A Process Model for Industrial New Product Development

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Abstract—**What steps should the industrial new product manager take to improve new product performance? This article pulls together the findings from the many research studies into what makes a new product a success. Six important lessons for managers are developed from those studies. The lessons point to a flow model approach to the development and commercialization of a new product—a step-by-step approach to successful product innovation. A seven-stage model, designed to move a product from the idea stage to product launch, is described. Actual case histories illustrate how each stage of the model can be implemented.**

INTRODUCTION

WHAT STEPS should the industrial new product manager take to improve new product performance? Twenty years of research into reasons for new product success and causes of failure have yielded valuable clues to more effective new product management. Yet many firms continue to make the same mistakes in their new product programs. This article tackles the problem, first by reviewing recent research into new product success and failure, and second, by translating the findings into a process model as a normative guide for managers.

The last two decades have witnessed a plethora of research into industrial new products. We have probed such issues as: how firms develop and launch new industrial products; the anatomy of new product success; why new products fail; and what separates successes from failures. Whether this new-found information has had much impact on management practice or on product performance is doubtful. New product failure rates remain high; and the same reasons for failure are repeated. For example, a recent *Conference Board* study into why new products fail identified exactly the same set of failure reasons as a study done 17 years before [18], [27].

One reason why firms have been slow to act on the research findings is the way the findings have been presented [4]. Reasons for failure or success have been reported on a variable-by-variable basis, whereas managers tend to think in terms of gestalts or scenarios [24], [25]. More critical is that the research has not been translated into meaningful and tangible guides to action. For example, one noted study of new product success factors, Project SAPPHO, found that "an understanding of users' needs" was the number one factor in success, a finding of interest from an academic standpoint. But what steps should the engineering-oriented new product manager take to become more "aware of user needs?" The answer is not provided by the research.

What is missing is a shaping of the research conclusions into a managerial guide. The most commonly proposed managerial new product framework is the process model—a stepwise sequence of activities designed to move the product from the idea stage through to successful launch. A clear need exists to redesign the process model to include these new research findings.

CLUES TO NEW PRODUCT SUCCESS

Diagnosis of Product Failures

Research into the product R&D process has generally focused on what can be learned from our previous experiences. Diagnosis of past failures has been one important research direction. Such studies are premised on the belief that a *post mortem* of previous failures should identify pitfalls and obstacles, that management can then take steps to avert or overcome in future projects.

Three *Conference Board* studies, in 1964, '71, and '80, all identified marketing variables as the major weaknesses in firms' new product failures [18], [19], [27]. Inadequate market analysis was cited as the number one reason for failure, and by a considerable margin over other causes.[1] Also important were product defects, lack of an effective marketing effort, higher costs than expected, competitive strength, bad timing, and salesforce or distribution weaknesses. Most of these failure causes were marketing related. But the prime cause involved a lack of market information, while deficiencies in the marketing, promotion, and selling efforts at the launch phase were only secondary reasons.

Recommendations of these studies called for more and better marketing research and marketing efforts (including selling and promotion efforts), careful product positioning, more effective concept testing, and better test marketing. Also a need for better evaluation was noted, including early screening of new product proposals. Finally, the *Conference Board* studies pointed to better venture management, improvements in coordination and internal communication, and a more planned approach to venture management.

The causes of industrial new product failure were investigated by Cooper for a sample of 114 actual product cases [5]. The major reasons were again marketing dominated:

1) underestimated competitive strength and/or competitive position in market (36.4 percent);
2) overestimated number of potential users (20.5 percent);
3) product's price set too high (18.2 percent); and
4) technical difficulties/deficiencies with product (20.5 percent).

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[1] 45 percent of respondents cited inadequate market analysis, versus 29 percent for product defects and 25 percent for poor marketing efforts.

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Six scenarios of new product were identified [3]. The most common scenario was the "better mousetrap no one wanted" (an innovative product that did not serve a market need, 28 percent of cases), followed by the "me-too product meeting a competitive brick wall" (similar to competitiors' products with no differential advantage, 24 percent of cases) [3].

The study also pinpointed areas of weakness within the firm and the new product process. In almost two-thirds of the cases, a lack of marketing research skills or personnel was thought to have contributed significantly to the failure, while the detailed market study phase was the most poorly undertaken activity of the new product process. Again, this research points to a lack of a market and marketing orientation as the culprit in industrial new products.

New Product Successes

Studies of new product success stories have focused on identifying what these successes shared in common. An extensive descriptive study of 567 successful innovations by Myers and Marquis showed that most were market-derived (market pull) ventures and only 21 percent were technology push [26]. Correct identification of an existing demand was the critical common ingredient among these innovations. Other lessons learned were that internal sources of information were the most important to the innovation process, pointing to the need to foster internal communication. External information via nonstructured channels also played a key role. A descriptive process model, consisting of five major steps and eight activities, outlined the actual process followed in these innovations.

In contrast, the ingredients of success in Globe's study of ten radical innovations were dominated by technological and internal variables, with external factors least important [15]. Success factors included:

1) a recognition of a technical opportunity;
2) a need (market) recognition;
3) proficient internal R&D management;
4) well-executed venture decisions;
5) ample development funds;
6) a technical entrepreneur.

Both internal (technological) and external (market) variables helped decide the fates of six successful innovations at GE Labs studied by Roberts and Burke [30]:

1) market needs were recognized and R&D was targeted at satisfying these needs;
2) when a technical success did not have a specific market need, the product was adapted to suit the identified need;
3) research managers communicated the possibility of a technical breakthrough clearly to other departments, which facilitated the identification of a market need;
4) communication existed between engineers and scientists in the operating departments.

In another investigation, detailed case studies of three high technology, significant industrial new products revealed an intricate and balanced new product process as the key to information acquisition and risk management [6]. The entire new product process could be viewed as a goal directed stepwise process, involving a series of information acquisition activities and evaluation points. The process was characterized by a phenomina called "incremental commitment," where resources were committed to the project such that uncertainty and amounts committed were balanced. The process itself was multidisciplinary and integrated, with inputs from marketing, engineering, R&D, and production. Extensive market studies, especially near the beginning of each project, were common to all three products, and played a key role in shaping the success of the products.

Townsend's study of one radical innovation and subsequent incremental innovations showed that successful innovations depend on intimate collaboration between user and innovator, and that a well defined market need facilitates the innovation's success [37]. Other key factors included the existence of a "technical champion;" interdisciplinary exchange of information and internal communication; and highly developed testing and screening procedures.

Gronhang analyzed 36 products in 15 small- and medium-sized Norwegian firms [16]. Highly novel products tended to originate from outside the company, while medium and low novelty products came from within. The most successful were medium novelty products. The magnitude of R&D input was positively correlated with number of new product ideas, developed products, and successful products. Finally a strong competitive environment led to less novel products, but a more systematic search for ideas. An effective internal and external communication system was felt essential to successful innovation.

Successes versus Failures

Most recent research has focused on contrasting successes and failures in order to find those variables or characteristics that discriminate between the two. The British study, Project SAPPHO, identified a pattern of differences between a paired sample of 43 successful and unsuccessful innovations [31], [35]. Of the 122 variables measured, 41 were found to discriminate between successes and failures, and five underlying factors that separated successes from failures were identified:

1) understanding of users' needs;
2) efficiency of development;
3) characteristics of management and managers;
4) effectiveness of communications (internal and external);
5) magnitude of marketing efforts.

Other conclusions were that many variables leading to product outcomes were, to a large extent, amenable to better management control, particularly in the area of marketing. But product outcomes—success versus failure—could rarely be reduced to a single variable. Finally, the investigation yielded a rank order list of what variables appear important in deciding new product results.

A similar but smaller scale study was undertaken in the Hungarian electronics industry [33]. The sample size was limited to 12 product pairs and featured a different pairing tech-

nique. In spite of the differences in research design and the obvious contrasts between the two countries, the Hungarian results were strikingly similar to the British SAPPHO. The following characteristics were highly associated with successful innovations:

1) market need satisfaction;
2) effective communication (internal and external);
3) efficient development;
4) a market orientation;
5) the role of "key individuals."

Another success/failure study undertaken by Kulvik in Finland yielded similar results to the two studies above [21]. But several additional success facilitators were identified, including the effective utilization of company potentials (good product/company fit); the utilization of technical "know how" of the company; and the exploitation of market opportunities. Familiarity with technology and markets both were determinants of success, with market familiarity having a more pronounced effect. An important finding of the Finnish study was that failures are often the result of a few critical factors, but in order to succeed, competence must be demonstrated in a wide range of tasks.

A similar study undertaken on European and Japanese firms measured the impact of the external environment and industry maturity on the innovation process [39]. Successful innovations, when compared to failures:

1) had no initial difficulties in marketing;
2) had a real product advantage;
3) had market needs recognized prior to a solution;
4) had more customer contact;
5) involved top management initiation.

Advance planning, the use of outside consultants, the absence of patent protection, and responses to government actions were all positively related to success.

A West German study investigated products that were commercialized versus those that were canceled [13]. The source of the idea—whether market pull or technology push—had a marked impact on commercialization, with market pull products fairing better. All products were incremental innovations.

The SAPPHO researchers recently reported the results of a five country study of innovation in the textile industry [32]. Incremental innovations were found important to short term prosperity. Firms employing qualified scientists and R&D engineers were more able to produce the successful breakthroughs, and more radical innovations stemmed from those firms with a technically qualified chief executive. Successful firms had superior marketing programs and frequent customer contact in this textile industry study. Successful firms understood users' needs better, and were able to assess whether these needs could be filled economically. Specific sales strategies were matched to market requirements. An open and flexible management structure, the existence of a "product champion," effective external communication, and several other controllable variables were all related to positive new product outcomes.

Fifty-four significant facilitators for success were identified in Rubenstein *et al.*'s study of American new products, but no single characteristic of success or failure could be detected [36]. Further, one person's facilitator could be someone else's barrier. Some of the important facilitators included:

1) existence of a strong product champion;
2) marketing factors, such as need recognition;
3) strong internal communications;
4) superior techniques for data gathering, analysis, and decision-making;
5) planned approaches to venture management.

Project NewProd contrasted almost 200 randomly selected Canadian industrial new products—half successes, half failures—on each of 77 characteristics [7]-[10]. The three most critical determinants of new product success were:

1) having a unique or superior product in the eyes of the customer: one that was innovative; had unique features for the customer; met customer needs better than competing products; did a unique task; lowered customer costs; and was of high quality;
2) having marketing knowledge and proficiency: properly undertaking preliminary market assessment, market research, and test markets; having a sound understanding of the market—needs and wants, price sensitivity, buyer behavior, market size, and competition; and executing the launch well;
3) having technical and production synergy and proficiency: having a good fit between the product and the company in terms of R&D, engineering, and production; having "in-house" technical and production knowledge; and undertaking the technical and production activities well.

Another eight factors were also related to success, but less strongly. Subsequently, new product scenarios were developed, each with its own likelihood of success [4].

Other important conclusions of NewProd were that there were many variables that influenced new product success. Most were amenable to management action, while success was not nearly so dependent on the new product situation or environment. Finally, weaknesses exist in many firms' new product processes: many firms were developing "me-too" products; often products were new and different but offered no new benefits to customers; typically vital market information was lacking in the process; and the market launch itself was frequently poorly planned or executed.

WHAT NEW PRODUCT RESEARCH HAS TAUGHT US

A number of underlying themes or messages begin to emerge as one reviews the research into new product performance. Consider some of the more evident lessons we can learn from a synthesis of these studies.

Lesson 1. For Industrial New Products, a Much Stronger Market Orientation is Needed

Need recognition, understanding user needs, undertaking market assessment and market research, and having a sound knowledge of the marketplace were prevalent findings, common to virtually every study. The ultimate success of a new product is determined in the marketplace, and market information must play a critical role in the shaping of the product and the launch strategy. Most successful projects are market pull, relying heavily on market information. In the case of succesful technology push products, innovators determine the existence of a market need before proceeding, and then determine precisely user needs and interpret them in the design of the new product [34].

Equally clear is that many firms are still not performing the market research and market studies essential to successful product development. Too little market research is undertaken, and it is often too late in the process. Moreover, important, often vital, market studies tend to get omitted altogether. A lack of market research remains the most frequent cause of failure.

The ideal new product process would see technical and engineering research balanced with extensive market research. Market information should be integrated into every stage of the process, and not just as an afterthought or towards the launch phase. Whether a technology push or parket pull project, market information should be used, not only in the evaluation decisions, but most importantly, as an input to the product design, engineering, and product development activities.

Lesson 2. New Product Success is Largely Amenable to Management Action

Most of the studies concur that the actions of the people involved in these projects decided the fates of the ventures. Product innovators are not victims of circumstance or prisoners of the environment: the outcome of a venture depends not so much on the nature of the market or nature of the project, but rather on what people do about it. The role of key players (for example, the product champion) and the impact of certain activities and procedures (for example, market research) underscore this point. As Rothwell notes: "...while chance and uncertainty can upset even the best laid schemes, responsibility for the success or failure of innovations ultimately rests firmly in the hands of the innovating companies' own management"[34].

This is a provocative finding. The traditional new product literature is preoccupied with project selection, with relatively little focus on the activities of the new product process. The assumption appears to be that "selecting the right project" is paramount. Not so according to recent research, where success appears to depend more on execution rather than selection. The design and implementation of an appropriate new product process–the key activities from idea to launch–becomes critical to success.

Lesson 3. There is No Easy Explanation for What Makes a New Product a Success

Success does not depend on one or a few variables. Most studies identified a large number of characteristics that explained success. An accepted conclusion is that the "success equation" is a complex one; and that success depends on doing many things well, while failure can result from a single error.

The new product manager is therefore faced with the complex task of managing a highly uncertain endeavor where many things must be done properly and a single miscue can spell disaster. One implication is that a carefully developed activity plan or process model would help in ensuring that no vital activity or information-seeking step is overlooked. A second concerns the need to organize for varied inputs to the process from many sources within the firm: a multidisciplinary approach.

Lesson 4. The Product Itself–A Unique Product with Real Customer Advantages–is Central to Success

The central role of the product itself–its design, features, advantages, and benefits–in creating success should come as no surprise. But several studies point out that tired products and "me-too" designs are the rule rather than the exception in most firms' new product efforts.

Equally clear is that merely having an innovative product–unique or totally new–is not sufficient. Rather, the product must be unique and superior in *the eyes of the customer* and not just in the opinion of the R&D department.

The desire to deliver a "better product" in terms of meeting customer needs, parallels the need to be market oriented. Clearly the firm must possess the tehnological skills to develop a "superior" product: the product may be better because it uses newer technology or is better designed and engineered than competing products. But in order that the product deliver significant advantages to the customer, a clear understanding of the customers' needs, wants, preferences, choice criteria, and use practices is essential before serious product development begins. The new product process must marry the technical side of product design and engineering to the needs of the marketplace to ensure that the product does indeed deliver unique benefits to the customer.

Lesson 5. A Well-Conceived Properly Executed Launch is Vital to Success

A strong marketing effort, a well targeted selling approach, effective aftersales service, and sound marketing communications were common themes in much of the research. But a well integrated and properly targeted launch effort does not happen by chance. It is the result of a fine-tuned marketing plan backed up by proper execution. The marketing planning process, itself a complex process, must therefore be built into the new product activity plan. For example, selection of target market, a key step in marketing planning, should logically preceed product design and development. Critical to an effective marketing plan is market information: how customers buy; their choice criteria; sources of information; and competitive

practices. Once again we see a need for market research, but this time research designed to provide information essential to the design of a launch plan.

Lesson 6. Internal Communication and Coordination Between Internal Groups Greatly Fosters Successful Innovation

Many of the research studies spoke of interfaces between R&D and marketing; of coordination between key internal groups; and of multidisciplinary inputs to the new product process. Product innovation is not simply a matter of R&D, but consists of many varied activities that ideally should be undertaken by different groups within the firm: market research, R&D, sales, engineering, industrial design, production, and advertising. Multiple inputs must be coordinated and integrated throughout the process. This calls not only for a systematic approach to the new product process, but also one where various groups are logically brought together in the process.

CONCEPTUALIZING THE NEW PRODUCT PROCESS

The lessons learned from new product research suggest needed changes in the process many firms use to develop new industrial products. Consider the new product process or flow diagram model. A process model is a useful approach to organizing and controlling the various activities involved in the development of a new product, and provides a skeleton around which each project manager can build his/her own PERT or critical path plan specific to any one project.

New product process models can be categorized as descriptive versus nomative, and further by industrial product versus consumer product. Descriptive process models have evolved from empirical studies of the new product case histories. Booz, Allen, and Hamilton, [2], Myers and Marquis [26], Utterback [38], Rothwell [31], and Little [22] all propose flow charts that identify the steps of the new product process. Myers and Marquis' model is typical: a five-stage descriptive model, whose stages include recognition, idea, search, solution, and implementation. Such models, however, were never intended as normative guides for managers: while conceptually correct, they lack the detail and precision necessary for use as a normative model. Moreover, since descriptive models are based on actual practice, there is no guarantee that such practice itself is ideal and could stand as a guide to others.

The most specific and detailed process normative models are in the field of non-industrial goods. Klompmaker's "idealized process for new product development" outlines a 27-step model for consumer goods, that specifies details such as "select a name," "design the package," and "create copy theme" [10]. Similarly, Hanan presents a detailed 24-activity flow diagram, but it too appears most appropriate for consumer goods [17]. Management Decision System Inc. outlines a detailed process for new pharmaceutical products, that even suggests how some steps should be carried out (for example, "concept screening" using focus groups) [23].

Normative models for the *industrial* new product process suffer by comparison. Several models in use by companies are reviewed by the National Industrial Conference Board (NICB) [28]. Of the three that are most developed, two omit marketing activities altogether, and the other lacks specificity, consisting of a few major steps, not unlike a descriptive model. In contrast, Gisser's "new product introduction program" consists of a 67-step recipe to new product success, and is designed for use as a computer planning model [14]. Finally, Cooper and More's "modular approach" is not a process model at all, but rather *an approach to constructing* a flow model [12].

The engineering literature makes several notable contributions to the industrial new product process. But such models, typified by Albala's "stage approach activities," tend to view the new product process from a technological perspective, and focus attention on the "front end" stages (with little emphasis on commercialization) and on engineering activities [1]. Albala's model, for example, provides only passing mention of preliminary market assessment and no reference to marketing research in all its seven stages.

AN IMPROVED PROCESS MODEL

What are the requirements of an ideal process model for industrial new products? First, it must be sufficiently specific and detailed to act as an action guide to managers, yet not to pedantic so as to discourage its use. Second, it must be strongly market oriented, building in market research and marketing planning throughout the process. A constant concern must be the ideal of developing a product with a differential advantage in the marketplace: one that delivers unique benefits to the customer. The model must be multidisciplinary and foster internal communication amongst key groups. And it must recognize the high failure rates and risks of new products, building in timely evaluation and "bail out" points throughout the process.

The stage model presented below is designed to meet these requirements. It was conceived on the basis of the recent research findings, an analysis of previous normative models, and a review of 60 flow charts of case histories of new product projects.

The normative model consists of seven stages. Each stage contains a number of activities, for a total of 16 activities and seven evaluation points (see Fig. 1). The seven stages are:

I. IDEA
II. PRELIMINARY ASSESSMENT
III. CONCEPT
IV. DEVELOPMENT
V. TESTING
VI. TRIAL
VII. LAUNCH.

Each stage is separated from the previous (or following) stage by an evaluation point or GO/KILL decision node. Thus the process can be truncated at the completion of any one of the stages.

Stage I. Idea

The process begins with the definition of a *product idea.* An idea results when technological possibilities are matched with an expected market demand. Ideas for a new product may be spotted in the marketplace: a competitor's product, recognition of unsatisfied customer needs, or direct requests from customers. Such "market pull" projects represent the

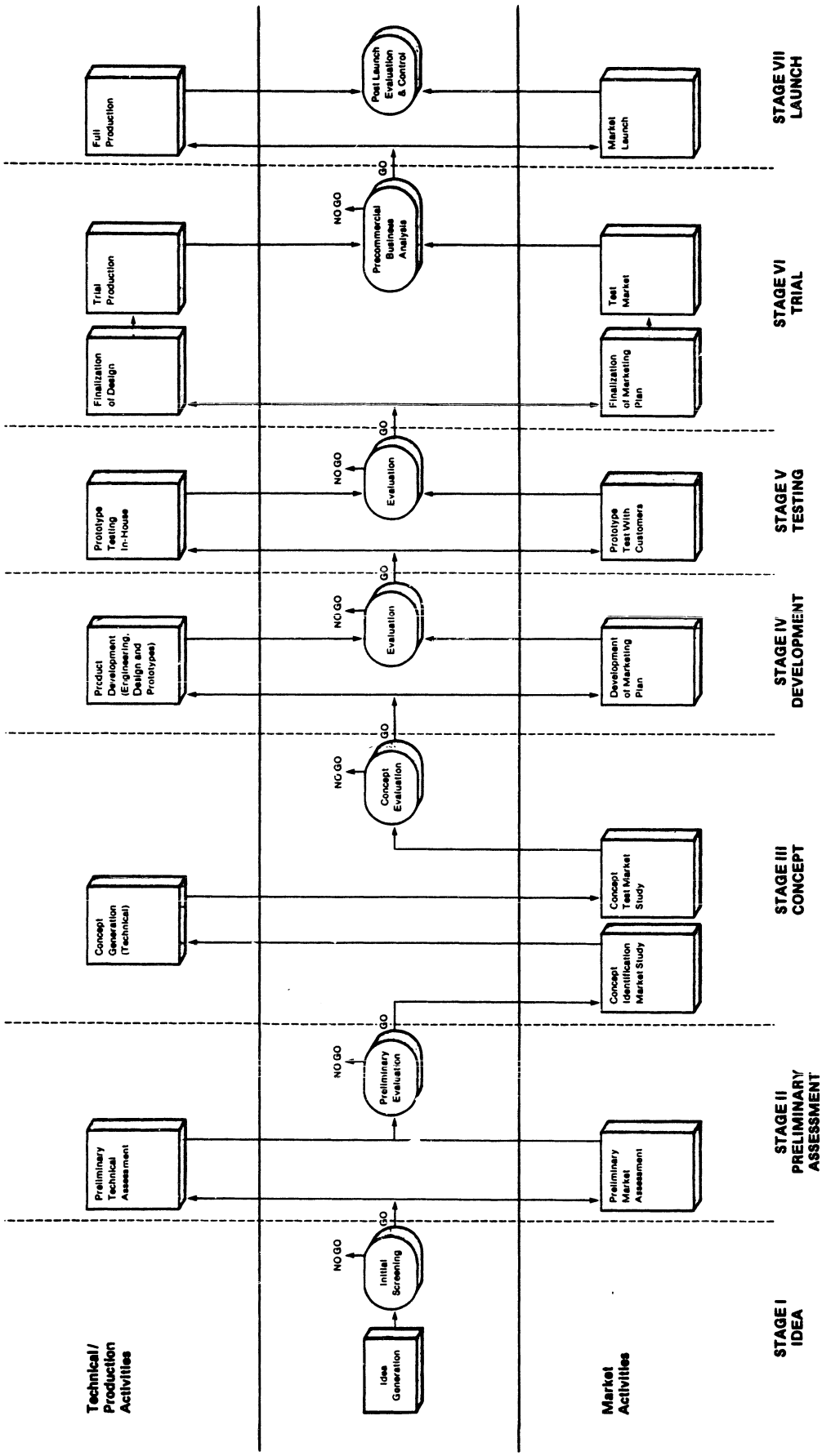

Fig. 1. A flow diagram of the seven-stage new product process model.

majority of industrial new product projects. But "technology push" projects–where the product idea comes from basic research or a technological discovery–also play a role, particularly in the case of radical innovations or breakthrough products, which are important to long term success [32].

Screening is the first evaluation of the new product idea, and represents the initital decision to commit resources to the idea. At this point, if GO, it becomes a project. The screening decision should be viewed as a "tentative positive" decision, allowing the project to proceed to the next stage, where it will again be reviewed in the light of more and better information. Note that because information is so lacking at this early stage, the decision can only be a tentative one; at the same time, the resources committed by the decision are also small: a limited amount of time and money to be spent on preliminary assessment in Stage II. Using this incremental commitment approach, resources and uncertainty are balanced; and risk is kept to a tolerable level.

Ideally, screening is a multilevel culling process. Two obvious criteria must be met before any product idea receives serious consideration:

1) Does the proposed product fit with the company's new product guidelines or mission? This culling question underscores the need for a sharply defined new product strategy or "innovation charter" for the firm.

2) Is the project "do-able" by the company? Does the company have the needed resources? Could these resources be readily acquired? And is the project feasible technologically?

The third criterion pertains to the attractiveness of the venture. Here screening amounts to an investment decision made in the absence of financial data. As a result, nonfinancial proxies that gauge the attractiveness of the venture must be used. Checklist and scoring models, based on lists of criteria, are often used to rate the attractiveness of alternate projects. Such a scoring model has been proposed by O'Meara [29] and an empirically derived industrial product model is also available [11].

Stage II. Preliminary Assessment

Preliminary assessment is the first stage where significant resources are spent to gather information regarding the feasibility and attractiveness of the project. This preliminary stage, which includes market assessment and technical assessment, should be deliberately limited, in terms of time and manpower or expense, to a prespecified ceiling.

Preliminary market assessment involves a quick market study, using in-house information (for example, the salesforce); relying on secondary data (for example, published statistics or research reports); and accessing outside sources (such as several knowledgeable potential customers or industry experts). Desired information concerns an overview of the market; identification of possible segments; market size; and likely prospects for the new product.

Preliminary technical assessment amounts to exposing the idea to the firm's technical staff–R&D or engineering–for technical appraisal. The key questions concern the technical viability of the idea and some indication regarding the resources required to develop and produce the product.

Following these two preliminary information steps–market and technical–an evaluation is performed. At this point, preliminary financial analysis may be possible; but it is likely that qualitative issues will continue to play a major role in the GO/KILL decision. If the decision is GO, the commitment is to move the project to the next stage, Concept.

An illustration:

A major chemical company has streamlined and computerized the first two stages of the model as follows: product ideas are actively solicited from a number of sources, and are stored as written proposals in a computer memory bank. This is called the "white stage." Initial screening is next, and involves the use of a checklist questionnaire, completed by independent evaluators within the firm. Responses are combined and weighted by computer to yield a product score for each project.

If an acceptable score is achieved, the project moves to the "green stage," where preliminary technical and market assessment is undertaken. With more complete information, a second computerized evaluation is carried out, again based on a checklist scoring model, but with more precise information requirements. If GO, the project moves to the "blue stage," where extensive market and technical studies begin.

Stage III. Concept

The purpose of the concept stage is to better define exactly what the product is, who it is aimed at, and how it will be positioned *vis a vis* market segments and competitive products. This concept definition stage is frequently ommitted by industrial product firms, often with disastrous results.

The first activity is a market study, *concept identification.* This market study of potential users or buyers first seeks to identify a hole in the marketplace: a segment of customers who are dissatisfied with what is currently available; a vulnerable or poorly designed competitor product; or a niche where a new technology or new design can gain a competitive advantage. Second, the study identifies what must be done in order to achieve success in this market: for example, the desired benefits or features sought in a new and "winning" product, and how the product should be positioned.

An example:

A major manufacturer of high quality highway trucks sought entry into the urban market; namely, dump trucks for construction applications. The product idea was: "let's build a high quality dump truck," and a preliminary investigation revealed that the company could indeed design and build such a vehicle, and that the market was a large and growing one. But the details of the product concept and how the product would be positioned were missing.

A concept identification market study was commissioned. Dump truck fleet owners were personally interviewed to determine their choice criteria; attitudes to various OEM's products; likes, dislikes, and preferences; reasons for these; areas of discontent; design improvements desired; etc.

Following the interviews, it became clear that truck

downtime was a major concern and a costly problem to fleet operators. In fact, many users kept spare vehicles simply to ensure that they could meet their own customers' demands. So the new product concept became: "a truck that can be repaired and back on the road overnight—in 12 h—no matter how serious the breakdown."

The design specifications for what constitutes a "better product for the customer" are defined from the concept identification market study (above). Next comes *concept development*. Here the market requirements are translated into an operational concept, one that is technically feasible:

Armed with the desired concept of a "minimum downtime truck," engineers conceived a modular vehicle. Every major "trouble component" in the truck was engineered to be easily removed and replaced quickly and easily—engine, transmission, rear axle, electrics, radiator, etc. And standard parts, available from a variety of local suppliers, were used. The minimum downtime concept was indeed technically feasible and at the right price.

The final activity in the concept stage is a *concept test*: a test of the likely acceptance of the concept by the marketplace. Another market study of potential buyers or users is required; but unlike the concept identification, the concept test has something specific to show respondents: sketches, diagrams, models, or descriptions of the proposed product. The object of this study is to obtain a gauge of market acceptance of the new product: interest, liking, preference, and intent to purchase. Additional information might involve suggested modifications to the proposed concept, or in the event of rejection, reasons why the concept is unacceptable to the buyer:

Another example:

Before proceeding with commercial development, a manufacturer of health care products conducted a concept test of a total health testing unit aimed at executives in corporations. The concept was for a trailer to be equipped with advanced equipment to perform a complete medical examination in minutes. The trailer would be brought to the corporate premises where executives would be examined on site. The benefits to the company were thought to be better executive health and no need for inconvenient two-day annual check-ups in a hospital. For the market concept test, the proposed product was described using artists sketches, simulated promotional literature, and a model of the van's interior. The visuals, descriptions, and price information were displayed to decision makers in the potential client firm, and their reaction—interest, liking, and purchase intent—was gauged.

The two market studies in this concept stage do more than identify and test a product concept. They also begin the marketing planning process. These initial market studies in effect identify the target market; specify the core element of the marketing mix, the product; and result in a product positioning statement. So prior to actual product development, the marketing planning process has been initiated.

A concept evaluation decision is now made. Note that the concept test market study provides intent to purchase data that permit estimates of market acceptance and expected sales. Similarly, the concept development, on the technical side, provides estimates of costs. For the first time in the project, a reasonable financial analysis can be performed. A reliable evaluation is essential at this point before moving the project to the next and more expensive stage: development.

Stage IV. Development

The actual *product development* now begins in earnest. Here technological resources—R&D and engineering and industrial design—are mostly involved. A prototype or product sample is the usual outcome of this stage.

Paralleling the development of the product is the development of a formal and complete *marketing plan*. Here the results of the concept stage—target market selection, product strategy, and product positioning—are shaped into a marketing plan. Next, the supporting elements of the marketing mix—pricing, distribution, advertising, salesforce strategy, and service—are decided. These supporting elements may require an additional market study on buyer behavior—how customers buy the product; who the purchase influencers are; sources of product information; etc.—in order to design an effective marketing plan.

Stage V. Testing

The testing stage is a validation of the product's design and features in use. Product *prototypes are tested* within the company to determine that no technical flaws exist. In parallel, a *customer test* of the product is conducted. Prototype samples are placed with potential customers for trial to test the product's design. The object is to identify design defects, and, in particular, modifications needed to improve customer acceptance.

During the development of a dial-in-hand telephone, a major telephone manufacturer assembled 100 prototype units. Fifty of these went for in-house testing—the usual reliability and durability tests that a new telephone must pass. The other 50 went into nontechnical employees' homes for customer testing.

The latter test proved crucial to the product's eventual success. Here a potentially disastrous flaw in the design was uncovered, one that had been overlooked in the lab setting: in the wall phone design, the receiver would fall off the hook if a nearby door were slammed in a stud-wall construction house. A minor design change to the receiver overcame the problem before millions of phones with faulty receivers would have found their way to telephone companies and eventually into households [6].

Following the in-house and customer tests to verify product design, an evaluation is made. A GO decision moves the product to the trial stage.

Stage VI. Trial

The trial stage represents a "dry run" of all commercial facets of the project: production, product design, and marketing. Before these trials begin, however, both the product design and the marketing plan must be completed and finalized. The customer and in-house tests from the previous stage pro-

vide the inputs to finalize the product design, while the development of a marketing plan has been proceeding since the concept stage.

A trial or *pilot production* run tests the production method that will eventually be used for full scale production. Modifications to the final production facilities or methods are often required in order to alleviate problems uncovered in the pilot production. In addition, more accurate estimates of production times, throughputs, and costs are obtained in the trial run. A *test market*—selling the product using the proposed marketing plan, but to a limited number of customers or in a limited geographic area—tests not only the product, but all the elements of the marketing mix together. The identification of needed adjustments to the marketing plan and a final estimate of market share and expected sales are two results of the test market:

> The telephone manufacturer used a trial production run of 1000 of the new dial-in-hand phones to obtain true estimates of production costs and to spot and correct production problems. These 1000 phones were then sold in a test market in one smaller but typical city with the cooperation of the manufacturer's own customer, the telephone company. All the elements of the marketing mix were tested, including the pricing strategy (a monthly premium); the communications strategy (newspaper, radio, and announcements in the monthly phone bill); and personal selling (use of installers to promote the premium product in new installations). The test market confirmed most elements, but revealed that sales would be double what the manufacturer had thought. A revised national launch plan—on a region by region basis—was quickly devised, so that production could meet demand [6].

A final *precommercialization business analysis* and evaluation is made, based on concrete financial data from the test market and trial production.

Stage VII: Launch

The launch stage involves startup of full or commercial production, and the implementation of the marketing plan in the full market area. Note that all facets of the launch have been well tested prior to this stage. If the tests have been well carried out, and barring any unforeseen or new circumstances in the market, the launch should be a simple matter of executing a well-designed plan of action.

Postlaunch evaluation or control points at predesignated times after launch provide benchmarks to gauge whether the product is "on target." Such benchmarks include market share, sales volume, production costs per unit, etc. Postlaunch evaluations are essential to control the product and to signal the implementation of corrective schemes to move the product back on course.

CONCLUSION

New product development will always be a high risk undertaking. But much can be learned about effective new product management from a review of the experiences in past new product projects and in other firms. Many of these insights have been incorporated into the seven-stage process model presented in this article. No product project will necessarily follow the model religiously; certainly unforeseen events and special circumstances will dictate additional steps, recycling through previous steps, or deletion of certain activities. The intent was merely to provide a normative guide to managers to ensure that many of the critical steps in the process are not overlooked.

The benefits of implementing the model are many. One result is that the process becomes more multidisciplinary: note that technical and production activities were denoted along the top of the model, and the market oriented activities along the bottom (Fig. 1). The balance between the internal versus external orientation becomes obvious. A second payoff is that interaction between varied groups is encouraged: the many evaluation nodes demand diverse inputs from different groups in the company. Also, one activity tends to feed another, often in a different functional area within the firm. Notice for example, the amount of criss-crossing back and forth between marketing and technical activities throughout the model. A third benefit is the incremental committment nature of the process: expenditures tend to be balanced with certainty level; each stage involves progressively better information and concurrently entails progressively higher expenditures; and risk is managed. Further, decision nodes and bail-out points are provided at each stage. Finally, the process is decidedly market oriented, providing for ample market information and marketing planning, not only towards the launch phase, but throughout the entire process.

New product success can never be guaranteed. But more thoughtful attention and a systematic approach to the way we proceed to develop and launch products can surely help us avoid many of the pitfalls that have plagued product development in the past.

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