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FOR STRATEGIC PLANNING

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ABSTRACT

The STRATPORT decision support system represents an extension and operationalization of current business portfolio approaches. It is designed to aid top managers and corporate planners in the evaluation and formulation of business portfolio strategies. A description of the basic structure of the STRATPORT model is presented as well as an illustrative example of its use.

Over the last 15 years, a great deal of experience has been accumulated in the development of marketing models. The initial concentration on purely technical aspects of modeling has been supplemented by an increasing consideration of implementation issues (Little 1970, Montgomery and Weinberg 1973, Larréché and Montgomery 1977, Larréché 1979). Marketing modeling has consequently become a more mature discipline and now provides effective support to marketing decision-making (Webster 1978, Little 1979).

The bulk of marketing modeling efforts has traditionally been oriented towards assisting managers in the formulation of an appropriate marketing mix for a given product or brand (Montgomery and Urban 1969, Kotler 1971, Naert and Leeflang 1978). In the seventies, increasing environmental and competitive pressures have induced corporations to redefine to some extent the role of marketing in the firm. Instead of implementing the marketing philosophy mainly towards the achievement of growth objectives for individual products in a typical brand management organization, firms have given increasing importance to other factors such as profitability, market share, competition, product-line management and allocation of resources among products (see, for instance, Hopkins 1976).

The more strategic orientation of marketing has already been integrated, to some extent, in marketing education (Larréché and Gatignon 1977, Abell and Hammond 1979, Kotler 1980). This evolution is also reflected in the development of new marketing approaches and models to

assist managers in the formulation of segmentation and positioning strategies in the context of a product line (Wind and Claycamp 1976, Pessemier 1977, Shocker and Srinivasan 1979, Jackson and Shapiro 1979). But marketing modeling has failed, so far, to assist top managers or corporate planners in the allocation of marketing resources across product lines or business units. This is reflected, in particular, by the poorness of the marketing component in most corporate models (Larréché and Montgomery 1980). In 1976, Naylor and Schauland identified close to 2,000 firms in North America and Europe which made use of some type of corporate model. This wide use of corporate models seems to have been overlooked by marketing modelers.

After having surmounted to a large extent the implementation problems which plagued early modeling works, marketing modelers now face the new challenge of adapting their efforts to the increasing strategic orientation of marketing. The purpose of this paper is to present such an effort, the STRATPORT (for STRATegic PORTfolio planning) decision support system. This system was designed to assist top managers and corporate planners in the formulation of business portfolio strategies, and it represents both an operationalization and extension of the business portfolio analysis approaches developed in the seventies by a number of firms. This article will review the main aspects of these approaches, present the basic structure of the STRATPORT model, describe an example of its utilization, and discuss the contributions and limitations of the model in the allocation of resources among business units.

A Brief Review of Business Portfolio Analysis Approaches

Following the pioneering work of General Electric in the late sixties, a number of business portfolio analysis approaches have been proposed and used by various firms, including the Boston Consulting Group, McKinsey, Arthur D. Little and Royal Dutch Shell (see, for instance, Hedley 1977, Robinson, Hickens and Wade 1978). These different approaches have been compared by Boyd and Larréché (1978) and only the main characteristics will be reviewed here.

These approaches conceptualize the firm as a portfolio of business units and identify the major corporate strategic decision as being the allocation of resources among these business units. To aid top managers in this decision, they provide different procedures to cluster the business units into more homogeneous groups in terms of their expected contribution to the dynamic evolution of the portfolio.¹ In the Boston Consulting Group approach, relative market share and market growth are used to classify business units as Question Marks, Stars, Cash Cows or Dogs. In the General Electric/McKinsey approach, the business units are classified into nine groups according to "company strength" and "industry attractiveness." The position of a given business unit on each of these dimensions is determined qualitatively from a number of market, competitive, environmental and internal factors. The Royal Dutch Shell approach is somewhat similar although the two dimensions are called "company's competitive capabilities" and "prospects for sector profitability," and the set of factors and their integration into these composite dimensions are also different.

The philosophy underlying these approaches is, however, similar. At a given point in time, each business unit has a specific role in the portfolio according to its short-term and long-term economic potential. This role determines the allocation of financial resources among elements of the portfolio. Minimum or maintenance investments will be made in a group of business units so that they generate a maximum cash flow in the short term. These may be business units which have a strong market position and are not vulnerable to competitive pressures, or which do not represent satisfactory long-term potential. This generated cash flow allows investments in other business units which will provide growth in the short and medium term. In the long term, these business units will, in turn, become net cash generators and will contribute to financing the growth of other units of the portfolio. The development and renewal of a balanced portfolio of business units through careful resource allocation is considered essential to the long-term survival and growth of the firm.

Business portfolio analysis approaches are being increasingly used in corporations (see, for instance, Business Week 1975), for a number of reasons. They have effectively formulated the key strategic corporate decision as being the allocation of resources among business units. They provide a simple framework and language to classify business units into more homogeneous groups to facilitate this decision. From the position of a business unit in some dimensions, such as market growth and relative market share, they readily provide inferences on the cash requirements or

cash generation of the business unit. These inferences are supported by past experience as well as empirical studies on cost and price dynamics (Boston Consulting Group 1972, Stobaugh and Townsend 1975) and on the relationship between market share and profitability (Buzzell, Gale and Sultan 1975). Finally, they aid strategic thinking by graphically representing business units on two critical dimensions.

Different authors (Day 1977, Channon 1977) have already discussed the limitations of these business portfolio approaches which stem from three main sources: the representation of the portfolio situation, the implicit relationships assumed in drawing inferences on desirable strategies, and the scope of the analysis. The representation of the current business portfolio situation involves a definition of the business units and the measurement of their position on the two dimensions considered. The analysis requires that business units should not share any cost or marketing interdependency. Implementation of the portfolio strategy, on the other hand, requires that delineation of business units should be coherent with the organizational structure of the firm. In practice, it is unlikely that all these conditions will be met simultaneously. The only safeguard available is to define business units in such a way as to minimize potential problem in analysis and implementation, and to explicitly consider the implications of the assumptions when interpreting a given portfolio strategy.

The definition of business units will also have a critical impact on the measurement of their position on the dimensions of analysis. The Boston Consulting Group approach considers two quantitative dimensions, relative market share and market growth, which can easily be determined as long as the relevant market and competitors are precisely defined for each business unit. The other approaches raise the additional issues of eliciting managerial judgments on the position of business units on qualitative factors, and of integrating these factors into a composite dimension.

Another commonly cited limitation of the business portfolio analysis approaches is the implicit relationship which they assume between the position of a business unit on the dimensions of analysis and its cash requirements or cash generation capabilities. In the Boston Consulting Group approach, cash flows are inferred from relative market share and market growth. For instance, a higher market growth is implicitly associated with a more unstable market structure and with higher marketing and production investments. A higher relative market share is implicitly associated with a competitive cost advantage and higher profit margins. Combining the effects of these two factors, a business unit having a dominant posture in a high growth market will be expected to have a relatively small positive or negative cash flow, the high marketing and production investments being approximately financed by the high profit margin. These implicit relationships are generally valid and

provide a basis to evaluate the overall balance of a business portfolio in a preliminary screening stage. They may, however, not hold under specific competitive and environmental conditions, and it is indeed possible to find business units which are highly profitable without enjoying a high relative market share (Hamermesh, Anderson and Harris 1978, Hall 1980). Moreover, these implicit relationships can at best provide only an indication, but not a quantitative appraisal of the financial implications of a given portfolio strategy.

The use of these portfolio analysis approaches is also limited in practice by other aspects which have not been given due emphasis in the literature. The limitations are due to the fact that a number of important elements have been left out of the scope of the analysis. The previous approaches do not explicitly distinguish between cash flows and profits. In fact, cash flows represent constraints on the strategic options which may be adopted while profits are required to provide a satisfactory return to shareholders and to have further access to external financial sources. The previous approaches concentrate on total cash flow levels and do not explicitly distinguish between capacity, working capital, R & D or marketing investments. As a result, they are particularly valuable in the diagnostic of an existing situation but offer only an indication of the financial implications of changes in the market postures of business units. Finally, they center on existing business units while a long-term profitability of the firm may require investing in new business units.

The development of the STRATPORT decision support system was guided by two main considerations. The first one was to overcome some of the limitations of current business portfolio analysis approaches, especially by extending the scope of the analysis and by making explicit some of the relationships on which these approaches are built. In particular, STRATPORT explicitly considers marketing, capacity and working capital investments, potential new business units, cash flows, profits and external financial resources. In addition, it provides an explicit specification of the relationship between changes in the market posture of a business unit and its cash flow requirements as well as its long-term profit potential.

The second consideration in the development of STRATPORT was to provide an operationalization of the business portfolio analysis concept so that a number of alternative portfolio strategies and their underlying assumptions could be effectively investigated. In particular, STRATPORT allows:

1. An integration of empirically-based data with managerial judgments. The system may be used with managerial judgments to study the sensitivity of outcomes to specific inputs and to guide accordingly the gathering of additional empirical data in areas where it is most valuable.
2. A determination of adequate business portfolio strategies for different financial requirements, on the basis of key quantifiable factors.

3. A rapid investigation of the robustness of a given business portfolio strategy to changes in the underlying assumptions.

The STRATPORT system does not resolve all of the limitations of the business portfolio analysis approaches. In particular, it assumes that the firm has appropriately defined its business units. Although progress is currently being made in this difficult area (Day, Shocker and Srivastava 1979), no ideal solution will usually exist. The definition of business units in the end is the result of a managerial decision based on a compromise between cost and market interactions as well as coherence with the current organizational structure. The STRATPORT system provides, however, a convenient support to test the robustness of a given portfolio strategy to alternative aggregations of business units.

In addition, because of the complex and long-term nature of corporate strategy, top executives will continuously have to cope with incomplete and approximate data, with imperfect knowledge of the outcome of alternative actions, with uncertainties on market, competitive and environmental dynamics, and with factors which do not lend themselves to quantitative analysis. In this context, STRATPORT does not claim to determine the optimum business portfolio strategy. STRATPORT is a decision support system. It tries to extract relevant information from existing empirical data and managerial judgments and to integrate this information to assist decision-making, while relieving corporate planners

from fastidious computations. It provides a framework to investigate strategic factors and key assumptions. It identifies "optimum" portfolio strategies on the basis of critical quantifiable factors. Taking other qualitative considerations into account, top management may then concentrate on a more complete analysis of the proposed strategies, which may lead to the selection of a strategy or to further investigation of other alternative strategies.

An Overview of the Model

STRATPORT is composed of a mathematical model and extensive input and output capabilities. Only the model component will be described here, in the context of the portfolio planning framework represented in Figure 1.

Insert Figure 1 about here

At any point in time, the firm has internal cash resources from its equity and earnings retained from past operations. It also has access to external financial sources. For a given dividend policy, the maximum sustainable growth which the firm may afford can be investigated from the current capital structure and an anticipation of profits and cost structure (see, for instance, Babcock 1970, Higgins 1977). The choice of a maximum sustainable growth for the firm determines the maximum amount of external financial funds which it can attract. The sum of these external financial

funds and of internal cash resources provide the maximum cash resources available.

For a given amount of total cash resources available, the strategic portfolio problem is to determine how they should be allocated among the N business units considered in the firm's portfolio. These include on-going operations of the firm as well as potential new business units which do not currently exist but which may be either developed internally or acquired externally. The main investments considered will usually be in the areas of production capacity, working capital, marketing and R & D. Over a certain period of time and for a given investment, a business unit will generate a level of profits and the resulting cash flow. This cash flow will affect the internal cash resources of the firm which will, in turn, influence the maximum cash resources available. Thus the problem is highly dynamic.

In STRATPORT, the time horizon for the analysis is divided into two parts. The planning period is the one over which investments and cash constraints are explicitly considered. Marketing investments are expected to result in changes in market share and sales, which may require additional investments in the expansion of capacity and for working capital. In the post-planning period, market shares of business units are considered to be stable. Marketing investments are set at maintenance levels while capacity expenditures and changes in working capital follow the evolution of sales. The purpose of the post-planning period is to provide an evaluation of the long-term profit implication of actions taken during the planning period.

Insert Figure 2 about here

The distinction between the planning and post-planning periods is illustrated in Figure 2 in terms of the evolution of the market share of different business units. The lengths of these two periods are chosen according to the characteristics of the industries considered and the confidence of management in the reliability of data for different time horizons. Typically, the planning period will cover from 2 to 5 years and the post-planning period from 5 to 10 years. The time horizon is further divided into time units which typically represent quarters, semesters or years and which are the basis for representing different elements of the model.

The STRATPORT model may be used at two different levels which are represented by the dotted lines in Figure 1.

1. Strategy evaluation. The user of the model may evaluate a given portfolio strategy by indicating specific marketing investment levels (or, alternatively, market share objectives) for each business unit. The model will project for each business unit the expected market share (or marketing investment), capacity expenditures, working capital, profit and cash flow resulting from such a strategy. Aggregation of these results over the business units provides an evaluation of the total cash flow requirements in the planning period and of the total profits over the planning and post-

planning periods. The model may in particular be used in this fashion to project the long-term implications of a status quo strategy, or of incremental changes in the current strategy.

2. Strategy formulation. Given a specific cash flow requirement in the planning period, the model may be used to formulate a strategy in terms of the allocation of resources among business units which maximizes total profits over the planning and post-planning periods. The user may specify a range of values for the cash flow requirement based on the maximum external financial funds available, or the maximum cash inflow which should be generated by the portfolio during the planning period. The optimum resource allocations recommended by the model may be used by the manager as a basis to formulate a portfolio strategy, taking into account factors not incorporated in the model. Furthermore, the user may test the robustness of the recommended resource allocations to changes in the data by performing sensitivity analyses.

The Structure of the STRATPORT Model

The core of the STRATPORT model is composed of a business unit module which represents the cash flow and profit implications of a given marketing investment in a specific business unit. This module is used for both the evaluation of a specific portfolio strategy and the formulation of appropriate portfolio strategies. We will successively describe the overall structure of the business unit module, the key functional relationship in this module, and the principles of the optimization routine. ²

Overall structure of the business unit module

The structure of the model is common to all business units and is represented in Figure 3. The specific values of parameters and inputs are obviously specific to each business unit.

Insert Figure 3 about here

The marketing investment made in the business unit considered during the planning period results in an expected market share m_T for that business unit at the end of the planning period. This also determines the values for market share over the planning period and the marketing expenditures required to maintain market share in the post-planning period. The sales are obtained for each time unit by multiplying the market share by the market size. Different market growth rates for the planning and post-planning periods may be specified by the user.

At a given point in time, the market size determines the cumulative production of the industry which influences the competitive price level for the firm. The revenues of the business unit are obtained from the sales volume and price level during each time unit. Similarly, the sales volume determines the cumulative production of the firm at a given point in time which influences the unit costs. The total costs of the business unit are computed directly from the sales volume and unit costs during each time unit. Finally, the sales level determines the capacity expenditures and working capital required during the planning period.

The cash flow during the planning period is computed as the after tax profits from the business unit (revenues minus costs minus marketing investments adjusted by the appropriate tax rate), minus the increase in working capital, minus the portion of the additional capacity investment not depreciated during the planning period, plus the depreciation during the planning period of assets acquired before the beginning of the planning period. The total after tax profits over the time horizon considered are obtained from total revenues minus total costs, marketing investments during the planning period and marketing expenditures during the post-planning period, adjusted by the appropriate tax rate.

All the financial entities in the STRATPORT model are expressed in constant dollars. Consequently, the model may be used to determine portfolio strategies which would maximize the total after-tax profits in constant dollars cumulative over the planning and post-planning periods, subject to a cash flow constraint. Although this approach may be desirable as a first step of the analysis, it does not take into account the time value of money and a discounting of profits and cash flow will usually be more appropriate. Furthermore, the systematic risk associated with the investments considered will often be different for the different business units. Consequently, the STRATPORT model allows an optimization of total discounted profits subject to a constraint on discounted cash flow, where the discounting rate may be specified to be different for each business unit to reflect different levels of systematic risk. This approach

follows the capital assets pricing model (see Van Horne 1980, Chapters 7 and 8).

Main functional relationships

The five main functional relationships of the business unit module are (1) the market response function; (2) the maintenance function; (3) the capacity expenditures function; (4) the working capital function; (5) the cost function; and (6) the price function. They are identified by the corresponding numbers in Figure 3 and represented graphically in Figure 4.

Insert Figure 4 about here

1. The market response function. The market response function specifies the market share m_T , on a quantity basis, which may be expected at the end of the planning period for a given marketing investment. It will generally be S-shaped reflecting an increasing marginal response for small investments and a decreasing marginal response for large investments, but it may also assume a concave form. Since the market response function is strictly monotone increasing it is feasible and managerially more attractive to interpret this curve as a specification of the marketing investments required to obtain different market share levels. These marketing investments will typically include personal

selling and advertising expenditures, but also developmental costs to improve product quality or to modify the product line within a business unit.³

Following a procedure proposed by Little (1970), the market response function is estimated from four inputs: the market share expected at the end of the planning period if no marketing investment is made; the marketing investment required to achieve a reference market share level; the expected market share for a higher marketing investment; and the maximum market share expected for an unlimited marketing investment. For an existing business unit, the reference market share is taken as the current market share, while for a potential business unit, the minimum expected market share is set to zero.

2. The maintenance function. This function specifies the marketing expenditures required during the post-planning period, expressed as a percentage of sales, to maintain market share at the level reached at the end of the planning period. It will generally decrease as market share increases, reflecting economies of scale in marketing, although it may increase in some situations. This may, for instance, be the case if a higher market share is anticipated to generate more than a proportionate increase in competitive reactions. A linear form was deemed sufficiently appropriate to represent the variation of relative marketing maintenance expenditure as a function of market share. It is estimated from managerial inputs corresponding to two market share levels.

3. The capacity expenditure function. This function represents the additional investment required to expand the current capacity to be consistent with the market share to be achieved. It also specifies the additional resources available if the activity level of the business unit is decreased. These additional resources represent the resale value of the freed capacity or the cash equivalent when transferred to other business units. The capacity expenditures are the proportion of the investment not accounted as depreciation in the computation of the costs during the planning period.

The capacity expenditures function for an existing business unit is evaluated from five estimates provided by the user: the cash flow generated by a complete sale or transfer of the current capacity; the additional investment required for two expansion levels; and the investment required for a marginal expansion beyond a high capacity level. If the firm is not able or willing to sell off a business unit or to use freed capacity for other activities, the cash flow corresponding to a complete sale may be set to a small value. The plant expansion function may be S-shaped or concave depending on the estimates provided by the user.

In the case of a business unit with no existing capacity, the investment function has a concave form and is evaluated from estimates of the investment required for two capacity levels.

4. The working capital function. The working capital requirements (cash + inventory + equipment on lease + accounts receivable -

accounts payable) are usually expected to differ for various levels of market share. Working capital is specified as a function of revenues. The parameters of this function are evaluated on the basis of estimates expressing the appropriate working capital as a proportion of revenues for two revenue levels. The working capital function may be expected to be generally concave, but it may also be convex when, for instance, an increase in market share will result in penetrating market segments which require more favorable credit or delivery terms.

5. The cost function. Following the works of the Boston Consulting Group on experience effects (1972), the STRATPORT model assumes that unit costs, expressed in constant dollars, decline as an exponential function of the firm's cumulative production. In STRATPORT, however, unit costs include all costs with the exception of marketing investments which are accounted for separately. The evaluation of the cost function is based on a loglinear regression of past data or, alternatively, on current unit costs and a managerial estimate of the cost reduction anticipated for an increase in cumulative production. If, however, the evolution of unit costs is estimated to be more a function of time than of cumulative production, the model can be extended to handle such cases. This extension may be particularly appropriate when raw materials costs are anticipated to evolve significantly, or/and when they represent a substantial amount compared to value added.

6. The price function. The price function also assumes an exponential decline in average industry unit price as a function of industry cumulative production, similar to the behavior of unit costs. The evolution of price may, however, be different in the planning and post-planning periods to reflect different patterns of price competition over time which have been empirically identified by the Boston Consulting Group (1972). For instance, the average industry price may decline at a lower rate than unit costs for a new industry and decrease at a faster rate later as the market matures and competition intensifies.

This formulation does not assume that there is a market price followed by the firm. The price set by the firm may actually be above or below average industry prices according to the price positioning strategy adopted. Moreover, just as in the case of costs, the model can be extended to consider price as a function of time as opposed to a function of industry cumulative sales.

The Optimization Module

The business unit module described above is sufficient for the evaluation of a specific portfolio strategy. In addition, STRATPORT may be used to determine the allocation of resources among business units which provides the maximum discounted after-tax profits over the time horizon considered, subject to a net cash flow constraint in the planning period. This cash constraint may be evaluated over a range of levels as indicated earlier.

The optimization procedure follows the Generalized Lagrange Multiplier technique (Everett 1963) and transforms the simultaneous optimization of N variables to N univariate maximizations.⁴ The univariate maximization algorithm is based on the decomposition of the Lagrangean derivative into a sum of monotone increasing and decreasing functions. It automatically provides the expected profit level for alternative cash flow constraints as well as an estimate of the marginal increase in profit for an increase in the level of the cash flow constraint.

This optimization procedure is highly efficient and the computer time required to find an optimum allocation goes up only linearly with the number of business units. It determines the optimum allocations to 10 business units for 11 different levels of the cash flow constraint in less than 20 seconds of CPU time on a DEC 2050 system. This high efficiency makes feasible the on-line interaction to conduct sensitivity analysis.

An Illustrative Use of the Model

Figure 5 contains selected parts of a computer terminal printout corresponding to an illustrative utilization of STRATPORT. The inputs provided by the user have been underlined to distinguish them from the text printed by the computer. In a previous utilization of STRATPORT, a data file had been created, containing the appropriate inputs for six business units over a planning period of 3 years and a post-planning period of 5 years. Without going into the detailed characteristics of the

business units, we may summarize that, in terms of the Boston Consulting Group terminology, business units 1, 2, 3 and 4 are a Cash Cow, a Star, a Dog and a Problem Child, with current market shares of 20%, 30%, 5% and 5%, respectively. Business units 5 and 6 are new opportunities which the firm is considering entering into.

Insert Figure 5 about here

The strategy evaluation and strategy formulation modes of STRATPORT are illustrated in Figure 5. For simplification, the financial entities in these examples are presented only before tax and without discounting. In the first part, the model is used to project the current situation over the planning horizon. Over the planning period, the marketing investments which would be required to maintain the current market share of each business unit are 45, 150, 40 and 30 millions dollars for business units 1, 2, 3 and 4, respectively. This status quo strategy implies that the firm will not make new entries into business units 5 and 6.

The results of this evaluation indicates that this strategy would generate a net cash flow of \$297 millions over the 3-year planning period and profits of \$1366 millions over the total 8-year time horizon considered. The detailed results show that all business units would, under this strategy, be net cash generators although business unit 1 would account for close to 70% of the cash flow in the planning period. Over the long term, business units 1 and 2 would generate close to 90% of the total profits of the firm.

There are some indications that this status-quo strategy may be far from optimum. There are obvious disparities between the marketing investments made in the business units and their long term profit potential. It is possible, in particular, that more cash could be generated by business units 1 and 3 and invested more profitably into business units 2, 4, 5 and 6. Moreover, it is difficult to evaluate whether the total cash flow generated in the planning period corresponds to the appropriate level for the firm without knowing the long-term profit implications of alternative cash flow levels.

For these different reasons, in the second part of Figure 3 the strategy formulation mode of STRATPORT is used to investigate a range of portfolio strategies from a net cash generation of \$600 millions to a net cash need of \$200 millions. The detailed results of the optimization routine are saved in an output file for off-line printing. They can also be selectively displayed on line but only the key results of the optimization are presented here. They represent the profit, marginal percent yield and market shares for eleven portfolio strategies (options) corresponding to different cash flow levels. These cash flow levels correspond to constant steps in the marginal yield. At one extreme, option 1 would require \$206 millions of additional cash in the planning period and would provide a total profit of \$2,911 millions. At the other extreme, option 11 would generate a net cash flow of \$609 millions and a total profit of \$1,330 millions.

Business unit 6 does not appear to be an attractive opportunity over the whole range of cash flows considered. Similarly, the most

appropriate strategy for business unit 3 in all options is a minimum marketing investment resulting in a minimum market share. At the other extreme, business unit 4 appears to warrant a sustained marketing investment which would result in a substantial market share increase under all options.

The optimum strategies for the remaining three business units appear to differ widely for different cash flow levels. These strategies vary from a sustained marketing investment for a given cash flow level to a minimum marketing investment when the cash flow requirement becomes very stringent. For instance, if a net cash generation of at least \$383 millions is required, a sustained marketing investment cannot be made in business unit 2 and its market share will drop to a minimum level of 5% at the end of the planning period (see under option 7). The user could also look at the detailed cash flow and profit projections made available by the model for each option, although this capability is not presented here because of space limitations.

An analysis could be performed to compare the long-term profitability of different strategies with their cash requirements. Such an analysis is represented graphically in Figure 6 from the information obtained from the interaction with STRATPORT. The curve obtained by linking the points corresponding to different optimum strategies determines the profit/cash flow envelope of optimum strategies, and it increases at a declining rate. The slope of this envelope represents the marginal profit from the additional amount of investment involved in one option compared to the next. Comparing the marginal profit with the marginal cost of external financing can aid in the determination of a desirable cash flow level.

Insert Figure 6 about here

The final recommendation would obviously have to consider a number of factors not explicitly included in the STRATPORT model, such as labor implications, financing possibilities and considerations of risk. But this example clearly shows that the choice of an investment strategy may depend mainly on the characteristics of a business unit, as in the case of business units 3, 4 and 6, or be significantly affected by the net cash flow requirements of the firm, as in the case of business units 1, 2 and 5.

Finally, this analysis also provides a perspective on the adequacy of the status-quo strategy. As represented in Figure 6, this strategy would be far from optimum. For the same cash flow level in the planning period, the profits of the firm could be increased by \$500 million over the next eight years by a better allocation of resources among business units. Moreover, the same increase in long term profits could be achieved while providing an additional \$100 million surplus to the net cash flow during the planning period.

Conclusion

STRATPORT is a decision support system designed to assist top managers and corporate planners in the formulation of business portfolio strategies. The development of this system has been based on two specific research areas which have had a substantial impact on marketing in recent years: the decision-calculus approach in marketing modeling and strategic planning techniques.

The STRATPORT system is easy to understand and easy to use. Yet, it is complete in integrating the key aspects of the business portfolio problem. The complexity inherent in the mathematical formulation of the model, in the estimation of function parameters or in the optimization procedure have been transferred to the computer so as to facilitate the use of the model by corporate planners and managers. The model attempts to make the best use of existing empirical data as well as managerial judgment. Judgmental inputs are elicited from managers on issues with which they are familiar and in a way which is coherent with managerial thinking. The model provides information which may readily be interpreted by managers. These features are the result of an implementation-oriented model design as advocated by Little (1970).

STRATPORT represents simultaneously an extension and operationalization of current business portfolio analysis approaches. The three main extensions included in the model are the distinction made between specific types of investments, the inclusion of potential new business units in the analysis, and the explicit specification of the relationship between changes

in the market posture of a business unit, its cash flow requirements and its long-term profit potential. The operationalization of the business portfolio concept allows a more extensive and easier investigation of this complex problem, in particular by providing: a better exploitation of existing information, either empirical or judgmental, and guiding the gathering of additional data; a rapid evaluation and formulation of a large number of alternative business portfolio strategies; and an investigation of the robustness of a given portfolio strategy to changes in the underlying assumptions. A further benefit from the operationalization of the business portfolio concept into an interactive model is the potential linkage that one may anticipate, at least partially, between the STRATPORT decision support system and data bases as well as explanatory models developed by some firms in the context of the PIMS (Schoeffler, Buzzell, and Heany 1974) and ADVISOR (Lilien 1979) projects.

The appropriate use of the STRATPORT decision support system also requires an understanding of its key limitations which stem from three main sources:

1. Restricted scope. The model centers uniquely on critical quantifiable factors in the formulation of business portfolio strategies. The main types of investments which it considers explicitly are: capacity, working capital and marketing investments, the later including also product development. Other types of investments such as basic R & D are not directly incorporated in the model. Nor are qualitative elements such as quality of management or political risks. The conclusions obtained from using the model have to be interpreted in the light of these missing factors.

2. Structural assumptions. The main assumptions in the structure of the model concern the specific forms selected for each function, the absence of market or cost interactions between business units and the treatment of price behavior and market size as exogeneous. The functional forms specified in the model are relatively general and will not usually represent a serious limitation. The other assumptions were made mainly because of the difficulty to obtain reliable data, either empirically or through managerial judgments to represent these more complex phenomena. These factors should also be considered in interpreting the results generated by the model.

3. External aggregation. Some aspects of the business portfolio problem which are kept outside the scope of the model have to be integrated in the formulation of the managerial judgments provided as inputs. In particular, the use of an aggregate response function of market share to marketing investment assumes that the manager providing the inputs for estimation will integrate such factors as: the presence of multiple products and market segments; potential opportunities and threats; strengths and weaknesses of the firm; development of adequate marketing programs; and possible competitive reactions.

The adequate utilization of a model requires an understanding of its basic structure, capabilities and limitations. We have attempted to provide such an understanding of the STRATPORT model. It is hoped that by providing a simple approach to better comprehend the quantitative aspects of corporate resource allocation, the model will enable top managers to give greater attention to the more qualitative issues included in strategic decisions on business portfolios.

APPENDIX

Mathematical Formulation of Some Aspects of STRATPORT

Equations (1) to (13) refer to a specific business unit and the subscript i has been omitted for notational convenience. A more detailed mathematical description of the STRATPORT model is given in (Larréché and Srinivasan 1980).

1. Market response function

$$m_T = L + (U - L) \frac{E^\alpha}{B + E^\alpha} \quad (1)$$

where m_T = market share at time T (the end of the planning period)
 E = marketing investment in planning period
 L, U = lower and upper limits on m_T
 B, α = parameters of the market response function

2. Evolution of market share in planning period

$$m_t = m_0 + (m_T - m_0) \left(\frac{t}{T} \right)^\beta \quad (2)$$

where m_t = market share at time t
 m_0 = current market share
 β = parameter of market share evolution function

3. Revenues in planning period: R_T

$$R_T = \frac{p\omega}{1-\eta} \sum_{t=1}^T \left[\left(G_0 + \sum_{\tau=1}^t M_\tau \right)^{1-\eta} - \left(G_0 + \sum_{\tau=1}^{t-1} M_\tau \right)^{1-\eta} \right] \left\{ \frac{(m_T - m_0)}{2} \left[\left(\frac{t}{T} \right)^\beta + \left(\frac{t-1}{T} \right)^\beta \right] + m_0 \right\} \quad (3)$$

where G_0 = current industry cumulative production

M_τ = market size in time period τ

p, η = parameters of the experience function for price
(planning period)

ω = ratio of firm's average unit price to industry
average unit price

4. Total costs (other than marketing) in planning period: C_T

$$C_T = \frac{c}{1-\lambda} \left\{ \left[P_0 + \sum_{t=1}^T M_t \left(\frac{m_T - m_0}{2} \left[\left(\frac{t}{T} \right)^\beta + \left(\frac{t-1}{T} \right)^\beta \right] + m_0 \right) \right]^{1-\lambda} - P_0^{1-\lambda} \right\}$$

where P_0 = current firm cumulative production

c, λ = parameters of experience function for cost

5. Revenues in post-planning period: T^R_S

$$T^R_S = \frac{p'\omega}{1-\nu} \left[\left(G_0 + \sum_{t=1}^S M_t \right)^{1-\nu} - \left(G_0 + \sum_{t=1}^T M_t \right)^{1-\nu} \right] m_T$$

where p', ν = parameters of the experience function for price
(post-planning period)

6. Total costs (other than marketing) in post-planning period: T^C_S

$$T^C_S = \frac{c}{1-\lambda} \left\{ \left[P_0 + \sum_{t=1}^T M_t \left(\frac{m_T - m_0}{2} \left[\left(\frac{t}{T} \right)^\beta + \left(\frac{t-1}{T} \right)^\beta \right] + m_0 \right) + m_T \sum_{t=T+1}^S M_t \right]^{1-\lambda} - P_0^{1-\lambda} \right\} - C_T$$

7. Capacity expenditure in planning period Z

$$Z = \theta \left(\frac{b m_T^Y M_T^Y}{a + m_T \delta M_T \delta} - q \right)$$

where θ = proportion of capacity expenditures not included in costs during planning period

a, b, q, γ, δ = parameters of capacity expenditure function

8. Additional working capital in planning period: W_0

$$W = \chi R_{T-1}^{\zeta} - W_0 \quad (8)$$

where χ, ζ = parameters of working capital function

W_0 = working capital at beginning of planning period

9. Maintenance marketing expenditures in post-planning period: T^H_S

$$T^H_S = T^R_S \{d - e(m_T - L)\} \quad (9)$$

where d, e = parameters of maintenance function

10. Net cash outflow in planning period: F and DF

$$F = (1 - \kappa) (E + C_T - R_T) + W + Z - A \quad (10)$$

where κ = tax rate

A = depreciation during planning period of assets acquired before beginning of planning period

After discounting:

$$DF = (1-\kappa) (E+DC_T-DR_T) + Z + W - A \quad (11)$$

where $DF, DC_T, DR_T =$ discounted forms of E, C_T
and R_T

11. Total profits over planning and post-planning periods: π and $D\pi$

$$\pi = (1-\kappa) (R_T - C_T - E + R_S - C_S - H_S) \quad (12)$$

After discounting:

$$D\pi = (1-\kappa) (DR_T - DC_T - E + DR_S - DC_S - DH_S) \quad (13)$$

where $D\pi, DR_T, DC_T, DR_S, DC_S$ and $DH_S =$
discounted forms of π, R_T, C_T, R_S, C_S and H_S

12. Optimization

Maximize, over $\{m_{Ti}\}$:

$$D\pi = \sum_{i=1}^N \{ K_{1i} + K_{2i} m_{Ti} + K_{3i} m_{Ti} (m_{Ti} - K_{4i}) - \sum_{t=1}^S (K_{5it} + K_{6it} m_{Ti})^{K_{7i}} \} \\ - \left(K_{8i} \frac{m_{Ti} - K_{4i}}{K_{9i} - m_{Ti}} \right)^{K_{10i}} \quad (14)$$

subject to:

$$\sum_{i=1}^N \{ -K_{11i} - K_{12i} m_{Ti} + \sum_{t=1}^T (K_{5it} + K_{13it} m_{Ti})^{K_{7i}} + \left(K_{8i} \frac{m_{Ti} - K_{4i}}{K_{9i} - m_{Ti}} \right)^{K_{10i}} \} \\ + \left(\frac{K_{14i} m_{Ti}^{K_{15i}}}{K_{16i} + m_{Ti}^{K_{17i}}} \right) + (K_{18i} + K_{19i} m_{Ti})^{K_{20i}} \} \leq \Delta \quad (15)$$

where i = business unit number, $i = 1$ to N

$K_{1i}, K_{2i} \dots K_{20i}$ = non-negative coefficients

Δ = limit on external cash flow

FOOTNOTES

1. These approaches are usually presented as classification procedures so that a finite number of typical strategies may be conveniently identified. In a more detailed analysis, the posture of business units is more accurately defined in terms of continuous dimensions. The distinction between these two levels of analysis is particularly clear in the BCG approach.
2. The main functional relationships of the model are summarized in the Appendix. For the detailed mathematical formulation, see Larréché and Srinivasan (1980).
3. A distinction is made between R & D investments concerning product development, which is an integral part of a business unit strategy, and more fundamental research which, because of the unpredictability and distant nature of its outcome, will not affect the market posture of the business unit during the planning horizon. The former is included as part of the "marketing" investment required to obtain a specific market share level. The latter reflects a policy decision made to protect the firm beyond the current planning horizon and is not directly incorporated in the model. The minimum cash flow acceptable for the firm should, however, be determined after allowing for the investments resulting from such policy decisions.
4. For a mathematical description of the optimization routine, see Larréché and Srinivasan (1980).

FIGURE 1

OVERVIEW OF THE MODEL

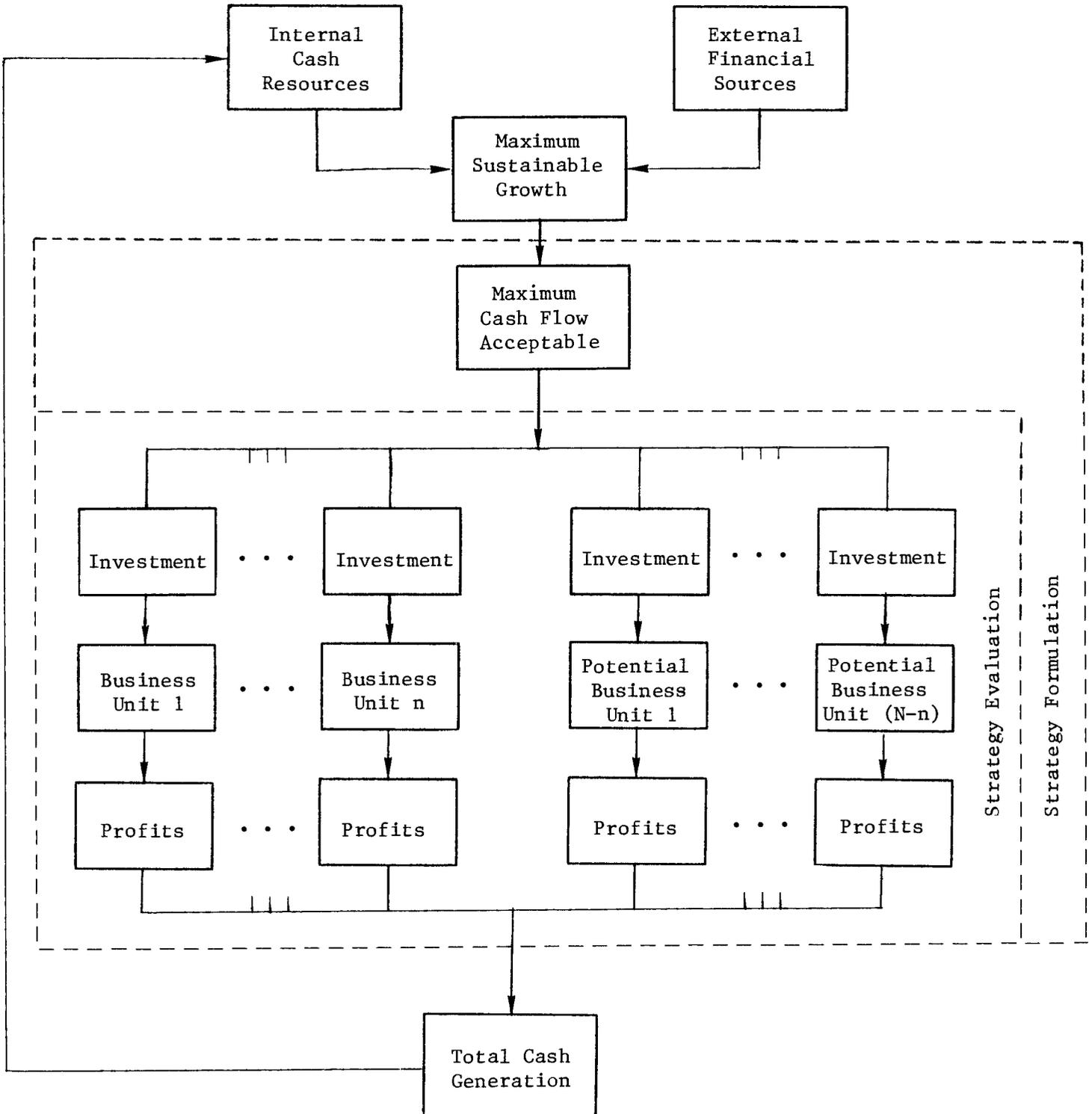


FIGURE 2

PLANNING AND POST-PLANNING PERIODS

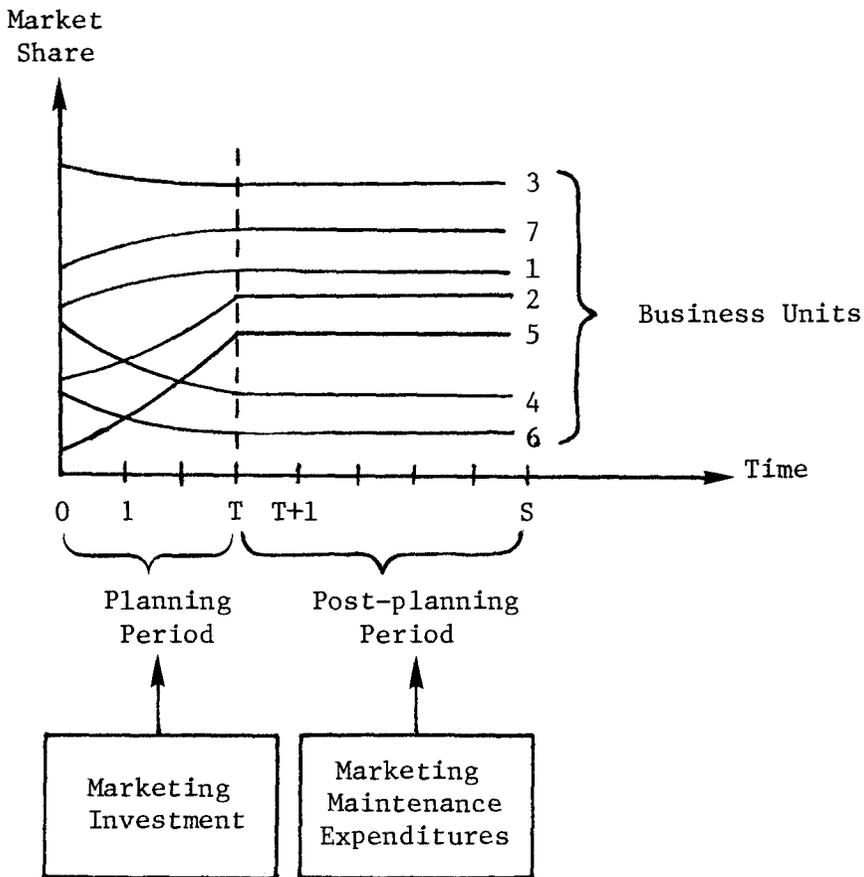


FIGURE 3

STRUCTURE OF STRATPORT FOR A SINGLE BUSINESS UNIT

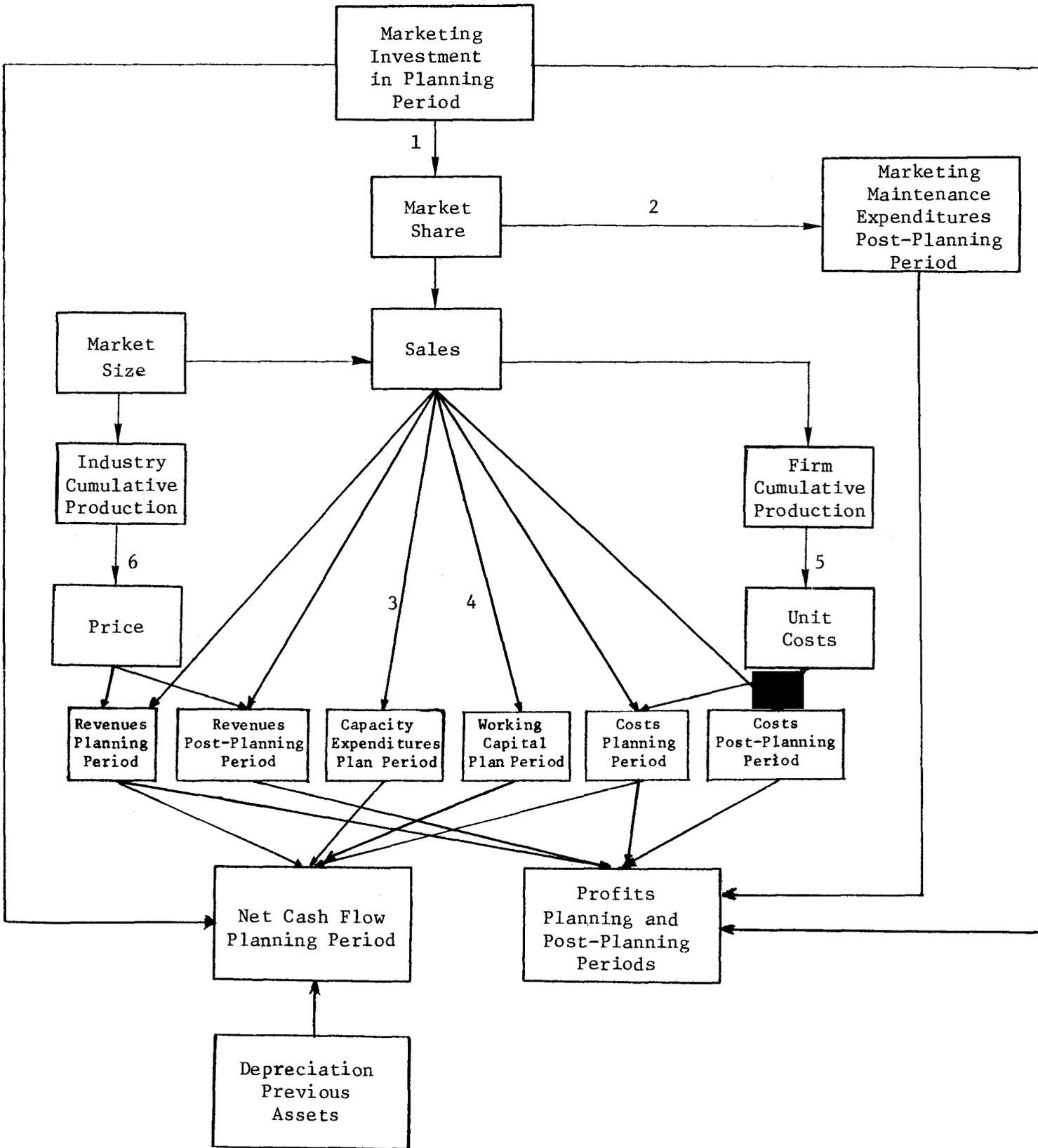
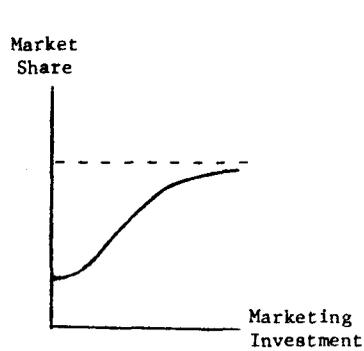
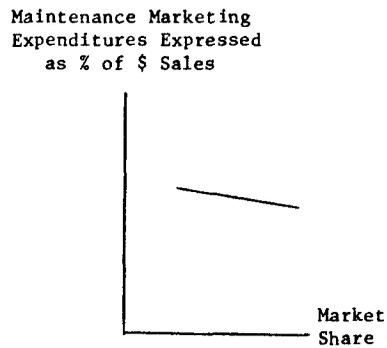


FIGURE 4

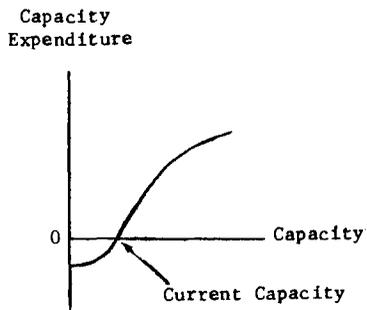
MAIN FUNCTIONAL RELATIONSHIPS



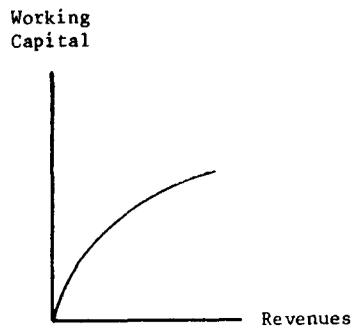
4a. Market Response Function



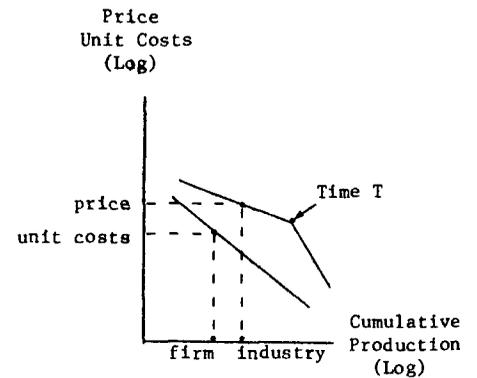
4b. Maintenance Function



4c. Capacity Expenditure Function



4d. Working Capital Function



4e. Cost and Price Functions

FIGURE 5

AN ILLUSTRATIVE RUN OF THE STRATPORT MODEL

INDICATE MARKETING INVESTMENT FOR

BUSINESS UNIT 1 : 45
 BUSINESS UNIT 2 : 150
 BUSINESS UNIT 3 : 40
 BUSINESS UNIT 4 : 30
 BUSINESS UNIT 5 : 0
 BUSINESS UNIT 6 : 0

OUTPUT SAVED IN FILE FOR OFF-LINE PRINTING.

DO YOU WANT TO PROCEED (0), OR TO DISPLAY RESULTS (1)? 1

EVALUATION OF PORTFOLIO STRATEGY

CASH NEEDS -297.
 PROFIT LEVEL 1366.
 MARKET SHARE
 B. U. 1 .202
 B. U. 2 .300
 B. U. 3 .050
 B. U. 4 .050
 B. U. 5 .000
 B. U. 6 .000

SOURCES AND USES OF FUNDS

B U NUMBER	1	2	3	4	5	6
CASH NEEDS						
REVENUE.FL	824.	1372.	345.	190.	0.	0.
COSTS.FL	551.	1082.	295.	127.	0.	0.
NETG.IN.FL	45.	150.	40.	30.	0.	0.
CAPA.IN.FL	25.	79.	-11.	23.	0.	0.
TOTAL	-204.	-51.	-21.	-10.	0.	0.
PROFITS						
REVENUE.FL	824.	1372.	345.	190.	0.	0.
COSTS.FL	551.	1082.	295.	127.	0.	0.
NETG.IN.FL	45.	150.	40.	30.	0.	0.
REVENUE.FP	1627.	3839.	623.	468.	0.	0.
COSTS.FP	1089.	2969.	530.	302.	0.	0.
NETG.IN.FP	98.	460.	67.	84.	0.	0.
TOTAL	685.	550.	37.	115.	0.	0.

FIGURE 5 (cont'd)

AN ILLUSTRATIVE RUN OF THE STRATPORT MODEL

INPUT MINIMUM AND MAXIMUM LEVELS OF EXTERNAL CASH
AVAILABILITY: -500.000

OUTPUT SAVED IN FILE FOR OFF-LINE PRINTING.

DO YOU WANT TO PROCEED (0), OR TO DISPLAY KEY RESULTS (1),
PROFIT CONTRIBUTIONS (2), OR CASH FLOWS (3) 1

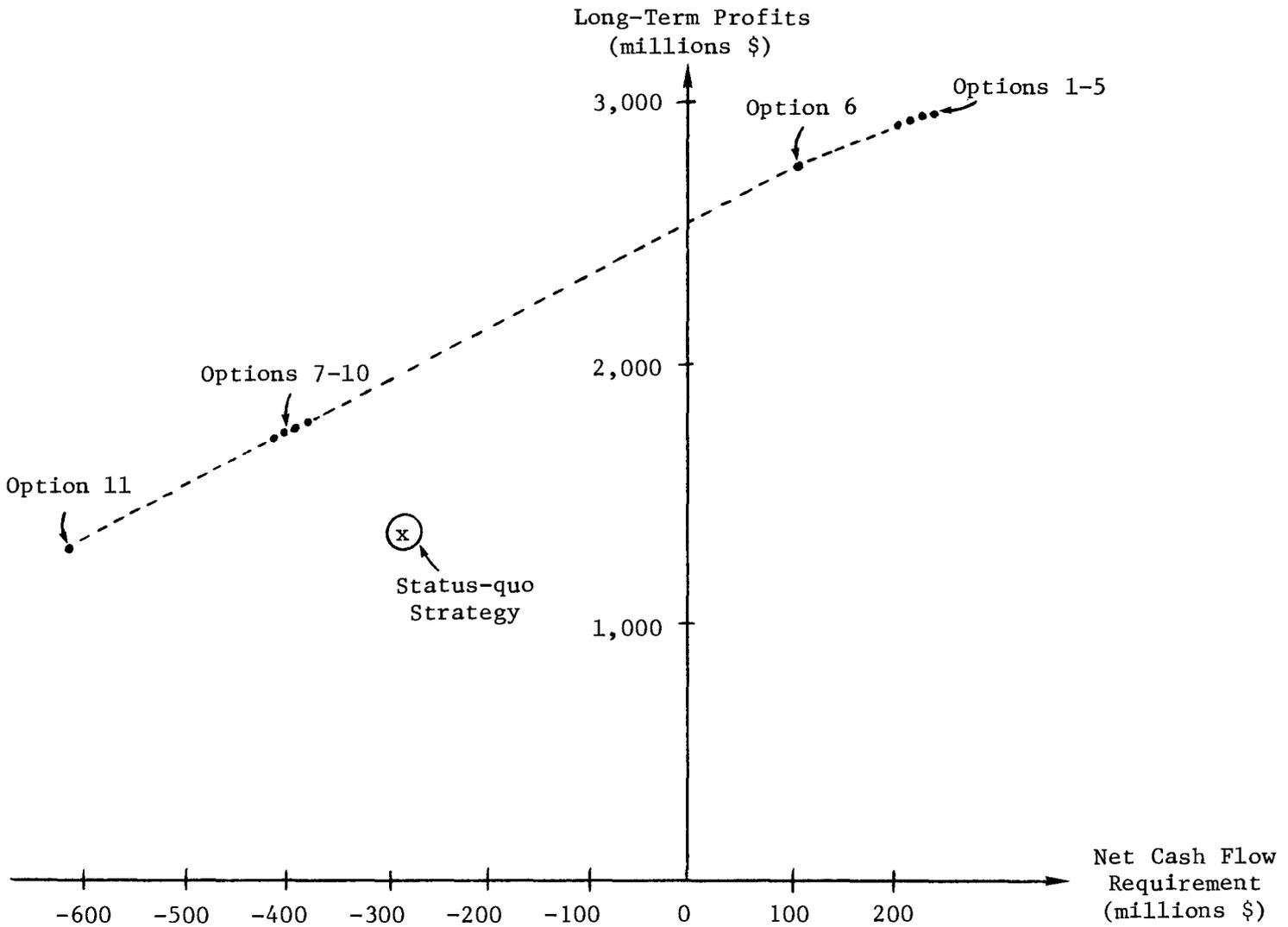
KEY OPTIMIZATION RESULTS

OPTIONS	1	2	3	4	5	6
CASH NEEDS	206.	195.	185.	175.	165.	106.
PROFIT LEVEL	2911.	2894.	2877.	2860.	2842.	2735.
MARG. YIELD	19.53	20.26	21.00	21.73	22.46	23.19
MARKET SHARE						
B. U. 1	.203	.201	.198	.195	.193	.150
B. U. 2	.394	.393	.391	.390	.389	.387
B. U. 3	.010	.010	.010	.010	.010	.010
B. U. 4	.171	.170	.170	.169	.169	.168
B. U. 5	.360	.358	.355	.353	.351	.349
B. U. 6	.000	.000	.000	.000	.000	.000

OPTIONS	7	8	9	10	11
CASH NEEDS	-383.	-386.	-389.	-393.	-609.
PROFIT LEVEL	1813.	1807.	1801.	1793.	1330.
MARG. YIELD	23.92	24.66	25.39	26.12	26.85
MARKET SHARE					
B. U. 1	.150	.150	.150	.150	.150
B. U. 2	.050	.050	.050	.050	.050
B. U. 3	.010	.010	.010	.010	.010
B. U. 4	.168	.167	.167	.166	.166
B. U. 5	.346	.344	.342	.339	.000
B. U. 6	.000	.000	.000	.000	.000

FIGURE 6

OPTIMUM PROFIT/CASH FLOW ENVELOPE



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