MITSloan
MANAGEMENT

Note on Product Development[1]

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Marketing, with its focus on the customer, has had great success in the improvement of product development. Tools such as conjoint analysis, voice-of-the-customer analysis, perceptual mapping, value-mapping, portfolio optimization, and lifecycle forecasting are now in common use. Firms that continuously and efficiently generate new products that are in tune with their end customers' needs and wants are more likely to thrive. Direct communication with customers allows firms to learn from customers and tailor products to their requirements.

Today, more than ever, new challenges and opportunities are arising driven by global markets, global competition, the global dispersion of engineering talent, and the advent of new information and communication technologies such as electronic mail, the world-wide web, and increased electronic bandwidth. The new vision of product development is that of a highly disaggregated process with people and organizations spread throughout the world . At the same time products are becoming increasing complex with typical electro-mechanical products

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[1] The introduction to this note is modified from Dahan and Hauser (2003).

requiring close to a million engineering decisions to bring them to market. Even software products such as Microsoft Word or Netscape require disaggregated, but coordinated processes involving hundreds of developers.

## Product Development – An End-to-End Process

In the late 1980s and early 1990s a marketing focus on product development stressed customer satisfaction. Researchers in marketing believed that the key to success was a better understanding of the voice of the customer and a better ability to link that voice to the engineering decisions that are made in launching a product. Important changes during that period included new ways to understand the voice of the customer, new ways to develop optimal product profiles in the context of competition, more efficient preference measurements, and the ability to handle larger, more complex customer information. At the same time the quality movement focused product development engineering on improved reliability through continuous improvement such as Kaizen methods, statistical quality control, modified experimental design, and design for manufacturing. There were many successes and the popular press came to believe that the key to success was a better quality product.

Also during that time both marketing and engineering realized that time-to-market was critical. Marketing saw the phenomenon as that of rewards to early entrants while engineering saw, among other things, the lost profits due to rework and delays. Both customer satisfaction and time-to-market became panaceas that, if only the firm could achieve them, would guarantee success and profitability.

Today, both industry and academia view successful product development as an integrated process that must overcome many tradeoffs. Customer satisfaction, time-to-market, and cost reduction through total quality management are all important, but none is viewed as a guarantee of success.

All else equal, a product will be more profitable if it delivers customer benefits better, is faster to market, costs less to produce, and costs less to develop. However, the firm must recognize that there are tradeoffs. In order to make these tradeoffs effectively, most firms now view product development (PD) as

an end-to-end process that draws on marketing, engineering, manufacturing, and organizational development throughout the product development cycle.
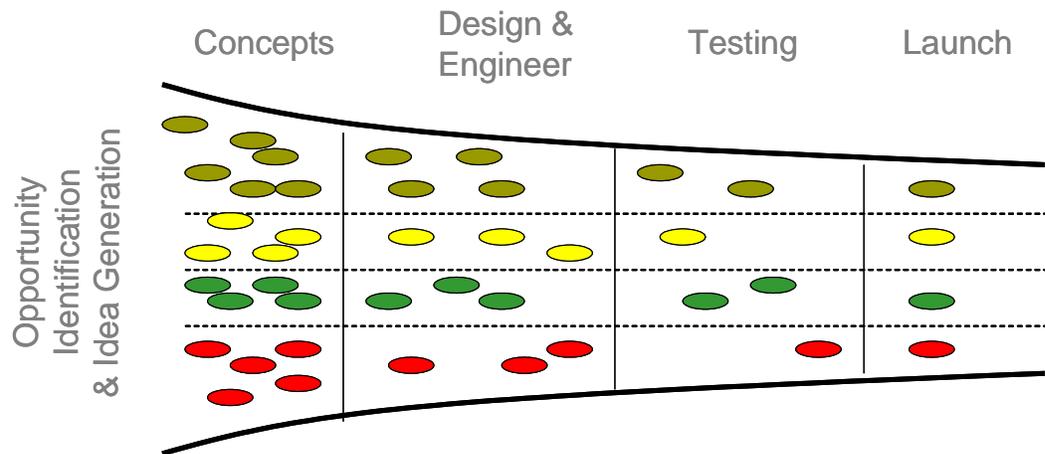
Figure 1. Product Development Funnel

The PD cycle is depicted in Figure 1 as a funnel. The funnel represents the traditional view that PD proceeds in stages as many ideas are winnowed and developed into a few high-potential products that are ultimately launched. We adopt here the stages of opportunity identification (and idea generation), concept development and selection, detailed design and engineering, testing, and launch used by Urban and Hauser (1993). Each text and each firm has slightly different names for the stages, but the description of PD as a staged process is fairly universal. The key management ideas are (1) that it is much less expensive to screen products in the early stages than in the later stages and (2) that each stage can improve the product and its positioning so that the likelihood of success increases. Simple calculations demonstrate that such a staged process is likely to reduce development costs significantly. This staged process is best summarized by Cooper (1990) who labels the process stage-gate. Figure 2 summarizes a typical stage-gate process. Stage-gate processes provide discipline through a series of gates in which members of the PD team are asked to justify the decision to move to the next stage – later stages dramatically increase the funds and efforts invested in getting a product to market successfully.
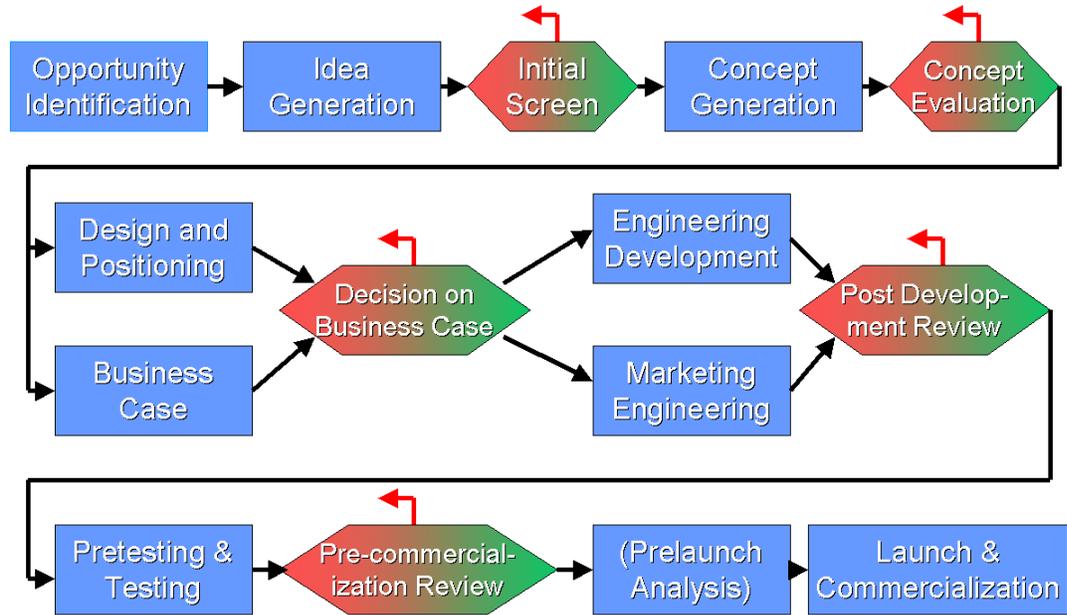
Figure 2: Cooper's Stage-Gate Process (Dahan and Hauser 2003)

The funnel in Figure 1 also illustrates the concept of pipeline management by having multiple, parallel sets of projects moving through the funnel. Often the best strategy for a firm is to have sufficiently many parallel projects so that it can launch products to the market at the most profitable pace. The PD funnel does not explicitly capture the important characteristic of real PD processes that stages often overlap. For example, with new methods of user design and rapid prototyping, it is possible to test concepts earlier in the design and engineering stage or to screen ideas more effectively in the concept stage. The PD funnel also does not explicitly capture the iterative nature of the entire process (although we have tried to illustrate that with the feedback arrows in Figure 2). For example, if a product does not test well, it might be cycled back for further development and retested. In fact, many firms now talk about a "spiral process" in which products or concepts move through a series of tighter and tighter stages. The key difference between a funnel process and a spiral process is that, in the latter, there is a greater expectation of iterative feedback loops as successive journeys through the funnel lead to improvements.
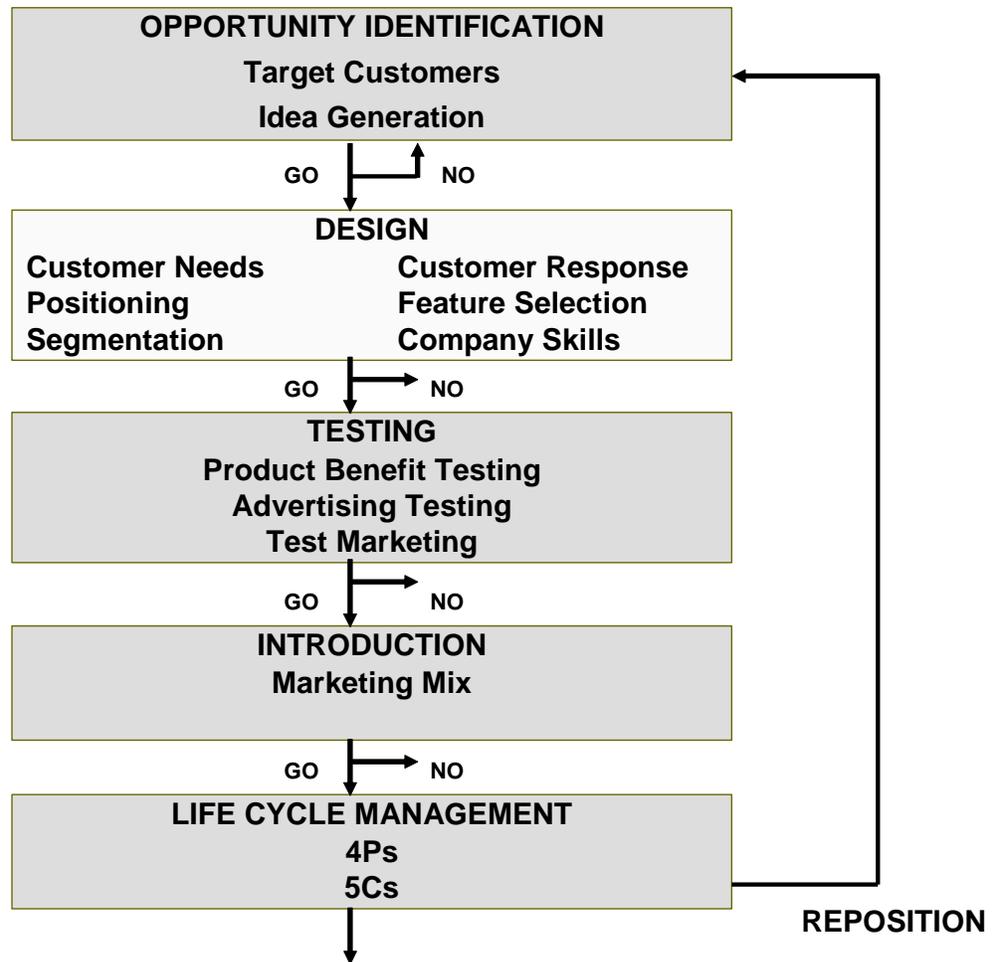
The small ovals in the PD funnel represent either individual products or product platforms. In many industries, including complex electro-mechanical products, software, and pharmaceuticals, firms have found that it is more profitable to develop product platforms. A platform is a set of common elements shared across products in the platform family. For example, Hewlett Packard's entire line of ink-jet printers is based on relatively few printer-cartridge platforms. By sharing elements, products can be developed more quickly, and at lower cost. Platforms might also lower production costs and inventory carrying costs, and provide a basis for flexible manufacturing. On the customer side, platforms enable a firm to customize features in a process that has become know as mass customization.

Managing Product Development from a Marketing Perspective

Product development is an integrated activity addressed in many advanced subjects at the MIT Sloan School of Management. To be effective, a product development team must understand technology strategy, financial issues, organizational structure, competition, and engineering, to name a few. In 15.810, we focus on product development from a marketing perspective. We begin with another look at the product development funnel – that depicted in Figure 3. The remainder of this note highlights the marketing issues in each stage of this product development funnel.

Opportunity Identification

To succeed the market must be sufficiently large and the ideas appropriate to solving customer needs. Marketing's role in opportunity identification is to identify the size of the potential market and to provide input for idea generation. Idea generation sessions often include information from market surveys, from tracking studies in related categories, and input from other sources about customer needs and desires.

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┌──────────────────────────────────────────┐
│          OPPORTUNITY IDENTIFICATION        │
│               Target Customers             │
│               Idea Generation              │
└──────────────────────────────────────────┘
        GO │        │ NO
┌──────────────────────────────────────────┐
│                   DESIGN                   │
│  Customer Needs        Customer Response   │
│  Positioning           Feature Selection   │
│  Segmentation          Company Skills      │
└──────────────────────────────────────────┘
        GO │   →    NO
┌──────────────────────────────────────────┐
│                  TESTING                   │
│           Product Benefit Testing          │
│             Advertising Testing            │
│               Test Marketing               │
└──────────────────────────────────────────┘
        GO │   →    NO
┌──────────────────────────────────────────┐
│                INTRODUCTION                │
│                Marketing Mix               │
└──────────────────────────────────────────┘
        GO │   →    NO
┌──────────────────────────────────────────┐
│            LIFE CYCLE MANAGEMENT           │
│                    4Ps                     │
│                    5Cs                     │
└──────────────────────────────────────────┘
                                    REPOSITION
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**Figure 3: Product Development Process, A Marketing Perspective
(from Urban and Hauser 1993)**

Design

The role of marketing in design is to ensure that potential products or product concepts satisfy customer needs. No matter how innovative a product, customers will not buy the product if it does not satisfy their needs better (or more cheaply or more efficiently) than existing products. For example, Shaper Image's Ionic Breeze air freshener is perceived to clean the air more effectively and to do so silently. Customers perceive that the product removes harmful contaminants from the air and, perhaps, kills flu germs. Because the image of Ionic Breeze are so strong relative to perceived customer needs, Shaper Image is able to maintain extremely high margins.

We addressed positioning in the "Note on Defensive Strategy." In that

note (and in class) we discussed why it is important to have a differential positioning to obtain a profitable "local monopoly." In a forthcoming session we address how to identify customer needs. This material is covered in the "Note on the Voice of the Customer."

To understand better the concept of customer needs, we provide two examples and a theoretical model. Suppose that you are designing a new computer monitor. You might be tempted to seek information from customers' preferences with respect to the number of pixels, the refresh rate, whether the monitor is interlaced, or other technical characteristics. These are not customer needs. They are solutions to customer needs. Customer needs are more fundamental. Customer needs might include the need to work at the monitor all day without getting eyestrain. Or, the ability to see sufficient detail to work with high-definition graphics. Or, the need for a monitor that works well with changing computers (computers are upgraded more often than monitors). Or, the need to see visual output in all lighting conditions. Or, the need for a monitor that supports work in groups (can be seem by all who huddle around the monitor). Or, the desire for a modern design that fits well in an office environment, etc. Customer needs describe how the monitor is used, not how it is built.

Even this articulation of customer needs may be limiting. The customer may not need a monitor at all. The more basic needs of visual output might be realized by projections on walls, virtual-reality goggles, or other creative solutions. If you define the needs broadly, you might be able to generate more innovative solutions that solve these needs without the limitations of existing technology.

The relationship of customer needs and product features is illustrated with the "Lens" model in Figure 4. The Lens model says simply that what really matters to customers is how they perceive the world. Customers see the world through the lens of their perceptions. For example, a customer might purchase an Ionic Breeze Air Purifier because the customer perceives that it cleans the air of harmful particles. Of course it might actually clean the air. The fact that the customer can feel a breeze when the unit is turned on and that

"dirt" collects on the ionizing wires reinforces this perception. These percep-
tions are, in turn, related to the particular product features in the design of the
product. However, the customer's perceptions are also influenced by advertis-
ing, by packaging, by statements by Shaper Image's salespeople, by recommen-
dations from friends, and by product reviews. The common term used to sum-
marize these influences is "psycho-social cues." Such cues may be as important
as product features in the customer's decision to purchase a product. A good
product design, from a marketing perspective, takes into account both product
features and psycho-social cues.
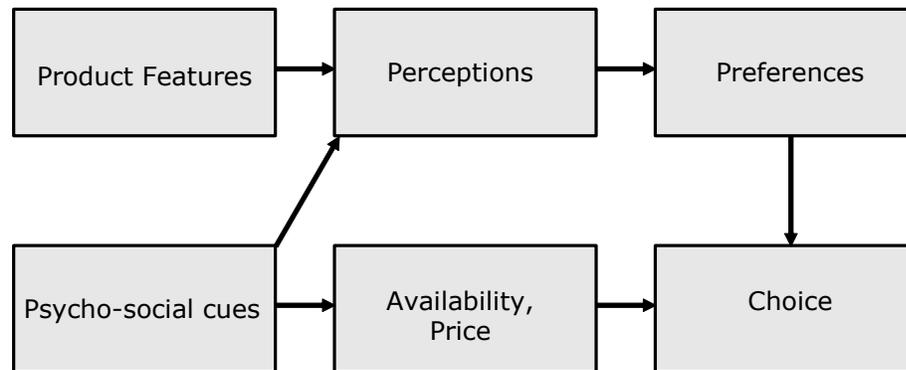
Figure 4. The "Lens" Model of Customer Perceptions

The Lens model also reminds us that customer <u>preferences</u> are based on
customer perceptions and that customers do not always purchase (choice) the
products that they prefer.[2] If the Ionic Breeze Air Freshener is too expensive,
customers might buy something else. If Shaper Image stores (or partners, such
as Bed & Bath) are not near a customer's location, or if Ionic Breeze products
out of stock, or if Ionic Breeze products are otherwise unavailable (say the cus-
tomer's dorm does not allow them), then the customer cannot or will not buy the

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[2] There are many methods in marketing to identify how <u>preferences</u> are based on <u>perceptions</u>.
If we are dealing directly with customer needs, we use "voice-of-the-customer" methods that re-
ly on survey research and statistical analysis. If, after we have identified a target positioning,
we seek to determine which physical features (size of unit, color, cubic meters of coverage, etc.)
are best, we use methods called "conjoint analysis." VOC methods are described in the 15.810
"Note on the Voice of the Customer." Conjoint analysis methods are described in the 15.810
"Note on Conjoint Analysis."

product. Fortunately, marketing can affect price and availability – we address these topics later in 15.810.

Product design can also affect price perceptions and/or availability. For example, in the 1980s, laundry detergents in the US only came in very large boxes. This made sense in the US because most consumers brought their products home with automobiles and had sufficient storage in their homes. However, in Japan, many consumers brought home products by foot or bicycle and lived in homes that had little storage space. Even the stores that sold laundry detergents had limited storage space. The Kao Corporation solved this problem with a product called "Attack." Attack was a highly concentrated laundry detergent sold in a much smaller container. Not only was it highly successful in Japan, but, ultimately, concentrated laundry detergents crossed over into the US market as "Tide Ultra" and other products.

Price perceptions also can be influenced with design. Those student familiar with the Ionic Breeze product line will recognize that Ionic Breeze is available in many sizes (and with many features) in prices ranging from below $100 to over $500. We discuss later in the course how the presence of the $100 product influences the image of the $500 product and vice versa.

Testing

One of the characteristics of an iterative product development process is testing. Products are tested to determine if they are reliable and if they have the appropriate features to satisfy the identified customer needs. Advertising, promotions, salesforce messages, packages, and other marketing materials are tested to determine if they are consistent with the product's positioning (in a perceptual or value map) and if they provide the appropriate psycho-social cues to reinforce the solution of key customer needs.

When the team is satisfied that the physical product (or service) and the image-related materials, such as packaging and advertising, are likely to satisfy customer needs profitably, it is time to test the entire benefit proposition. In consumer package goods, the next step is usually "pretest marketing." See Ozer (1999). Related methods are used for durable goods and for industrial products.

See, for example, papers by Urban, Hauser, and Roberts (1990) and Urban, Weinberg, and Hauser (1996).

Pretest marketing was developed at MIT by Professors Glen Urban and Alvin Silk (now retired).[3] At the time, firms routinely spent millions of dollars and twelve months in "test markets." For example, they might launch the new product in Peoria, IL and monitor customer reaction. Profs. Urban and Silk were given the challenge of developing a method that took 2-3 months (rather than 12 months) and at a cost equal to about 5% of a typical test-market expense. In their now classic paper, they proposed a method based on a simulated store with a follow-up repurchase opportunity.

In the simulated store consumers are first shown advertising for the new product and for existing products (they are not told which is the new product) and they are then allowed to shop in a mock-up of a store. The simulated store is just like stores in which the consumer normally shops, but only a few product categories are available. The new product team observes whether the consumers buy the new product. Such purchases are labeled as "trial" purchases. Those consumers who do not purchase the product by themselves are given product sample. These samples simulate many of the actions that are taken as part of an aggressive marketing campaign. After 2-3 weeks, depending upon the purchase cycle for that product category, consumers are given a chance to repurchase the product. The detailed measurement is called "repeat." Sales forecasts are then a function of "trial" and "repeat."

The specific measurements and the arithmetic of combining trial and repeat have evolved over the last twenty years, but the basic idea remains the same. Simulate the consumer's purchase environment and observe their behavior. Today there are many pretest-market services. If you are familiar with the pretest markets, you may have hear brand names such as "Assessor" or "Bases." Very few consumer packaged goods are launched to the market without a pretest-market test.

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[3] Both Profs. Urban and Silk served MIT Sloan as Deputy Deans. Prof. Urban also served as Dean. For the classic reference, see Silk and Urban (1973).

Pretest markets are surprisingly accurate. Typically, the forecasts come within two share points of what is ultimately achieved in market. Interestingly, most of the two-share-point deviation can be explained because the marketing materials used in the pretest market are not the same as those used in market. This difference is not due to negligence, but rather to careful management. Pretest markets often provide valuable diagnostic information with which to improve either the product or the psycho-social cues. Once these differences are taken into account, pretest markets have a <u>proven</u> accuracy of about $8/10^{ths}$ of 1 share point.

The accuracy for durable products and for industrial products is not nearly as high. However, the accuracy is usually sufficient to provide the information necessary for a GO/NO GO decision on product launch. Durable (or industrial) simulations are also more complex. For example, Figure 5 illustrates computer screens that General Motors used to simulate magazine advertising, word of mouth, newspaper advertising, and television advertising for an electric vehicle. The pretest market also included simulations of dealer visits and "information acceleration" to describe a new world where the infrastructure was available to support an electric vehicle. Figure 5 also illustrates one of the measurements that was taken to project consumers intentions to purchase the new vehicle. This research was done well in advance of the availability of electric vehicles.[4]

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[4] The output of this research suggested that the market for electric vehicles was too small to justify investment. Hybrid vehicle markets and, perhaps, hydrogen vehicle markets were more viable.
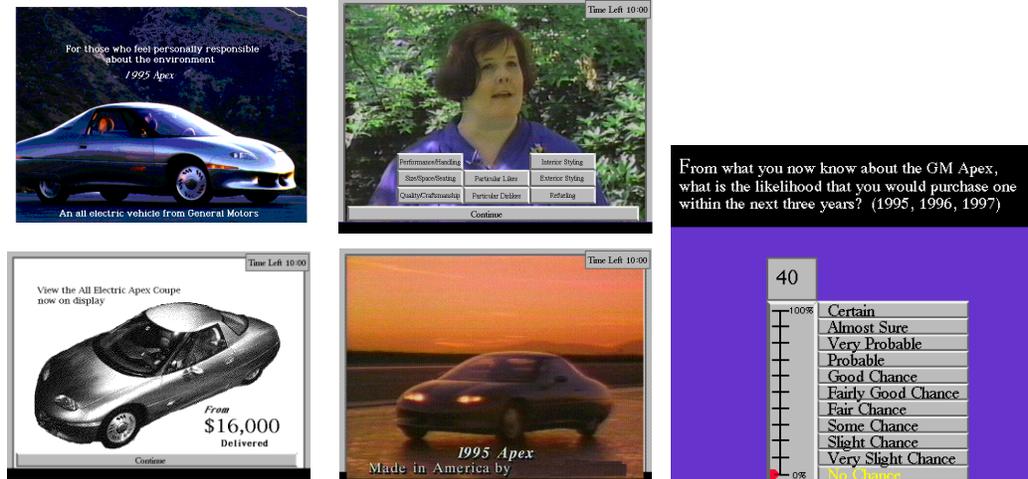
Figure 5. Forecasting Electric Vehicle Sales

More and more testing is moving to the web. "Virtual Concept Testing" has become a viable tool for testing new products. Figure 6 is one example of a virtual prototype for a bicycle pump. This product was consumer-tested as a virtual concept and as a real physical product. The test results were nearly identical suggesting that virtual concept testing could provide a viable alternative to tests with real products.
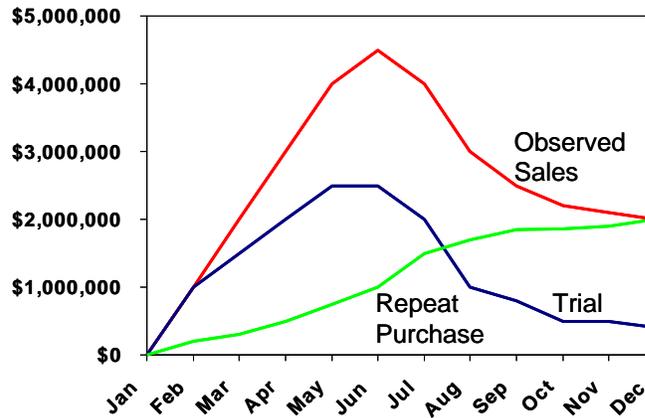

Figure 6. Virtual Concept – Bicycle Pump

Introduction

After the product (or service) has been tested and the management team has determined that the risks associated with product launch are acceptable, the product must be launched. The lessons of 15.810 are important to assure a successful launch. The firm must coordinate its product-price-promotion-place (4 P's) strategy and must match its product offering to the customers, company skills, competition, context, and collaborators (5 C's).

In addition, it is important that managers monitor trial, repeat, and the other aspects of the diffusion of the product. High advertising and heavy promotion may "buy trial." However, the product will not be successful if consumers do not repurchase the product on their own (for frequently purchased products) or if consumers are not satisfied with the product and do not recommend it to their friends or colleagues (durable goods).

For example, Figure 7 illustrates trial and repeat for one packaged good. Notice that sales peak by month 6 and that sales stabilize by month 12. In this case, management used heavy advertising pressure and sales promotion to launch the product. They achieved their goals. Many consumers tried the product. However, not all consumers chose, on their own, to repurchase the product. By month 12 "trial" had tapered off and the long-run viability of the product depended upon repeat sales. Had management ramped up production in month 6, they would have been left with excess capacity in month 12. By monitoring the components of sales (trial and repeat) rather than just sales, management was able to plan production and marketing for the time when sales would stabilize.

For durable goods and for industrial goods management needs to monitor the diffusion of the product through the market. Such diffusion depends upon word-of-mouth and other recommendations as well as the marketing pressure from the manufacturer and its channel partners. For more information on the analysis of diffusion, see the "Note on Life Cycle Diffusion Models."

$5,000,000
$4,000,000
$3,000,000
$2,000,000
$1,000,000
$0

Observed Sales
Repeat Purchase
Trial

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Figure 7. Trial and Repeat During Product Launch

Life Cycle Management

After launch, product management evolves to maintenance and monitoring. The 4 P's and 5 C's remain important. Product development is a never-ending process. Competitive products improve, new technology becomes available, and customer needs evolve. Faced with these pressures the management team might seek a product refresh, a product repositioning, or, perhaps, a next generation product.

Summary

This note addresses key ideas in product development – from a marketing perspective. For those students interested in product development we recommend Urban and Hauser (1993) for a marketing perspective and Ulrich and Eppinger (2004) for an operations management and engineering perspective.

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