SPRINTER: A Tool for New Product Decision Making

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The necessity of introducing new products has become widely recognized by today's business executives. Firms which do not innovate and produce new product offerings soon find their profitability impaired. But those who do attempt to introduce new products are plagued by a high failure rate in their new products. This large proportion of failures does not reflect the incompetence of decision makers, as much as it indicates the complexity and difficulty associated with the decision to market a new product.

This article indicates an effective approach to the new product problem and describes how today's computer and management science technology can be used to implement this approach. The analysis is based upon a computer program called SPRINTER which is designed to be used by executives to aid them in making the new product decision. SPRINTER does not completely relieve the executive of the burden of the new product decision, but it is a tool that he can use to reduce the failure rate of new products and to improve the quality of new product decisions. The model integrates the large number of complex factors affecting the decision and uses the computer to supply the muscle power necessary to optimize within this integrated framework. The basic output is a recommendation to either introduce the product, reject the product, or to investigate the product more fully. The model also recommends the best price, advertising allocation, distribution level, competitive strategy, and production capacity for the new product.
A General Approach to the New Product Decision

The new product decision can be approached in the wider context of an analytic approach to business decision making. After discussing this approach in general terms, it will be applied to the new product decision problem.

The analytic approach can be described by a series of six basic steps. See Figure 1. The first step is the accurate definition of the problem. Many of the difficulties and disputes surrounding a given decision stem from the fact that the parties to the decision are not considering the same problem. The decision should be set in a wide conceptual framework, but then the bounds and limits of the problem area should be established. After the problem has been explicitly defined, all the factors affecting the problem should be identified (step 2). In this step an exhaustive list of factors should be established without regard to the relative importance of the factors. The interrelationships between the variables that have been listed should be fully investigated in the third step of the total analytic approach. The interrelationships should first be approached on a verbal basis and then a mathematical specification of the relationships should be derived. With these relationships in mind a solution method is formulated to supply an answer to the problem (step 4). The fifth step in the process is to explicitly recognize the assumptions made in the solution method and to identify those factors not considered in the solution method. This is an important step since it indicates what adjustments must be made to the proposed solution. The last step in
Figure 1.
An Analytic Approach to Business Decision Making
the analytic approach is to validate the solution method. Full confidence should not be placed in the proposed solution until the mechanism used to generate it has been monitored and tested by continued successful use.

These general steps will become more clear and exact as this framework is applied to a specific problem -- the new product problem.

Step 1 -- Explicitly Define Problem

The decision concerning the adoption of a new product takes place in the total product planning system. This process begins with a search procedure designed to generate a large number of new product ideas. These ideas are then screened to remove those suggestions that are not compatible with the goals of the firm or are obviously unsuitable. The new product proposals that pass through the screening step are then analyzed. This analysis takes place in an information network. At each step in the process the product can be adopted (GO decision), rejected (NO decision), or investigated further (ON decision). See Figure 2. If an ON decision is reached the evaluation analysis is repeated and the sequence continues until either a GO or NO exit is made. If a GO decision is reached the firm has committed itself to the product and implementation of the new product marketing plan is begun.

The implementation step may include additional efforts in the area of product development or market testing before full commercialization, but a GO decision represents a commitment which will not be reversed
EXPlicitly Define Problem

Product Planning System

Figure 2.
Step One
unless the underlying parameters of the analysis change. The problem of the new product decision is then: should a GO, ON, or NO decision be made for the new product?

Step 2 -- List All Factors Affecting the Problem

Now that the problem has been explicitly defined for the purposes of this analysis, all factors that may affect the decision should be identified. In Figure 3 the basic factors relating to the decision are listed. The overall considerations relate to the profit to be generated by the new product, the investment required to obtain this profit, the risk associated with the proposed product, and the interactions effects the new product will have upon existing product offerings.

The profit generated by the new product will depend upon both the demand and cost associated with the product. The demand of the new product will probably change over time; the product will grow, reach maturity, and decline over its life cycle. The quantity sold in any one year will not only depend upon the stage of the life cycle, but will also depend upon the price level, the amount of advertising expenditure, and the intensity of the distribution and sales effort in each year. These three factors together constitute the marketing mix for the product and the sales of the product will depend upon not only the level of each factor in the mix, but also upon their combined effectiveness. For some products the quality level of the new product is also part of the marketing mix. The competitive environment, as well as the marketing mix, surrounding the new product will affect the firm's sales of the
LIST ALL FACTORS AFFECTING PROBLEM

PROFIT ------- DEMAND -- LIFE CYCLE, PRICE, ADVERTISING, DISTRIBUTION, COMPETITION, QUALITY
COST ------ PLANT SIZE, TECHNICAL POSSIBILITIES, UTILIZATION OF THE PLANT, FUTURE TECHNICAL DEVELOPMENTS
TIMING OF PROFITS

INVESTMENT ---- AMOUNT OF INVESTMENT REQUIRED
TIMING OF OUTFLOW

RISK -------- AMOUNT OF RISK DECISION MAKER WILL ASSUME, RISK IN MARKET, AND UNCERTAINTIES OF ESTIMATION

CONSTRAINTS --- MANAGEMENT LIMITATIONS
PLANT CAPACITY
FINANCIAL LIMITATIONS
DISTRIBUTION REQUIREMENTS
GOVERNMENT REGULATIONS
LABOR RESTRICTIONS

INTERACTIONS -- EFFECTS NEW PRODUCT WILL HAVE ON EXISTING PRODUCTS NOW OFFERED BY THE FIRM

OTHERS -------- ADD ALL SIGNIFICANT FACTORS THAT MAY INFLUENCE THE NEW PRODUCT DECISION

Figure 3.
Step Two
product. The competitive effects will depend upon the competitor's strategy and the counter-strategy employed by the introductory firm. The total sales of the firm will depend upon the resultant effects of the competitive and marketing mix factors.

The costs of production will depend on the plant size, the technological level of plant facilities, and utilization of the plant. The new product decision will also be affected by the future technological developments since a firm may not want to invest in a large productive plant if developments in the future may significantly lower costs.

The combination of the demand and costs will determine the profits for the new product. These profits will be received in future years, so the timing of this cash inflow will affect the return on investment and the time value of the inflow should be considered.

The investment required for the product will be an important parameter in the decision. The amount and timing of the investment outflow must be combined with profit considerations to see if the return on investment is satisfactory. The determination of the satisfactory level of return will not only depend upon the level of profits and investment, but also upon the amount of uncertainty the decision maker will assume. The total uncertainty will depend upon the risks inherent in the market and the uncertainties of estimation. This uncertainty will be balanced against the profit. Since the profit will depend upon the price, advertising, and distribution level the firm designates, as well as the cost structure it establishes. The decision concerning the product should be made at the point where the optimum
marketing mix and cost structure are established. Here profits are greatest.

In striving for this maximum profit level for the new product, certain constraints will have to be met. The level of the constraints may affect the desirability of proceeding with the project. The production facilities open to the new product may be limited, the availability of trained managers may be restricted, the financial budget for the new product may be constrained, the size of the sales force or distribution system may be fixed, or government and labor restrictions may be significant. The existence and level of these constraints will affect the demand creation, investment, and cost aspects of the new product proposal.

The new product will probably not be offered as an entity independent of the other products currently being sold by the firm. The new product may reduce or increase the sales of other existing products offered by the firm. In addition to these demand interactions, cost interactions may be felt. The proposed product may change the unit production and marketing costs of other products. The new product will certainly affect old products if common resources such as advertising funds are allocated between them. The new product may also affect the total risk associated in the firm's line of goods. Its fluctuations may amplify or compensate for variations in other products. These interactions may be important to the advisability of adding the new product.

Any other factors of importance should also be listed at this step in the new product decision procedure.
Step 3 -- Describe Interrelationships Between Factors

The factor listing step is important, but it does not become meaningful until the factors have been integrated into a framework which solves the proposed problem. The factors could be related by a subjective weighing procedure. However, it is more beneficial and enlightening to examine the underlying relationships between factors. An understanding of these basic interrelationships is necessary if the power of today's management science technology is to be utilized.

The demand for the new line of products originates from basic consumer needs. Some of these needs are perceived to be satisfied by the old and new products and sales are achieved when the marketing mix of price, advertising, and distribution are presented to the consumer. These total industry sales depend on the level of the elements of the marketing mix while the sales of each firm reflect the competitive environment in the market. The consideration of demand interaction effects between the new product and existing products completes the determination of the demand for the new line of goods. The demand relationships are indicated in functional notation in Figure 4. For example, the demand equation for the new line is:

\[ d_L = f(S_o, S_n, K, I_d) \]

This equation indicates that the new line demand \( d_L \) depends upon the sales level of the old products \( S_o \), the sales level of the new product \( S_n \), competitive behavior \( K \), and interaction effects \( I_d \). It should
Perceived Needs Satisfied by old Products

$\left( S_o \right) = f(P, A, D)$

Company sales of old products

Perceived Needs Satisfied by New Product

$\left( S_n \right) = f(P, A, D)$

Company sales of new product

Competitive Behavior (K)

$\left( I_d \right)$ Demand Interaction Effects

$d_L = f(S_o, S_n, K, I_d)$

$P = \text{Price}$

$A = \text{Advertising}$

$D = \text{Distribution}$

Figure 4.

Demand Relationships
be noted that some of these are dependent upon other parameters. For example,

\[ S_n = f(P, A, D) \]

or the sales of the new product \( S_n \) depends upon the price \( P \), advertising \( A \), and distribution \( D \) for the new product.

The cost factor relationships can be similarly described. The total cost \( C \) depends on the quantities of the new and old product produced, the nature of the technical production facilities \( T \) and distribution system \( DS \) and cost interactions \( I_c \):

\[ C = f(S_o, S_n, T, DS, I_c) \]

The cost and demand equations must now be combined to yield the profits of the new product. In this combination a maximum level of profit is desired. This maximum can be achieved by selecting the optimum level of price, advertising, and distribution for the new and old products. It must be remembered that since the product is not independent of the old products in the line, the price level to be called "optimum" is the one that maximizes the total new line profits, not merely the new product's profits. This maximization is constrained by the limitations on the firm's financial, managerial, and technical capabilities. These inter-relationships are indicated in Figure 5. Given price, advertising, and distribution levels for the new and old products, the demand and costs are calculated for the new line. The quantity to be produced and intermediate variables are then tested to see that none of the constraints
Choose a price (P), advertising (A), and distribution (D) for each product and an allocation of resources (All).

Determine demand for this allocation
\[ d_L = f(S_o, S_n, K, I_d, All) \]
where
\[ S_n, S_o = f(P, A, D) \]

Determine cost for this allocation
\[ C = f(S_o, S_n, T, DS, I_c, All) \]

Test to see that the allocation of resources (All), the demand (d_L), and the cost (C) satisfy the firm's financial, managerial and technical constraints.

Determine the profits (Pr) generated over the product's life cycle
\[ Pr = f(d_L, P, C, All) \]

Using an analytical or other procedure continue testing different allocations and prices until profits have been maximized.

Figure 5.
Allocation Interactions
are violated. If all the constraints are satisfied, the profit can be calculated by multiplying the quantity of each product sold times its price minus unit cost. The process can be repeated for other values of price, advertising, and distribution until profits have been maximized.

The maximum new line profit must next be compared with the new product investment. All the new line profit is not attributable to the new product. The new product produces only the difference between the new line profit and the profit of the line if the new product had not been introduced. This difference between the new line and old line profits is called the "differential profit". This differential profit is the profit generated by the new product and it reflects demand, cost, and allocation interactions. When the differential profit is discounted to reflect its time value it can be compared with the investment and uncertainty to reach a new product decision. The uncertainty is also a differential measure. It is the difference between the uncertainty associated with the new line and that associated with the old line.

The balancing between the profit and uncertainty can be done with the aid of Figure 6. In this figure $Z_1$ and $Z_2$ divide the area into three areas -- GO, ON, and NO. $Z_1$ and $Z_2$ represent probabilities of making a minimum rate of return on investment. The GO-ON area is divided by a line which represents a $Z_1$ probability of making the minimum rate of return on investment. For example, if the $Z_1$ probability is 90 percent, if $Z_2$ is 40 percent, if 5 million dollars of investment is
MDDP
Maximum Discounted Differential Profit

DU = Differential Uncertainty

Figure 6.
Decision Quadrant
required, and if the minimum rate of return on investment is 20 percent, the quadrant would be divided as shown in Figure 7. Now if the maximum profit were 10 million dollars, and the differential uncertainty were 2 million dollars, the decision for the new product would be GO. This means the achievement of a 20 percent return on investment is more than 90 percent probable.

At this point in the analysis the integrated decision framework can be specified. See Figure 8. The demand and cost models combine to specify the profit relationship which is to be maximized, subject to the firm's constraints. This optimization produced the maximum level of differential profit. This profit is combined with the differential uncertainty to determine a GO, ON or NO decision for the new product.

Step 4 -- Derive a Solution Method to Solve the Problem

The integrated structure outlined in Step Three is utilized in this step of the decision process to specify the new product decision. The solution method is based on a mathematical model. This model is a series of equations which mathematically specify the interrelationships described in the previous section. The detailed mathematics of the model will be presented here, but it is instructive to examine the general mathematical framework. The overall model is composed of sub-models in the areas of demand, cost, allocation, and uncertainty.

The demand sub-model is based on a reference estimate of the quantity to be sold over the planning period given that some specific marketing
Figure 7.

New Product Decision Plot
Figure 8.
Integrated Product Planning Model
programming is carried out. This reference estimate of the product life cycle is adjusted by several factors as the marketing program is changed. The demand for the new product is specified by:

\[ X = (PLCX)(COMPYX)(INDUSTRYX)(INTERACTIONS) \]

PLCX is the reference life cycle estimate of the quantity sold. COMPYX is a term which reflects the competitive share of the total market the firm introducing the product will achieve. This factor is dependent upon the strategy of the competitors and the counter-strategy of the firm. It is assumed that the market is split on the basis of the relative marketing effectiveness of each firm in the market. The INDUSTRYX term reflects the effects of changes in the industry price, advertising, or distribution level upon total industry sales. INTERACTIONS is a term which reflects the effects of old products on the new product. The magnitude of this effect depends upon the new and old product price, advertising, and distribution. Equations similar to this one are formulated for other products so that the new line demand is completely described by a set of mathematical equations which depend upon the marketing mix of each product. The cost sub-model is made up of the equations which describe the total cost of producing given quantities of goods in the new line.

These demand and cost models are combined into a computer program called SPRINTER which maximizes the profit attributable to the new product. SPRINTER is an abbreviation for Specification of PRofits with INteraction under Trial and Error Response. This program is a trial
and error simulation that evaluates a range of marketing programs and identifies the best price (P), advertising (A), and distribution (D) levels for the new product in each year of the planning period. The simulation is described in Figure 9. It begins at the reference program and then systematically evaluates the effects of various marketing mixes on the new line profit. After maximizing the new line profits, the estimated old line profits over the planning period are subtracted from the new line profits to ascertain the maximum differential profits. The value of maximum differential profits is then compared to the differential uncertainty to see if the point when plotted on the profit-uncertainty graph falls in the GO, ON, or NO area of the quadrant. See Figure 6.

The output of SPRINTER is a GO, ON, or NO decision for the product, the optimum level of price, advertising, and distribution for the new and old product, and the maximum level of differential profit generated by the new product. This maximization is carried out while giving full consideration to the interdependencies between the new product and old products, to the competitive environment surrounding the product, and to the constraints on the firm.

Step 5 -- List All Assumptions That Were Made and All Factors That Were Not Considered

The use of a simulation to solve the mathematical model removed the necessity of making any restrictive assumptions. In addition, all factors listed in Step 2 (Figure 3) were fully considered.
Given a reference marketing program

- Choose a D (Do for various levels of distribution)
- Choose an A (Do for various levels of advertising)
- Choose a P (Do for various levels of price)

- Calculate amount demanded of each product in line
- Calculate costs of producing these quantities
- Test to see that the firm's constraints are satisfied

- Calculate profit for the new line
- Calculate profits of old line

- Determine change in total profits and discount at the minimum rate of return

- Select combination of D, A, P which maximizes the discounted differential line profits

Figure 9.

SPRINTER Model
The greatest limitations relate to the scope of the model. SPRINTER assumes that the new product ideas are proposed and analyzed one at a time. This may not always be true. Sometimes the problem may be to choose from a number of new product ideas. Although SPRINTER can supply differential profit and uncertainty information about each product, the model in its present form cannot select from a group of alternatives unless they are all at the same stage in the information network. The second limitation is that although the model specifies the GO, ON or NO decision, it does not specify what study to undertake if the ON decision is reached. SPRINTER does indicate which relationships are most uncertain, but it does not explicitly specify the optimal sequence of market research studies. The model assumes the "best" study is carried out at each ON alternative. After the study is completed, SPRINTER again evaluates the GO, ON, and NO decision. In this way it goes step by step down the information network leaving it as soon as sufficient information is present to warrant a GO or NO decision.

In addition to these limitations, this model, as all models, is subject to limitations of the input data. The result can be no more accurate than the input, but at least SPRINTER does determine if there is enough confidence in the information to justify a final decision. The input and other limitations should be carefully considered to assure that they are reasonable in each particular situation before the model is applied.
Step 6 -- Validate the Solution Method

SPRINTER has been tested in an actual new product environment. The model was applied to a new product to be introduced by a major chemical firm. The model encompassed all the essential aspects of the decision including the interdependency between the new and old products. SPRINT has specified a NO decision at the originally proposed marketing program, but generated a GO decision and six million dollars of additional differential profit after its trial and error routine specified an optimum marketing program. This test of SPRINT could not be construed as a validation; it is only the first step in the validation. Full confidence will be gained only as the model is successfully used in a continuing sequence of new product decisions.

Dealing with the questions of validation and application of mathematical computer models like SPRINT requires a mature attitude on the part of business executives. The first step in developing a mature attitude is accomplished by overcoming the fear of quantitative computer methods. Next, any naive confidence that mathematical techniques will completely solve all problems must be subdued. A mature attitude is achieved when the decision maker realizes the limitations and values of the model as well as the costs of applying the model. Realizing that the model is a tool that he may profitably use, he will balance the costs and benefits to ascertain the advisability of implementing the model. In decision areas of extreme complexity, such as new product decisions, mathematical computer models may find their most profitable applications.
Summary

The new product problem can be approached by a six step analytic procedure. The procedure begins by explicitly defining the new product decision problem within the wider context of the total product planning system. The specific decision in the analysis stage of the system is whether the product should be introduced (GO decision), rejected (NO decision) or investigated more fully (ON decision). With this definition of the problem in mind, the second step is begun. In this step all factors affecting the problem are identified. The interrelationships between these factors are specified in the third step and an integrated framework for the decision is formulated. When the interrelationships of this framework are mathematically stated, the power of today's computing technology can be tapped to produce a solution for the problem. In this fourth step a computer simulation called SPRINTER is proposed to help a business executive solve the new product problem. SPRINTER integrates the large number of complex factors into a decision framework which yields a GO, ON, or NO decision for the new product. This decision is based on a trial and error computer routine which maximizes the profits attributable to the new product after giving full consideration to the effects of various levels of price, advertising, and distribution, the competitive environment surrounding the product, the constraints on the firm's operations, and the interdependencies between the new product and old products. This maximum profit is used to ascertain if the probability of making a specified rate of return on the investment justifies
a final decision (GO or NO). This derivation of a solution method comprises the fourth step in the decision process. The explicit specification of the assumptions and limitations of the solution method completes the fifth step. The assumptions of the proposed model are few and reasonable, but the limitations of the scope of the model must be clearly understood before it is implemented. The final step in the analytic approach is the validation of the model. SPRINTER has not completed this step. Preliminary testing in an actual new product environment is encouraging and indicates SPRINTER is capable of being a practical business tool. In these tests SPRINTER took input estimates supplied by business executives and integrated them in a model which analyzed the factors surrounding the decision to produce the maximum level of differential profits for the new product and a GO decision for the proposed product offering.

2 SPRINTER is an abbreviation for Specification of Profits with Interaction Under Trial and Error Response.

3 This networking approach was first presented by A. Charnes, W. W. Cooper, J. K. DeVoe, and D. B. Learner, DEMON: Decision Mapping Via Optimum GO-NO Networks -- A Model for Marketing New Products (a report presented at the Tenth International Meeting of the Institute of Management Science, Tokyo, Japan, August 24, 1963) p. 3.


7 The first three terms of this conceptual equation were first forwarded by Philip Kotler in "Competitive Strategies for New Product Marketing Over the Life Cycle," Management Science, XII, December 1965, B-104 to B-119.

8 In an actual new product application SPRINTER evaluated a range of two million marketing programs.

Anderson, Sigurd L., "Venture Analysis," *Chemical Engineering Progress*, LVII (March 1961), 80-84.


