OPTIMIZING PRODUCT DEVELOPMENT AND SHORTENTING THE LEAD TIME FOR PRODUCT INTRODUCTION

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Abstract

This article describes the application of a new research tool, systematized development and testing of prototypes, The approach facilitate the task of identifying the most promising product to be launched while shortening the lead time for introduction.

Introduction

Traditionally, marketing directors have faced the following dilemma: How to accelerate the lead time for introducting a new product quality. For packaged goods this problem become particularly acute. Competitors can pre-empt the innovating firm in the marketplace, despite one's ability to develop a technological breakthrough technology, if not brought to the marketplace in time, may lose its window of opportunity, while a competitor takes advantage of that opportunity, albeit with a product that might be less advanced. For instance, Airwick took three years to launch its rug and room deodorant, Carpet Fresh. This three year cycle included an extensive, 9 month test market. Yet, it took Lehn & Fink only six months to launch a competitor, "Love My Carpet" - a "knock-off" product. The extensive work done by Airwick to develop its product may not have paid out to the fullest extent possible, because of Lehn & Fink's strategy of copying the Carpet Fresh product.

In addition to the negative competitive implication which might be associated with the relatively long introduction process, the introduction process is costly. It cost Helene Curtis $35 million just to launch Finesse.[3] Similarly, it took Gillette $28 million to launch Right Guard[1] and $19 million for General Foods when it launched the Smurf-Berry Crunch Cereal. Add to this expenses such as R & D and test marketing which might amount to more than $1 - 4 million per product.[11]

One could cite other examples of such strategies, in which a competitor shortened its development time, to launch a "knock-off" product, while the originator of the product spent a long time, and a lot of money thoroughly refining and testing the product, as well as the positioning.

In general, it appears that companies have to generate a great number of product ideas in order to finish with a few goods ones. A Booz, Allen & Hamilton study of 51 companies, for example, indicates that typically, about 58 new ideas must be priced at a level profitable enough to cover all the expenses lost by the company in researching the 57 other concepts.[2]

The long introduction process is costly, and, in fact, may not generate the optimal return. The purpose of this article is to present a systematized approach for the development process, which has the key benefit of substantially shortening the lead time needed to develop the product, optiit for the target audience, and thus take advantage of the opportunity window. Such a systematized approach, now becoming popular in product development circles under the rubric of "response surface analysis" provides the marketer with a technology which truly shortens development time, increases accuracy of product development, and makes the development process efficient, and responsive to marketing needs.

Response Surface Analysis - Designed Products

Traditional development, guided by marketing, often consists of evaluating alternative products that the developer believes will satisfy the marketing objective. Practitioners of product testing who have been involved in the development and launch of a new product recognized that one can go through a tortuous, back and forth process, testing new alternatives and variants in the hope that one of the entries "beats" competition, or at least delivers what the concept promises. Each prototype being considered may take several weeks for development, and a month or two for testing. The required repetitions of the back and forth cycle to "get the product right" can cost a company a year or more in valuable time.

Statisticians have long recognized the need to reduct the number of "experiments" or probes in product development.[5] Unlike product prototype development in the packaged goods business, statisticians may work with durables which cost many tens of thousands of dollars to develop, for each prototype. The tooling process alone may incur prohibitive costs, Consequently, the back and forth testing scheme, prior to product introduction often proves costly and highly ineffective with durables, and other product demanding high initial investment.

The response surface strategy used by statisticians, and recommended here for packaged goods, consists of development a set of product prototypes. The matrix comprises systematically varied products. For instance, if the product category is coffee, one might vary the proportion of three or four beans, as well as the roasting times.

A limited number of "runs" or prototypes (not more than 15 - 20) suffices to cover a wide range of alternative coffee prototypes. The statistician can then develop relations between formula (or process variables) and consumer perceptions (e.g. sensory attributes (such as taste), level or purchase intent, etc.). The relations allow for interactions or synergisms among the formula variables (e.g. color texture), and enable the marketer and product developer to discover the formula levels at which consumer acceptance maximizes.[7]

From the marketer's point of view, the technology provides a significant array of advantages. The development of multiple prototypes, and the evaluation of these prototypes at one point in time, by a single group of consumers reduces much of the inefficiencies in consumer testing. The research occurs rapidly, rather than proceeding inefficiently over an extended period. Second, an integrated database is generated comprising product formulations, cost of product ingredients, and consumer evaluations (from the marketing research test with consumers). The database allows the researcher to relate R & D modifications of the product to consumer reactions.[10] More importantly, it allows one to discover rapidity, the optimally acceptable formulation, i.e. the most liked formulation out of the set of tested formulations, by interpolation.[8] Finally, the procedure permits the evaluation of costs of production, and technical feasibility (scale up) for these products.[9] If a product fails to comply with technical or financial constraints, it is a straightforward matter to project another formulation, which does lie within the constraints, and yet achieves the highest possible acceptance.

From the marketer's point of view, the research effort expended in the development of the new product now takes on an added dimension. Whereas traditionally research has functioned as an evaluative tool, reactive to product development, and providing only a report card of "how well the prototype performed", now it acts as a proactive tool. Consumers not only evaluate the products, but their ratings provide direction to R & D to modify the product to improve acceptance.

The Stages Of Development And Their Tie In Of The Optimization Strategy

Traditionally, product development and consumer testing has followed a sequence of well defined steps, (in theory if not always in practice). These steps include the following:

1. Sensory Description (R & D Level). Here the technical evaluates existing products on the market, to find out their characteristics, and to see whether any in-market competitors possesses the requisite characteristics for the new product. This stage is generally done by in-house panels, or even by the product developers themselves, and may never involve consumer feedback.

2. Determination Of Revelant Formula Variables And Designed Experiments. Once the product developers decide about the formulation, they create either one or a limited number of prototypes (traditional method), or a larger array of systematically varied formulations (currently proposed technique). The formulation time is shorter when one develops only one or two prototypes, but the prototypes emerging from that shorter development time are covertly assumed to represent the "optimal product" for consumer test. In contrast, the disciplined development or prototypes by statistical experimental design starts off with a product that R & D feels is best, but goes into a wide array of variations, some of which are known, a priori, to be poor products. However, the discipline of testing all prototypes is necessary.

3. Consumer Evaluation An Sensory Testing. Here the consumers assess the products, by tasting them, using them, etc. They evaluate liking of the propurchase intent, and rate the perception of appearance, aroma, taste/flavor, and texture (for food products). The evaluations may take place with small groups of consumers in one market (so called church panels) or with larger groups, across the country, and representing different target audiences. This stage generates the requisite data for relating consumer perceptions and acceptance to formulations.

4. Modelling An Optimizing. This step pulls together the consumer ratings with the formulation, develops the models, and then projects out winning formulations, subject to constraints. Typically, this step takes 2 - 3 weeks, at most. Since the technical group systematically varied the formulations, and one can relate consumer ratings to these formulations, much of the ambiguity in interpreting the consumer data is reduced and possibly even eliminated. Consumer complaints about the flavor, texture, appearance, etc. are revealed as low ratings of these attributes (for attribute liking, e.g., a poor rating for liking of flavor). By developing a model relating liking of flavor to formulations and their interactions it becomes straightforward to discover the particular formulation combination which would generate a significantly improved product. Or, if indeed no formulation change within the range tested can improve the product, this will be clearly revealed as well.

A Comparison To Conventional Research Approaches

Traditional methods for consumer research attempt to provide feedback to development, just as the current system does, but using different tools. The current system uses a continuous, expanded scale.[12] Respondents act as measuring instruments, to provide numerical ratings for liking, and for sensory characteristics. Indeed, in terms of the analytic approach, the panelist data is treated simply as another numerical input, similar to formula concentrations, cost of goods, etc. The consumer is not directly asked to compare two products to each other, and to indicate which one he or she prefers more. Rather, we infer that from the scores for liking or for purchase intent. The product liked more is the product obtaining the highest purchase intent rating.

Conventional marketing research also provides feedback to product developers, and to shorten the development cycle, but in a more roundabout fashion. In many cases the marketing researcher will ask consumers to evaluate two products, one a target product (in market), and the other a prototype. The consumer has to judge which product he/she prefers, which has a stronger flavor, a sweeter taste, a firmer texture, etc. Analytically, the researcher then tries to determine which of the sensory elements generated the preference, as well as what to do to the prototype to improve it (versus competition).[13] There is no road map relating product ingredients to consumer acceptance. Consequently, the conventional procedure leads to hypotheses which attempt to "explain" the results. From these hypotheses (developed by consumer research) the product developer has to intuit what to do to improve the product. This sequence of hypothesis generation and intuition takes time, and may lead to a significant loss in development efficiencies and a delay in the market introduction of an acceptable product.

Other research procedures use directional scales. The consumer tastes the product, and states what is wrong with the product (e.g., tastes too sweet, versus just right, versus does not taste sweet enough). Traditionally, the researcher tabulates these directional ratings, to develop a consensus direction (e.g., the product should taste sweeter, be less crispy, etc.). Again, however, there is no road map between formulation and consumer rating to guide development. Consequently, the developer is again left to intuit the exact meaning of the consumer feedback.

In the following example, we will illustrate the application of the approach to the development of a low-calorie nutritious cereal. The industry was selected because it is characterized by a relatively long lead time for introduction - up to 37 months.[4] Though the name of the company is withheld and the data are disguised, the study is based upon the actual responses generated by the consumers who rated existing products in addition to evaluating specifically designed prototype variations. The object is to show that with the modeling of consumer perceptions linking physical features of product preference, it is possible to develop a nutritious and highly acceptable, yet relatively inexpensive, cereal for the consumer. This approach can be applied to other food products and other packaged goods as indicated earlier.

Development Of A Nutritius Cereal - An Illustration

Company X is one of the leading food processors in the United States. Recently two important market trends were identified. The first was that the heavy user segment of the market - the under 25 year orld - has been declining as a percentage of the population and is expected to decline in absolute numbers. The second was the successful introduction of the New Horizon bread manufactured by the ITT Continental Baking Company of New York, which focused attention on the use of bran and other fillers as the health providing agents. In addition, up until 1981, the cereal industry had been involved in litigation by the FTC regarding alleged oligopolistic marketing condust - i.e., tacit agreement by the 5 leading cereal manufacturers to dominate the cereal industry in terms of market share.

Though the FTC failed to prove collusions among cereal manufacturers, its' investigation resulted in bitter denouncements of presweetened cereals as being harmful to children. As a result of these three factors the management of Company X decided to introduce a new cereal which would fulfill the following requirements:
a) appeal to the adult segment of the market (defined as 20 - 49 years old).
b) provide healty and nutritious benefits to users.
In sum, it was decided to develop a product which would appeal to a growing segment of the market's health-oriented adults.

The Project: Initial focus group and in-depth interviews were held with health-oriented adults. Analysis of these interviews resulted in the identification of 8 important product attributes. These attributes were: shape, piece size, color, crispness, taste, crunchiness, sweetness, and natural flavor.

In order to develop the appropriate ingredient combination for their cereal, an experimental design was used. The design called for 2 levels of fiber, 3 levels of sweetener, and 3 levels of flavor. The total number of possible formulations was 18 (i.e. 2 x 3 x 3).[6] Three ingredients - fiber, maple flavor, and a sweetener - were varied systematically, resulting in 18 product variations altogether. Since the purchasing costs of the ingredients and the manufacturing costs were known, an accurate cost for each variation was also available for comparison.

The respondents were 120 consumers who had stated that they would be receptive toward tasty health cereal, and 120 respondents who were classified as non users. All were between 20 and 49 years old. Laborabory testing was conducted in New York and Los Angeles.

The 18 laboratory prototype cereals and 6 disguised competing brands were utilized as a product set to be evaluated by the respondents. Under carefully controlled test conditions, each consumer rated 9 cereals selected at random from the product set. A total of 200 respondents participated, (all adults), generating 75 ratings per product.

At the test session the respondent learned how to scale their perceptions using magnitude estimation (an open ended scale). The test lasted 3 hours which allowed ample time to maintain on-going sensory sensitivity to the existing as well as to the laboratory-created products.

The data generated a tabular display of ingredients, perceptions, acceptance, and cost of goods for all 24 products. Exhibit 1 shows that portion of the Table which deals with three of the products and 3 of the product attributes previously identified.

In this exibit it is clear that product #3 was perceived to be both sweeter and crispier than products 2 and 1. Similarly, product 1 was perceived to be darker than the others. In general consumers do perceive the differences among the three product variations. Furthermore, these variations lead to differences in the liking. acceptance ratings of each variation. Correlations between overall liking and specific sensory attribute indicated that 3 out of the 8 sensory attributes were particularly important as determinants of acceptance. These were consumer perceptions of: product color (darkness), sweetners, and crispness. The sensory ratings of the product become dependent variables and the physical composition of each product become independent variables. A regression model was developed to relate each of the 8 sensory attributes (dependent variables) to the formula levels of fiber, sweetner, and flavor. The regression analysis allows the marketer and product developer to gain insight into what must be done to influence and modify consumer's per-

EXHIBIT I

BASIC INPUT DATA

	Formula Ingredient Levels			Consumer Rated Perception of 3 Sensory Attributes*		
Product	Fiber Level	Sweetener	Flavor Level	Crispness	Color Darkness	Sweetness
1	5	5	22	145	83	90
2	4	5	22	142	79	83
3	4	10	88	147	66	92

* 160 = Top of the scale.

ceptions of the product. Specifically, the regression analysis indicated the changes in attribute perceptions that could be expected as a result of increasing the level of one or several ingredients.

Acceptance Modelling And Product Optimization

Our model assumes the following relations: Ingredient Combination will lead to Sensory Response Sensory Response will lead to Degree of Liking will lead to Purchase Interest.

An equation which directly relates liking (dependent variable to the formula variables and their interactions was developed. This equation provides the required link between formula variables and acceptance.

After identifying the relationship between ingredients and liking, we then sought to discover that feasible combination of ingredients which maxized consumer acceptance.

The results computer search for the optimal formula generated the ingredient profile shown in Exhibit 2.

EXHIBIT 2

OPTIMAL COMBINATION OF INPUTS WHICH MAXIMIZES CONSUMER ACCEPTANCE

Fiber level	4.0
Sweetener level	7.9
Flavor level	86.4
Unit cost of inputs	$0.70
Optimal value of liking	85

An important implication of the foregoing table and approach is that the peak acceptance can be identified - in this case it is 85. Even more important to the manufacturer is the fact that the particular and feasible combination of cereal components which generates that maximal acceptance interest can also be identified. In addition, the exact costs of this combination become known. In the conventional procedure, one might discover this formula, but only after extended, back and forth testing. Here the optimal formula emerges rather rapidly.

Constrained Optimization - Planning Systematic Cost Reduction

Because the model interrelated ingredients, perceptions and cost by equations we can take this approach one step further, and incorporate cost considerations into the analysis. Thus for example, the product developer can specify the desired upper limit on unit cost. Given this upper limit it is possible to develop the most acceptable combination of ingredients. The end result, and greatest utility of the model, is thus the development of a highly acceptable, but not necessarily the optimal, product at a lower cost.[12]

The following example illustrates this point. If the specified unit cost of $0.45 (rather than the $0.07 of the optimal product) the results will appear as follows (Exhibit 3):

EXHIBIT 4

THE COMBINATION OF INPUTS WHICH MAXIMIZES CONSUMER ACCEPTANCE UNDER A COST CONSTRAINT

Fiber Level	4.0
Sweetener Level	3.2
Flavor Level	64
Liking Level	83
Cost	0.45

Exhibit 3 indicates that, when the developer limits the search for an optimal product to a cost constraint, liking decreases from 85 Exhibit 2 to 83. This combination is still highly acceptable (very close to the liking of the optimal product) and cheaper by roughly 30 cents. Thus, the company faces the following options:

a) The introduction of the optimal, more expensive or
b) The introduction of an almost equivalent product at a new cost.

Implications & Conclusions

In previous sections we have discussed how the product optimization approach was applied to the relation between ingredient combinations and consumer perceptions of a food product. Using a computer search our model explicity indicates:

* the highest acceptance possible
* the set of ingredients which maximizes acceptance

* the cost of those incredients which maximize acceptance
* the expected change in consumer acceptance when product costs are cut by reducing levels of those ingredients which maximize acceptability.

The optimization procedure described above was applied to responses generated from all panelists. The same procedure can be applied to data generated by non-users separately. An optimal product can be identified for each group. The benefit of the approach is that we can identify the optimal products for two potentially different target markets. Depending upon marketing programs it can be developed. In the same vein, to the extent that a price sensitive and economically viable segment exists, a lower-cost highly acceptable product can be developed.[13]

The specific case history just discussed typifies of the competitive environment of many consumer packaged goods. Several firms offer products that are in effect highly substitutable (e.g., cereals, soft drinks). One observable market characteristic of strongly substitutable products turns out to be that small changes in price, with no change in real income, lead to large shifts in relative quantities purchased. The benefit of the product optimizations approach for the manufacturer lie in the increased flexibility when developing his pricing strategy, especially when the market rewards low price.

Most significantly, the procedure described above could be applied to a wide range of products. Thus for example, the Coco Cola Company could have examined the impact on product acceptability or liking when it substituted sugar for corn syrup as a sweetener. Similarly, the strategy of testing an array of systematically varied prototype can provide answers to the viability of brand strategies such as:

* the impact on taste when reducing the tar content of a cigarette
* the impact on coffee desirability by increasing the proportion of dark beans
* the perceived efficacy of a medicinal syrup resulting from making it more bitter
* the perceived efficacy of hand lotion as related to the level of its viscosity.

In all of these examples, the approach measures changes in product liking acceptance resulting from specified changes in the physical levels of one or more ingredients. As such, the technology provides the product developer with insights regarding consumer perceptions versus formula ingredients, and a tools for engineering perceptions. The technology could be then used by marketing to "home in" on the prototype(s) that are going to be included in a test market. The application of the approach shortens the lead time and make it more efficient.

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