	12	9	-1729516.	0.	7252428.	8.	0.072266
274	19	10	-2201748.	0.	8825456.	7.	0.068848
275	12	6	5496180.	7.	20288864.	5.	0.180664
276	13	7	-267724.	0.	11241796.	7.	0.096191
277	13	8	-161828.	0.	12786912.	7.	0.097656
278	12	8	-1898696.	0.	9056660.	8.	0.074707
279	15	11	-3085328.	0.	4685872.	10.	0.047852
280	14	11	-6655264.	0.	-789308.	0.	-0.007813
281	15	9	2912508.	8.	17859456.	6.	0.143555
282	14	6	6342640.	7.	24724624.	5.	0.180664
283	8	6	-2654908.	0.	3932084.	7.	0.051270
284	15	8	346876.	15.	14653920.	7.	0.104492
285	17	7	3493372.	7.	18220848.	5.	0.153320
286	13	7	7568092.	7.	26488696.	5.	0.199219
287	15	11	-1273756.	0.	9587192.	8.	0.081055
288	14	6	2467972.	10.	18523696.	6.	0.129883
289	17	11	634652.	17.	15261736.	7.	0.108398
290	18	7	12498256.	6.	43645280.	4.	0.227539
291	15	12	-5610694.	0.	5534004.	12.	0.050133
292	14	14	-5571968.	0.	1362964.	14.	0.012695
293	19	7	3265892.	8.	19371048.	5.	0.145508
294	15	7	5971272.	9.	29450312.	6.	0.159180
295	9	9	-2498366.	0.	3107236.	8.	0.045898
296	14	8	-170520.	0.	12499696.	7.	0.097656
297	17	7	10105724.	6.	36049568.	5.	0.210938
298	15	5	11568112.	6.	37304680.	4.	0.230469
299	15	7	4113524.	9.	21665992.	6.	0.151367
300	10	0	-3925876.	0.	2347220.	9.	0.028320
301	14	9	-1243140.	0.	9701848.	8.	0.082031
302	18	9	2310628.	9.	17193748.	6.	0.132813
303	14	8	3320860.	9.	19371136.	6.	0.143555
304	12	6	6614348.	7.	23436272.	5.	0.187500
305	14	14	-4209014.	0.	4397896.	12.	0.037598
306	15	14	-6349270.	0.	361812.	15.	0.003174
307	15	8	1453940.	12.	17197400.	7.	0.117676
308	16	8	9795624.	6.	35646864.	5.	0.208964
309	13	6	8429152.	7.	31711664.	5.	0.185547
310	16	9	678892.	16.	14279844.	6.	0.109375
311	15	9	-3474232.	0.	5076272.	10.	0.045898
312	14	10	-3397312.	0.	5085028.	10.	0.046875
313	18	9	8054876.	7.	34314944.	5.	0.184570
314	15	8	5988156.	8.	27692520.	6.	0.166016
315	11	7	3249820.	8.	17329536.	6.	0.142578
316	16	9	3933184.	9.	23696568.	6.	0.145996
317	16	7	11776604.	6.	39403632.	5.	0.231445
318	15	7	4431552.	9.	24382304.	6.	0.148438
319	15	7	6911624.	7.	27141064.	5.	0.166523
320	15	5	13189772.	6.	42473744.	4.	0.232398

321	15	6	-4653000.	0.	22704532.	11.	0.022401
322	12	9	-936152.	0.	8114076.	8.	0.083496
323	18	6	8185368.	6.	28449200.	4.	0.216797
324	19	7	7199620.	6.	28056064.	5.	0.198242
325	15	7	5770880.	8.	25138048.	6.	0.171875
326	12	10	-3615310.	0.	5122404.	10.	0.046387
327	17	7	7025752.	6.	21696696.	5.	0.199219
328	14	6	7169464.	7.	27250136.	5.	0.188477
329	19	7	9197976.	7.	36470224.	5.	0.199219
330	11	7	2143528.	9.	13793052.	6.	0.131836
331	13	8	-1998256.	0.	8352660.	8.	0.071777
332	12	8	771488.	12.	12589168.	7.	0.111328
333	11	7	2229664.	9.	15916760.	6.	0.128418
334	19	6	8274928.	7.	34250352.	5.	0.185547
335	15	11	-587764.	0.	13071284.	8.	0.092773
336	13	9	298672.	13.	14191972.	7.	0.104516
337	15	8	2803548.	11.	19719496.	7.	0.137939
338	11	7	1718260.	10.	15786424.	6.	0.121094
339	12	8	-637440.	0.	10575104.	7.	0.099609
340	21	6	9243068.	6.	34765904.	4.	0.208984
341	16	10	5852116.	8.	28092936.	6.	0.164551
342	15	8	-2725820.	0.	6773952.	9.	0.059570
343	14	11	-2131654.	0.	7329740.	9.	0.066406
344	18	8	3836790.	9.	23350656.	6.	0.143555
345	17	6	8732436.	6.	31209816.	5.	0.207031
346	15	7	-120152.	0.	11794932.	7.	0.098145
347	12	10	-4430240.	0.	5290960.	10.	0.042480
348	18	6	14092984.	5.	46466992.	4.	0.245117
349	13	8	524056.	13.	12591204.	7.	0.107422
350	19	7	3220892.	8.	19197236.	5.	0.143555
351	15	8	-1181480.	0.	9215160.	7.	0.082031
352	17	8	1039896.	10.	11807492.	6.	0.118164
353	14	8	-3537900.	0.	7216336.	9.	0.064688
354	16	8	7425356.	7.	30642728.	5.	0.181641
355	13	6	3530868.	8.	15314904.	5.	0.143555
356	16	10	1952896.	10.	14618436.	6.	0.131836
357	18	7	0543500.	6.	31855680.	5.	0.203125
358	14	9	-3760710.	0.	4655272.	10.	0.042480
359	19	14	263788.	19.	14029940.	7.	0.103516
360	12	9	-1724516.	0.	7252428.	8.	0.072266
361	19	10	-2201748.	0.	8825456.	7.	0.088848
362	12	6	5496180.	7.	20288864.	5.	0.180664
363	13	7	-267724.	0.	11241796.	7.	0.096191
364	13	8	-161828.	0.	12780912.	7.	0.097656
365	12	8	-1898696.	0.	9056660.	8.	0.074707
366	13	11	-3085328.	0.	4685872.	10.	0.047852
367	14	11	-6550264.	0.	-785408.	0.	-0.007813
368	18	9	2912508.	8.	17852456.	5.	0.174805
369	14	6	6342640.	7.	24724624.	5.	0.[illegible]
370	8	6	-2654908.	0.	3932064.	7.	0.[illegible]
371	15	8	346876.	15.	14653928.	7.	0.[illegible]
372	17	7	3493372.	7.	18220840.	5.	0.[illegible]
373	13	7	7588092.	7.	26786596.	5.	0.199219
374	15	11	-1273756.	0.	9567192.	8.	0.081055
375	14	6	2467972.	10.	18523696.	6.	0.129883
376	17	11	634652.	17.	15261736.	7.	0.108398
377	18	7	12493256.	6.	43645200.	4.	0.227539
378	15	12	-5610634.	0.	5534004.	12.	0.036133
379	14	14	-5571988.	0.	1362964.	18.	0.012695
380	19	7	3265092.	8.	19371048.	5.	0.145508
381	15	7	5971272.	9.	24450312.	6.	0.159180
382	9	9	-2498366.	0.	3107236.	8.	0.045898
383	14	8	-170320.	0.	12499696.	7.	0.097656
384	17	7	10105724.	6.	36049568.	5.	0.210938
385	15	5	11568112.	6.	37304688.	4.	0.230469
386	15	7	4113524.	9.	21665992.	6.	0.151367

387	10	6	-3723876.	0.	2547220.	7.	0.028320
388	14	9	-1243140.	0.	9701040.	8.	0.082031
389	16	9	2310628.	9.	17193744.	6.	0.132813
390	14	8	3320850.	9.	19371136.	6.	0.143555
391	12	6	6614348.	7.	23438272.	5.	0.187500
392	14	14	-4209014.	0.	4397896.	12.	0.037598
393	15	14	-5349270.	0.	361812.	15.	0.003174
394	15	8	1453940.	12.	17197400.	7.	0.117676
395	16	8	5745624.	6.	35646864.	5.	0.208984
396	13	6	8429152.	7.	31711664.	5.	0.185547
397	16	9	678892.	16.	14279848.	8.	0.109375
398	15	9	-3478202.	0.	5676272.	10.	0.055898
399	14	10	-3357312.	0.	5895028.	10.	0.046875
400	18	9	8054870.	7.	34314944.	5.	0.184570
401	15	8	5988156.	8.	27692520.	6.	0.166016
402	14	7	3248820.	8.	17329536.	6.	0.142578
403	16	9	3933184.	9.	23696568.	6.	0.145996
404	16	7	11776608.	6.	39403632.	5.	0.231445
405	15	7	4431552.	9.	24382304.	6.	0.148438
406	16	7	6911624.	7.	27141064.	5.	0.186523
407	15	5	13169772.	6.	42473744.	4.	0.243798
408	15	8	-4850080.	0.	2278152.	11.	0.022461
409	12	9	-986152.	0.	8114076.	8.	0.083496
410	18	6	8185368.	6.	28445280.	4.	0.216797
411	19	7	7196620.	6.	28056064.	5.	0.198242
412	15	7	5770880.	8.	25138048.	6.	0.171875
413	12	10	-3615312.	0.	5122408.	10.	0.046387
414	17	7	7025752.	6.	25895696.	5.	0.199219
415	14	6	7189464.	7.	27250136.	5.	0.199477
416	19	7	9197976.	7.	36470824.	5.	0.199219
417	11	7	2143528.	9.	13793052.	6.	0.131836
418	13	8	-1990256.	0.	8352660.	8.	0.071777
419	12	8	771488.	12.	12589164.	7.	0.111328
420	11	7	2229064.	9.	15916760.	6.	0.123019
421	19	6	8273928.	7.	34250352.	5.	0.185547
422	15	11	-587764.	0.	13071284.	8.	0.092773
423	13	9	294672.	13.	14191972.	7.	0.103516
424	15	8	2403548.	11.	19719496.	7.	0.127930
425	11	7	1710260.	10.	15786324.	6.	0.121094
426	12	8	-637440.	0.	10575103.	7.	0.090820
427	21	6	9243068.	6.	34765904.	4.	0.200984
428	16	10	5852116.	8.	28092936.	6.	0.164551
429	15	8	-2725820.	0.	6773952.	9.	0.059570
430	14	11	-2131654.	0.	7339740.	9.	0.066406
431	18	8	3838700.	9.	23350656.	6.	0.143555
432	17	6	8732436.	6.	31209816.	5.	0.207031
433	15	7	-120152.	0.	11794932.	7.	0.098145
434	12	10	-4430240.	0.	5290980.	10.	0.042480
435	18	6	14092964.	5.	46466992.	4.	0.245117
436	13	8	524056.	13.	12591204.	7.	0.107422
437	19	7	3220892.	8.	19197296.	5.	0.143555
438	15	8	-1181480.	0.	9215160.	7.	0.082031
439	17	8	1039896.	10.	11807492.	6.	0.118164
440	14	8	-3537900.	0.	7216336.	9.	0.054688
441	16	8	7425356.	7.	30642728.	5.	0.181641
442	13	6	3530868.	8.	19314984.	5.	0.143555
443	16	10	1952896.	10.	14619436.	6.	0.131836
444	18	7	8543500.	6.	31859680.	5.	0.203125
445	14	9	-3760710.	0.	4655272.	10.	0.042480
446	19	14	263786.	19.	14029940.	7.	0.103516
447	12	9	-1724516.	0.	7252920.	8.	0.072266
448	19	10	-2201748.	0.	8825456.	7.	0.088848
449	12	6	5496180.	7.	20298664.	5.	0.180664
450	13	7	-267724.	0.	11241796.	7.	0.096191
451	13	8	-161828.	0.	12786912.	7.	0.097656
452	12	8	-1898696.	0.	9056660.	8.	0.076707

453	13	11	-3083520.	0.	46838672.	10.	0.097632
454	14	11	-6655264.	0.	-789308.	0.	-0.007813
455	18	9	2912500.	8.	17859456.	6.	0.143555
456	14	6	6342640.	7.	28724624.	5.	0.180664
457	8	6	-2654908.	0.	3932084.	7.	0.051270
458	15	8	346876.	15.	14653928.	7.	0.104492
459	17	7	3493372.	7.	18220848.	5.	0.155320
460	13	7	7580092.	7.	26408696.	5.	0.190219
461	15	11	-1273756.	0.	9507192.	8.	0.041055
462	14	6	2467972.	10.	18926696.	6.	0.135803
463	17	11	634652.	17.	15261736.	7.	0.108398
464	18	7	12498256.	6.	43665288.	4.	0.227539
465	15	12	-5610694.	0.	5534004.	12.	0.036133
466	14	14	-5571988.	0.	1362964.	14.	0.012695
467	19	7	3265092.	8.	19371048.	5.	0.145508
468	15	7	5971272.	9.	22450312.	6.	0.159180
469	9	9	-2498366.	0.	3107236.	8.	0.045898
470	14	8	-170320.	0.	13499696.	7.	0.097656
471	17	7	10185724.	6.	36049568.	5.	0.210938
472	15	5	12568112.	6.	37368608.	4.	0.230469
473	15	7	4113524.	9.	21655992.	6.	0.151367
474	10	0	-3925876.	0.	2347220.	9.	0.028320
475	14	9	-1243140.	0.	9701848.	8.	0.082031
476	18	9	2310628.	9.	17193744.	6.	0.132813
477	14	8	3320960.	9.	19371136.	6.	0.143555
478	12	6	6619348.	7.	22438272.	5.	0.167500
479	14	14	-4209614.	0.	-397896.	12.	0.037598
480	15	14	-6349270.	0.	361812.	15.	0.003174
481	15	8	1453948.	12.	17197400.	7.	0.117676
482	16	8	9795624.	6.	35646864.	5.	0.208984
483	13	6	8429152.	7.	33711664.	5.	0.185547
484	16	9	678892.	16.	14973844.	6.	0.109375
485	15	9	-3474282.	0.	9876272.	10.	0.045898
486	14	10	-3397312.	0.	5685028.	10.	0.046875
487	18	9	8054876.	7.	34314944.	5.	0.184570
488	15	8	5986156.	8.	27633520.	6.	0.166016
489	11	7	3249620.	8.	17329536.	6.	0.142578
490	16	9	3933184.	9.	23696568.	6.	0.145996
491	16	7	11776604.	6.	39403632.	5.	0.231445
492	15	7	4431552.	9.	24582304.	6.	0.148438
493	16	7	6911624.	7.	27141064.	5.	0.186523
494	15	5	13189772.	6.	42473744.	4.	0.233398
495	15	8	-4850060.	0.	2278452.	11.	0.022461
496	12	9	-986152.	0.	8114076.	8.	0.083496
497	18	6	8185368.	6.	28449280.	4.	0.216797
498	19	7	7199620.	6.	23556064.	5.	0.198242
499	15	7	5770680.	8.	25138048.	6.	0.171875
500	12	10	-3615318.	0.	5122404.	10.	0.046387

DESIGN CAPACITY (LB/YR) = 75000000.

PROBABILITY	PRESENT WORTH AT 10.0PERCENT
0.0000000E+00	-0.6655264E+01
0.5000000E-01	-0.4850079E+01
0.9999999E-01	-0.3760710E+01
0.1500000E+00	-0.3397311E+01
0.1999999E+00	-0.2498365E+01
0.2499999E+00	-0.1724516E+01
0.2999998E+00	-0.9861519E+00
0.3499998E+00	-0.1618280E+00
0.3999997E+00	0.3468759E+00
0.4499997E+00	0.1039896E+01
0.4999996E+00	0.2143528E+01
0.5499995E+00	0.2912507E+01
0.5999994E+00	0.3320860E+01
0.6499994E+00	0.3933184E+01
0.6999993E+00	0.5770080E+01
0.7499993E+00	0.6614347E+01
0.7999992E+00	0.7199619E+01
0.8499992E+00	0.8185368E+01
0.8999991E+00	0.9197975E+01
0.9499991E+00	0.1156811E+02
0.9999990E+00	0.1781902E+02

DESIGN CAPACITY (LB/YR) = 75000000.

PROBABILITY	YIELD
0.0000000E+00	0.7812500E+00
0.5000000E-01	0.2832031E+01
0.9999999E-01	0.4248047E+01
0.1500000E+00	0.4687500E+01
0.1999999E+00	0.5957031E+01
0.2499999E+00	0.7470703E+01
0.2999998E+00	0.8349609E+01
0.3499998E+00	0.9765625E+01
0.3999997E+00	0.1049[illegible]E+02
0.4499997E+00	0.1176758E+02
0.4999996E+00	0.1284180E+02
0.5499995E+00	0.1425781E+02
0.5999994E+00	0.1435547E+02
0.6499994E+00	0.1484375E+02
0.6999993E+00	0.1645508E+02
0.7499993E+00	0.1816406E+02
0.7999992E+00	0.1865234E+02
0.8499992E+00	0.1992188E+02
0.8999991E+00	0.2089844E+02
0.9499991E+00	0.2275391E+02
0.9999990E+00	0.2695312E+02

DESIGN CAPACITY (LB/YR) = 50000000.

PROBABILITY	PRESENT WORTH AT 10.0PERCENT
0.0000000E+00	-0.5448956E+01
0.5000000E-01	-0.4126331E+01
0.9999999E-01	-0.3172525E+01
0.1500000E+00	-0.2496641E+01
0.1999999E+00	-0.1925036E+01
0.2499999E+00	-0.1546808E+01
0.2999998E+00	-0.9079578E+00
0.3499998E+00	-0.5386520E+00
0.3999997E+00	-0.1214200E+00
0.4499997E+00	0.3116720E+00
0.4999996E+00	0.1054540E+01
0.5499995E+00	0.1538700E+01
0.5999994E+00	0.1697402E+01
0.6499994E+00	0.2290671E+01
0.6999993E+00	0.3489923E+01
0.7499993E+00	0.4403212E+01
0.7999992E+00	0.4763100E+01
0.8499992E+00	0.5049690E+01
0.8999991E+00	0.5574766E+01
0.9499991E+00	0.7004278E+01
0.9999990E+00	0.9303379E+01

DESIGN CAPACITY (LB/YR) = 50000000.

PROBABILITY	YIELD
0.0000000E+00	-0.2978516E+01
0.5000000E-01	0.2392578E+01
0.9999999E-01	0.4003906E+01
0.1500000E+00	0.4589844E+01
0.1999999E+00	0.4931641E+01
0.2499999E+00	0.6787109E+01
0.2999998E+00	0.8105469E+01
0.3499998E+00	0.8984375E+01
0.3999997E+00	0.9765625E+01
0.4499997E+00	0.1064453E+02
0.4999996E+00	0.1220703E+02
0.5499995E+00	0.1289063E+02
0.5999994E+00	0.1367188E+02
0.6499994E+00	0.1416016E+02
0.6999993E+00	0.1660156E+02
0.7499993E+00	0.1708984E+02
0.7999992E+00	0.1826172E+02
0.8499992E+00	0.1914063E+02
0.8999991E+00	0.1992188E+02
0.9499991E+00	0.2128906E+02
0.9999990E+00	0.2392578E+02

DESIGN CAPACITY (LB/YR) = 100000000.

PROBABILITY	PRESENT WORTH AT 10.0PERCENT
0.0000000E+00	-0.8568295E+01
0.5000000E-01	-0.6321619E+01
0.9999999E-01	-0.5359997E+01
0.1500000E+00	-0.4586568E+01
0.1999999E+00	-0.3525539E+01
0.2499999E+00	-0.2906792E+01
0.2999998E+00	-0.1711144E+01
0.3499998E+00	-0.6446199E+00
0.3999997E+00	0.1508000E-02
0.4499997E+00	0.1184368E+01
0.4999996E+00	0.1987052E+01
0.5499995E+00	0.2926483E+01
0.5999994E+00	0.3958116E+01
0.6499994E+00	0.4334204E+01
0.6999993E+00	0.6552763E+01
0.7499993E+00	0.7783897E+01
0.7999992E+00	0.8358206E+01
0.8499992E+00	0.1023685E+02
0.8999991E+00	0.1100801E+02
0.9499991E+00	0.1399842E+02
0.9999990E+00	0.1747676E+02

DESIGN CAPACITY (LB/YR) = 100000000.

PROBABILITY	YIELD
0.0000000E+00	-0.1879883E+01
0.5000000E-01	0.2050781E+01
0.9999999E-01	0.2856445E+01
0.1500000E+00	0.3808594E+01
0.1999999E+00	0.5664063E+01
0.2499999E+00	0.6738281E+01
0.2999998E+00	0.8007813E+01
0.3499998E+00	0.9228516E+01
0.3999997E+00	0.1000977E+02
0.4499997E+00	0.1118164E+02
0.4999996E+00	0.1201172E+02
0.5499995E+00	0.1279297E+02
0.5999994E+00	0.1386719E+02
0.6499994E+00	0.1464844E+02
0.6999993E+00	0.1582031E+02
0.7499993E+00	0.1767578E+02
0.7999992E+00	0.1826172E+02
0.8499992E+00	0.1914063E+02
0.8999991E+00	0.2031250E+02
0.9499991E+00	0.2197266E+02
0.9999990E+00	0.2392578E+02

DESIGN CAPACITY (LB/YR) = 125000000.

PROBABILITY	PRESENT WORTH AT 10.0PERCENT
0.0000000E+00	-0.1042753E+02
0.5000000E-01	-0.8200863E+01
0.9999999E-01	-0.7129126E+01
0.1500000E+00	-0.6162727E+01
0.1999999E+00	-0.5041147E+01
0.2499999E+00	-0.4223646E+01
0.2999998E+00	-0.2806696E+01
0.3499996E+00	-0.2037936E+01
0.3999997E+00	-0.1081856E+01
0.4499997E+00	-0.1656240E+00
0.4999996E+00	0.9310679E+00
0.5499995E+00	0.2240272E+01
0.5999994E+00	0.3885648E+01
0.6499994E+00	0.4313128E+01
0.6999993E+00	0.6761639E+01
0.7499993E+00	0.7891327E+01
0.7999992E+00	0.8584908E+01
0.8499992E+00	0.1135913E+02
0.8999991E+00	0.1175265E+02
0.9499991E+00	0.1523736E+02
0.9999990E+00	0.2053595E+02

DESIGN CAPACITY (LB/YR) = 125000000.

PROBABILITY	YIELD
0.0000000E+00	-0.3100586E+01
0.5000000E-01	-0.4882813E-01
0.9999999E-01	0.1586914E+01
0.1500000E+00	0.2197266E+01
0.1999999E+00	0.4443359E+01
0.2499999E+00	0.5322266E+01
0.2999998E+00	0.7055664E+01
0.3499998E+00	0.8105469E+01
0.3999997E+00	0.8886719E+01
0.4499997E+00	0.9863281E+01
0.4999996E+00	0.1103516E+02
0.5499995E+00	0.1210938E+02
0.5999994E+00	0.1303711E+02
0.6499994E+00	0.1401367E+02
0.6999993E+00	0.1503906E+02
0.7499993E+00	0.1669922E+02
0.7999992E+00	0.1728516E+02
0.8499992E+00	0.1845703E+02
0.8999991E+00	0.1953125E+02
0.9499991E+00	0.2104492E+02
0.9999990E+00	0.2319336E+02

DESIGN CAPACITY (LB/YR) = 25000000.

PROBABILITY	PRESENT WORTH AT 10.0PERCENT
0.0000000E+00	-0.5700676E+01
0.5000000E-01	-0.4591124E+01
0.9999999E-01	-0.4249096E+01
0.1500000E+00	-0.3533834E+01
0.1999999E+00	-0.3353993E+01
0.2499999E+00	-0.3171056E+01
0.2999998E+00	-0.2978082E+01
0.3499998E+00	-0.2778529E+01
0.3999997E+00	-0.2274356E+01
0.4499997E+00	-0.2065246E+01
0.4999996E+00	-0.1926954E+01
0.5499995E+00	-0.1734756E+01
0.5999994E+00	-0.1502948E+01
0.6499994E+00	-0.1158122E+01
0.6999993E+00	-0.9031579E+00
0.7499993E+00	-0.4262719E+00
0.7999992E+00	-0.8726999E-01
0.8499992E+00	0.3042879E+00
0.8999991E+00	0.5506899E+00
0.9499991E+00	0.1790560E+01
0.9999990E+00	0.2185648E+01

```
 DESIGN CAPACITY (LB/YR) =   25000000.

 PROBABILITY         YIELD

0.0000000E+00-0.4475090E+02
0.5000000E-01-0.3293457E+02
0.9999999E-01-0.1948242E+02
0.1500000E+00-0.1289063E+02
0.1999999E+00-0.7128906E+01
0.2499999E+00-0.4492188E+01
0.2999998E+00-0.3222656E+01
0.3499998E+00-0.1953125E+01
0.3999997E+00-0.1074219E+01
0.4499997E+00 0.4882813E+00
0.4999996E+00 0.1171875E+01
0.5499995E+00 0.2441406E+01
0.5999994E+00 0.3906250E+01
0.6499994E+00 0.5664063E+01
0.6999993E+00 0.7031250E+01
0.7499993E+00 0.8203125E+01
0.7999992E+00 0.9765625E+01
0.8499992E+00 0.1093750E+02
0.8999991E+00 0.1191406E+02
0.9499991E+00 0.1523438E+02
0.9999990E+00 0.1660156E+02
$EXE UPD
ASS SO MT1
NOCOMPRESS
ASS SI 9
REW SI
COPY
```

FIGURE 14

BETA DISTRIBUTIONS FOR SELLING PRICE ESTIMATES

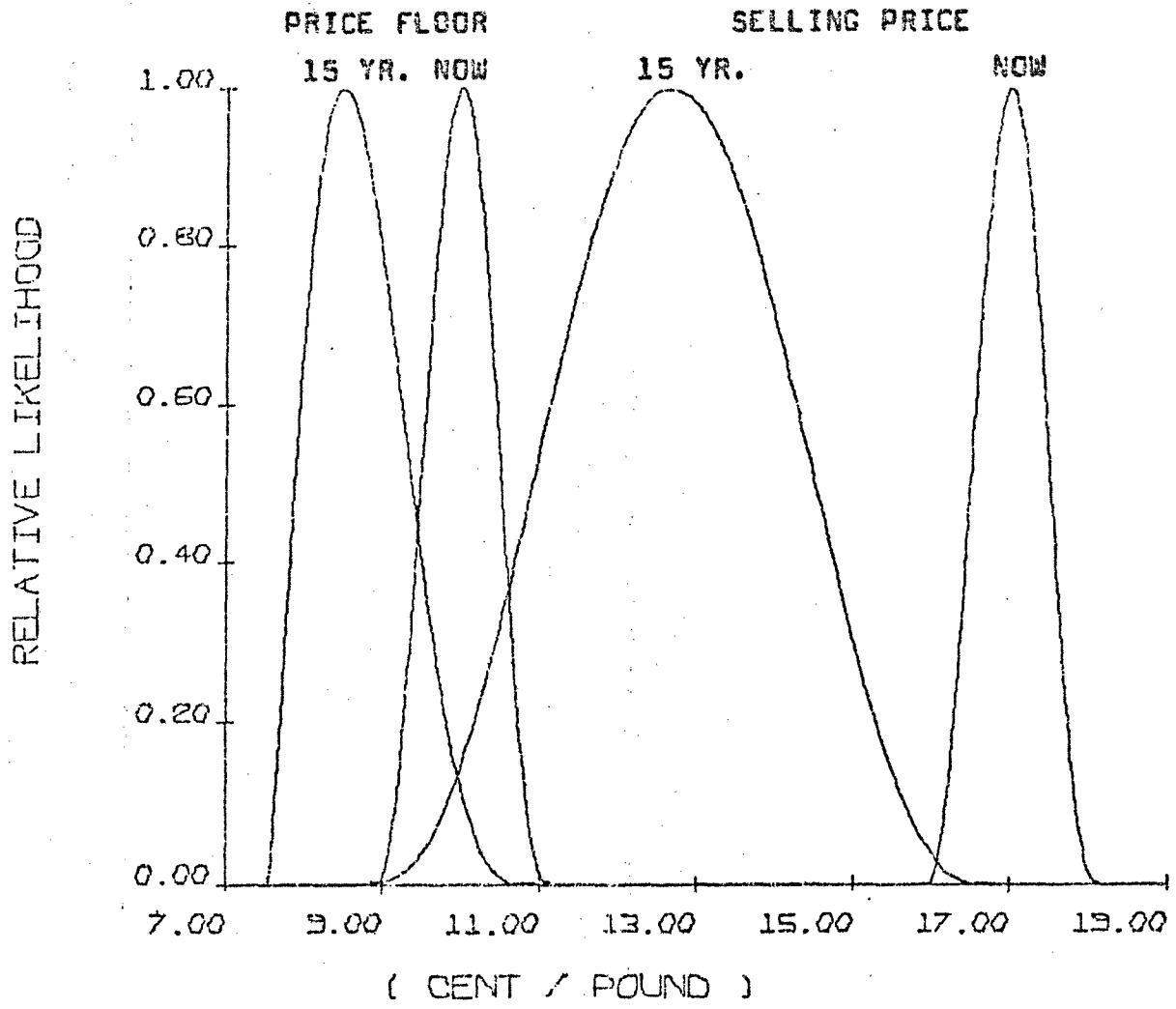


FIGURE 15

BETA DISTRIBUTION FOR INDUSTRY MARKET DEMAND ESTIMATES

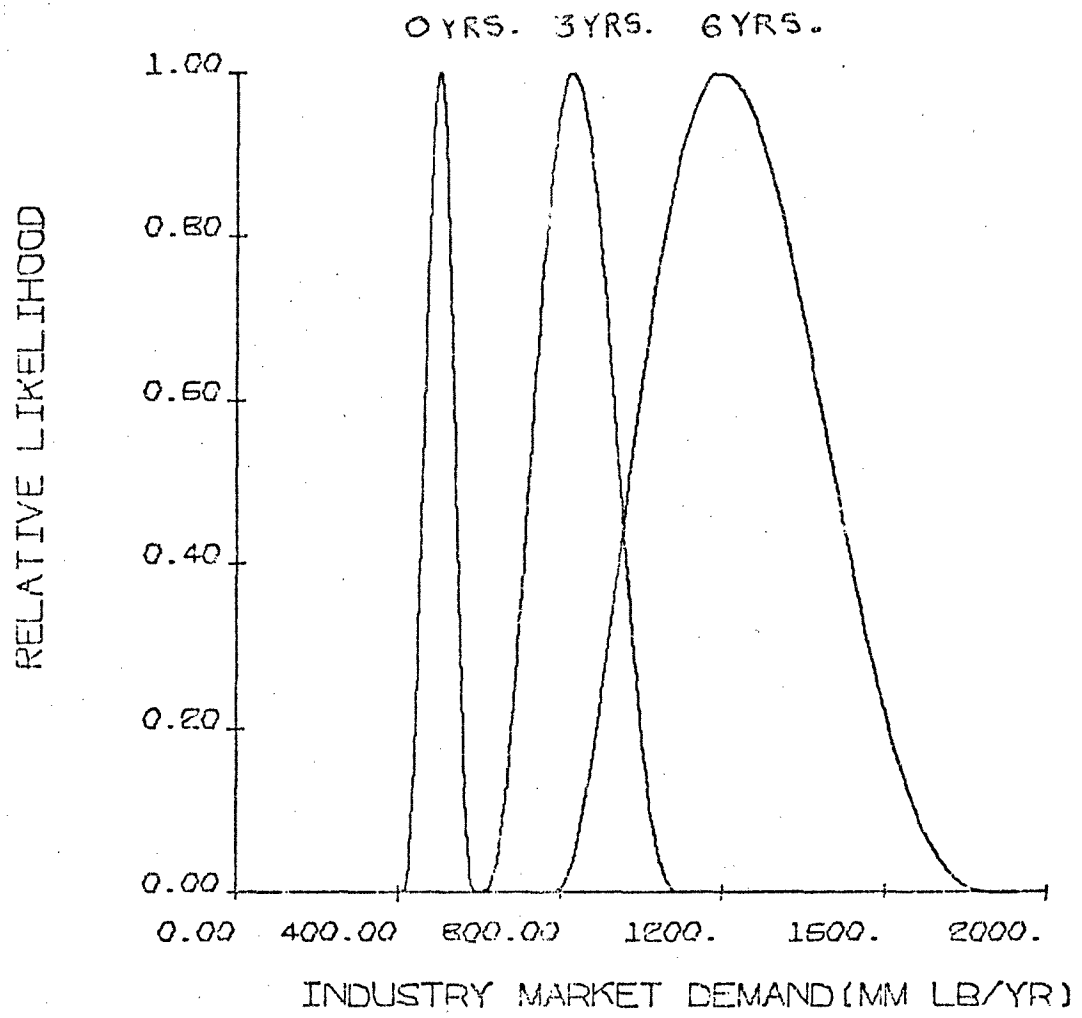


FIGURE 16

BETA DISTRIBUTION FOR LONG-RUN MARKET GROWTH

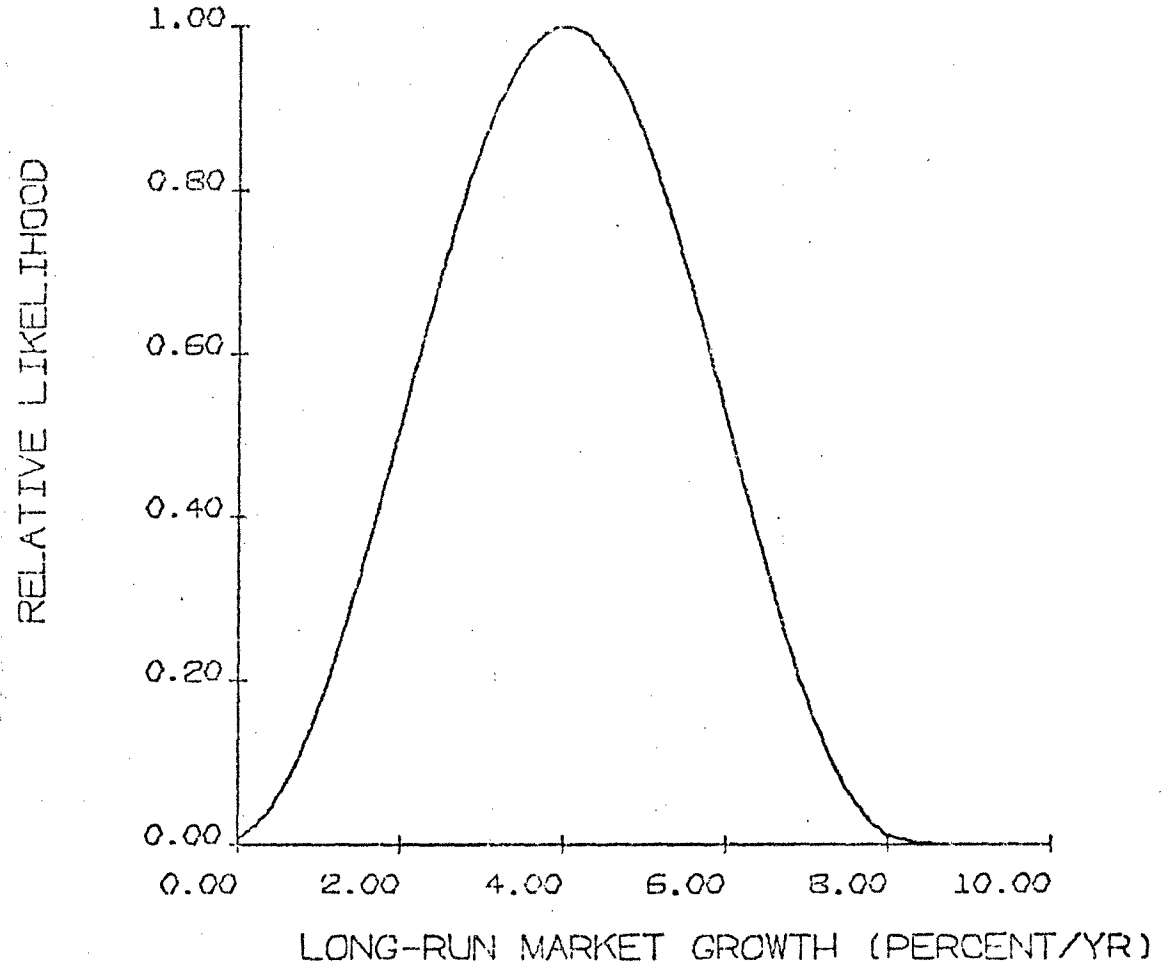


FIGURE 17

BETA DISTRIBUTION FOR MARKET SHARE

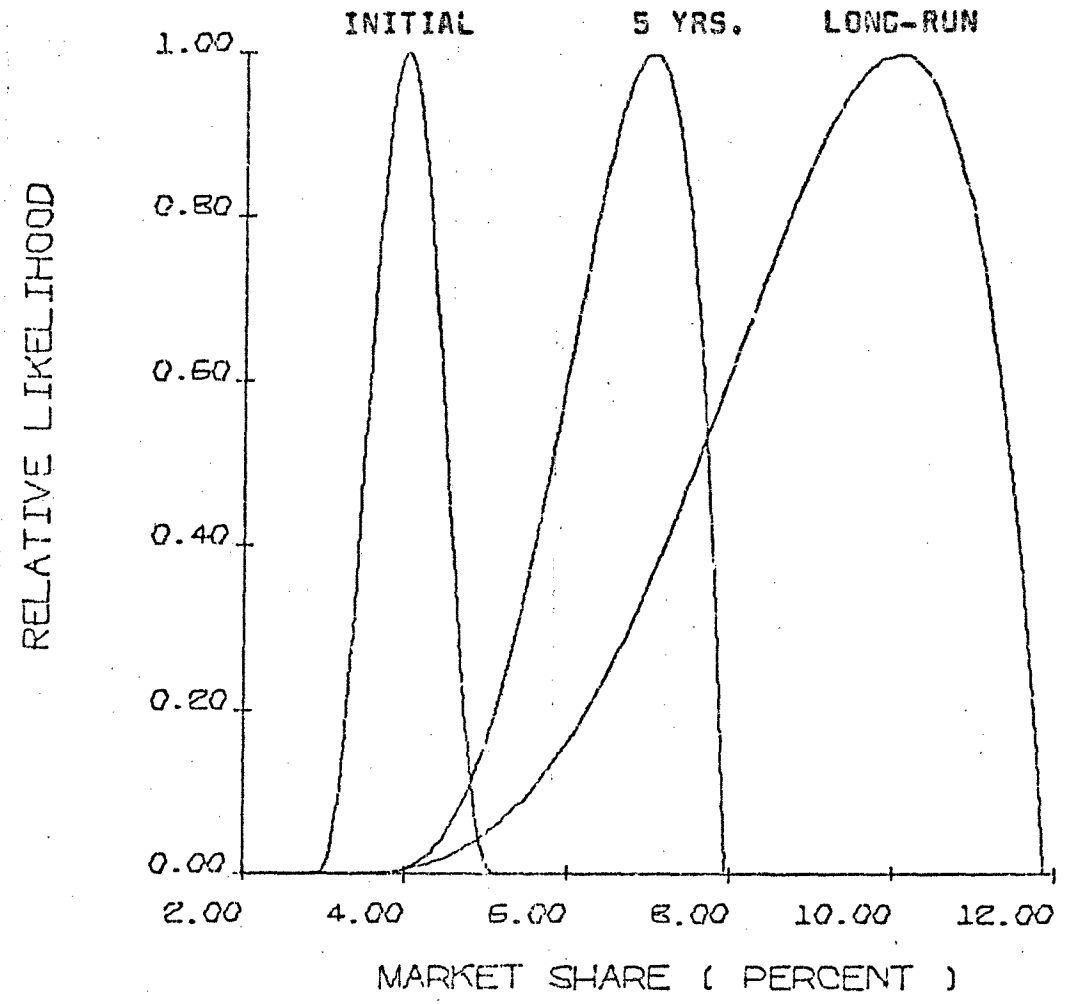


FIGURE 18

BETA DISTRIBUTION FOR LEARNING RATIO

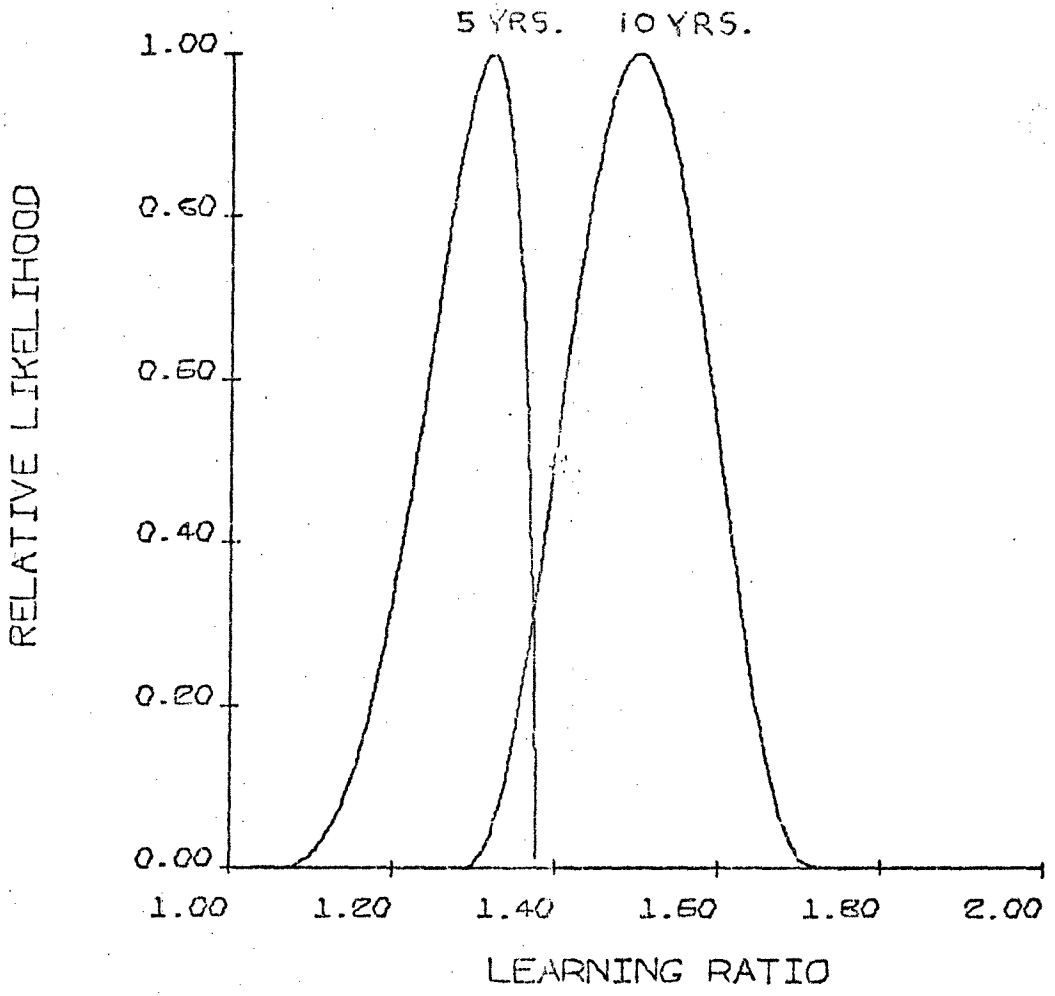


FIGURE 19

BETA DISTRIBUTIONS FOR OTHER VARIABLE COST

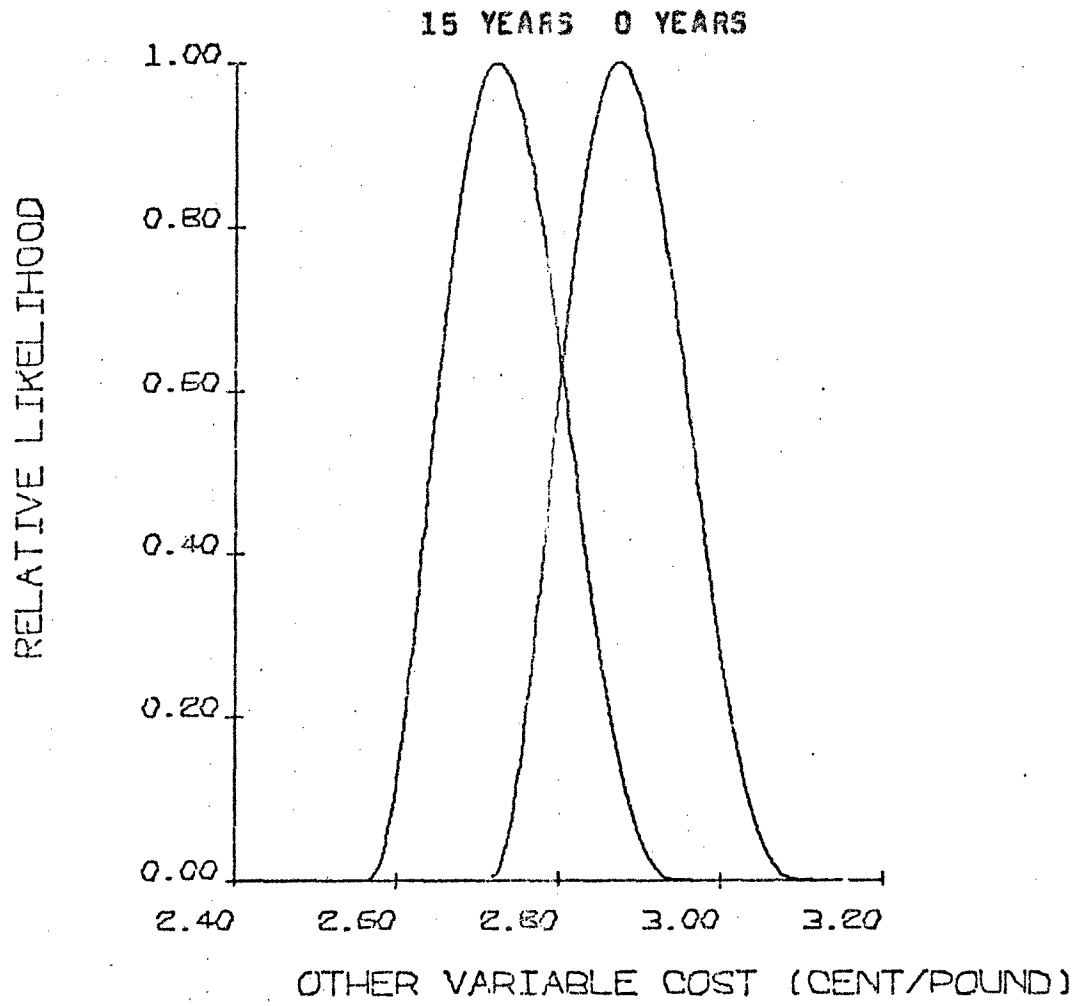


FIGURE 20

BETA DISTRIBUTIONS FOR RAW MATERIAL COST

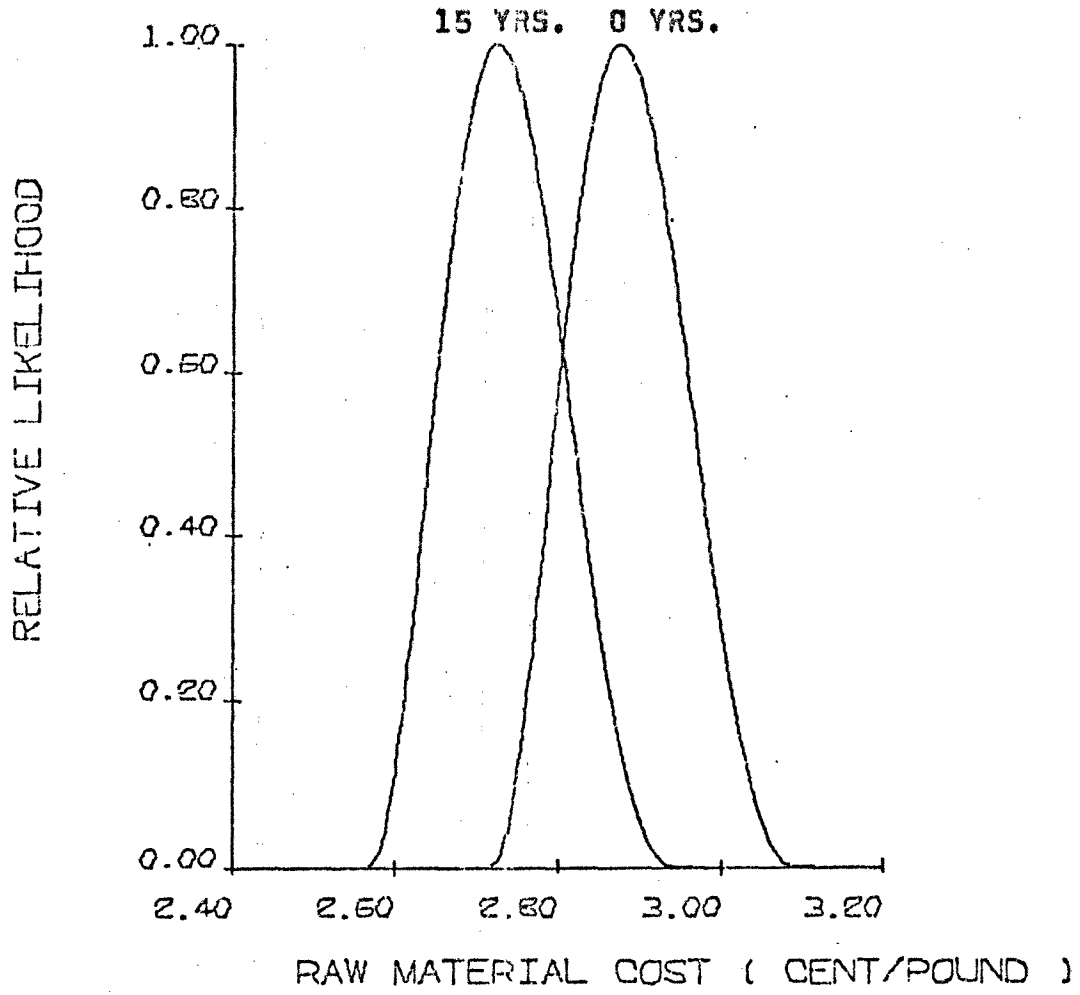


FIGURE 21

BETA DISTRIBUTIONS FOR INITIAL CAPITAL INVESTMENT FOR VARIOUS PLANT CAPACITIES

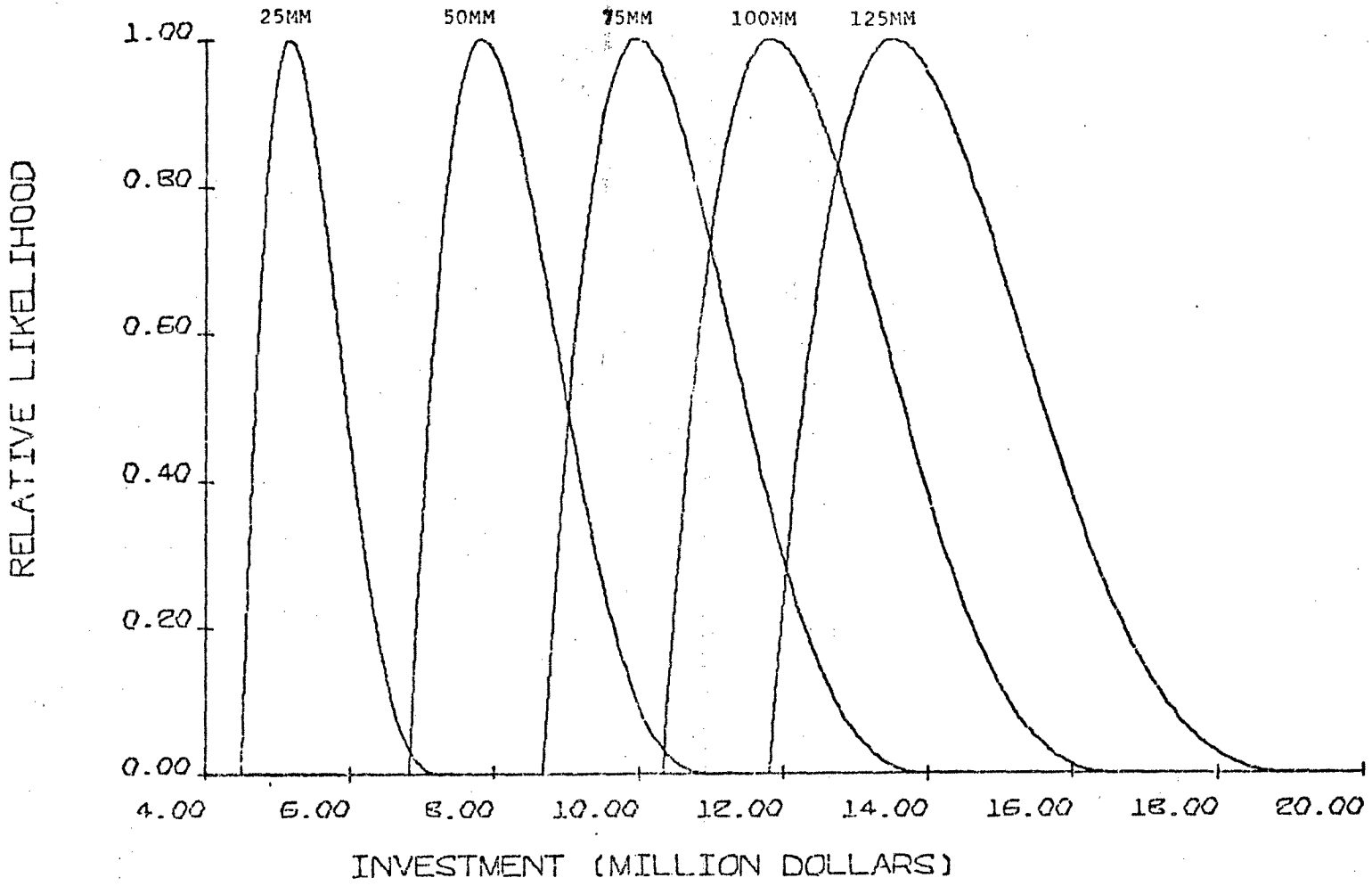


FIGURE 22

BETA DISTRIBUTION FOR SUSTAINING INVESTMENT

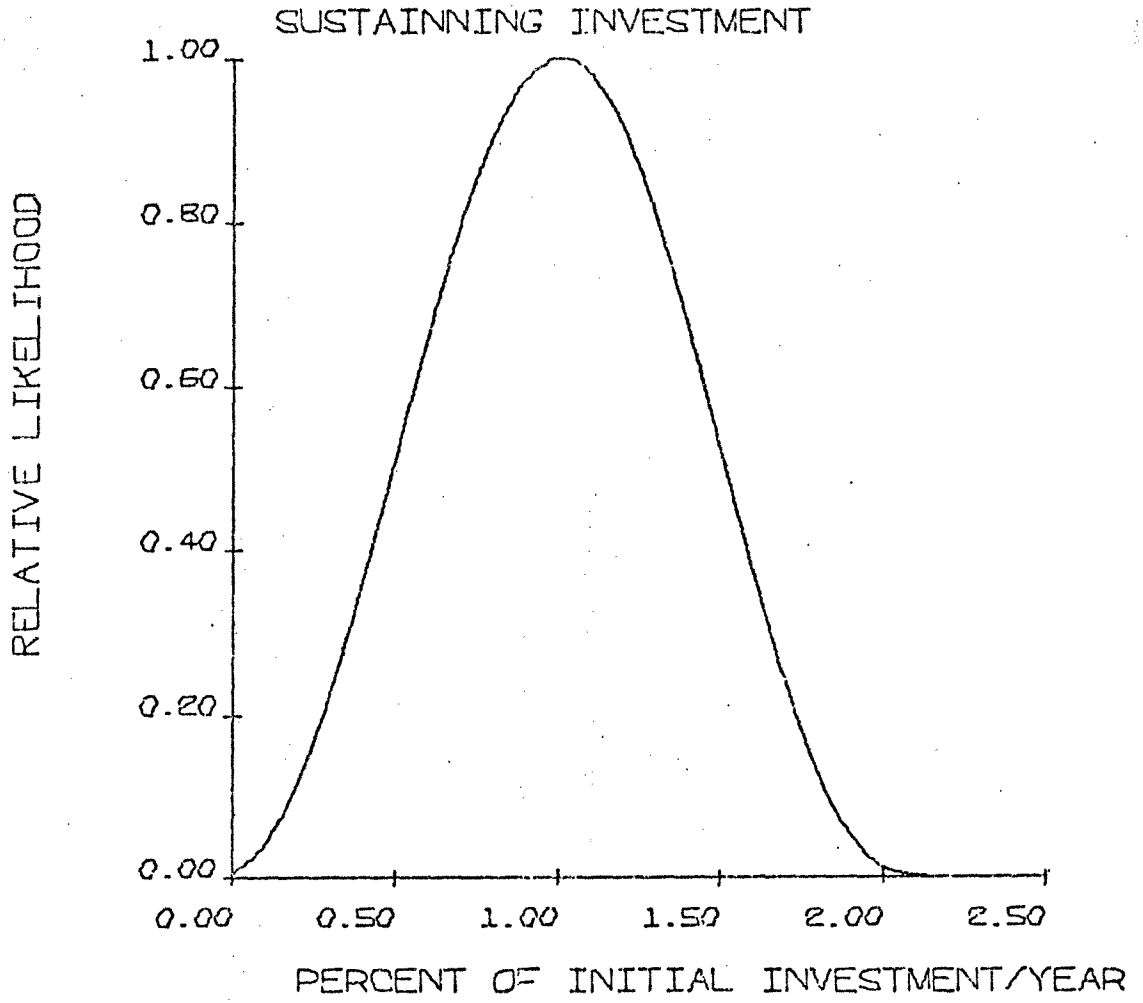


FIGURE 23

BETA DISTRIBUTION FOR DEBOTTLENECKING COST

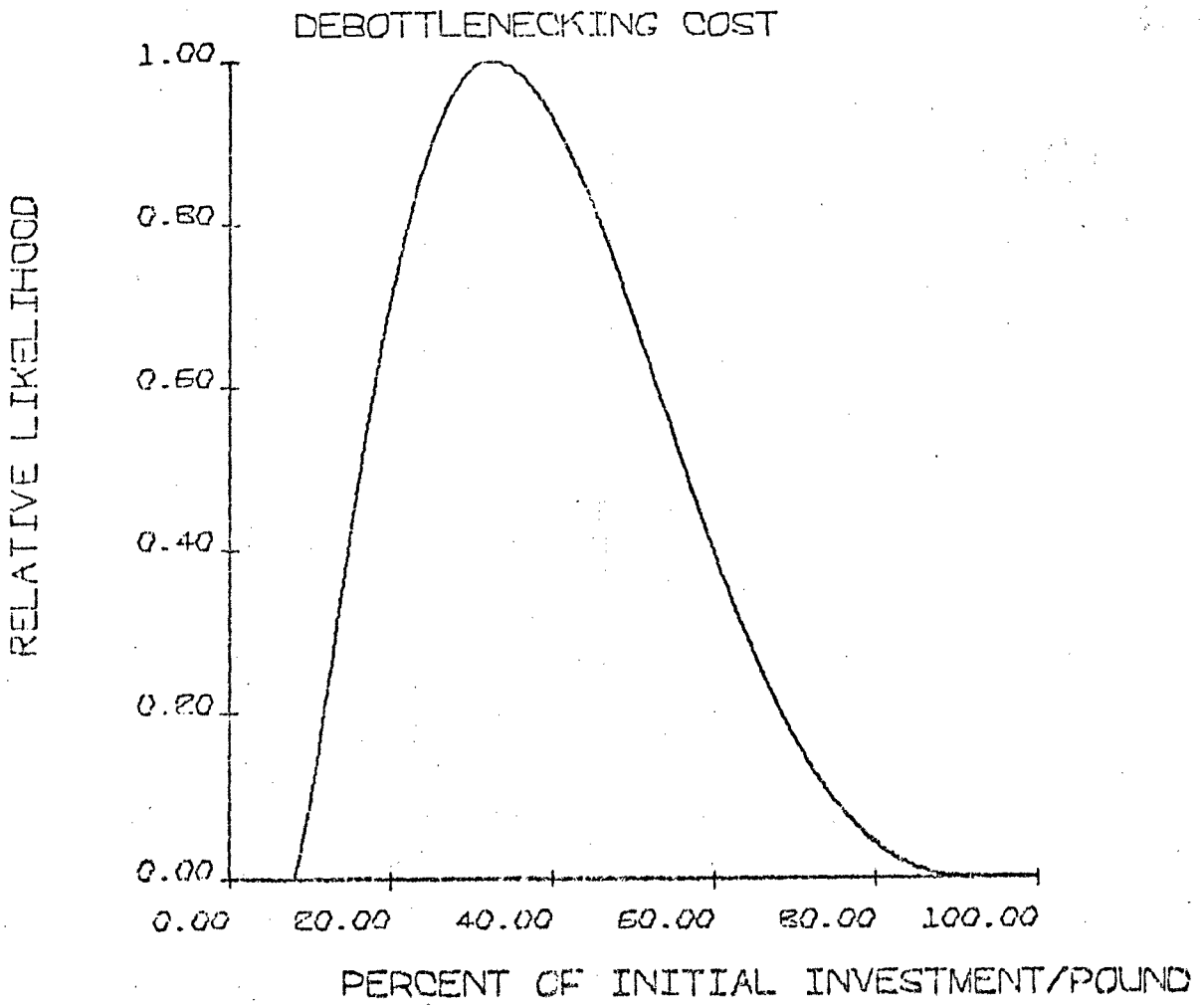


FIGURE 24

BETA DISTRIBUTION FOR TAXES AND INSURANCE AND MAINTENANCE

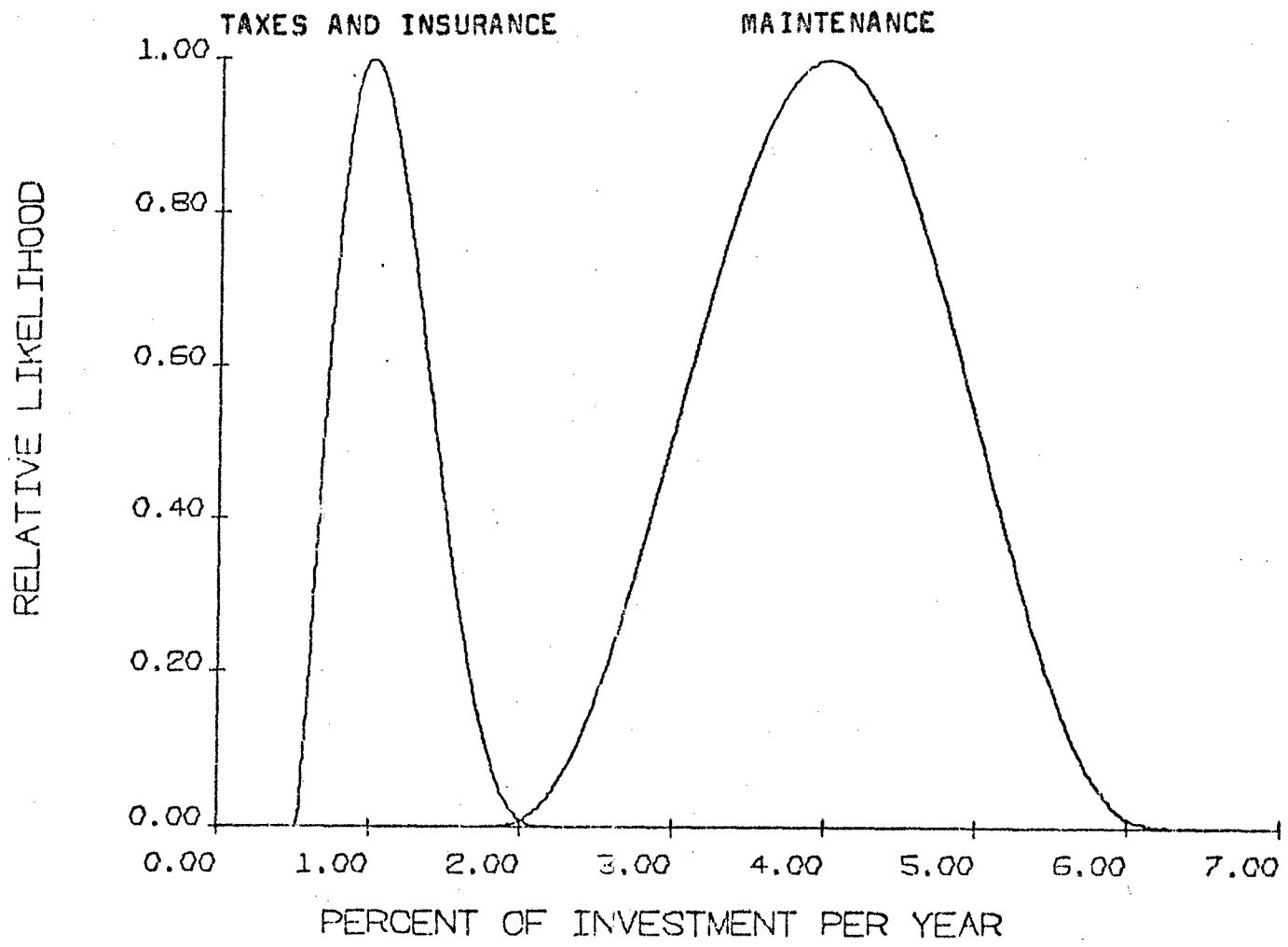


FIGURE 25

BETA DISTRIBUTION OF SPARES

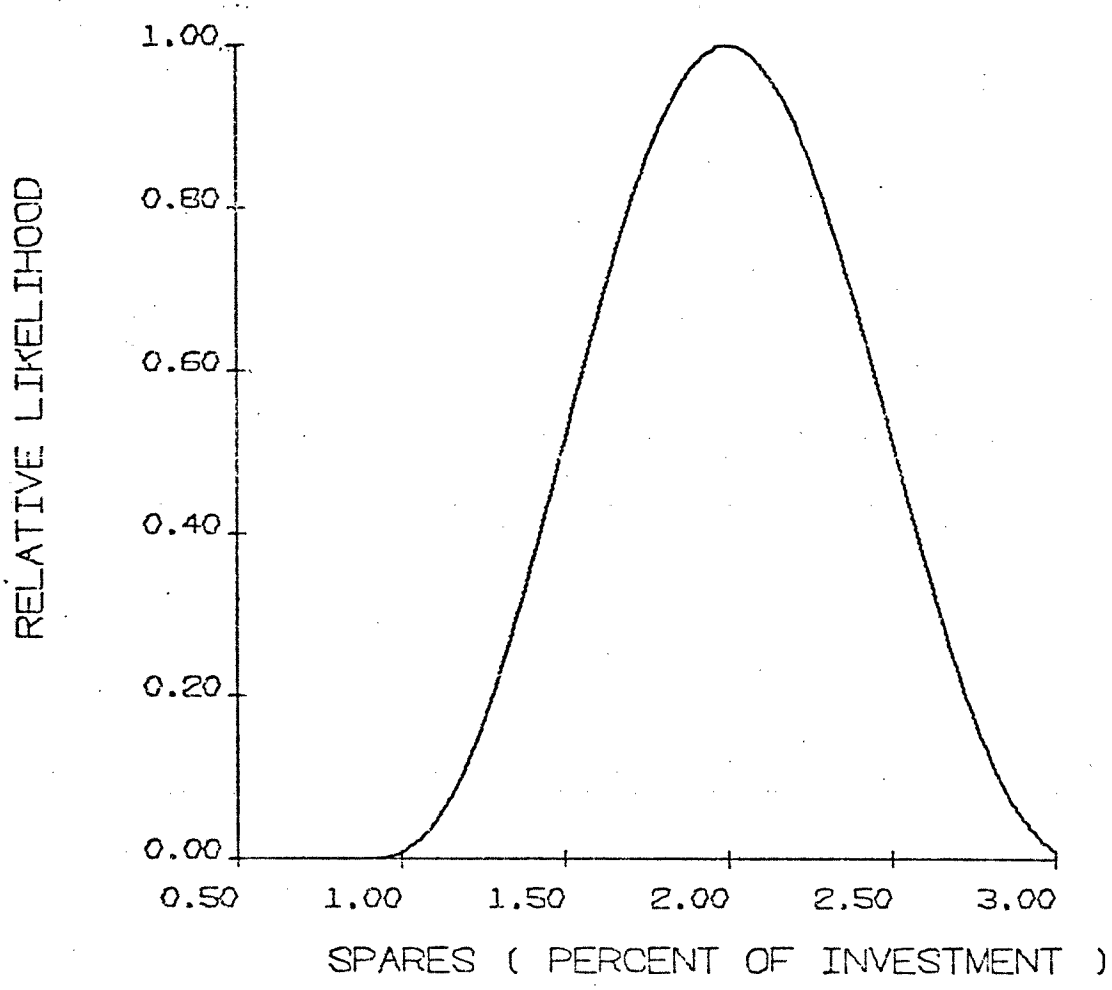


FIGURE 26

BETA DISTRIBUTION FOR FEED AND PRODUCT INVENTORIES

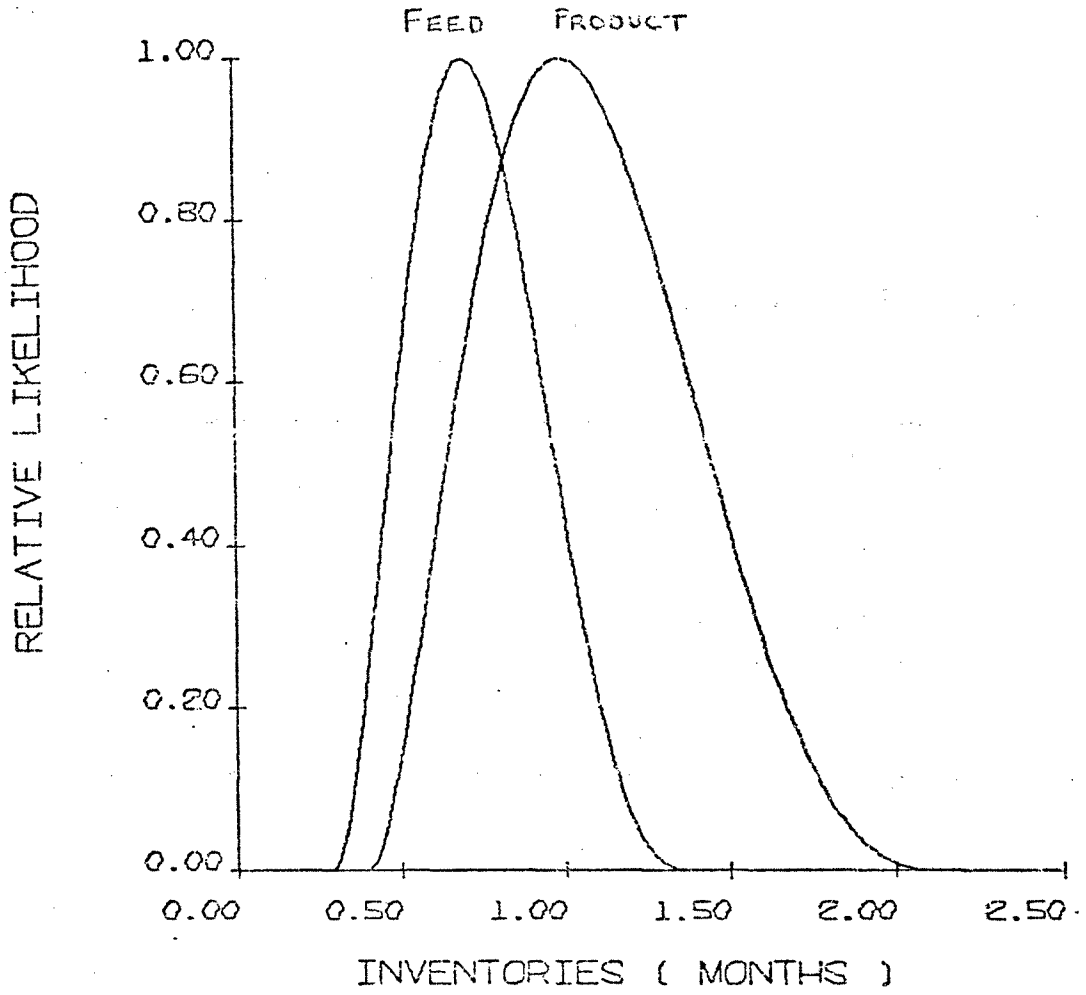


FIGURE 27

BETA DISTRIBUTION OF PAYABLES AND RECEIVABLES

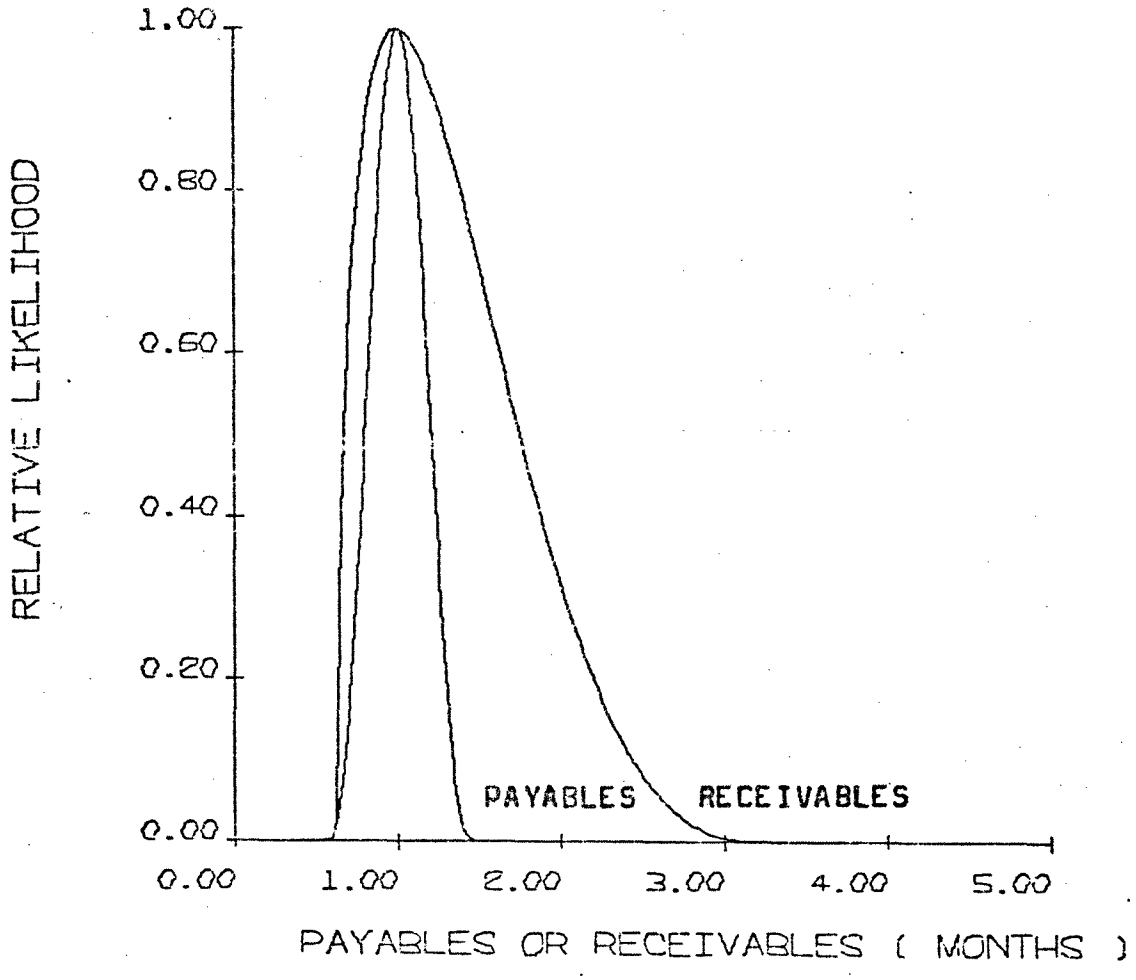


FIGURE 28

BETA DISTRIBUTION FOR CASH

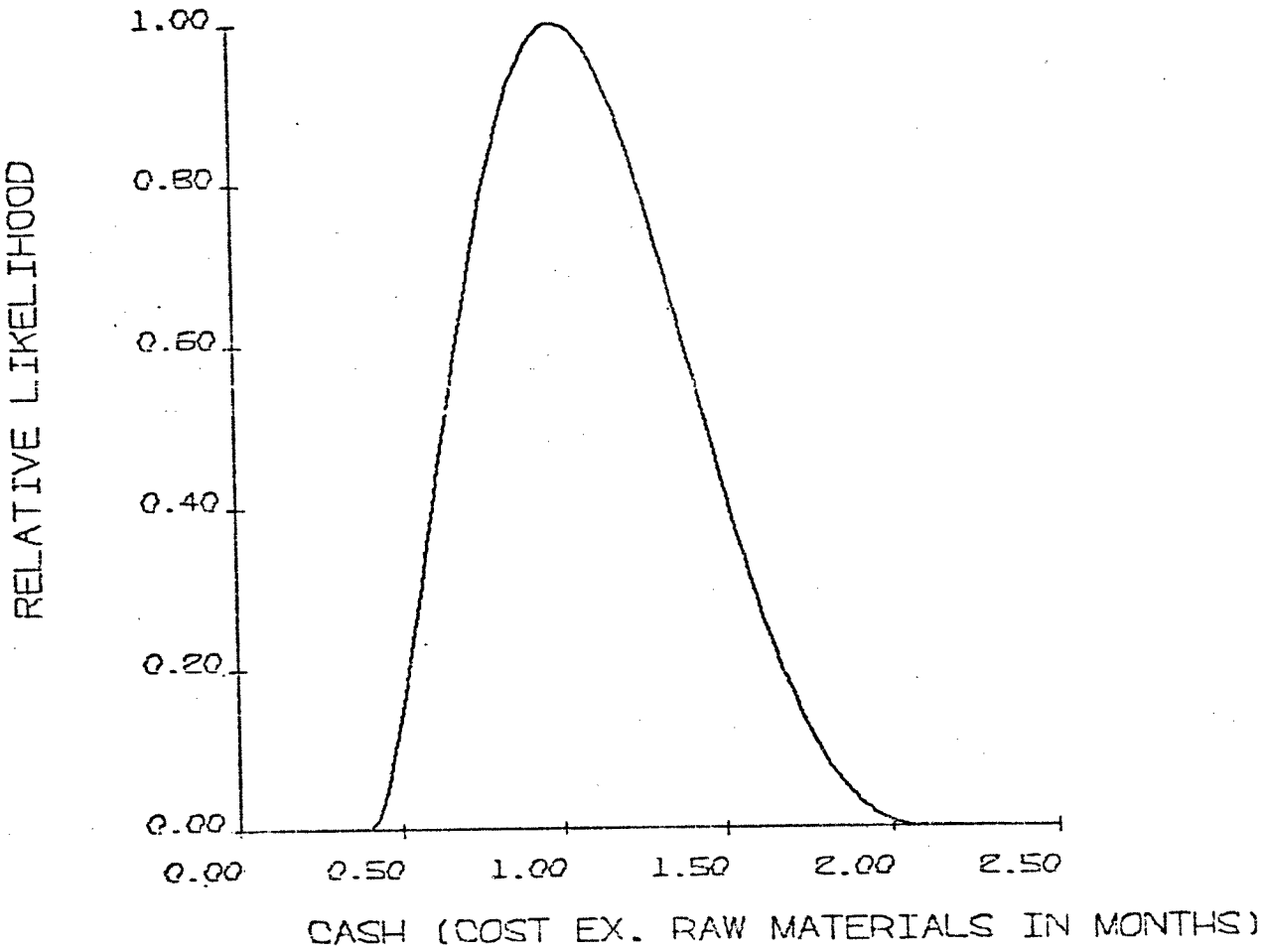


FIGURE 29

BETA DISTRIBUTION OF INITIAL FIXED COST

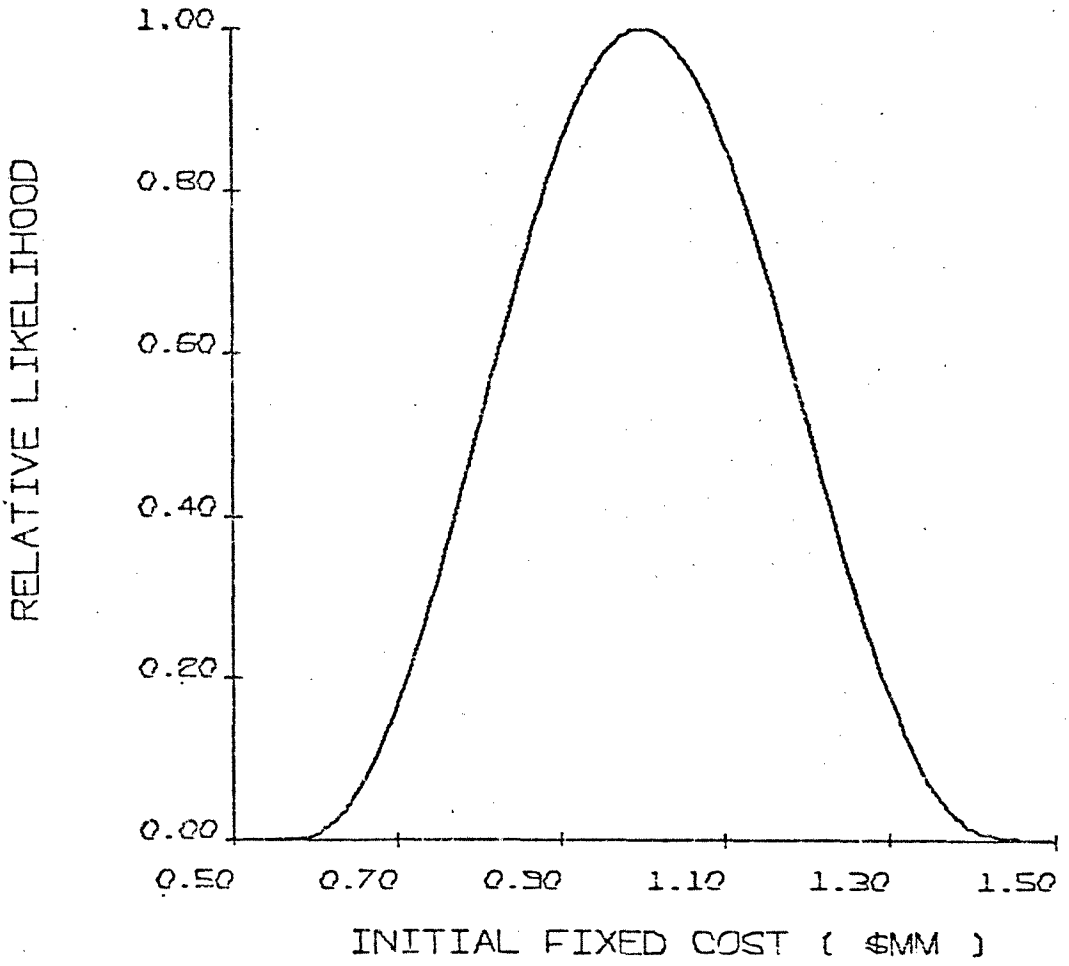


FIGURE 30

BETA DISTRIBUTION OF FIXED COST

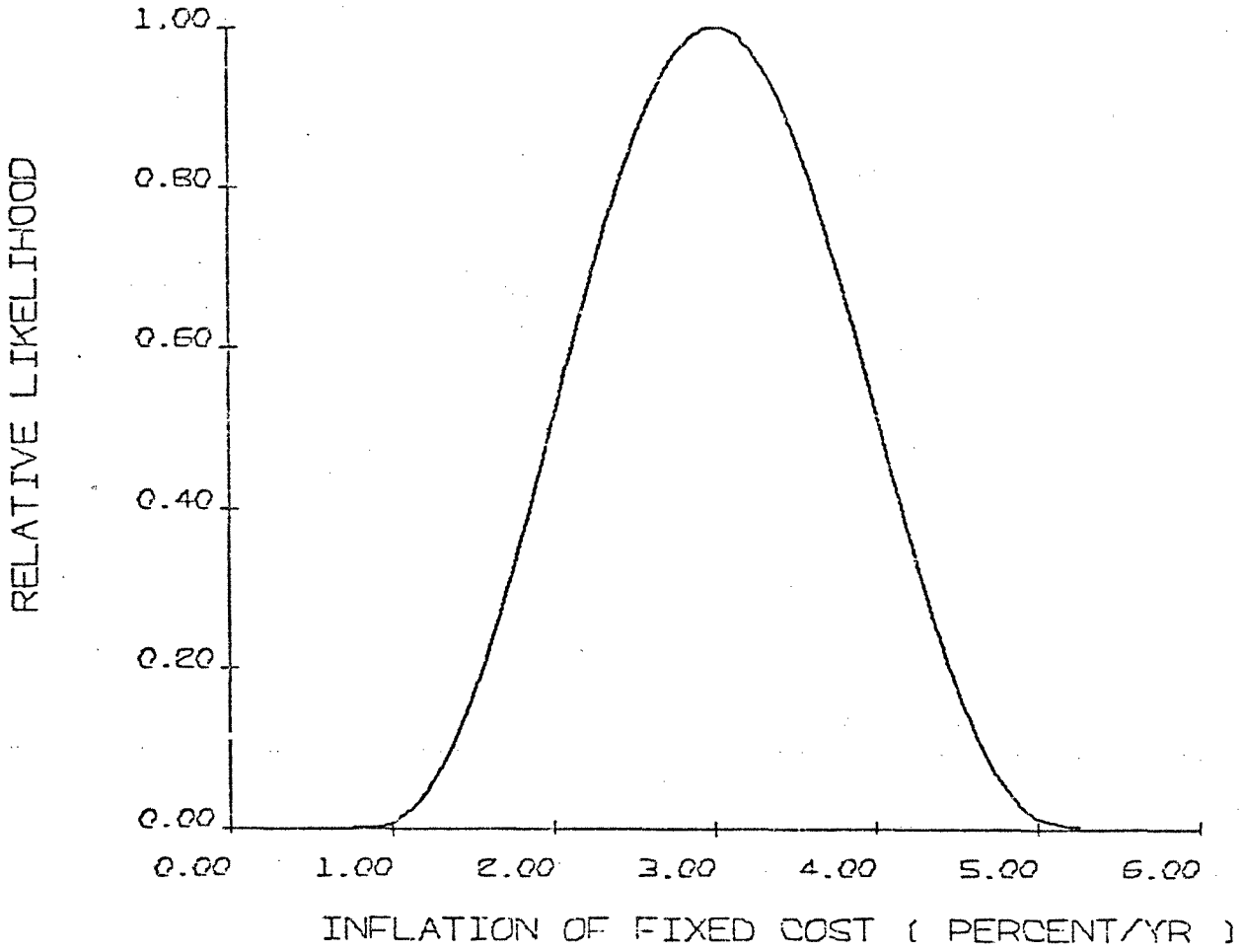


FIGURE 31

BETA DISTRIBUTION OF FEDERAL TAX RATE

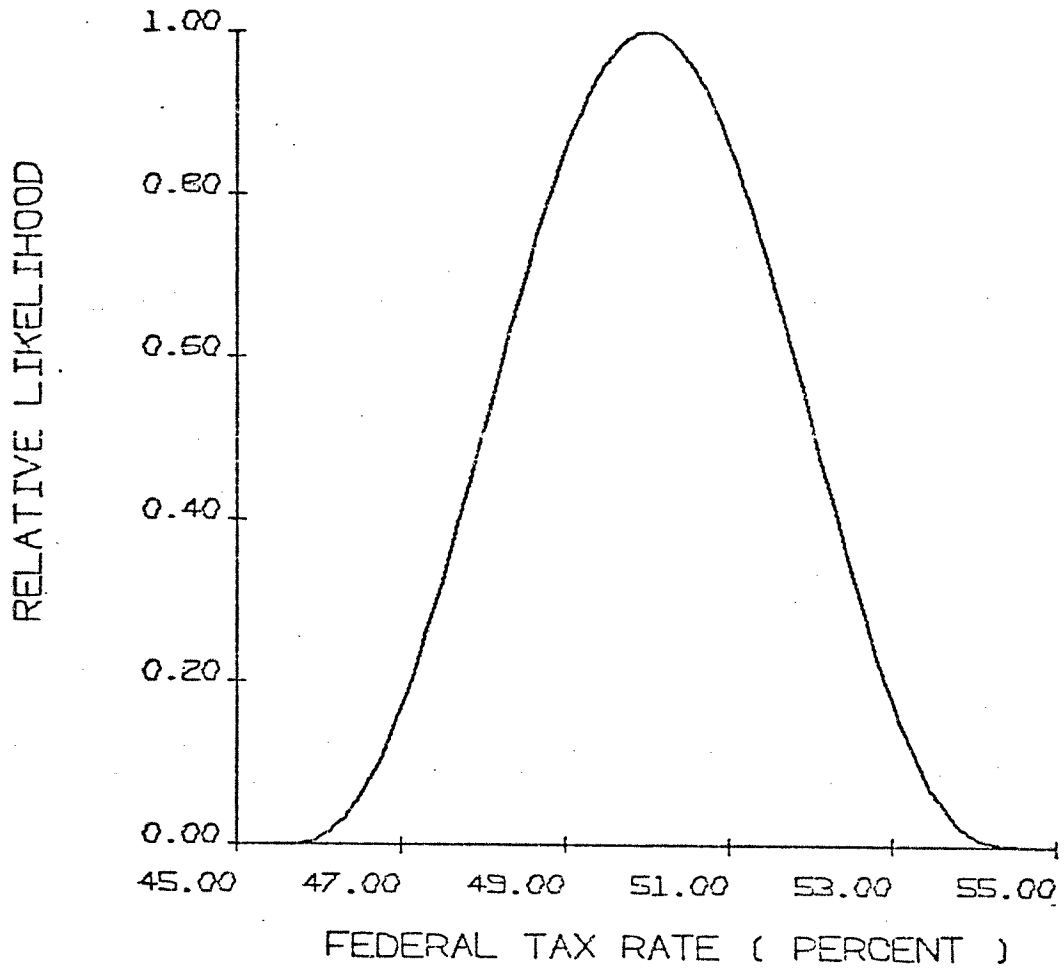


FIGURE 32

BETA DISTRIBUTION OF PROJECT LIFE

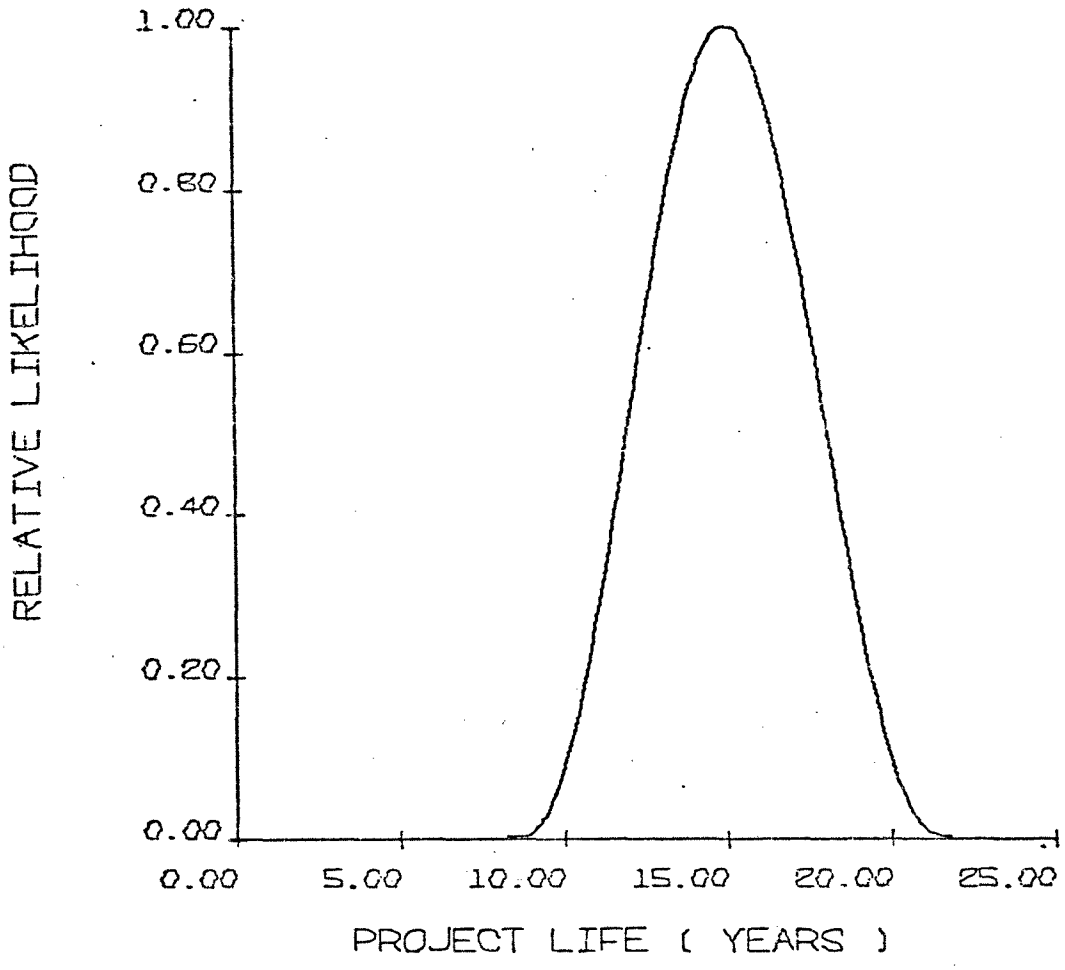


FIGURE 33

BETA DISTRIBUTION OF START-UP COSTS

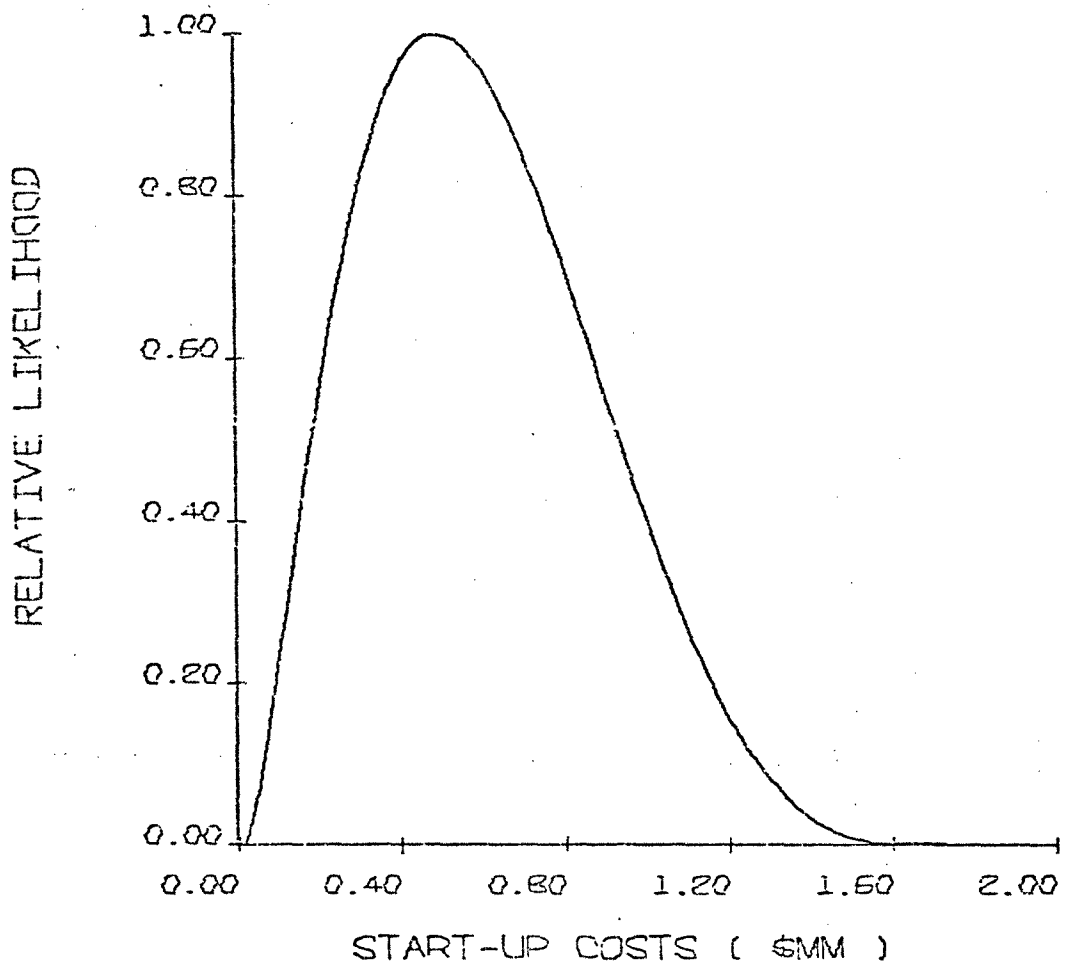


FIGURE 34

HISTOGRAM FOR PRESENT WORTH ABOVE TEN PERCENT RETURN
FOR 25MM POUND PER YEAR PLANT CAPACITY

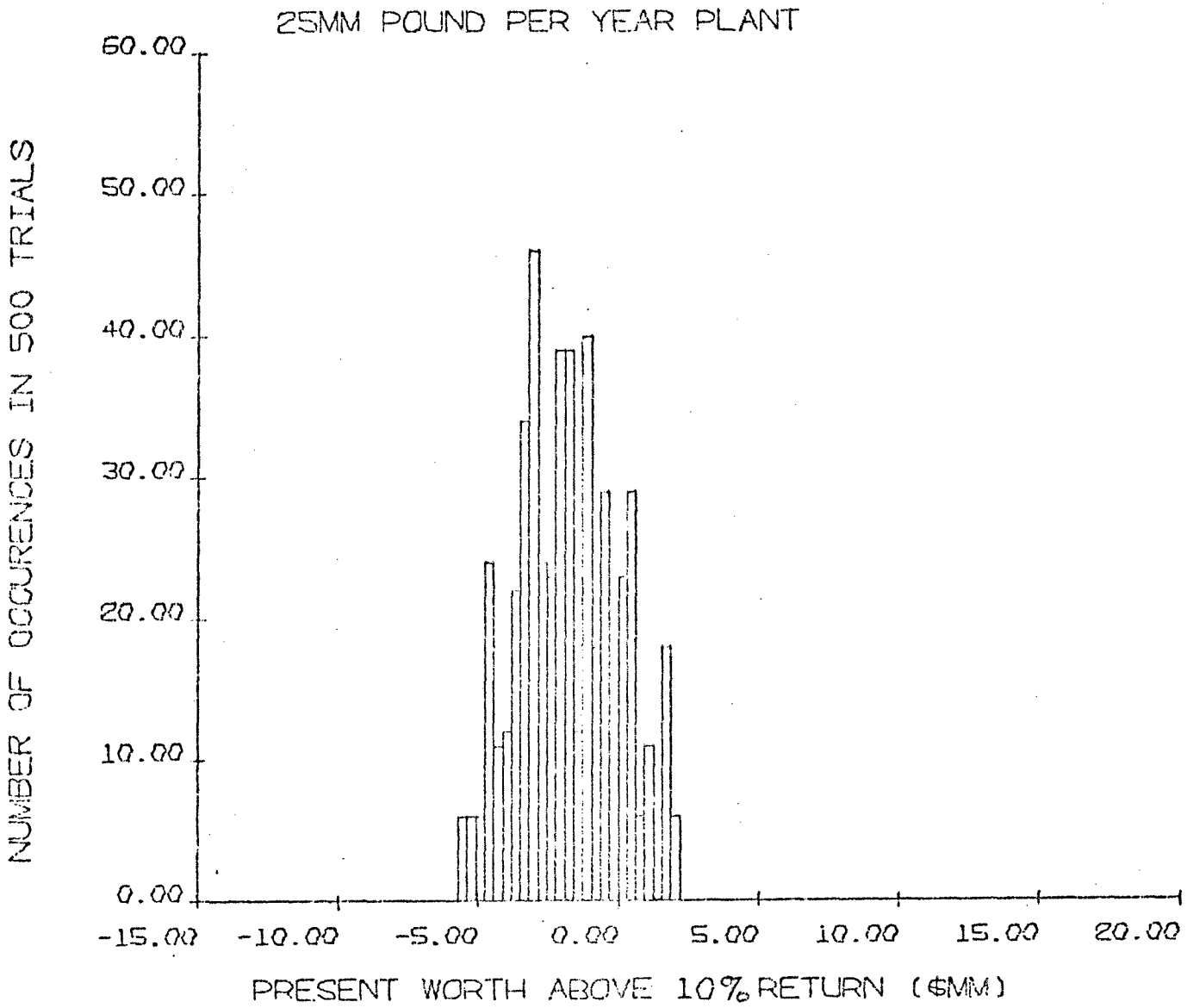


FIGURE 35

HISTOGRAM FOR PRESENT WORTH ABOVE TEN PERCENT RETURN
FOR 50MM POUND PER YEAR PLANT CAPACITY

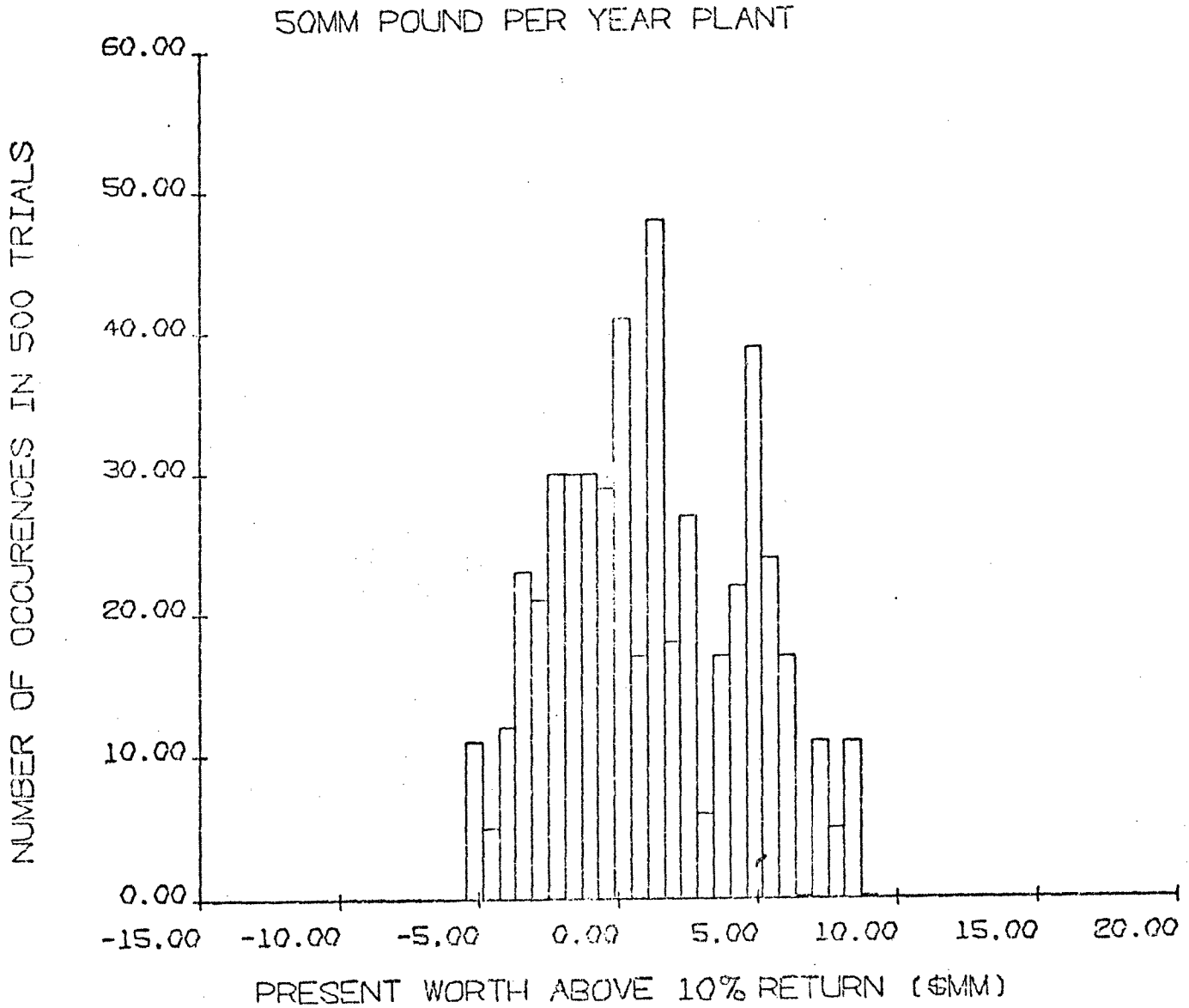


FIGURE 36

HISTOGRAM FOR PRESENT WORTH ABOVE TEN PERCENT RETURN
FOR 75MM POUND PER YEAR PLANT CAPACITY

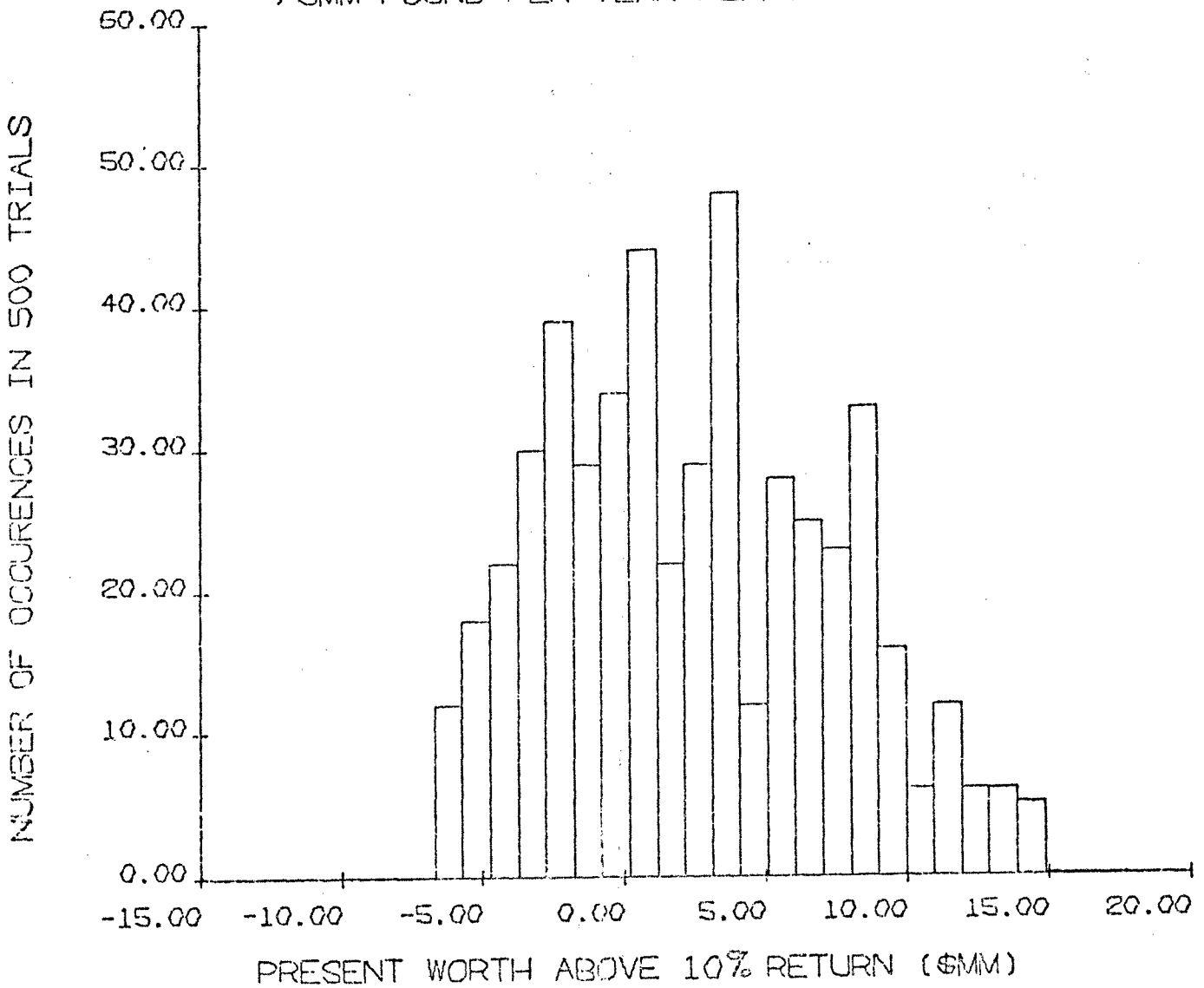


FIGURE 37

HISTOGRAM FOR PRESENT WORTH ABOVE TEN PERCENT RETURN
FOR 100MM POUND PER YEAR PLANT CAPACITY

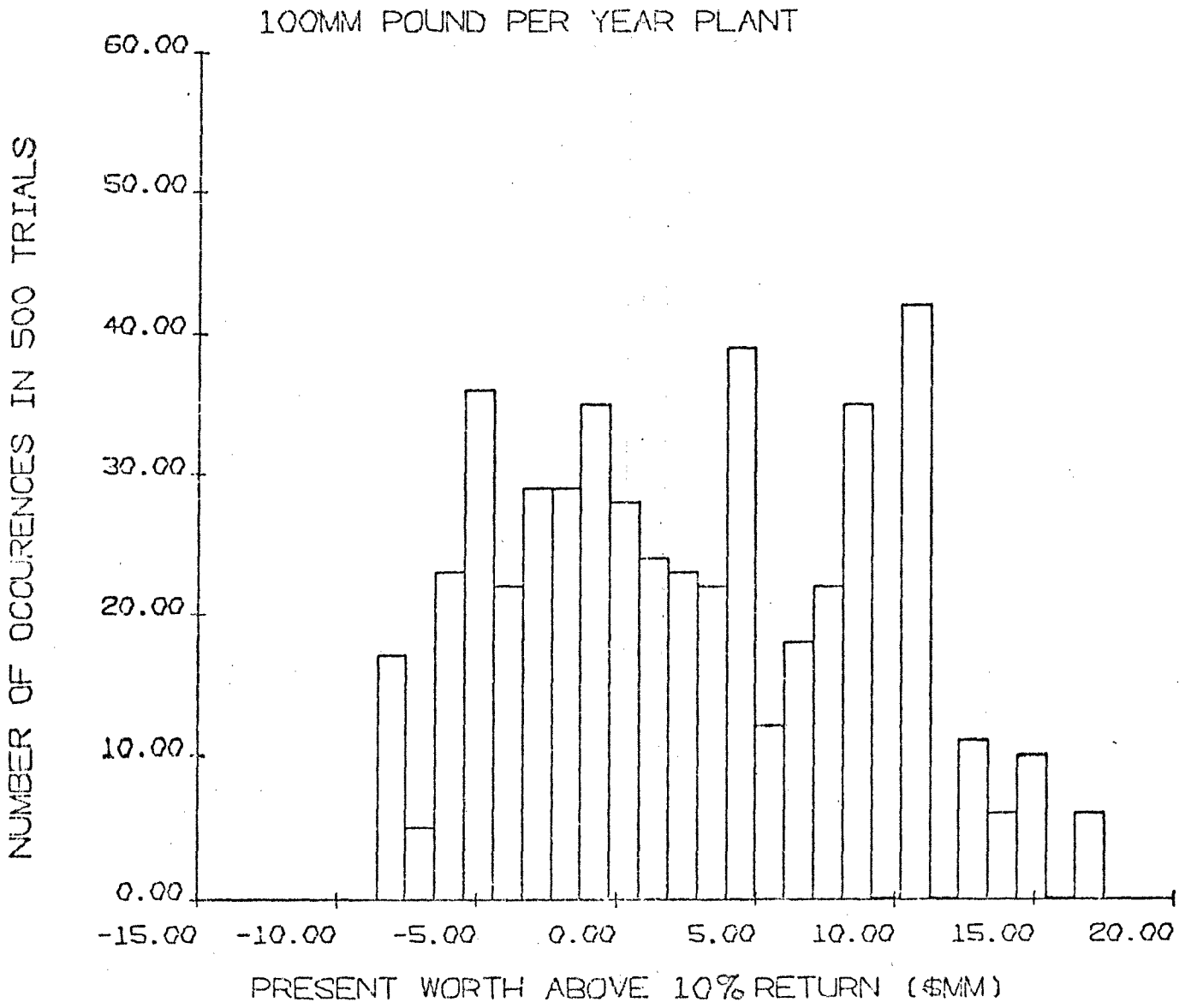


FIGURE 38

HISTOGRAM FOR PRESENT WORTH ABOVE TEN PERCENT RETURN
FOR 125MM POUND PER YEAR PLANT CAPACITY

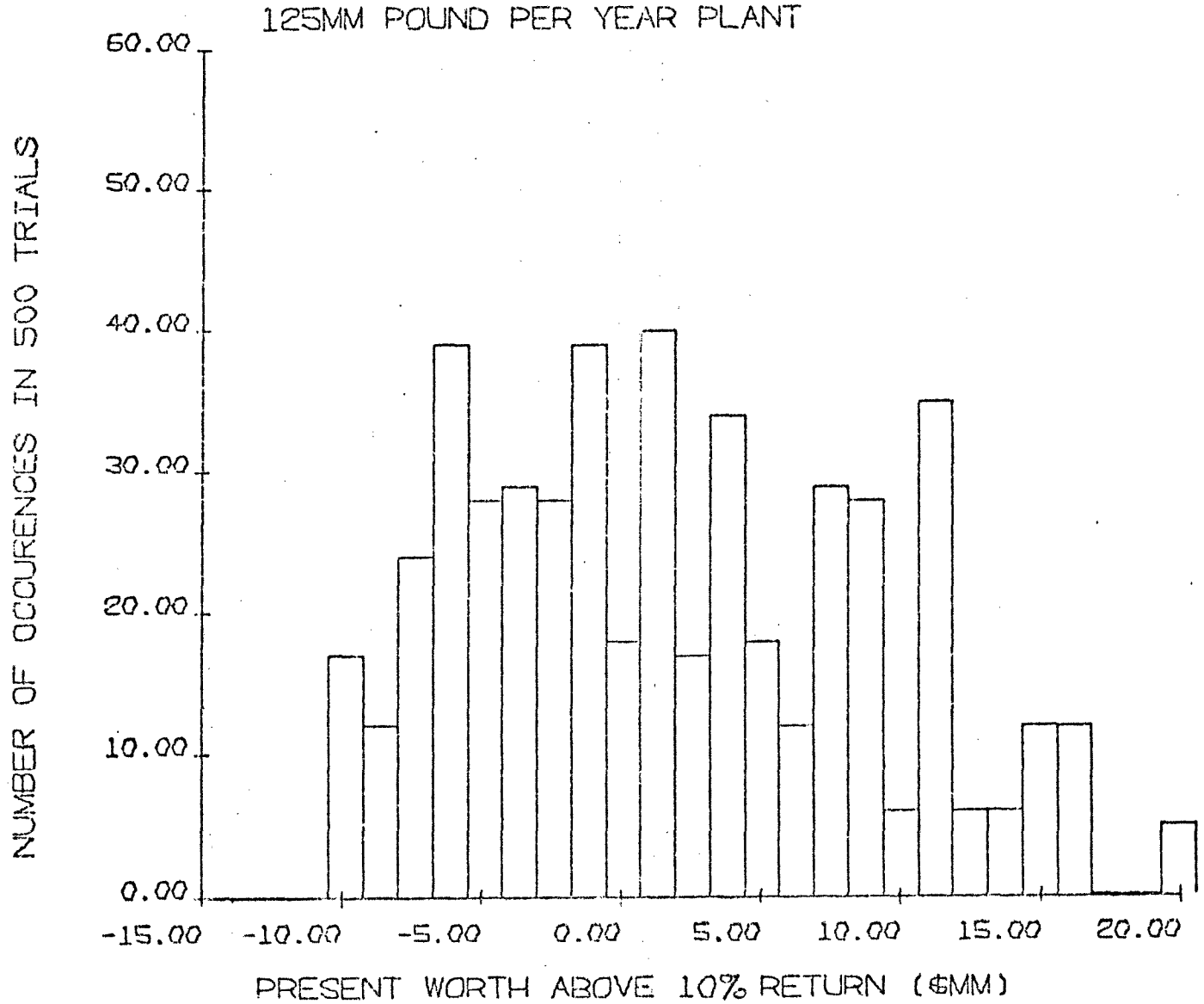


FIGURE 39

HISTOGRAM OF YIELD FOR 25MM POUND PER YEAR PLANT CAPACITY

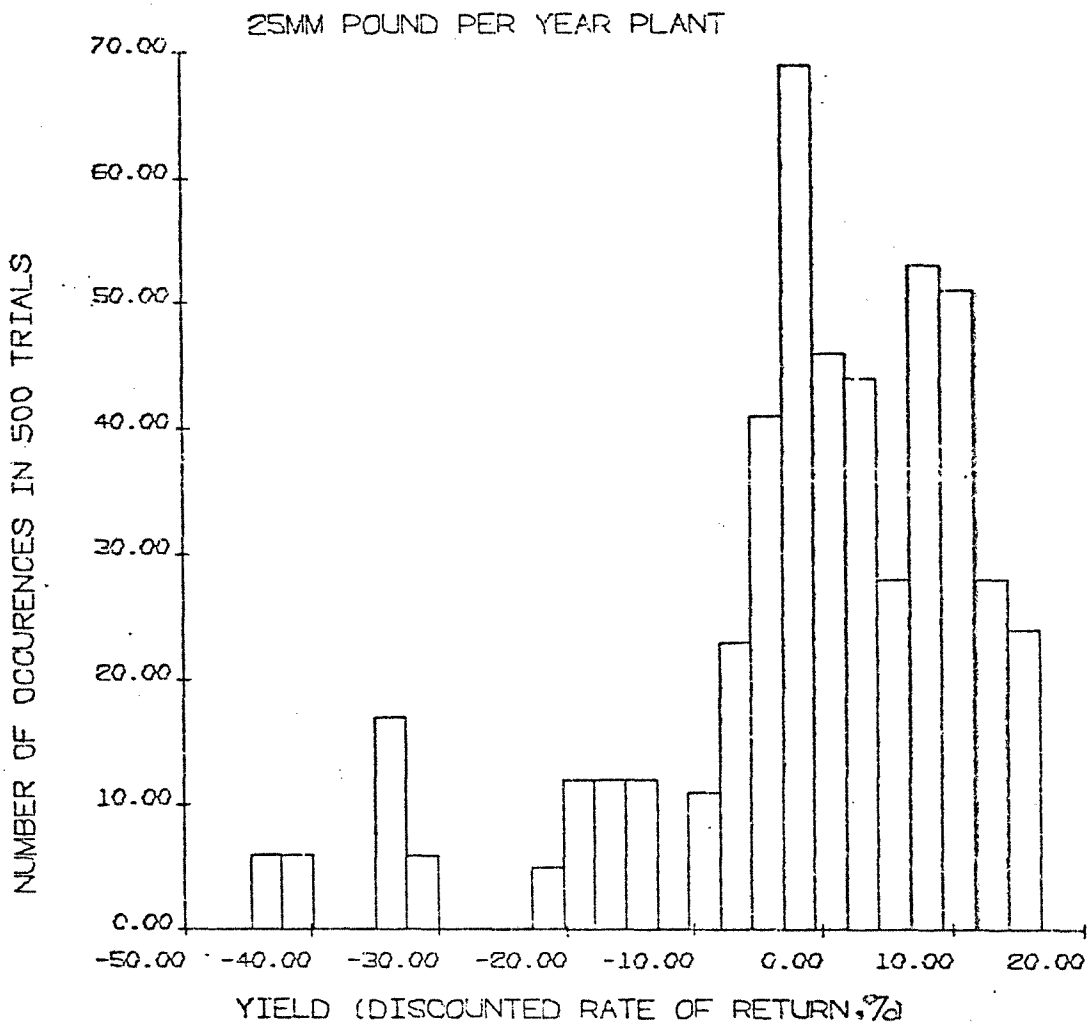


FIGURE 40

HISTOGRAM OF YIELD FOR 50MM POUND PER YEAR PLANT CAPACITY

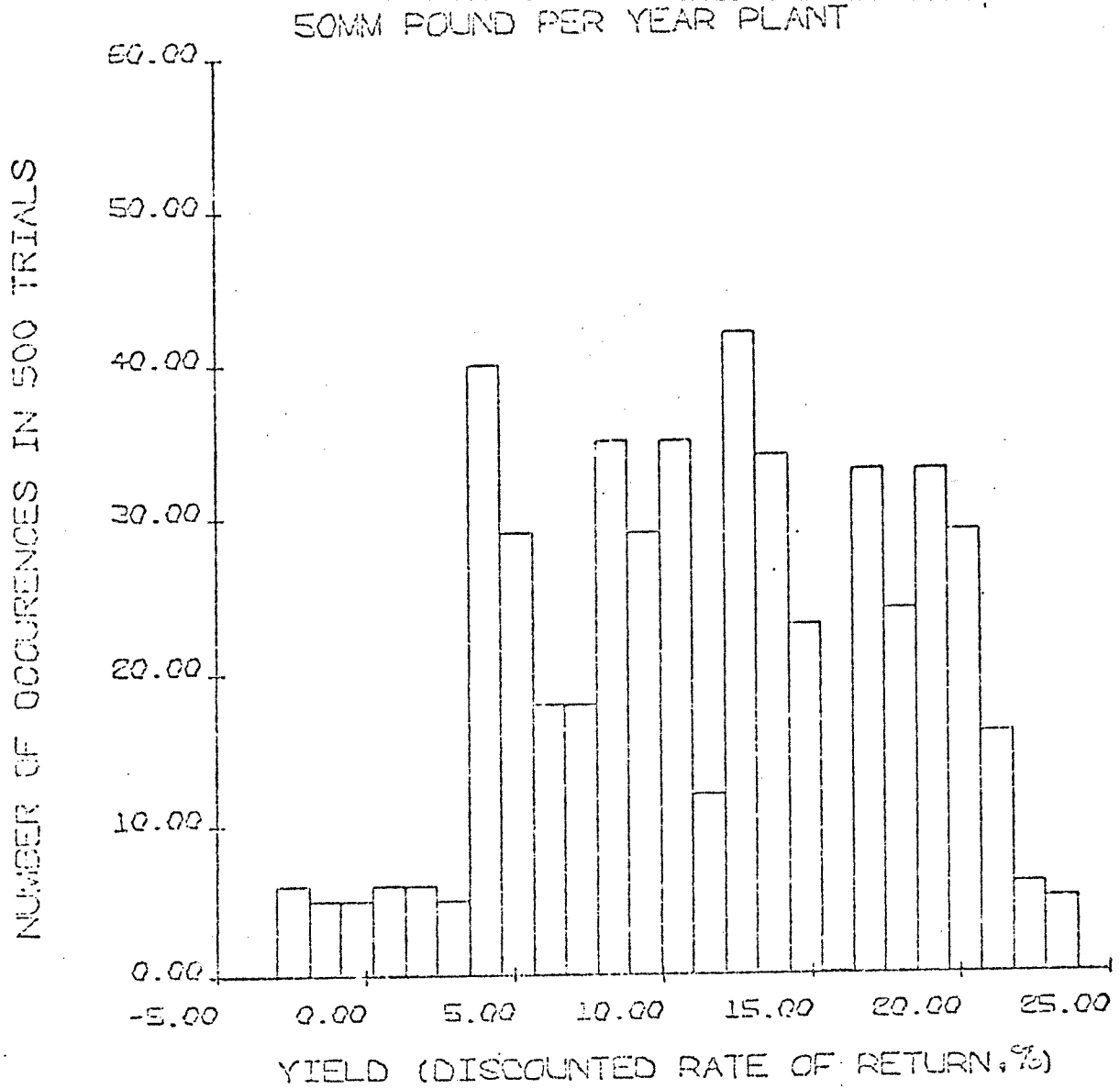


FIGURE 41

HISTOGRAM OF YIELD FOR 75MM POUND PER YEAR PLANT CAPACITY

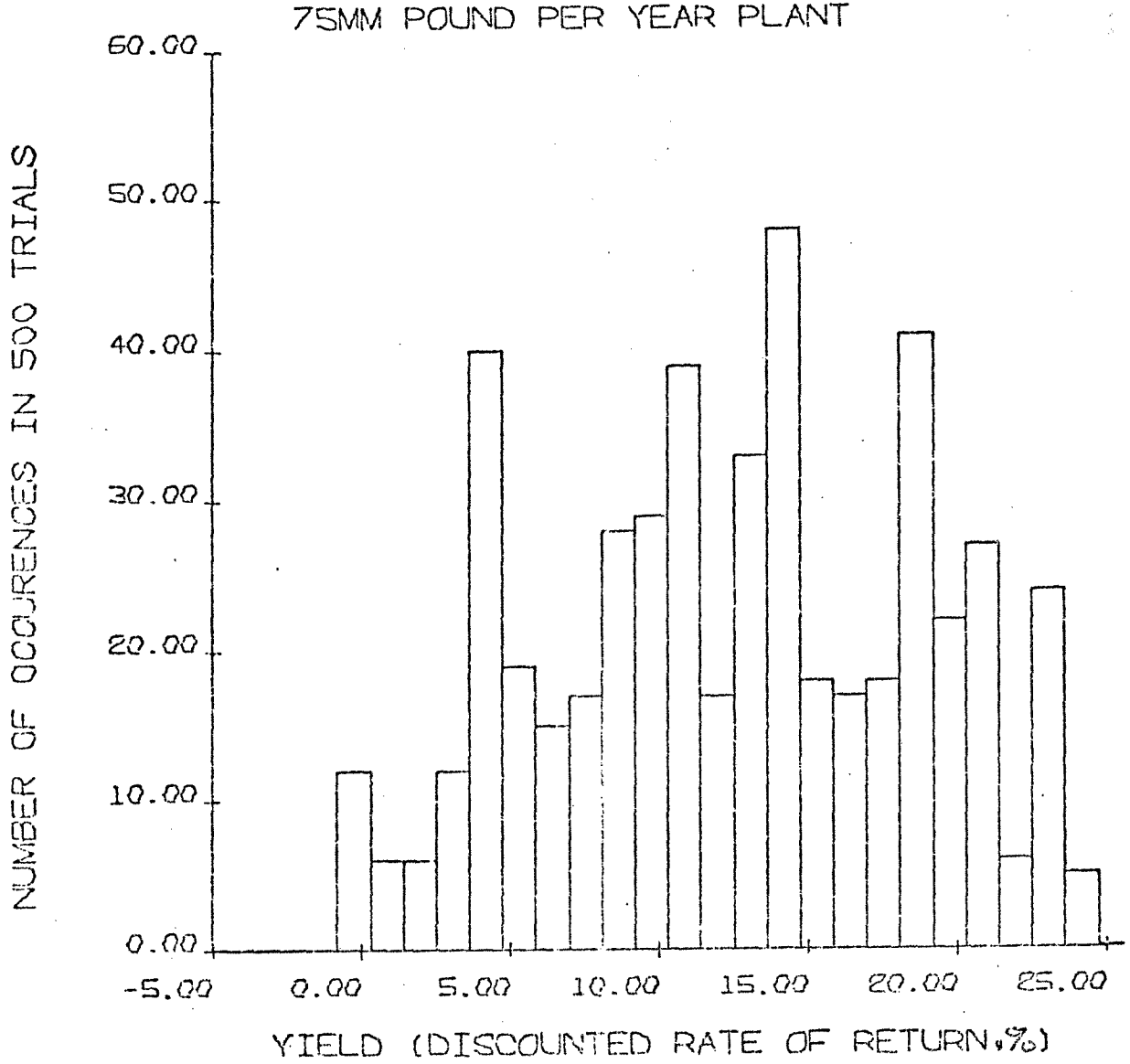


FIGURE 42

HISTOGRAM OF YIELD FOR 100MM POUND PER YEAR PLANT CAPACITY

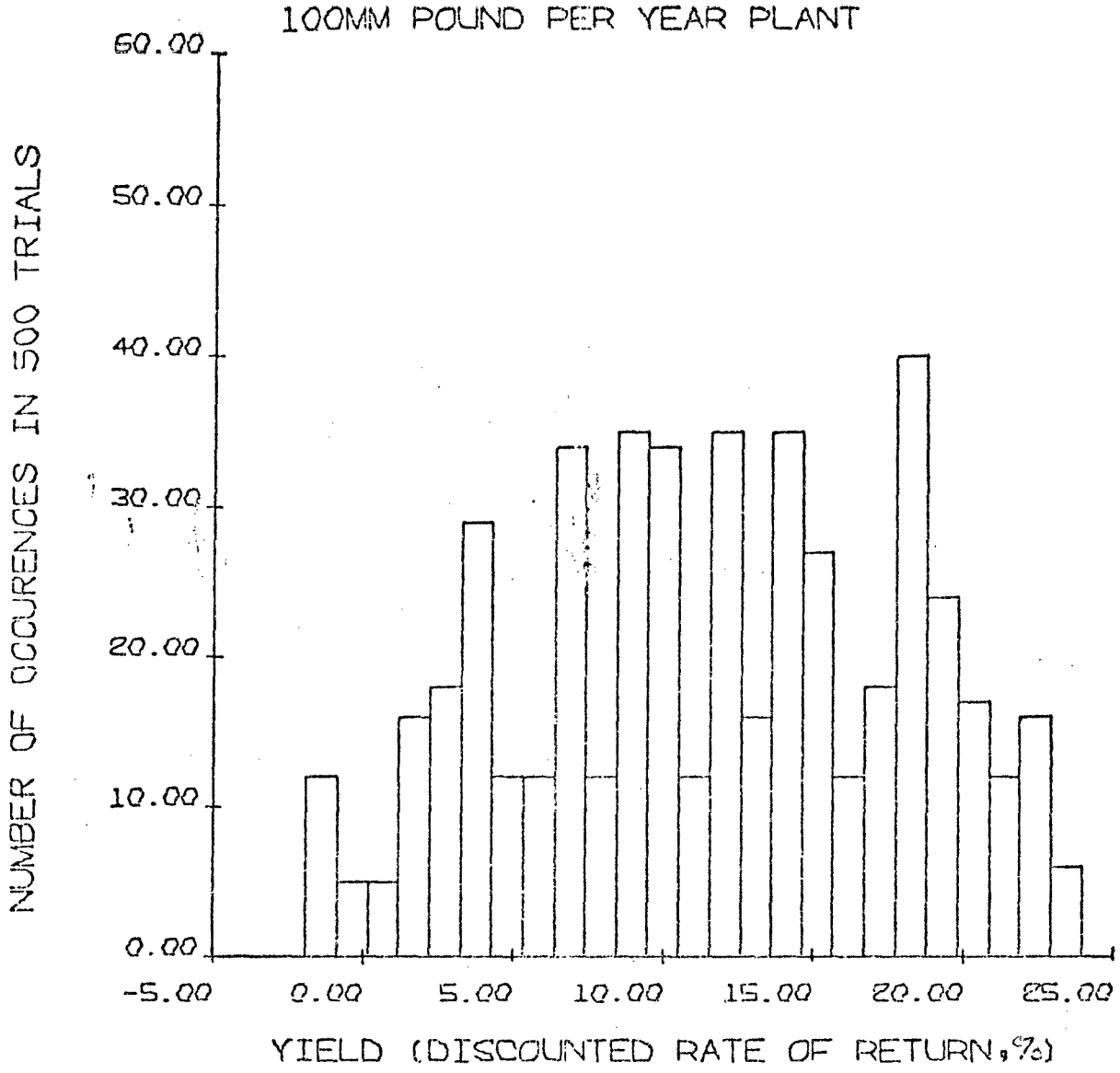
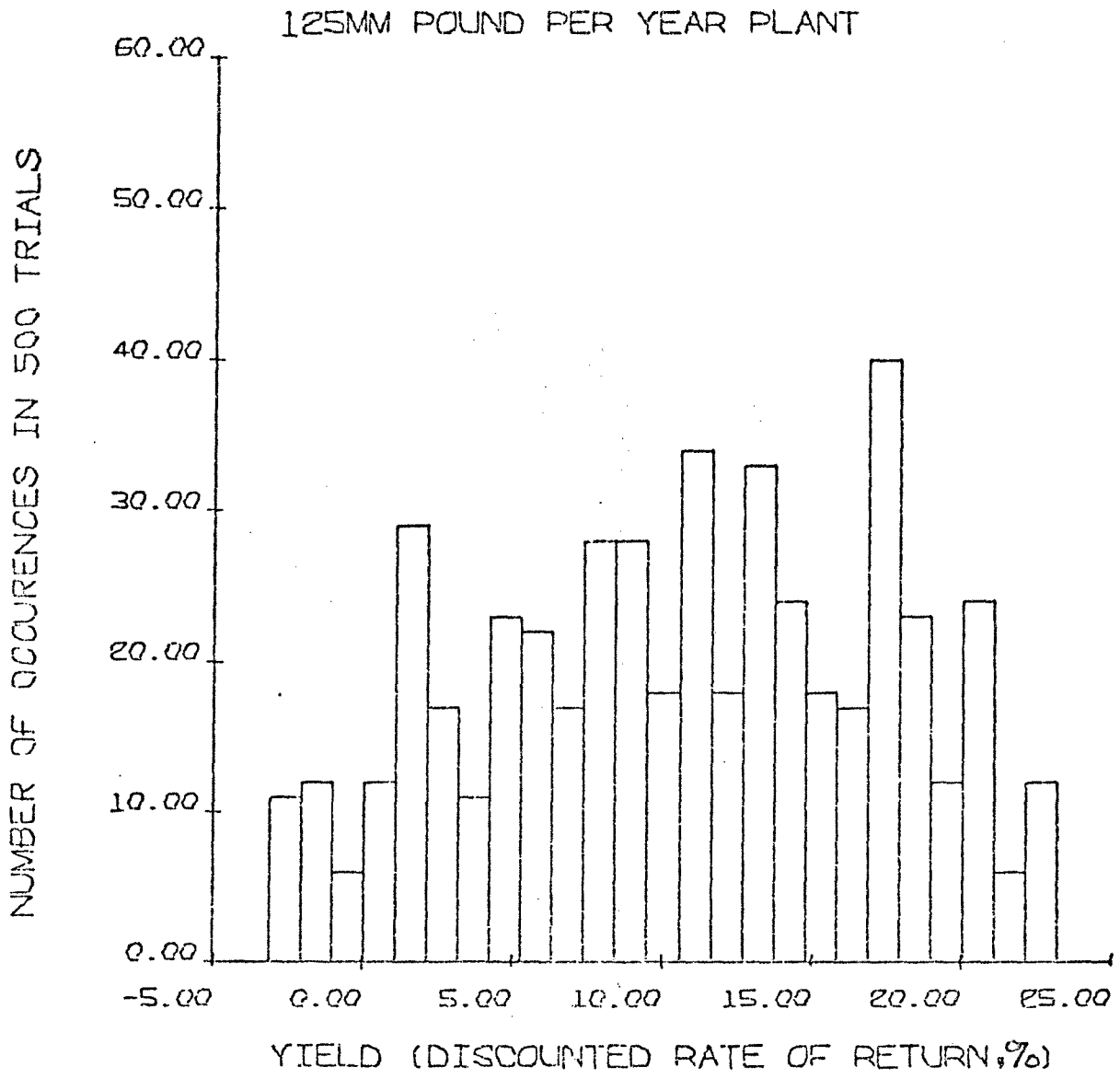


FIGURE 43

HISTOGRAM OF YIELD FOR 125MM POUND PER YEAR PLANT CAPACITY



REFERENCES

Corrigan, Thomas E. and Michael J. Dean, "Determining Optimum Plant Size," Chemical Engineering, August 14, 1967, pp. 152-56.

Hertz, David B., New Power for Management; Computer Systems and Management Science. New York: McGraw-Hill Book Company, 1969, pp. 46-85.

Hirschmann, Winfred B., "Profit From the Learning Curve," Harvard Business Review, Vol. 42, No. 1, January/February, 1964, pp. 125-39.

Malloy J. B., "Instant Economic Evaluation," Chemical Engineering Progress, Vol. 65, No. 11, November, 1969, pp. 47-54.

Malloy J. B., "Risk Analysis of Chemical Plants," Chemical Engineering Progress, Vol. 67, No. 10, October, 1971, pp. 68-77.

Michelsen, D. L., F. L. Monesmith, A. W. Zwiener, and S. J. Katz, "Monte Carlo Analysis of a New Plant in a Time-Dependent Economic Environment," Paper presented at the 63rd Annual Meeting, The American Institute of Chemical Engineers, November 29 - December 3, 1970.

Quigley, Harry A., and James B. Weaver, "Economic Considerations in Postponing Investment," Industrial and Engineering Chemistry, Vol. 52, No. 11, November, 1960, pp. 57-58.

Smith, G. L., "Monte Carlo Simulation - A Tool for Combating Uncertainty in Economic Analysis," Paper presented at the 10th Annual Meeting American Association of Cost Engineers, Philadelphia, Pennsylvania, June 20 - 22, 1967, pp. 1-17.

Sprow, Frank B., "Evaluating of Research Expenditures Using Triangular Distribution Functions and Monte Carlo Methods," Industrial and Engineering Chemistry, Vol. 59, No. 7, July, 1967, pp. 35-38.

Thorne, H. C. and D. C. Wise, "Computers in Economic Evaluation," Chemical Engineering, April 29, 1963, pp. 129-32.

Twaddle, W.W. and J. B. Malloy, "Evaluating and sizing new chemical plants," Chemical Engineering Progress, Vol. 62, No. 7, July, 1966, pp. 90-96.

Urban, W. J. and F. A. Holland, "How to Determine Optimum Plant Size," Chemical Engineering, March 28, 1966, pp. 103-108.