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DEVELOPMENT OF A RISK ANALYSIS MODEL,
FINAL REPORT,
OCTOBER 1979

APPENDIX C,
RISK ANALYSIS METHODOLOGY.

prepared for

THE OFFICE OF BUILDINGS AND COMMUNITY SYSTEMS
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PREFACE

This document is Appendix C of DYNATREND INCORPORATED's report, "Development of a Risk Analysis Model, Final Report" October 1979, prepared for the Department of Energy's Office of Buildings and Community Systems under Contract DE-AC03-77CS20158. Three case studies were included in the process of the contract effort. This appendix provides general information concerning the model used in the three case studies, its input data requirements, and its output reports. This appendix should be used in conjunction with each of the separately bound case studies: Appendix D, "Gas Fired Heat Pump Case Study"; Appendix E, "1000 Ton Per Day Anaerobic Digestion Plant Case Study"; and Appendix F, "District Heating and Cooling System Case Study".

The description of the RISK Model presented herein was provided by DYNATREND subcontractor ECON, Incorporated. Mr. Joel S. Greenberg served as the Principal Investigator.

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CHAPTER 1

RISK ANALYSIS CONCEPT

An investment decision involves the commitment of funds now with the hope of returns in the future. Since the future is not known with certainty, the consequences of an investment decision are also uncertain. Therefore, in order to arrive at a decision, management is forced to predict, forecast or guess the future. The uncertainty about the exact course of future events creates risk in the form of unforeseen fluctuations in cash flow patterns.

Management is normally faced with many investment alternatives from which an investment or venture set is to be selected. The selected set normally depends upon the availability of skills, company objectives, company image, etc. The risk associated with each of the ventures, as well as with alternatives in combinations, must ultimately be considered. Consideration must also be given to the relationship of the new ventures to business activities underway -- i.e., the effect of diversification upon the risk of the company.

The conventional approach to evaluation of investment alternatives considers only two fundamental dimensions: the magnitude of the particular measure in question and time. Thus, traditional analysis is based upon expressing the assumptions about key variables affecting future costs, revenues, and investment requirements in terms of single-point estimates. Figure C-1 illustrates this approach. These estimates are made based upon the best information available.

It is evident that single-point estimates of key input variables can, in turn, only result in single-point estimates of the key performance measures. In other words, the results of the "best guesses" are normally expressed in terms of most likely profit,

FIGURE C-1. TYPICAL SALES AND CASH FLOW PROJECTIONS
WITH SINGLE POINT ESTIMATES

cash flow, etc., as a function of time. Values of various performance measures such as payback period, return on assets, present value (worth), etc., may be computed and are also single-point results.

Management may consider the venture to be acceptable if the performance measures exceed specified criteria (or group of criteria). That is, the venture may be deemed acceptable if the return on investment (ROI) exceeds a minimum specified value, the payback is less than a maximum specified value, etc. If the venture is considered particularly risky, management may raise the basic requirements to counter-balance the greater level of risk.

Performance, cost, and market uncertainties can be explicitly and quantitatively considered and the consequences of these uncertainties--risk--can be established as a quantitative measure. Risk refers to the variability of performance measures created by input (to the analysis of a business venture) data uncertainty.

The analysis of risk requires the addition of a third dimension to those of magnitude and time; namely, the dimension of uncertainty. This means that each major input assumption must be described, not just by a single estimate, but by an entire range of possible values, with associated likelihoods of the variable falling into various sectors within the range. In other words, the probability distribution of the key parameters must be specified. These probabilities are referred to as uncertainty profiles.

The uncertainty profiles are derived from subjective estimates by informed persons. The method for accomplishing this is discussed later.

When uncertainty is admitted to in the input parameters, the derived or computed result and quantities also have an uncertainty dimension as indicated in Figure C-2. The resultant probability distribution can be replotted, as shown in Figure C-3 to indicate the chance that the performance measure will exceed various levels. This is referred to as a risk profile.

FIGURE C-2. RISK ANALYSIS - TYPICAL PROJECTIONS

FIGURE C-3. PROFIT PROBABILITY DISTRIBUTION

Risk analysis is a formal procedure whereby quantitative estimates of uncertainty associated with basic input quantities are converted to risk profiles of performance data.

CHAPTER 2

RISK ANALYSIS MODELS

Basic input data consists of deterministic data and probabilistic data. Examples of deterministic data are the number of time periods to be considered, the discount rates, tax rates, etc. The probabilistic data consist of the probability density functions, hereafter referred to as "uncertainty profiles," associated with the variables whose values cannot be predicted or known exactly in advance. The uncertainty profiles thus are subjective estimates which describe the range of uncertainty and the form (shape) of the uncertainty. Typical uncertainty variables are unit sales, selling price, market share, expense items, capital expenditures and others.

These data are input to a financial simulation model which is of the complexity necessary to adequately represent the real world situation being evaluated. The model indicated in Figure C-4 states that revenue (R) in the I th time period is equal to the product of unit sales (US), selling price (SP) and market share (MS); before-tax profit (BTP) is equal to revenue less the sum of all expense items (E) less the depreciation expense (D); after-tax profit is one minus the tax rate (TR) multiplied by the before-tax profit.

The risk analysis is performed by random sampling of the input data (according to the weighting of the uncertainty profiles), performing the computations contained within the simulation model, saving the results and thence repeating the process. This process is repeated a large number of times (Monte Carlo sampling) until a reasonable set of histograms can be developed from the saved output data. These histograms are then manipulated into the desired form so as to indicate the variability of pertinent performance measures such as profit, cash flow, indebtedness (negative of the cumulative cash flow to date),

- RISK ANALYSIS IS A FORMAL PROCEDURE WHEREBY QUANTITATIVE ESTIMATES OF UNCERTAINTY ASSOCIATED WITH BASIC INPUT QUANTITIES ARE CONVERTED TO RISK PROFILES OF PERFORMANCE MEASURES

FIGURE C-4. RISK ANALYSIS

rate of return and present worth. A convenient form of displaying the performance measures is that of "risk profiles" which indicate the chance of the performance measure exceeding specific levels (i.e., the complementary cumulative probability distribution).

Most risk analysis models used for financial analysis develop the probability distributions (in one form or another) of profit and cash flow. The basic structure behind the cash flow computation is shown in Figure C-5. Unit sales* is multiplied by unit selling price and the product is in turn multiplied by market share to produce annual revenue. Each of these basic quantities may be provided in the form of uncertainty profiles which are then sampled randomly (in the Monte Carlo analysis) to produce a value of the revenue random variable.

*I refers to the Ith time period.

FIGURE C-5. SIMPLIFIED CASH FLOW COMPUTATION

Variable cost (which may be related to unit sales, for example) is added to fixed cost to obtain total annual operating cost. The variable and fixed costs may also be uncertainty variables.

Capital expenditures are specified (in the form of uncertainty variables together with time of expenditure) and depreciation is computed and added to total operating cost to yield total annual expenses. The revenue less the annual expenses yields before-tax profit, which, when multiplied by one minus the tax rate and modified by carry-forward losses, yields after-tax profit.

Annual cash flow is obtained by adding depreciation and changes in the balance sheet items to after-tax profit and subtracting capital expenditures.

The risk profiles for profit and cash flow may be developed by repeating this process a large number of times, each time randomly selecting values of the uncertainty variables (unit sales, capital expenditures, etc.) and thence performing the indicated calculations.

CHAPTER 3

THE SELECTED RISK MODEL

The ECON, Incorporated RISK Model was selected for risk analyses for the Department of Energy Office of Buildings and Community Systems, was tested and modified. The modified model is a general venture simulation model which is capable of simulating the financial aspects of a wide range of business ventures. It is also capable of establishing the energy savings that might result from the industry sales of the products marketed by the business venture. The risk model, based upon Monte Carlo simulation techniques, converts a combination of deterministic and probabilistic input data, which describes the venture being analyzed, into the risk profiles which indicate the chance that various performance measures such as profit, cash flow, ROI, and others, will exceed different levels.

The deterministic input data consists of the specification of the number of years and number of products to be considered, tax rates, form of venture, etc. The probabilistic input data consists of those parameters which cannot be considered as known without uncertainty. Their specification consists of establishing, by subjective estimates, the range of uncertainty and the form of the uncertainty (associated with the specified range) associated with each of these uncertainty variables. The uncertainty variables consist of unit price, unit sales, market share, time of start of sales, magnitude of capital expenditures and numerous expense items. To minimize the data entry problem, the specification of the probabilistic input data is accomplished by specifying minimum and maximum values and the number of the probability distribution (identified from pictures of the large number of stored distributions) which describes the form of the uncertainty within the established range of uncertainty.

3.1 MODEL STRUCTURE

The risk model has sufficient structure so that a large number of diverse ventures can be simulated and evaluated. The model considers multiple time periods (20) explicitly, with trends considered for following time periods. Many uncertainty variables are considered as correlated from year to year. Multiple interrelated products may be considered such that a "razor-razor blade" type of situation can be simulated. Demand-price and cost-quantity relationships are considered so that the impact of variations in unit price can be realistically taken into account.

Multiple time-phased capital expenditures can be considered, with the type of depreciation specified for each expenditure. The model establishes the timing of specific capital expenditures which may be related to production requirements. All revenue, expenses, and capital expenditures are adjusted in accordance with the time delay uncertainty variable, which indicates the uncertainty associated with the "time of getting to the marketplace."

The model may be used to perform the financial computations for various business situations including those where the venture is part of an existing corporation, the venture takes the form of a partnership leading to a corporate entity, and the venture is a separate corporation (a start-up situation).

The model establishes risk profiles of annual revenue, expenses, capital expenditures, profit, cash flow, cumulative cash flow and return on assets. Risk profiles are also established for present worth (at a number of different discount rates), payback period, and energy savings by product and energy type.

It is important to understand the model structure and input data requirements, since these may influence the accuracy and

validity of the analyses conducted, as well as the interpretation of the results of the analyses. The following pages describe the structure and data requirements of the model. Discussion of the impact of the structure and data requirements on the analyses are included in the case studies.

The basic structure of the model is shown in Figure C-6. Similar to the illustration on page C-8, revenue less the sum of fixed and variable expenses yields before-tax profit from which (after multiplication by one minus the tax rate) are subtracted carry-forward losses, to yield after-tax profit. Revenues and expenses are adjusted in time in accordance with the random value of the time delay. The time delay is an uncertainty variable which reflects the uncertainty in the time of getting to the marketplace. All revenue, expense, and capital expenditures are adjusted in time according to this variable.

Fixed and variable depreciation are added to the after-tax profit, as is the change in balance sheet items. Fixed and variable capital expenditures are then subtracted from this amount to yield annual cash flow. Book values of the fixed and variable capital expenditure items are added to the other balance sheet items to produce total assets, which is then divided into after-tax profit to yield return-on-assets.

"Fixed" capital expenditures refer to those capital items which are anticipated to be independent of production level. "Variable" capital expenditures refer to those capital items which are production level dependent, and are thus random variables because their magnitude and timing depend upon unit sales, which is a random variable.

The model structure exists; it is completely programmed and its structure for a specific business analysis is established via input data. The model allows up to ten products, ten expense items with fixed and variable parts, ten fixed capital

FIGURE C-6. MODEL STRUCTURE OF RISK MODEL

expenditures and ten variable capital expenditures to be considered.

In Figure C-6 revenue is shown as a single box. Actually, the revenue has a rather elaborate structure, as illustrated in Figure C-7.

Revenue may be developed at either the aggregate or disaggregate level, depending upon the problem at hand; the choice being communicated to the model via the input data. In the aggregate case, total annual revenue is the basic uncertainty variable. Its range of uncertainty and form of the uncertainty profile is specified for each year of the analysis. Because of the random sampling of probability distributions, it is necessary to allow for correlation effects from year to year to avoid unrealistic fluctuations in the values of the uncertainty variables. Correlation effects are introduced for all revenue and expense items.

Revenue may also be developed by considering unit selling price, unit sales and market share; i.e., the disaggregate case. In this instance, multiple related products may be considered with total revenue being the sum of the individual product revenues. Individual product revenues are based upon establishing, through random sampling, unit selling price which, via demand curves established by input data, yields unit sales. The product of unit selling price, unit sales and market share yields revenue.

A simple but frequently useful product interrelationship structure exists in the disaggregate revenue computation. This relationship allows the number of units of product n which will be sold as a result of each unit sold of products 1 through $n-1$ to be established. The model structure allows up to ten products to be considered.

FIGURE C-7. REVENUE STRUCTURE OF RISK MODEL

Energy savings are a function of total unit sales and energy savings per unit sold. The present value of energy savings is established for each product. Since the type of energy (oil, gas, etc.) savings is related to products, the present value of energy savings is also established for each energy type.

3.2 UNCERTAINTY VARIABLES

The risk model considers the items listed in Figure C-8 as uncertainty variables. All uncertainty variables are specified as the range of uncertainty (i.e., minimum and maximum values) and the name or I.D. number of the applicable probability density function. Thirty uncertainty profiles are stored and are easily referenced by specifying an I.D. number. All uncertainty profiles consist of piece-wise continuous approximations to continuous functions. The reason for this particular form is the necessity to have an easy way of developing and inputting other uncertainty profiles and having an understanding and appreciation of the meaning of the profiles.

A useful and frequently used procedure for establishing the shape of new uncertainty profiles is as follows (see Figure C-9):

- a. Estimate the range of uncertainty--minimum and maximum bounds (little or no chance of falling outside these bounds). Divide this range into a number of equal intervals--five has been found, through experimentation, to be useful and is therefore used in the risk program.
- b. Make a relative ranking of the likelihood of the variable falling into each of the intervals; this establishes the general shape of the uncertainty profile (i.e., skewed left, central, etc.).

- VALUE OF EACH CAPITAL EXPENDITURE ITEM
- DEVELOPMENT DURATION (TIME TO START OF SALES)
- FIXED AND VARIABLE PORTIONS OF MULTIPLE EXPENSE ITEMS (BY YEAR)

- TOTAL COST OF SALES (BY YEAR)
- TOTAL REVENUE (BY YEAR)

OR

- UNIT COST OF SALES (BY PRODUCT AND YEAR)
- UNIT SALES (BY PRODUCT AND YEAR)
- SELLING PRICE (BY PRODUCT AND YEAR)
- MARKET SHARE (BY PRODUCT AND YEAR)
- ENERGY SAVINGS PER UNIT (BY PRODUCT)

FIGURE C-8. RISK MODEL UNCERTAINTY VARIABLES

FIGURE C-9. DETERMINATION OF SHAPE OF UNCERTAINTY PROFILE

- c. Set relative values for the chance of falling into each interval. (For example, the chance of falling into interval 1 is half that of falling into interval 2.)
- d. Having assumed the probability of falling within the range of uncertainty as 1.0, the chance of falling in each of the five intervals can be summed and set equal to unity. This equation can be solved for the probabilities associated with each interval (by substituting the relative values as obtained in step c).

3.3 INPUT DATA EXECUTION AND DETERMINISTIC VARIABLES

A list of input data execution and deterministic variables for the risk model is presented in Figure C-10. The input data determines both the logic structure to be used in the computations as well as the specific values to be used for the variables. For example, the aggregate/disaggregate analysis variable specifies which level of analysis is to be performed. If the aggregate is specified, then specific input data such as unit sales, selling price, etc. is not necessary. Other variables, such as depreciation life, provide the numeric value to be used in the computations.

Because of the large quantity of data which is required to run the model, particular care has been devoted to the user-model interface. Many of the variables have been initialized to default values. Thus data for many variables (such as tax rates) need not be specified if the user agrees that the default values are applicable.

The input data for the model is developed by answering a series of carefully worded questions. The answers to the questions describe the venture being analyzed. The input data structure is organized so as to simplify the analyst's data entry problems and minimize errors. Data is provided in the following categories:

o General Data (Part 1)	o Detailed Expense Data
o Uncertainty Profiles	o Capital Expenditure Info.
o Revenue and Cost of Sales Data	o Unit Dependent Capital Expenditures
o General Product Data	o Balance Sheet Related Information
o Detailed Revenue Data	o Consideration of Existing Balance Sheet Items
o Product Interrelationships	o Energy Related Data
o Detailed Cost of Sales Data	o General Data (Part 2)
o Expense Data	
o Output Report Request Data	

- NUMBER OF YEARS
- *• LIQUIDATION (Y/N)
- *• GROWTH RATE
- *• BUSINESS SITUATION
- *• CORPORATE ASSESSMENT
- *• AGGREGATE/DISAGGREGATE ANALYSIS
- NUMBER OF PRODUCTS
- *• UNCERTAINTY PROFILES
- *• NAME OF UNCERTAINTY PROFILES TO BE USED FOR EACH UNCERTAINTY VARIABLE
- PRICE/QUANTITY DATA
- COST/QUANTITY DATA
- PRODUCT INTERRELATIONSHIP
- NUMBER OF EXPENSE ITEMS
- PRODUCTION LEVEL INDEPENDENT CAPITAL EXPENDITURE DATA
 - NUMBER
 - TIME OF ACQUISITION
 - TYPE OF DEPRECIATION
 - DEPRECIATION LIFE
- *• PRODUCTION LEVEL RELATED CAPITAL EXPENDITURE DATA
 - INCREMENTAL PRODUCTION CAPABILITY
 - PRODUCTION LEVEL THRESHOLD
 - TYPE OF DEPRECIATION
 - DEPRECIATION LIFE
- *• TYPE OF ENERGY SAVINGS (BY PRODUCT)
- *• ENERGY SAVINGS PROPORTIONAL TO ANNUAL SALES OR CUMULATIVE SALES
- *• ENERGY PRICE
- BALANCE SHEET RELATED ITEMS
 - CASH (%)
 - RECEIVABLES (%)
 - PAYABLES (%)
 - INVENTORY (%)
- *• EXISTING BALANCE SHEET ITEMS
 - CURRENT CASH
 - CURRENT RECEIVABLES
 - CURRENT PAYABLES
 - CURRENT INVENTORY
 - BOOK VALUE OF ASSETS
 - TYPE OF DEPRECIATION
 - REMAINING DEPRECIATION LIFE
- *• NUMBER OF DISCOUNT RATES
- *• DISCOUNT RATES
- *• CORRELATION FACTOR FOR EACH UNCERTAINTY VARIABLE
- *• NUMBER OF SIMULATION RUNS
- *• TAX RATE STRUCTURE
- *• INVESTMENT TAX CREDIT RATE
- *• OUTPUT REQUEST DATA

* DEFAULT VALUES USED IF DATA OMITTED.

FIGURE C-10. RISK MODEL EXECUTION AND DETERMINISTIC VARIABLES

All data are provided in response to questions as illustrated in Figure C-11. The answers to the questions may be either alphabetical or numeric, as stated in the column headed "Possible Values." The column headed "Notes" indicates whether or not it is mandatory to answer the question. For example, a number in the range of 1 to 10 must be provided as the response to Question No. 1; Y or N may be used to respond to Question No. 2 with N assumed by the model if the question remains unanswered.

The responses to the questions are made on data sheets which are provided. It should be noted that the need to answer certain questions is conditioned upon the response to other questions. For example, if the response to Question No. 4 was 3, then Questions No. 11 through 13 should be answered.

A typical input data form, with input data entries, is illustrated in Figure C-12. The response to Question No. 1 indicates that the venture will be analyzed for each of ten years and that time dependent data such as unit sales must be provided for each of the ten years. The response to Question No. 3 is omitted implying that the analyst assumes that the after-tax earnings growth rate of 10 percent (the default value) is to be utilized.

The time delay uncertainty data is entered in response to Questions No. 8, 9 and 10. The response to Question No. 8 indicates the minimum anticipated time delay (the negative sign indicating a speed-up), the response to Question No. 9 indicates the maximum anticipated time delay (a delay of one-half year), and the response to Question No. 10 indicates the name of the uncertainty profile associated with the range of uncertainty. This format for entering uncertainty variable data is used for all uncertainty variables.

1. For what period of years is the venture to be evaluated?
2. Is liquidation at the end of the above time period assumed?
3. If liquidation is not contemplated (response to #2 is 'N'), it is assumed that the venture will continue after the end of the above time period. What would be the most likely growth rate of after tax earnings in this case? (express as a percentage.)
4. What type of business situation is to be considered (see Exhibit A for a brief description of the business situations which can easily be simulated and evaluated).

- Venture is embedded in a larger corp which will absorb tax losses as they occur (answer 1)?
- Venture is an independent organization which will carry forward tax losses and funding is as required (answer 2)?
- Venture is a separate organization taking the form of partnership (answer 3)?

5. If the venture is to be assessed a fixed percentage of sales, enter amount(%). Answer only if the response to Question 4 was equal to 1.

6. If it is desired to compute annual sales as the product of unit sales, selling price and market share enter Y. If it is desired to specify gross sales enter N.

Possible Values	Notes
1 to 10	Do not omit
Y or N	N assumed if omitted
-200.0 to 200.0	10.0 assumed if omitted. If negative enter sign to left of entry.
1,2,3	1 assumed if omitted

.0 to 99.9	.0 assumed if omitted
Y or N	N assumed if omitted

7. If the answer to #6 is Y, how many different products are to be considered in the analysis?
8. What is the minimum anticipated time delay (in years) for the start of sales of the venture? (Actually, the response entered here may indicate that a time advance is possible. A response of -.5 indicates a six month advance as one boundary of the range of possible values of time of start of sales.)
9. What is the maximum anticipated time delay (in years) for the start of sales of the venture?
10. Responses #8 & 9 established a range of possible values. Which uncertainty profile (see section 2) should be used to estimate the uncertainty within the range?

If the answer to Question #4 was 3, then answer Questions 11-13

11. What percentage of the losses will be assumed by the investing partner for tax purposes?
12. At the time that the initial loss period ends, what percentage of the profit will be allocated to the investing partner?
13. From which viewpoint is the venture to be evaluated? "I" refers to investor and "S" refers to seller or entrepreneur.

Possible Values	Notes
1 to 10	Do not omit
-1.0 to .0	.0 assumed if omitted
.0 to 1.0	.0 assumed if omitted
1 to 30	12 assumed if omitted

.0 to 100.0	100.0 assumed if omitted
.0 to 100.0	50.0 assumed if omitted
I or S	S assumed if omitted

FIGURE C-11. RISK MODEL INPUT DATA -GENERAL DATA

SECTION 1 - GENERAL DATA (PART 1)

Complete #11-13 only when
3 is entered in #4

1.	MAXYRS=	10
2.	END =	'Y'
3.	GROR =	.
4.	CASE =	1
5.	CAP =	.0
6.	DETREV=	'Y'
7.	MAXPR =	3
8.	DELMIN=	-.5
9.	DELMAX=	.5
10.	PTDEL =	4

11.	PSHAR1=	.
12.	PSHAR2=	.
13.	VIEWPT=	' '

FIGURE C-12. RISK MODEL INPUT DATA - GENERAL DATA INPUT FORM

All input data is entered on the preprinted forms which indicate the question number, FORTRAN name of the variable, and all pertinent punctuation marks. Once data is entered, the forms may be given to a keypunch operator who keypunches all data within the boxes--i.e., one line per card. The data is entered in free form; that is, location on the card is unimportant, as are blanks or spaces between characters.

Figure C-13 illustrates the type of data that is required when the disaggregate revenue option is followed. The corresponding input data forms and typical data are illustrated in Figure C-14.

In Figure C-14, the price responses, Nos. 1 through 3, represent most likely, minimum, and maximum anticipated unit price for each year of the analysis. Response No. 4 represents the names of the associated uncertainty profiles (this may vary from year to year). In a similar manner, Responses No. 5 through 8 refer to market share data and Responses No. 9 through 12 refer to unit sales.

3.4 REPORTS

The risk model produces two basically different types of reports (Figure C-15). The first type is an echo of the input data. It presents, in basically the same form as the input data, all of the input data utilized in the analysis, including all default values used in lieu of input data.

The second type of report presents the risk profile data. Risk profile data is available upon request for annual revenue, expenses, capital expenditures, profit, cash flow and cumulative cash flow (indebtedness). Also available are risk profiles of present worth (at up to ten discount rates), payback period and present value of energy savings by product and energy type.

	Possible Values	Notes
1. What is the unit selling price (K\$) of each product at the most likely sales level (i.e., the selling price at which unit sales--Question #9--is estimated)?	.0 to 9999.999	Do not omit
2. What is the minimum anticipated unit selling price (K\$) for each year of the venture?	.0 to 9999.999 (must be $\leq$ response to #3 for each year)	Do not omit
3. What is the maximum anticipated unit selling price (K\$) for each year of the venture?	.0 to 9999.999 (must be $\geq$ response to #2 for each year)	
4. Responses #2 & 3 established a range of possible values for unit selling price for each year. Which uncertainty profile (Exhibit B) should be used to estimate the distribution within each range?	1 to 30	12 assumed for each yr if omitted.
5. What is the most likely market share (%) which will be achieved by the venture for each product and for each year to be considered?	.0 to 100.0	100.0 assumed if omitted
6. What is the minimum anticipated market share (%) to be achieved for each year of the venture?	.0 to 100.0 (must be $\leq$ response to #7 for each year)	100.0 assumed if omitted

FIGURE C-13. RISK MODEL INPUT DATA - DETAILED REVENUE DATA

PRODUCT # 1

		YEAR #					
		1	2	3	4	5	6
1.	PRICEØ =	.Ø.	.Ø.	1.25.	1.2.	1.15.	1.15.
2.	PMINØ =	.Ø.	.Ø.	1.Ø.	1.Ø.	1.1.	1.1
3.	PMAXØ =	.Ø.	.Ø.	1.5.	1.4.	1.2.	1.
4.	PTPØ =	12.	12.	12.	12.	12.	12

5.	SHAREØ =	.Ø.	.Ø.	15.Ø.	15.Ø.	13.Ø.	
6.	SMINØ =	.Ø.	.Ø.	1Ø.Ø.	1Ø.Ø.	1Ø.Ø.	
7.	SMAXØ =	.Ø.	.Ø.	2Ø.Ø.	2Ø.Ø.	15.Ø.	
8.	PTSØ =	.	.	.	.	.	

9.	UNØ =	.Ø.	.Ø.	11ØØØ.Ø.	21ØØØ.Ø.		
1Ø.	UMINØ =	.Ø.	.Ø.	1ØØØØ.Ø.	2ØØØØ.Ø.		
11.	UMAXØ =	.Ø.	.Ø.	12ØØØ.Ø.	22ØØØ		
12.	PTUØ =	.	.	.	.		

13a.	CHU1Ø =	.Ø.	.Ø.	1Ø.Ø.			
13b.	CHU2Ø =	- .Ø.	- .Ø.	-1Ø.Ø			

FIGURE C-14. RISK MODEL INPUT DATA - DETAILED REVENUE DATA INPUT FORM

- ECHO OF INPUT DATA
- RISK PROFILES
 - REVENUES
 - EXPENSES
 - CAPITAL EXPENDITURES
 - PROFIT
 - CASH FLOW
 - CUMULATIVE CASH FLOW (INDEBTEDNESS)
 - RETURN ON ASSETS
 - PRESENT WORTH (MULTIPLE DISCOUNT RATES)
 - PAYBACK PERIOD
 - PRESENT VALUE OF ENERGY SAVINGS (BY PRODUCT)
 - PRESENT VALUE OF ENERGY SAVINGS (BY ENERGY TYPE)

FIGURE C-15. RISK MODEL OUTPUT REPORTS.

It should be noted that a risk profile is not explicitly developed for return on investment (internal rate of return). This can be established from the present worth risk profile data. The reason for not establishing a risk profile for rate of return is that in the Monte Carlo analysis it is possible to have cash flows which alternate in sign. The effect of this is to have more than one possible value of internal rate of return. To avoid trying to establish which is the correct value, the internal rate of return is not computed, but can be determined graphically from the present worth data.

The Annual Cash Flow risk profile data is presented in Figure C-16. All risk profiles indicate the percent chance of the variable exceeding the tabulated value. For example, there is a 40 percent chance that cash flow will exceed \$267,800 in the seventh year. This then represents the complement of the cumulative probability distribution--the risk profile. Multiple columns represent years, except in the case of present worth, where there is a different column for each discount rate.

Each column of data is also summarized in terms of an average or expected value and standard deviation.

The various risk analysis data may be plotted as in Figure C-17 which indicates cash flow and indebtedness as a function of time. A family of curves is plotted for each variable and indicates the values which will be exceeded at specified probabilities. These curves may be plotted directly from the tabular data by selecting rows with the desired probability values.

The indebtedness data is of particular interest since it represents the level of funding which is required by the venture. The risk analysis provides data on the probability of exceeding different funding levels. For example, Figure C-17 indicates that if funds in the amount of \$2.3 million are

-RISK PROFILE DATA-

ANNUAL CASH FLOW

(THOUSANDS OF DOLLARS)

PERCENT CHANCE OF EXCEEDING INDICATED AMOUNT	0	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100
	-72.2	-73.2	-74.8	-79.3	-77.7	-80.0	-80.3	-80.7	-81.1	-81.8	-85.4	-86.6	-86.8	-86.9	-87.1	-87.3	-87.7	-88.2	-89.1	-91.6	-94.0	-94.3	-95.4	-96.2	-96.9	-97.4
	-215.8	-228.0	-234.3	-239.6	-243.0	-247.9	-254.7	-261.5	-268.2	-275.0	-281.2	-287.3	-294.9	-307.1	-315.8	-324.9	-340.0	-368.0	-383.2	-391.4	-413.6	-425.8	-451.7	-489.7	-542.9	-596.2
	-623.8	-757.8	-865.0	-1025.8	-1133.0	-1196.3	-1245.1	-1291.8	-1427.0	-1561.8	-1718.1	-1807.5	-1870.0	-1923.6	-1997.3	-2124.6	-2231.8	-2339.0	-2416.1	-2493.1	-2670.5	-2935.3	-3236.8	-3404.3	-3705.8	-3973.8
	-2856.9	-2375.1	-3368.9	-3447.6	-3599.5	-3667.0	-3772.5	-3872.7	-3967.5	-4062.0	-4156.5	-4203.7	-4251.0	-4332.8	-4432.1	-4471.5	-4510.9	-4589.7	-4668.4	-4747.2	-4814.7	-4924.4	-5101.6	-5219.8	-5397.0	-5910.5
	-814.8	-1162.7	-1274.6	-1355.9	-1400.1	-1446.1	-1497.6	-1549.2	-1598.9	-1643.0	-1687.2	-1731.4	-1781.1	-1826.7	-1854.8	-1892.9	-1916.3	-1955.0	-2005.2	-2077.4	-2159.8	-2232.0	-2322.1	-2399.4	-2592.7	-2747.3
	178.8	-46.2	-158.7	-233.7	-284.2	-381.7	-458.7	-503.7	-531.7	-563.7	-596.1	-629.5	-696.1	-758.6	-809.6	-858.6	-916.1	-1021.1	-1081.1	-1118.6	-1148.6	-1196.1	-1321.1	-1446.1	-1527.3	-1696.1
	869.1	628.5	544.4	500.8	470.7	438.1	398.0	358.0	321.2	294.5	267.8	219.7	187.6	160.9	135.5	111.4	87.4	39.3	-39.6	-66.3	-93.0	-153.2	-273.4	-321.5	-433.9	-634.2
	1000.9	695.8	610.4	563.7	523.0	490.0	459.5	431.5	404.4	366.4	322.2	291.7	263.7	243.4	223.1	200.2	169.7	138.1	103.2	61.4	12.6	-36.2	-158.2	-198.9	-249.7	-524.2
	904.6	779.6	704.7	588.0	548.7	500.2	482.0	463.8	404.8	376.2	343.2	327.0	304.8	234.8	264.8	234.8	194.8	154.8	94.9	54.9	14.9	-20.1	-53.4	-86.8	-182.6	-345.0
	8115.7	7928.8	7600.0	7482.6	7365.2	7311.5	7252.5	7177.3	7135.6	7093.8	7049.2	7001.2	6958.1	6916.4	6872.0	6825.1	6770.3	6707.6	6670.1	6632.5	6519.8	6425.8	6363.2	6294.3	6206.7	5768.3
YEAR	1	2	3	4	5	6	7	8	9	10																
AVERAGE (\$1000)	-85	-331	-1988	-4281	-1805	-762	-153	-248	-279	-6941																
STD. DEV. (\$1000)	7	94	850	648	399	429	318	278	271	460																

FIGURE C-16. RISK MODEL OUTPUT DATA-CASH FLOW

FIGURE C-17. RISK MODEL OUTPUT DATA

provided, there is a 20 percent chance that the venture will require additional funding.