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Decision and Risk Analysis of a New Product and Facilities Planning Problem: CCA Company's Egg'N Foam Project

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'Prime Time' Magazine

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Abstract

The paper examines a decision and risk analysis approach applied to a new product and facilities planning problem.* The discussion describes the risk analysis process, and presents the step-by-step approach used by the project team. The initial results of the analysis are presented and are discussed by the team in a process of policy dialogue. It is shown that the project team questioned a number of project assumptions, particularly in the marketing area, and expressed concern about the perceived vagueness of CCA's objectives. The output of the dialogue process finally led to a strategy recommendation for Egg'N Foam, following an examination of the relationship of the Egg'N Foam project to the firm's long-term strategy path.

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*This problem is somewhat disguised in regard to project chronology and magnitudes of input data but the problem structure and new product area is unaltered.

INTRODUCTION

The paper discusses the role of risk analysis in relation to the Egg N'Foam project--a potential investment opportunity in the plastic egg carton market. The paper illustrates the step-by-step nature of the application of risk analysis [see Hertz and Thomas [4]] and also show the procedures adopted at each stage. In subsequent sections of this paper, we will develop the problem structure in flow diagram form, state the problem assumptions, perform an initial sensitivity analysis, develop investment alternatives, assign subjective probabilities, present the results of the risk analysis, demonstrate the process of policy dialogue about the strategy to be chosen, and summarize our conclusions.

The decision alternatives under consideration ranged from abandonment (which would involve the loss of the pilot plant) to expansion strategies (involving larger plants--so called "superplants"--and a series of small plants).

The risk analysis approach involved three sets of people. The management group at CCA, the CCA project team (charged with the responsibility for project evaluation), and the consultants (providing technical expertise and guidance). The most interesting element in the process involved the dialogue about choice and implementation which developed between the project team and management group at CCA.

THE CCA COMPANY'S EGG'N FOAM PROJECT

The Egg'N Foam project at CCA represented a large investment, a totally new market area, and a completely new product for CCA. For several years CCA had been developing Egg'N Foam, a plastic package as a competitive substitute for paper egg cartons, refining its product design and operating a pilot plant in Nesquehoning, Pennsylvania. The project involved substantial amounts of uncertainty.

The project team selected to work on the Egg'N Foam decision consisted of representatives from the Research and Development Division, Plastics Division, and Corporate Controller's Office. Those involved had been associated with the Egg'N Foam project for a considerable period of time, and were quite familiar with the development, production, and marketing aspects of this project.

The following section discusses the step-by-step approach used by the project team to study the attractiveness of investing more funds in Egg'N Foam.

THE RISK ANALYSIS PROCESS

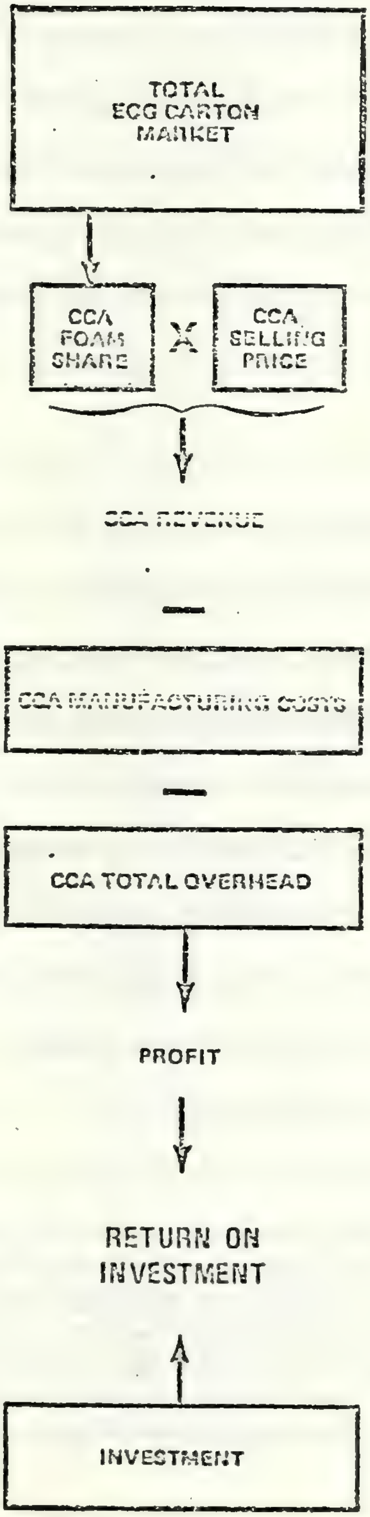
DEVELOPING THE FLOW CHART AND PROBLEM STRUCTURE

The first step in applying risk analysis to Egg'N Foam was to construct a flow chart of the investment analysis. The process started with an assessment of basic economics of the investment project, entering each element in a simple chart. The initial Egg'N Foam flow chart shown in Chart 1 consisted of six elements representing: (1) the total market size for egg cartons, (2) CCA's foam market share, (3) selling price, (4) manufacturing cost, (5) total overheads, and (6) investment base.

The initial flow chart was then expanded backward to encompass a large set of input factors. This involved establishing a value for each factor, analyzing the determinants of that value, questioning the validity of the determining factors, and where possible, exploding the

CHART 1

INITIAL FLOW CHART
EGG'N FOAM



elements into further detail. The final product was a flow diagram of all the factors relevant to determining the profitability of Egg'N Foam.

The final flow chart for Egg'N Foam is considerably more detailed than the initial chart (Exhibit I). The manufacturing costs, overhead costs, and investment base, were expanded into a substantial number of inputs. However, the unavailability of sufficient market data limited the amount of analysis which could be undertaken on the marketing elements (i.e., market size,* market share, and price).

STATING THE ASSUMPTIONS

When the flow chart was completed, assumptions underlying each of the factors were stated explicitly. This step was particularly important because it placed a limit on the amount of detail required to substantiate the data inputs. For example, if the project team assumed CCA would capture a 10 percent share of the carton market, little data would be needed to estimate CCA's sales volume. As this assumption demonstrates, however, the magnitude that assumptions can take reveals the need to verify their reliability. Invalid assumptions can result in misleading and inaccurate conclusions from investment analysis. Thus, verification of assumptions is an integral and important part of the phase of stating the assumptions.

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*For the purpose of this study, the total market for egg cartons has been divided into five regions. Each represents a market that could be covered by the output from one Egg'N Foam plant. The West Coast was excluded from the analysis because entering this market was considered to be a separate decision not related to building plants in the other four regions. Egg'N Foam cartons cannot be shipped to the West Coast as the freight costs are too high.

On the Egg'N Foam project, the team was able to verify the validity of most of the data. This included information such as equipment rates, supplied by Research and Development Division personnel, and forecasts of total egg production, supplied by the U.S. Department of Agriculture. With some data, however, it was felt that further study was necessary to determine the accuracy of the data and assumptions. In particular this included the percentage of eggs cartoned, and Egg'N Foam sales volume and price. Exhibit II lists all of the assumptions underlying the most important input factors of the flow chart.

ANALYZING SENSITIVITY

The next step in the analysis was to construct a nonprobabilistic computer model of the flow chart, using the basic data shown in Exhibit III. The model was built for a single plant, as each region represented a similar size market that would support a single plant operation. The model performed all the calculations indicated by the flow chart, and provided answers in terms of the return on investment and cash flows.

The model was also used to determine the sensitivity of investment returns and cash flows to changes in input variables. The team was quickly able to answer questions such as: "What would happen to the discounted rate of return if the price dropped by $0.50 per thousand cartons?" or "What would happen if the thermoformer cycle time were improved to 4-1/2 seconds?". The results of the sensitivity analyses on Egg'N Foam are shown in Chart 2. Changes in two factors--caliper (or thickness) and demand--had a dramatic effect on the rate of return, whereas changes in the value of other factors had only minor impact on

CHART 2

SENSITIVITY OF INVESTMENT RETURN TO CHANGES IN MAJOR INPUT FACTORS

BASE CASE:

One extruder
One thermoformer

Extruder rate = 525 lb./hr.
Thermoformer cycle time = 5.3 sec
Caliper = .080 in.

	Millions of Cartons		
	Year 1	Year 2	Year 3
Demand =	21	54	90

Physical capacity = 76 million cartons
Discounted rate of return = 12.96%

FACTOR	CHANGE	CHANGE IN RATE OF RETURN	ADJUSTED RATE OF RETURN ***
Extruder rate	525 to 625 lb./hr.	+2.24%	15.20%
Thermoformer cycle time	5.3 to 4.2 sec.	+1.71%	14.67%
Raw material costs	15.0¢ to 13.5¢/lb. pellets	+1.40%	14.36%
Equipment costs	$790,000 to $990,000	– 1.57%	11.39%
Caliper *	.080 to .100 in.	– 10.25%	2.71%
Demand	Millions of Cartons (Year 1 / Year 2 / Year 3): From 21 / 54 / 90; To 21 / 54 / 66 **	– 4.17%	8.79%
Price	Decreased 50¢	– 1.20%	11.76%
Direct labor	Extruder $11.00 to $13.20/hr.; Thermoformer $26.94 to $32.34/hr.	– 1.83%	11.13%

* *Caliper increase reduces the physical capacity of the plant considerably*

** *Sales volume drops from 76 to 66 in year 3*

*** *Adjusted to use one extruder to two thermoformers* profitability. The high sensitivity of the investment return to changes in caliper and demand indicated the extreme importance of the accuracy of the assumed sales volume of Egg'N Foam.

The sensitivity analysis was also valuable because it permitted the team to experiment on the computer with different equipment combinations, and plant sizes, to identify the optimal plant operation. When applied to Egg'N Foam, the sensitivity analysis suggested that one extruder could support two thermoformers instead of one thermoformer, and also demonstrated the feasibility of building larger plants containing two extruders and four thermoformers.

DEVELOPING INVESTMENT ALTERNATIVES

After the sensitivity analysis was performed, the single plant model was used as a building block in constructing investment strategies for Egg'N Foam.* The team developed four alternative strategies for CCA in the egg carton market. Two strategies involved building superplants, each containing two extruders and four thermoformers; the other two strategies called for small plants, each containing one extruder and two thermoformers.

The difference between the two superplant strategies** and the two small plant strategies is speed of market entry. One of the superplant strategies and one of the small plant strategies represent a slow, conservative investment pace, requiring the addition of thermoformers only

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*The appendix lists the input data that were used for each strategy.

**Superplant strategy assumes construction of two plants to serve the four regions, while the small plant strategy assumes construction of four plants.

after the demand for the output of existing equipment is firmly established. Conversely, the other strategies assume that CCA would act as quickly as possible to acquire equipment, hire and train the necessary manpower, and open the plants. The four strategies are shown in Chart 3, expressed in terms of the timing and sequence of equipment installation by plant location.

ASSIGNING THE PROBABILITIES

The team's next step was to obtain probability information on input factors. Subjective probabilities were developed for the five inputs of the model that had either a significant impact on profitability, or a considerable degree of uncertainty: extruder rate, thermoformer cycle time, caliper, price, and demand.

The probability distributions in Exhibit IV represent the best judgment of the CCA personnel most knowledgeable about Egg'N Foam. To provide a better understanding of the graphs shown in the exhibit, the following discussion highlights the important characteristics of each probability distribution.

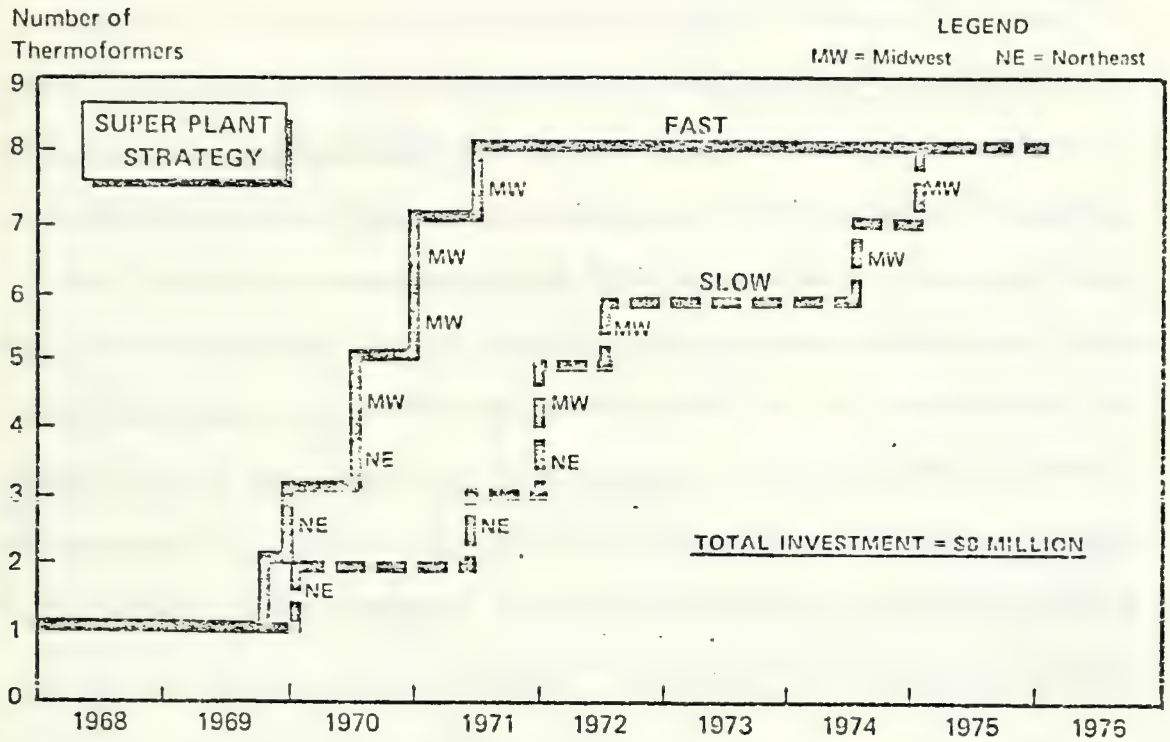
Extruder Rate

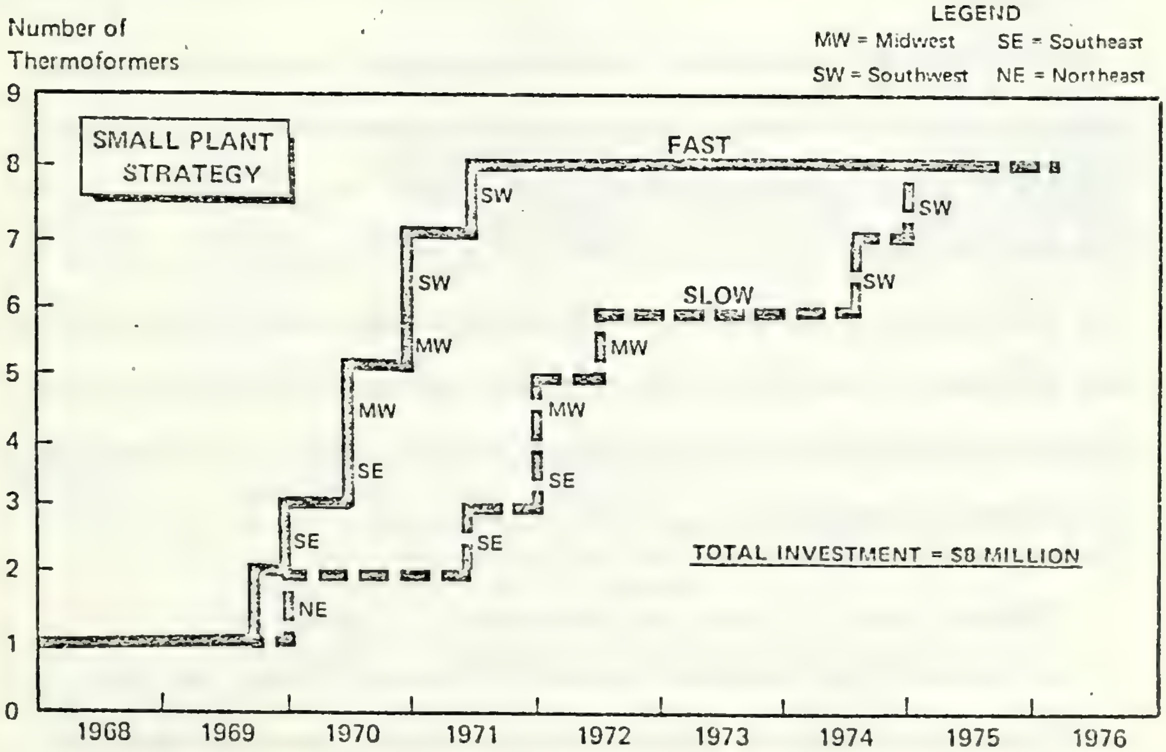
Information from CCA's production specialists, as well as from outside extruder manufacturers, indicated that extruders brought to the market after 1970 would have higher throughput rates due to advances in design. Therefore, two probability curves were developed; one for the period 1968 to 1970, and the other for the years 1970 to 1975. The width of both distributions is rather tight around the expected value for each distribution. This implies that CCA personnel were confident that the extruders would operate at the expected pounds of

CHART 3

INVESTMENT STRATEGIES

EGG'N FOAM





foam per hour. Furthermore, the shapes of the extruder probability curves are almost identical, indicating that the CCA representatives had the same amount of confidence in the performance of existing and future extruder designs.

Thermoformer Cycle Time

The same advances are expected for the thermoformers. Improved equipment should be available by 1971, so two different probability distributions were necessary. The first one covers the years 1968 to 1970, and ranges from 6.0 to 4.5 seconds with an expected value of 5.3. The distribution for the 1971 to 1975 thermoformer design ranges from a 6.0- to 3.0-second cycle time, with an expected value of 4.2 seconds. The shapes of the two curves differ, however, because CCA personnel had greater confidence in the performance of 1968 equipment compared to that expected of future thermoformer designs.

Caliper

Similarly, two probability distributions were developed for the thickness of foam sheets to be processed by thermoformers, as shown in Exhibit IV. In this case, however, CCA production personnel were less confident in their predictions. The probability distribution shows that the caliper could fall anywhere between .090 and .078 inches thickness with equal likelihood. The flatness and width of both probability curves indicate the lack of confidence in CCA's ability to produce foam of uniform caliper.

Price

The project team developed probability distributions for price in each of the years between 1968 and 1975, and predicted the expected value would drop $0.30 per thousand cartons each year. The probability distributions for three of the seven years are shown in Exhibit IV, and are representative of the remaining price curves.

Demand

Estimates of demand were developed for each strategy, for each plant, and for each year (the base data for means and standard deviations are shown in the appendix), based on the assumption that CCA can capture 10 percent of the egg carton market or 360 million cartons* by 1974 with the fast strategy, or, by 1978 with the slow strategy. For the fast strategy, there is a greater probability of deviation from the expected demand than for the slow strategy.

RESULTS OF THE "FIRST PASS" RISK ANALYSIS

Exhibit V shows the logical flow chart for the risk analysis simulation. This was used as the basis for the "first-pass" evaluation of each of the alternative strategies. The results of the analysis are shown in summary form in Table I below:

Table I
RESULTS IN TERMS OF NPV

STRATEGY	POINT ESTIMATE ($M.)	RISK-ANALYSIS SIMULATION ($M.) MEAN	RISK-ANALYSIS SIMULATION ($M.) STANDARD DEVIATION	PROBABILITY (NPV > 0)	NPV SUCH THAT 95% PROBABILITY OF EXCEEDING THAT VALUE ($M.)
1	4.12	3.53	0.84	0.99	2.0
2	0.85	0.74	0.45	0.94	0
3	2.90	0.94	1.37	0.88	-2.0
4	-1.38	-1.70	0.68	0	-3.0

NOTES FOR TABLES
a) Discount rate in simulation calculation is assumed at 5% net-of-tax, i.e., the riskless rate.
b) Point estimate calculation made using most likely values for each input variable and CCA's appropriate net-of-tax risk-adjusted rate of return.
c) Strategy 1 = super-fast; strategy 2 = super-slow; strategy 3 = small-fast; strategy 4 = small-slow.

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*The 360 million cartons represent a 10% share of the market in four regions: East, Southeast, Midwest, and Southwest.

Chart 4 shows the cumulative density functions (CDF's) for net present value for each of the strategies.

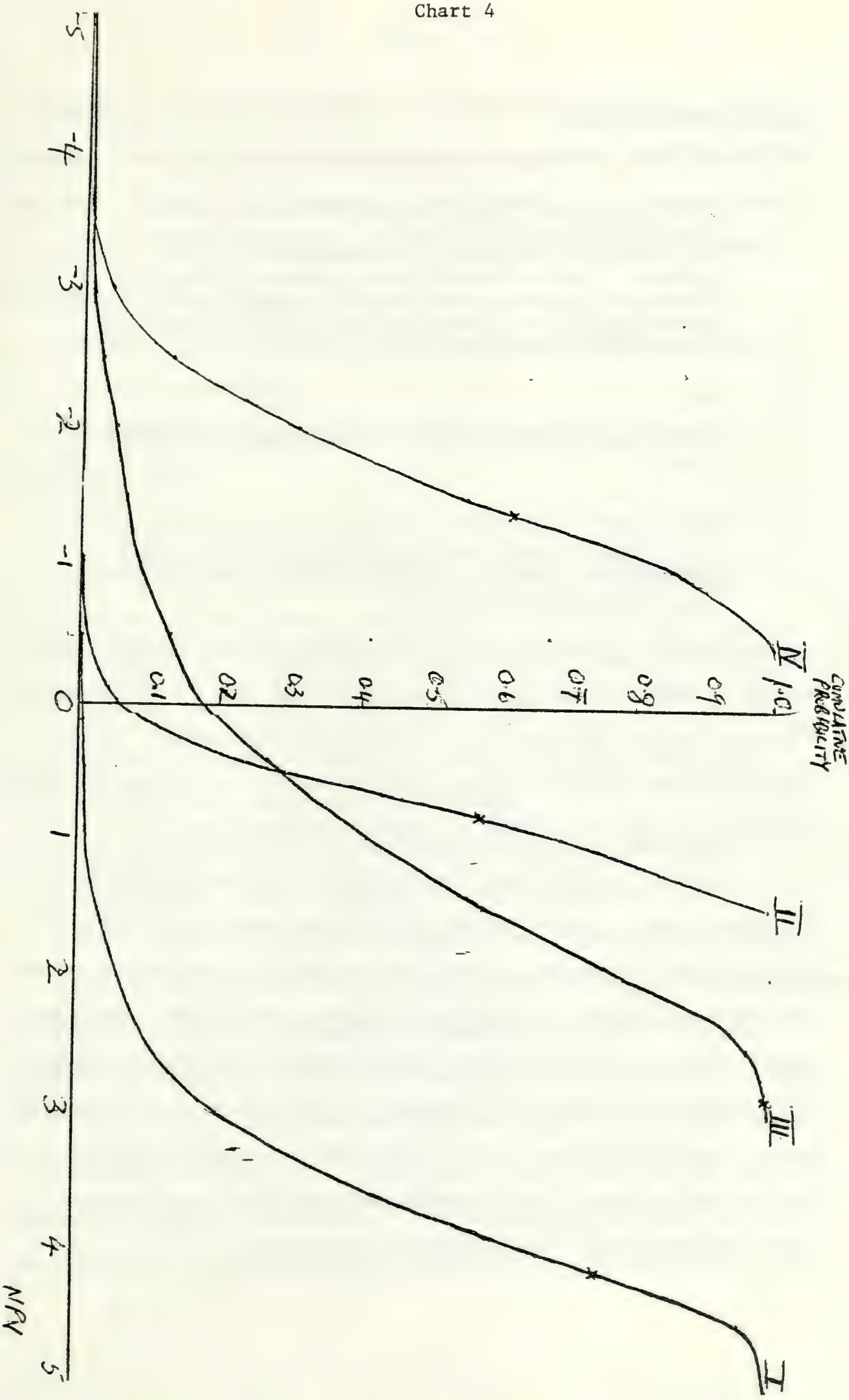
The performance measures shown in Table I are calculated in relation to the discounted return on investment measure, net present value. Columns 4 and 5 present two possible choice criteria for each strategy. These are the probability that the net present value is positive, and also that the value of NPV is such that there is a 95% probability of exceeding that value. Using these criteria, it would appear that strategy 4 could be eliminated immediately.

In addition, using principles of stochastic dominance, it would also appear that Strategy 1 dominates all other strategies. Therefore, strategy 1 is recommended. However, as a contingency plan, strategy 2 is the next best alternative, if, in the first four years, the market growth projections are revised downwards considerably.

Policy Dialogue

Following the initial risk analysis, the dialogue about strategy choice between the project and management teams at CCA focussed around two main concerns. Although it was agreed that the sensitivity and risk analyses had aided the process of strategy formulation, it did not lead to a clear-cut strategy choice. Much controversy centered around the inadequacy of the processes of problem identification (including key assumptions), and the lack of specificity and clarity about CCA's objectives. The strategic issues raised are outlined in subsequent paragraphs.

Chart 4



GRAPH OF C.D.F. FOR N.P.V. FOR EACH STRATEGY

Problem identification

Typical critical comments from management included:

> "The team seems to have considered heavily technologically oriented strategies, i.e., concentration on plant size and speed of introduction for the product. Little emphasis was placed on interpreting the demand picture, which seems to suggest that marketing related strategies have either not been considered or assumed away."
>
> or
>
> "Why should the first step...be to construct a flow chart?"
>
> or
>
> "The team's effectiveness might improve if its composition were better balanced, with the addition of some marketing personnel."

In general, it was felt that some problem assumptions and inputs should be examined more closely, and questioned in order to proceed to a more effective "structuring" of the risk analysis model. It was agreed that the listing of assumptions in Exhibit 2, and the sensitivity analysis in Chart 2, provided a valuable starting point.

In relation to the assumptions in Exhibit 2, some further observations were made. First, why did the CCA team assume that they will produce their own sheets of foam when the option of purchasing from an outside source might be a worthwhile alternative? Second, what additional correlation effects (with their attendant measurement complications) should be included in the model in relation to price elasticity, demand, production rates, etc.? Third, why were market decisions taken more or less as given, thus reducing CCA's decision to an apparent choice between one of four production strategies?

After considerable discussion, it was agreed that the greatest weakness concerned the marketing assumptions adopted in the model, and the level of empirical or research effort available to support these assumptions. Listed below are some of the areas in marketing which were questioned.

- Market share will be 10% by 1978. (Should there be a spread of possible values?)
- No manufacturer other than Diamond National will come in before 1978.
- Paper carton manufacturers will not react violently to their share being cut in ten years from 50% to 5%. (Why would they not start a price war? Could they afford to do so?)
- Pricing must be at Pillopost level. Why not consider the adoption of penetration pricing policies?
- Market forecasts are assumed correct. Has any attempt been made to check their forecast accuracy?
- Selling will be done by the plastics marketing department. It would appear that the transfer price will become an important motivating factor, and might indicate that a separate department for marketing Egg'N Foam in the carton market should be established.

Two other financial management assumptions were seen to require further justification. First, that working capital cannot be regarded as a certain need. The amount required will depend upon the accuracy of demand predictions (e.g., a stock pile-up might occur), the speed of payments by debtors and many other, as yet unknown, factors. Second, the influence of inflation cannot be ignored. It may hit foam harder than pulp, or vice-versa, seriously changing the competitive balance within CCA.

Specificity and Clarity of Objectives

The management felt that the project team were uncertain about the criteria by which choice should be made in relation to the available strategies. It was suggested, therefore, that attention should be directed towards the criterion for strategy choice in relation to CCA's overall portfolio of investments, both current and projected. The main concern was to relate project risk to the firm's overall risk, and to handle strategic issues. For example, the issue of whether the CCA Egg'N Foam project would be too risky, not only in the sense of variability of returns, but also in terms of its effect on the firm's portfolio of projects. Senior managers commented that the carton project might focus too great a proportion of the company's resources (financial, managerial, production, and marketing) on a single project to the detriment of other possible alternatives.

Conclusions of the Initial Policy Dialogue

It was agreed that certain tasks could be better performed by management than by the project team. It was suggested that the project team, (perhaps better balanced with additional marketing and financial expertise), should generate appropriate alternative strategies in line with management policy, and subsequently carry out some form of strategic evaluation using risk measures agreed jointly with management. Management's task should be to define the range of strategies to be considered, to direct the project group in the decision-making task, and to determine the final strategy choice, perhaps in a dialogue process involving the consideration of other factors and attributes.

It should be emphasized that both groups stressed the importance of management's role in the problem finding and formulation process. It was felt that the current strategy set had an overly production/R & D character. Also, it was agreed that the range of strategies for consideration should focus on a close scan of the environment as well as a screen of potential competitive market and technological uncertainties.

As a result, the following recommendations were made concerning further strategy formulation and evaluation through the analytic process. First, that greater attention should be paid to the influence of competition, competitive reaction and marketing forces on the Egg'N Foam decision. In other words, marketing/production mix combination strategies should be developed. Management felt that the most sensible approach would be to develop a number of marketing scenarios (using a Delphi-type approach), and if appropriate, carry out a simulation of each scenario. For example, scenarios of the following type should be developed in association with each of the set of production alternatives.

(i) steady price;

(ii) failure of the market to grow meaningfully;

(iii) tough competitive reaction, e.g., price war initiated by Diamond National and others;

(iv) a price war started by CCA to discourage other market entrants--i.e., an attempt to build-up share quickly;

(v) consumers preferring paper-based to plastic cartons.

Second, that attention should be given in model development to working capital and cash flow management. For example, inflation effects and their impact on potential cash flow generation needed to be examined thoroughly. Third, that the output of the analytic process should be presented in terms of a series of performance measures over the project time-horizon (15 years). This recommendation developed from the belief that the influence of contingencies on a series of measures such as cash flow and sales projections and NPV measures, would give valuable input to the process of strategy choice. The performance measures suggested were:

- Total $ sales
- Cash flow profile
- Gross profit as a percentage of sales
- Net profit after taxes
- Net profit as a return on investment
- Net present value
- Further sensitivity analysis of results to key changes in input factors.

Subsequent Policy Dialogue

Management reviewed the subsequent output of the risk analysis which showed that Strategy 1 (super-fast) was still dominant, except under adverse marketing and financial scenarios, when Strategy 2 would be preferred. Interestingly, it was also determined (from the marketing scenarios), that CCA had a competitive strength with the plastic carton. As a result, if it adopted an even more aggressive capacity-building strategy, it would be able to obtain both the dominant market share position, and hence the lowest relative cost position. This information provided an additional interesting discussion topic.

The management group commented upon the usefulness of the marketing and financial (e.g., cash flow) probabilistic forecasts provided by the "second-pass" risk simulation. Quite apart from better understanding the influence of uncertain events on their business activities, they felt that it gave them an insight into the "spin-off" from this project to the firm's entire portfolio.

As the project's NPV (for Strategies I and II) was positive when discounted at the required risk adjusted rate (determined from modern capital-asset pricing theories), then the project should certainly merit acceptance in portfolio terms. This was reinforced by the strategic aspects of the risk simulation, which enabled management to judge the project's viability under a range of alternative future scenarios. Indeed, managers commented that the confirmatory positive indications of the set of performance measures under the range of scenarios, enabled them to better understand the project.

Whilst they were now generally in favor of project acceptance, they wanted to examine CCA's goals in further detail. First, they wanted to ensure that this project was compatible with the firm's long-term growth plans and objectives. Second, in order to develop this strategic thinking process, they decided to simulate the firm's portfolio over a five to ten years horizon in terms of profitability and cash flow objectives. By so doing, they hoped to anticipate other business areas with future potential for decline/growth, and assess cash flow and financial implications for the Egg'N Foam project.

This subsequent portfolio analysis showed sound long-term viability, and gave strength to management's view that the growth into cartons was a useful related-business diversification. It was felt that it would be complementary in skills and growth potential to the firm's recent diversifications into the poultry processing and broiler chicken manufacturing areas.

Summary, Conclusions, Strategic Implication

The value of risk analysis in a facilities planning decision is examined here in relation to a disguised recent planning situation called Egg'N Foam. In essence, following Gluck et al [3], risk analysis is presented as Stage II/III of a sensible strategic thinking process. That is, as a vehicle for forecast/uncertainty based planning, in which an understanding of future scenarios, cash flow projections, and synergies between marketing and production activities is developed. This also enables managers to search more creatively in order to identify the menu of strategic options.

The strategic risk analysis presented here differs from that presented by some other authors in the same area [e.g., Spetzler and Zamora [6]; Buffa [2]] in terms of its treatment of risk preference and criteria for strategy choice. Risk preference involves the decision-maker's attitude towards risk, and is commonly handled via utility function assessment and certainty equivalence concepts. In this instance, the management group felt uncomfortable with the utility concept, even though they regarded risk preference as a policy question. They preferred to treat risk preference through a number of "lenses," i.e., by examining the risk simulation output in mean/variance terms, in terms of "risk of ruin" criteria (i.e., prob NPV > 0), and by looking at future cash flow profiles. In addition, they accepted that a project with a positive NPV, when discounted at a "risk-adjusted" rate, would increase the value of the firm in portfolio terms.

Management also felt that for strategy choice, both the project and the firm's portfolio should be examined in terms of a number of performance measures (cash flow, NPV, sales) specified over the fifteen-year project time horizon. This criterion of policy choice, specified in terms of a time stream of indicator measures (cash flow etc.) rather than in terms of a single criterion (such as expected utility), is consistent with the work on preferences over time (see Bell [1] and Meyer [5]).

In terms of strategic implementation, this risk analysis approach was successful. This was because of the value of risk analysis in encouraging policy dialogue amongst the management group about future uncertainty impacts. The continued questioning of assumptions and problem formulation is seen as essential for the effective formulation and evaluation of alternative strategy positions. By such continued questioning and dialogue, a meaningful consensus about strategy choice emerged. This consensus process, which involved "three passes" of a risk analysis process, could not have been achieved without adaptive mechanisms and flexibility being built into the process during the course of dialogue and successive risk analysis passes.

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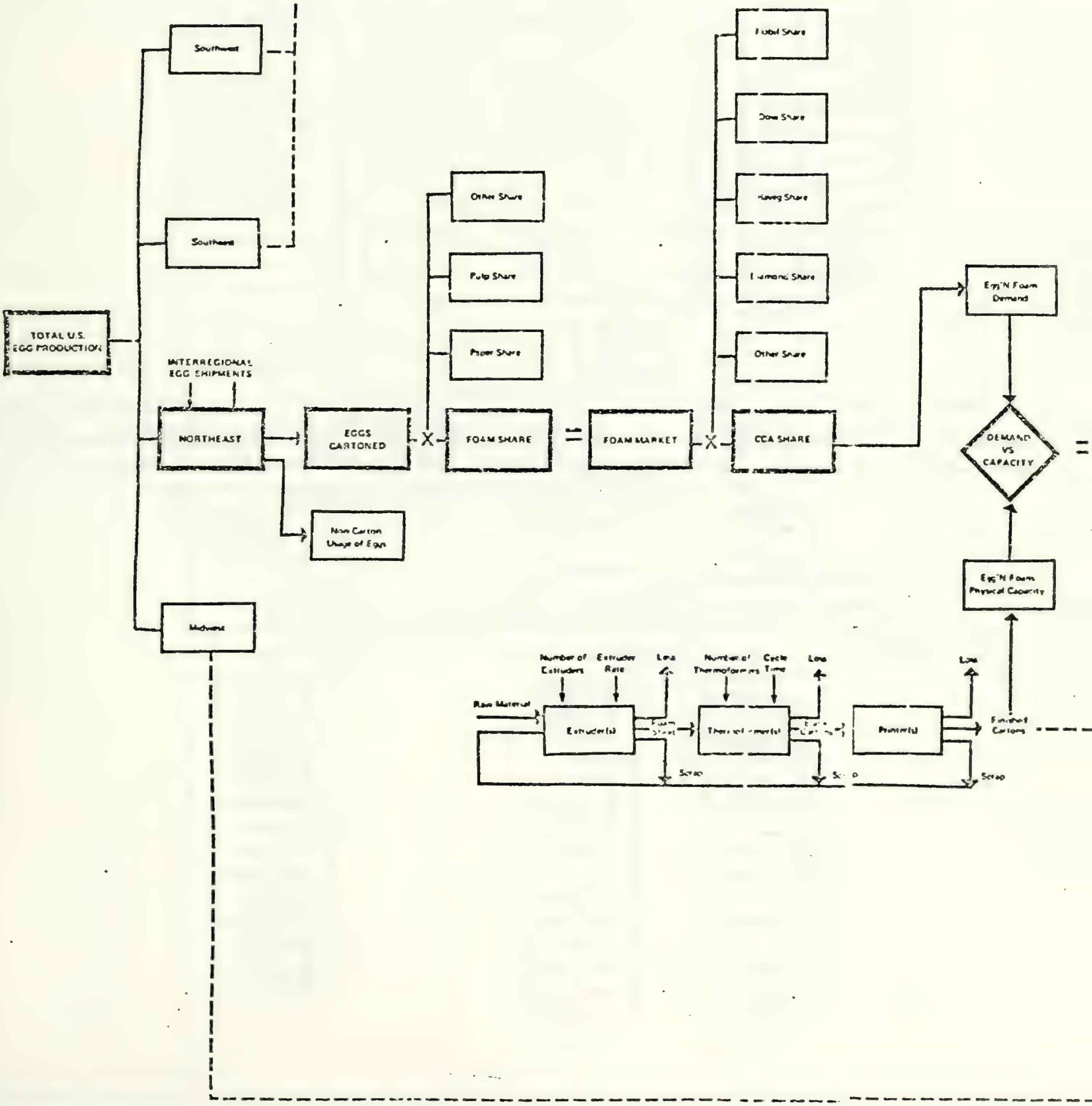
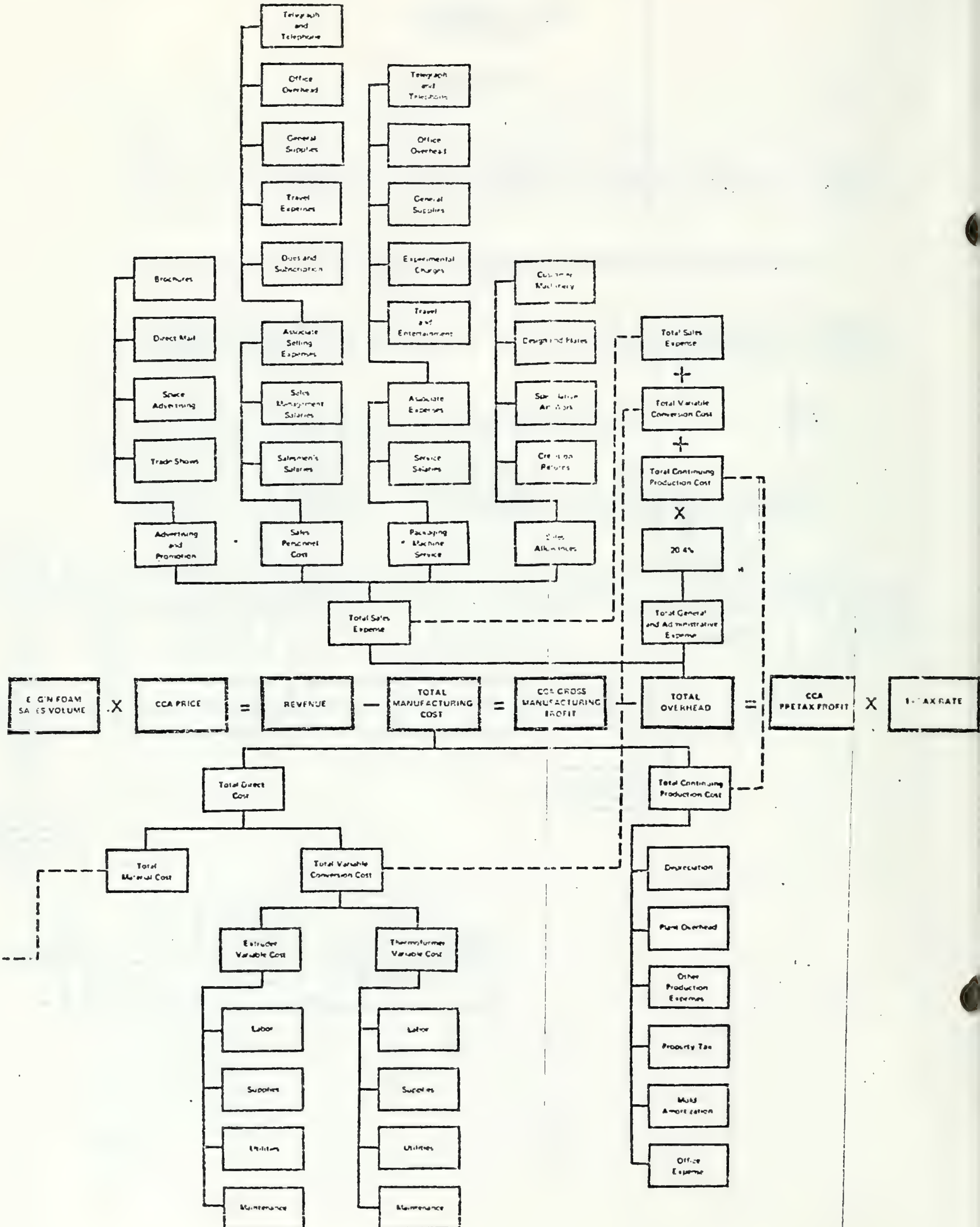
Exhibit 1

FINAL FLOW CHART
EGG'N FOAM

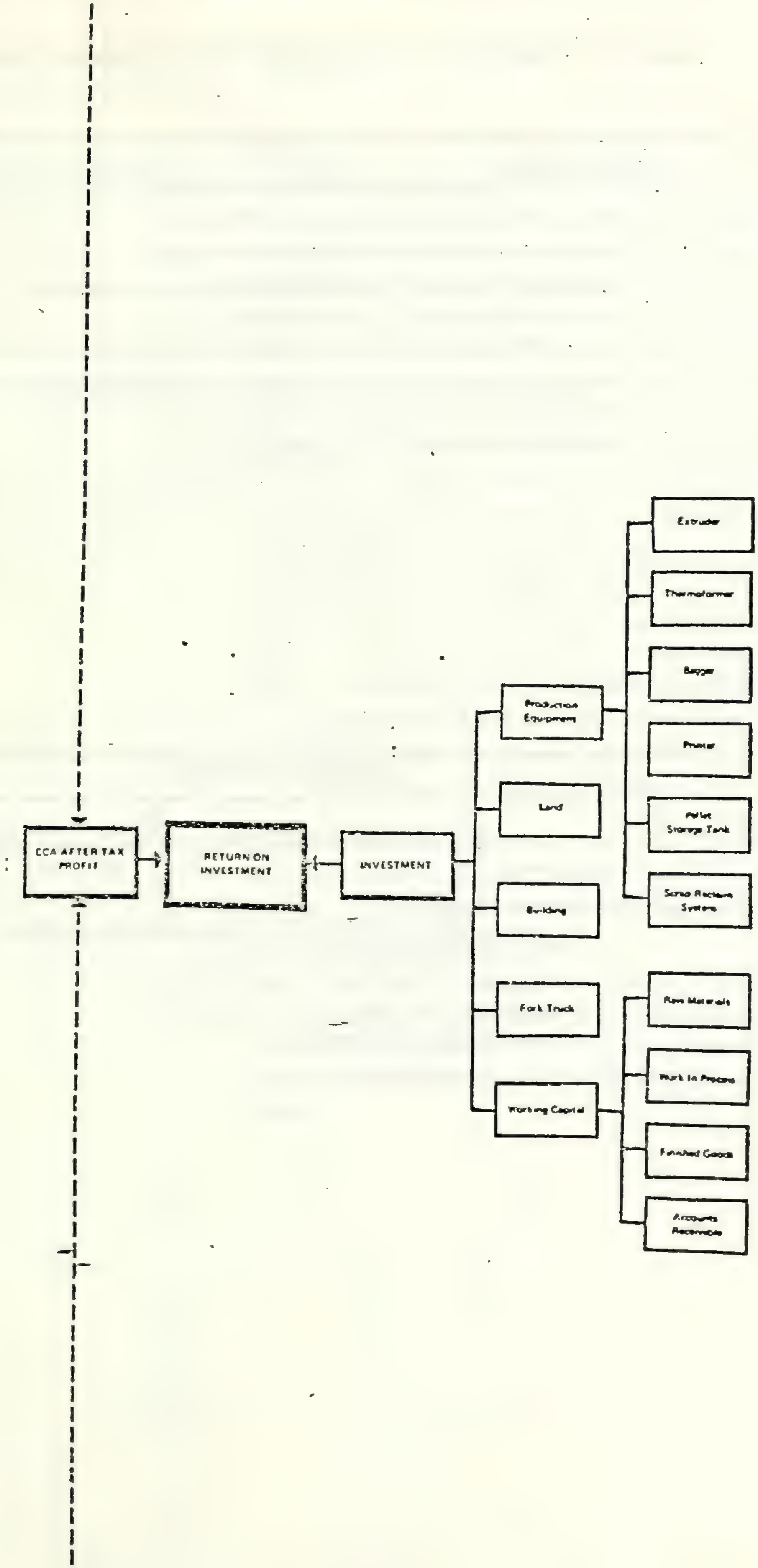



Telegraph and Telephone
Office Overhead
General Supplies
Travel Expenses
Dues and Subscription
Associate Selling Expenses
Sales Management Salaries
Salesmen's Salaries
Sales Personnel Cost
Brochures
Direct Mail
Space Advertising
Trade Shows
Advertising and Promotion
Telegraph and Telephone
Office Overhead
General Supplies
Experimental Charges
Travel and Entertainment
Associate Expenses
Service Salaries
Packaging Machine Service
Customer Machinery
Design and Plates
Sales Allowances
Total Sales Expense
Total Sales Expense
Total Variable Conversion Cost
Total Continuing Production Cost
X
20.4%
Total General and Administrative Expense
SALES VOLUME
X
CCA PRICE
=
REVENUE
TOTAL MANUFACTURING COST
=
CCA GROSS MANUFACTURING PROFIT
TOTAL OVERHEAD
=
CCA PRETAX PROFIT
X
Total Direct Cost
Total Material Cost
Total Variable Conversion Cost
Extruder Variable Cost
Thermoformer Variable Cost
Labor
Supplies
Utilities
Maintenance
Labor
Supplies
Utilities
Maintenance
Total Continuing Production Cost
Depreciation
Plant Overhead
Other Production Expenses
Property Tax
Mold Amortization
Office Expense

FINAL FLOW CHART

EGG'N FOAM

EXHIBIT I



MAJOR ASSUMPTIONS UNDERLYING EGG' N FOAM PROJECTIONS

PRICE

1. Foam cartons will sell at the Pillopost price level
2. Pillopost prices are expected to decline over the years
3. Market volume for foam cartons will drop sharply at prices above Pillopost level
4. Diamond National will be the price leader; price competition will be moderate
5. Price-volume discount schedule is unlikely to change significantly over the next decade
6. No transfer price for foam is considered

SELLING EXPENSES

1. Egg'N Foam distribution will be handled by the Plastics Division's Marketing Department
2. Selling costs include:
   - Unrecovered charges (design and plates, speculative art work, customer machinery)
   - Supplies
   - Dues and subscriptions
   - Advertising and promotion
3. There will be one-time start-up cost

MARKET SHARE
1. The market under consideration is the potential number of foam egg cartons sold through existing channels of distribution in four regions (West Coast is excluded) 2. CCA will be able to produce a high-quality foam carton which is acceptable to customers and will close satisfactorily on existing egg packers' machines 3. Product characteristics of Egg'N Foam will be competitive to Pillopost 4. CCA can successfully sell foam egg cartons through existing channels of distribution (to each type of customer in the market) 5. CCA's sales volume will be penalized by building plants in later years 6. CCA will sell out a plant's capacity regardless of when the plant is built 7. CCA will have captured 10 percent of the assumed carton market by 1978 (360 million cartons). 8. No additional carton suppliers are expected to become a significant factor in the egg carton market in the next 10 years 9. Diamond National will enter the market with its own foam carton some time before 1978 as opposed to considerably lowering their pulp carton prices 10. Colored foam will not be a factor in the market before 1978 11. CCA will equalize freight paid by customers when foam cartons are shipped into other regions

DIRECT COSTS
1. Significant cost savings can be achieved by building super plants 2. No major changes will take place in the manufacturing concept 3. In an Egg'N Foam plant no other products than foam egg cartons will be produced 4. CCA will produce its own foam sheets 5. CCA foam will have uniform quality and density characteristics 6. Through-put rates of the extruder and thermoformer will improve over time due to advancements in design and manufacturing knowledge 7. Inflation in future years has been excluded since it should affect both revenues and costs

SIZE OF CARTON MARKET

1. U.S.D.A. statistics on egg production by state are correct
2. Estimates from the editor of the Poultry Tribune are correct on eggs cartoned as percentage of total egg production
3. Statistics of U.S. Economics Corporation are correct
4. Total market is divided into five regions determined by:
   - Probable organization of CCA field sales force
   - Size of areas where a 10 percent share would be the equivalent of a small size plant
5. Foam will have better merchandising appeal than pulp or paper and therefore foam will tend to replace Pillopost, Case Ace, and folding cartons over the next 10 years
6. By 1978, share of market by carton type will have changed as follows:
   - Paperboard from 45% to 5%
   - Pulp from 53% to 50%
   - Foam from 2% to 45%

CONTINUING COSTS

1. Straight-line depreciation is used for calculating the return on investment. Double declining balances are used for calculating depreciation for tax purposes and the discounted cash flows
2. Life of the equipment is equivalent to standards allowed by the Internal Revenue Service
   - Building 30 years
   - Production equipment 7 years
   - Trucks 5 years

FIXED INPUT DATA – EGG'N FOAM RISK ANALYSIS MODEL

YIELD PERCENTAGES

Extruder garbage loss: 1.0%
Extruder reclaimable scrap: 7.0%

Thermoformer mold loss: 1.0%
Thermoformer buttends loss: 1.0%
Thermoformer reclaimable scrap: 13.0%

Printer loss: 2.5%
Printer reclaimable scrap: 1.5%

EFFICIENCIES

	EXTRUDER	THERMOFORMER
Mechanical efficiency	90%	90%
Scheduling efficiency	95%	100%

MATERIAL PRICES

Foam pellets: $0.15/lb.
Supplies: $1.01/thousand cartons

MANUFACTURING COSTS*

	ONE EXTRUDER	TWO EXTRUDERS
Extruder vairable costs	$15.25	$25.20
Thermoformer variable costs	22.21	38.94
Continuing costs	$237,350	$393,600

** The cost for three thermoformers is equal to the cost for one plus the cost for two. The cost for four thermoformers is equal to twice the cost of two.*

MANUFACTURING PROCESS

Extruders will work on a four-shift basis (7-day week); thermoformers on a three-shift basis (5-day week)

EQUIPMENT SPEEDS AND SPECIFICATIONS

EQUIPMENT SPEEDS AND SPECIFICATIONS	1968	1969	1970	1971	1972	1973	1974
Price/thousand cartons	$26.00	$25.50	$25.00	$24.50	$24.00	$28.50	$23.00
	$26.90	$27.00	$26.90	$26.80	$26.70	$26.60	$26.50
Extruder Rate (lb./hr.)	420-600		520-700				
Caliper (inches)	.080-.087		.078-.087				
Thermoformer Cycle Time* (seconds)	6.0-4.5			6.0-3.0			

** Thermoformers will use a twelve-up mold*

EGG CARTON MARKET

1968	1978
3.5 billion cartons	4.7 billion cartons

Continuing costs include:
- Plant overhead
- Office expenses
- Property tax
- Mold amortization
- Depreciation
- Other production expenses

Direct costs include:
- Material
- Labor
- Supplies
- Utilities
- Maintenance

Selling costs include:
- Sales force salaries
- Payroll taxes, employee benefits
- Travel and entertainment (25% of salaries)
- Telephone and telegraph
- Office rent
- Unrecovered charges
- Supplies
- Dues and subscriptions
- Advertising and promotion

A small plant sales force includes:
- 1/2 sales manager
- 3 salesmen
- 2 packaging machinery service

A large plant sales force would include:
- 1 sales manager
- 5 salesmen
- 3 packaging machinery service

PROBABILITIES ASSIGNED TO MAJOR INPUT FACTORS

LEGEND

ʘ Represents expected value

CHART 1

EXTRUDER RATE*

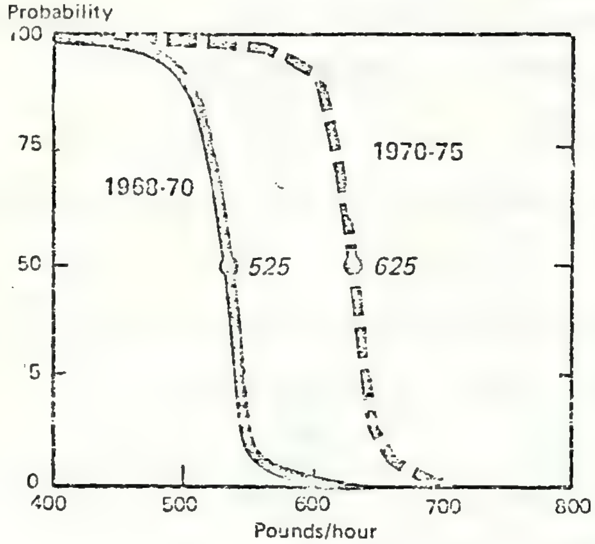


CHART 2

THERMOFORMER CYCLE TIME*

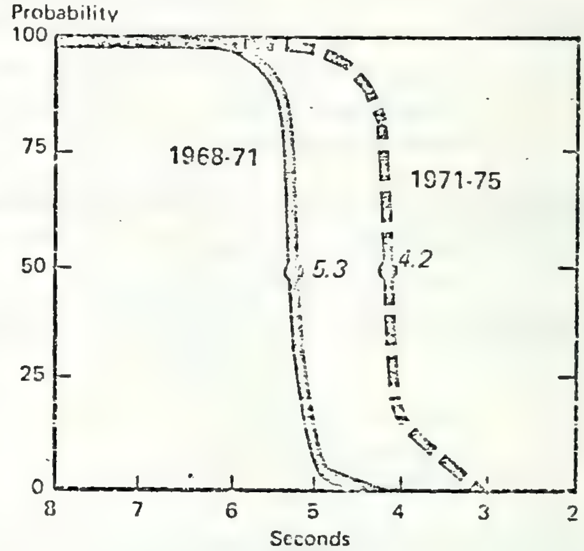


CHART 3

CALIPER*

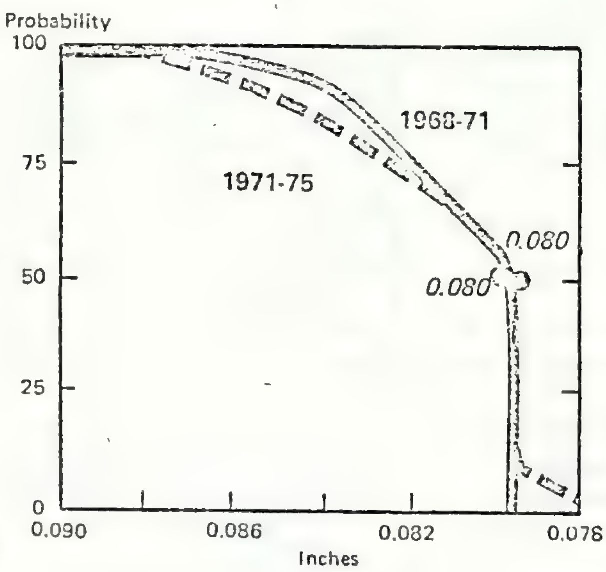
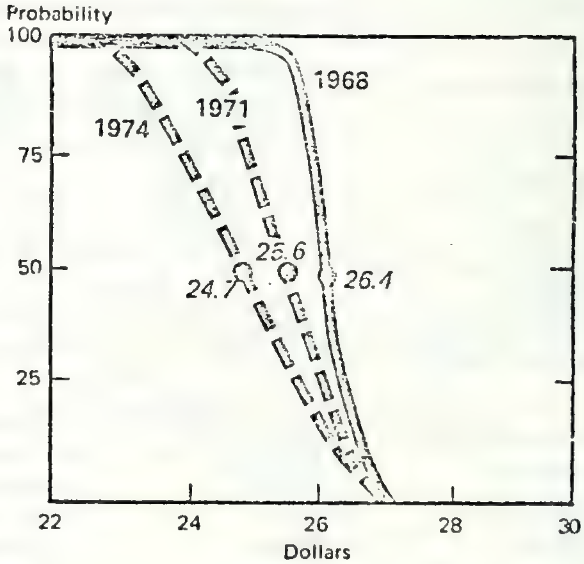


CHART 4

PRICE*

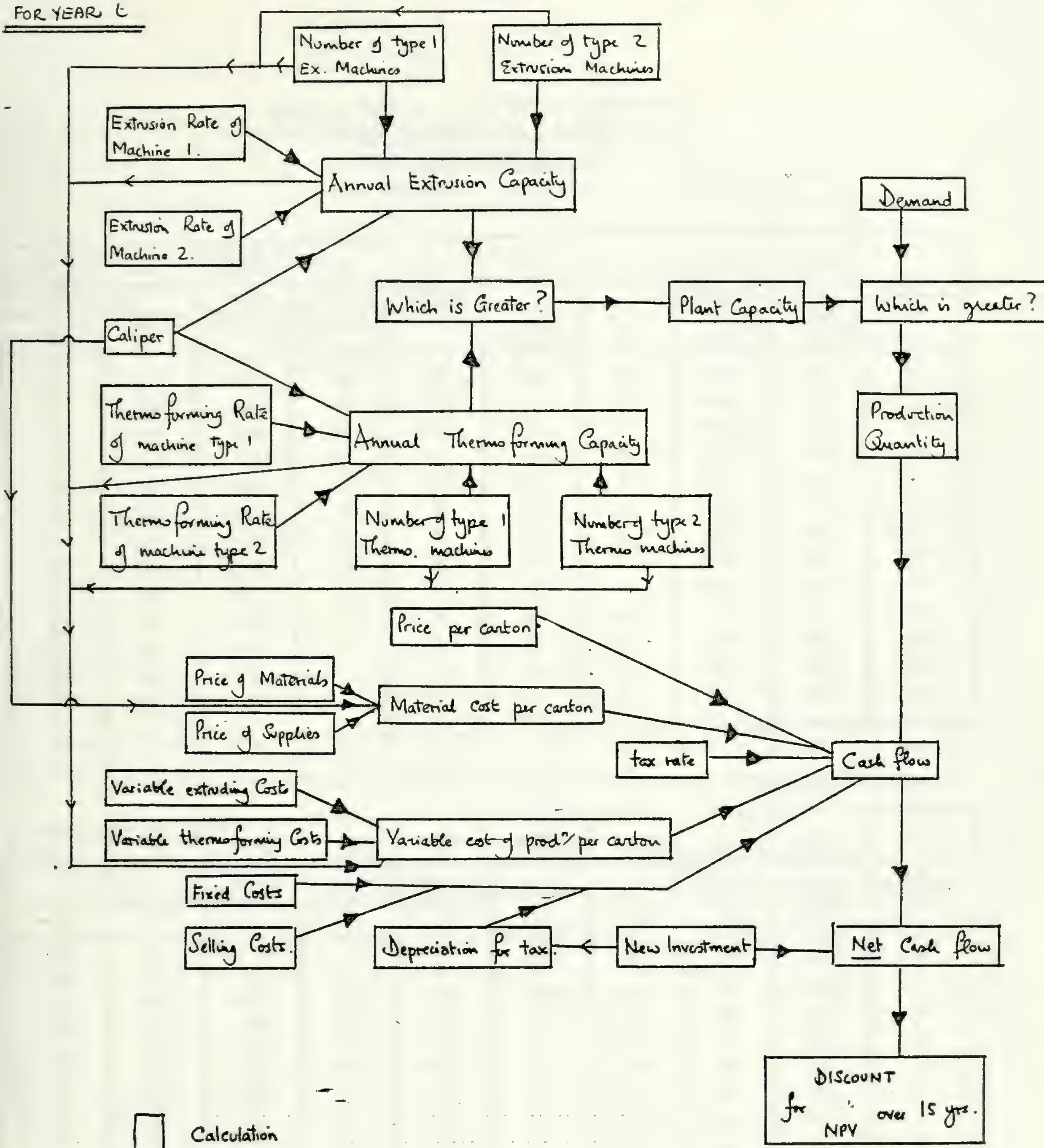


* *The probability distributions for these input factors are the same for each of the four strategies*

EGG'N FOAM LOGICAL FLOW CHART

EXHIBIT 5

FOR YEAR 't'



Calculation

Input of variable

Input of (strategy dependent) constant

Input of (strategy independent) constant

APPENDIX.

VARIABLE INPUT DATA – EGG'N FOAM
RISK ANALYSIS MODEL
STRATEGY: SUPER FAST

PLANT LOCATION: *Nesquehoning*

Year	Building	Equipment	Trucks	Working Capital	No. Extruders	No. Thermo-formers	Selling Expenses	Mean Demand	Standard Deviation
	($000)						($000)	Carton Millions	
1	720	671	20	250.0	1	1	70.0	22	30
2	0	120	0	201.2	1	1¼	121.7	41	30
3	720	701	10	401.2	2	3½	180.0	86	30
4	0	0	0	0	2	4	204.1	134	30
5	0	0	0	0	2	4	204.1	180	30
6	0	0	0	0	2	4	204.1	180	30
7	0	0	0	0	2	4	204.1	180	30
8	0	0	0	0	2	4	204.1	180	30
9	0	0	0	0	2	4	204.1	180	30
10	0	0	0	0	2	4	204.1	180	30
11	0	0	0	0	2	4	204.1	180	30
12	0	0	0	0	2	4	204.1	180	30
13	0	0	0	0	2	4	204.1	180	30
14	0	0	0	0	2	4	204.1	180	30
15	0	0	0	0	2	4	204.1	180	30

PLANT LOCATION: *Cairo*

Year	Building	Equipment	Trucks	Working Capital	No. Extruders	No. Thermo-formers	Selling Expenses	Mean Demand	Standard Deviation
	($000)						($000)	Carton Millions	
1	0	0	0	0	0	0	0	0	30
2	0	0	0	0	0	0	0	0	30
3	720	791	20	451.2	½	½	70.0	9	30
4	720	701	10	401.2	1¼	3	180.0	54	30
5	0	0	0	0	2	4	204.1	115	30
6	0	0	0	0	2	4	204.1	139	30
7	0	0	0	0	2	4	204.1	180	30
8	0	0	0	0	2	4	204.1	180	30
9	0	0	0	0	2	4	204.1	180	30
10	0	0	0	0	2	4	204.1	180	30
11	0	0	0	0	2	4	204.1	180	30
12	0	0	0	0	2	4	204.1	180	30
13	0	0	0	0	2	4	204.1	180	30
14	0	0	0	0	2	4	204.1	180	30
15	0	0	0	0	2	4	204.1	180	30

VARIABLE INPUT DATA – EGG'N FOAM
RISK ANALYSIS MODEL
STRATEGY: SUPER SLOW

PLANT LOCATION: *Nesquehoning*

Year	Building ($000)	Equipment ($000)	Trucks ($000)	Working Capital ($000)	No. Extruders	No. Thermo-formers	Selling Expenses ($000)	Mean Demand (Carton Millions)	Standard Deviation (Carton Millions)
1	720	671	20	250.0	1	1	70.0	22	10
2	0	0	0	50.0	1	1	100.0	36	10
3	0	120	0	151.2	1	2	121.7	54	10
4	720	581	10	250.0	1½	2½	150.0	79	10
5	0	120	0	151.2	2	4	204.1	106	10
6	0	0	0	0	2	4	204.1	133	10
7	0	0	0	0	2	4	204.1	180	10
8	0	0	0	0	2	4	204.1	180	10
9	0	0	0	0	2	4	204.1	180	10
10	0	0	0	0	2	4	204.1	180	10
11	0	0	0	0	2	4	204.1	180	10
12	0	0	0	0	2	4	204.1	180	10
13	0	0	0	0	2	4	204.1	180	10
14	0	0	0	0	2	4	204.1	180	10
15	0	0	0	0	2	4	204.1	180	10

PLANT LOCATION: *Cairo*

Year	Building ($000)	Equipment ($000)	Trucks ($000)	Working Capital ($000)	No. Extruders	No. Thermo-formers	Selling Expenses ($000)	Mean Demand (Carton Millions)	Standard Deviation (Carton Millions)
1	0	0	0	0	0	0	0	0	10
2	0	0	0	0	0	0	0	0	10
3	0	0	0	0	0	0	0	0	10
4	0	0	0	0	0	0	0	0	10
5	720	791	20	451.2	1	1½	100.0	16	10
6	0	0	0	0	1	2	121.7	50	10
7	720	701	10	401.2	2	3½	180.0	78	10
8	0	0	0	0	2	4	204.1	102	10
9	0	0	0	0	2	4	204.1	126	10
10	0	0	0	0	2	4	204.1	160	10
11	0	0	0	0	2	4	204.1	180	10
12	0	0	0	0	2	4	204.1	180	10
13	0	0	0	0	2	4	204.1	180	10
14	0	0	0	0	2	4	204.1	180	10
15	0	0	0	0	2	4	204.1	180	10

VARIABLE INPUT DATA – EGG'N FOAM
RISK ANALYSIS MODEL
STRATEGY: SMALL FAST

PLANT LOCATION: *Nesquehoning*

Year	Building	Equipment	Trucks	Working Capital	No. Extruders	No. Thermo-formers	Selling Expenses	Mean Demand	Standard Deviation
	($000)						($000)	Carton Millions	
1	720	671	20	250.0	1	1	70.0	21	21
2	0	120	0	201.2	1	1¼	121.7	41	21
3	0	0	0	0	1	2	121.7	57	21
4	0	0	0	0	1	2	121.7	90	21
5	0	0	0	0	1	2	121.7	90	21
6	0	0	0	0	1	2	121.7	90	21
7	0	0	0	0	1	2	121.7	90	21
8	0	0	0	0	1	2	121.7	90	21
9	0	0	0	0	1	2	121.7	90	21
10	0	0	0	0	1	2	121.7	90	21
11	0	0	0	0	1	2	121.7	90	21
12	0	0	0	0	1	2	121.7	90	21
13	0	0	0	0	1	2	121.7	90	21
14	0	0	0	0	1	2	121.7	90	21
15	0	0	0	0	1	2	121.7	90	21

PLANT LOCATION: *Southeast*

1	0	0	0	0	0	0	0	0	21
2	0	0	0	0	0	0	0	0	21
3	720	791	20	451.2	1	1½	100.0	27	21
4	0	0	0	0	1	2	121.7	62	21
5	0	0	0	0	1	2	121.7	90	21
6	0	0	0	0	1	2	121.7	90	21
7	0	0	0	0	1	2	121.7	90	21
8	0	0	0	0	1	2	121.7	90	21
9	0	0	0	0	1	2	121.7	90	21
10	0	0	0	0	1	2	121.7	90	21
11	0	0	0	0	1	2	121.7	90	21
12	0	0	0	0	1	2	121.7	90	21
13	0	0	0	0	1	2	121.7	90	21
14	0	0	0	0	1	2	121.7	90	21
15	0	0	0	0	1	2	121.7	90	21

PLANT LOCATION: *Midwest*

1	0	0	0	0	0	0	0	0	21
2	0	0	0	0	0	0	0	0	21
3	720	671	20	300.0	½	½	50.0	9	21
4	0	120	0	151.2	1	2	121.7	40	21
5	0	0	0	0	1	2	121.7	70	21
6	0	0	0	0	1	2	121.7	90	21
7	0	0	0	0	1	2	121.7	90	21
8	0	0	0	0	1	2	121.7	90	21
9	0	0	0	0	1	2	121.7	90	21
10	0	0	0	0	1	2	121.7	90	21
11	0	0	0	0	1	2	121.7	90	21
12	0	0	0	0	1	2	121.7	90	21
13	0	0	0	0	1	2	121.7	90	21
14	0	0	0	0	1	2	121.7	90	21
15	0	0	0	0	1	2	121.7	90	21

PLANT LOCATION: *Southwest*

1	0	0	0	0	0	0	0	0	21
2	0	0	0	0	0	0	0	0	21
3	0	0	0	0	0	0	0	0	21
4	720	791	20	451.2	1	1½	100.0	21	21
5	0	0	0	0	1	2	121.7	57	21
6	0	0	0	0	1	2	121.7	71	21
7	0	0	0	0	1	2	121.7	90	21
8	0	0	0	0	1	2	121.7	90	21
9	0	0	0	0	1	2	121.7	90	21
10	0	0	0	0	1	2	121.7	90	21
11	0	0	0	0	1	2	121.7	90	21
12	0	0	0	0	1	2	121.7	90	21
13	0	0	0	0	1	2	121.7	90	21
14	0	0	0	0	1	2	121.7	90	21
15	0	0	0	0	1	2	121.7	90	21

VARIABLE INPUT DATA – EGG'N FOAM
RISK ANALYSIS MODEL
STRATEGY: SMALL SLOW

PLANT LOCATION: *Nesquehoning*

Year	Building	Equipment	Trucks	Working Capital	No. Extruders	No. Thermo-formers	Selling Expenses	Mean Demand	Standard Deviation
	($000)						($000)	Carton Millions	
1	720	671	20	250.0	1	1	70.0	21	7
2	0	0	0	50.0	1	1	70.0	36	7
3	0	120	0	151.2	1	2	121.7	54	7
4	0	0	0	0	1	2	121.7	72	7
5	0	0	0	0	1	2	121.7	90	7
6	0	0	0	0	1	2	121.7	90	7
7	0	0	0	0	1	2	121.7	90	7
8	0	0	0	0	1	2	121.7	90	7
9	0	0	0	0.	1	2	121.7	90	7
10	0	0	0	0	1	2	121.7	90	7
11	0	0	0	0	1	2	121.7	90	7
12	0	0	0	0	1	2	121.7	90	7
13	0	0	0	0	1	2	121.7	90	7
14	0	0	0	0	1	2	121.7	90	7
15	0	0	0	0	1	2	121.7	90	7

PLANT LOCATION: *Southeast*

1	0	0	0	0	0	0	0	0	7
2	0	0	0	0	0	0	0	0	7
3	0	0	0	0	0	0	0	0	7
4	720	671	20	300.0	½	½	70.0	7	7
5	0	120	0	151.2	1	2	121.7	34	7
6	0	0	0	0	1	2	121.7	66	7
7	0	0	0	0	1	2	121.7	90	7
8	0	0	0	0	1	2	121.7	90	7
9	0	0	0	0	1	2	121.7	90	7
10	0	0	0	0	1	2	121.7	90	7
11	0	0	0	0	1	2	121.7	90	7
12	0	0	0	0	1	2	121.7	90	7
13	0	0	0	0	1	2	121.7	90	7
14	0	0	0	0	1	2	121.7	90	7
15	0	0	0	0	1	2	121.7	90	7

PLANT LOCATION: *Midwest*

1	0	0	0	0	0	0	0	0	7
2	0	0	0	0	0	0	0	0	7
3	0	0	0	0	0	0	0	0	7
4	0	0	0	0	0	0	0	0	7
5	720	671	20	300.0	1	1	70.0	16	7
6	0	120	0	151.2	1	1½	100.0	50	7
7	0	0	0	0	1	2	121.7	69	7
8	0	0	0	0	1	2	121.7	90	7
9	0	0	0	0	1	2	121.7	90	7
10	0	0	0	0	1	2	121.7	90	7
11	0	0	0	0	1	2	121.7	90	7
12	0	0	0	0	1	2	121.7	90	7
13	0	0	0	0	1	2	121.7	90	7
14	0	0	0	0	1	2	121.7	90	7
15	0	0	0	0	1	2	121.7	90	7

PLANT LOCATION: *Southwest*

1	0	0	0	0	0	0	0	0	7
2	0	0	0	0	0	0	0	0	7
3	0	0	0	0	0	0	0	0	7
4	0	0	0	0	0	0	0	0	7
5	0	0	0	0	0	0	0	0	7
6	0	0	0	0	0	0	0	0	7
7	720	671	20	300.0	½	½	100.0	3	7
8	0	120	0	151.2	1	2	121.7	18	7
9	0	0	0	0	1	2	121.7	42	7
10	0	0	0	0	1	2	121.7	66	7
11	0	0	0	0	1	2	121.7	90	7
12	0	0	0	0	1	2	121.7	90	7
13	0	0	0	0	1	2	121.7	90	7
14	0	0	0	0	1	2	121.7	90	7
15	0	0	0	0	1	2	121.7	[illegible]	[illegible]