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Overview

Innovation is one of the most important issues in business research today. It has been studied in many fairly independent research traditions. Our understanding of innovation and our progress in studying it can benefit from an integrative review. We identify 15 topics relevant to marketing science, which we classify under four research fields:

- Product development, which has been transformed through global pressures, increasingly accurate customer input, web-based communication for dispersed and global product design, and new tools for dealing with complexity over time and across product lines
- Organizations and innovation, which are increasingly important as product development becomes more complex and tools more effective but demanding (this topic includes recent thinking on managing by metrics)
- Market entry and defense strategies, which includes recent research on technology revolution as well as extensive marketing science research on strategies of entry and defense and rewards to entrants
- Consumer response to innovation, including attempts to measure consumer innovativeness, models of new product growth, and recent ideas on network externalities

For each topic, we summarize key concepts and highlight research challenges. For prescriptive research topics, we also review current thinking and application. For descriptive topics, we also review key findings.

Introduction

Innovation, the process of bringing new products and services to market, is one of the most important issues in business research today. Innovation is responsible for raising the quality and lowering the prices of products and services that have dramatically improved consumers' lives. By finding new solutions to problems, innovation creates new markets, transforms old ones, or destroys exiting ones. It can bring down giant incumbents while propelling small outsiders into dominant firms. Without innovation, incumbents slowly lose both sales and profitability as competitors innovate past them. Innovation provides an important basis by which world economies compete in the global marketplace.

While the marketing discipline has a long history of research on innovation, key breakthroughs have come also from related disciplines such as quality management, operations management, management of technology, organizational behavior, product development, and strategic management. This paper seeks to collect, explore, and evaluate research on innovation using a customer perspective. The discipline of marketing is well positioned to understand and manage innovation within firms and markets. Successful innovation satisfies important customer needs better than competitors do; marketing is intrinsically customer- and competitor-focused. This review attempts to summarize key ideas, highlight problems that are on the cusp of being addressed, and suggest questions for future research.

Innovation is a broad topic. Research on innovation has proceeded in many academic fields with incomplete links across those fields. For example, research on market pioneering typically does not connect with that on diffusion of innovations or the creative design of new products. Key goals of this paper are to highlight important streams of research on innovation, suggest interrelationships, and provide a taxonomy of topics relative to the product development cycle. Table 1 identifies four broad fields of innovation and various subfields or topics within each of them. Figure 1 shows the relative position of these various fields in the product development cycle. We hope this attempted integration will stimulate fertilization and interaction across fields and promote productive new research.

In the interests of space and relevance to marketing, our review is relatively focused. It does not include research on the antecedents of product development success (Henard and Szymanski 2001; Montoya-Weiss and Calantone 1994), the role of behavioral decision theory to inform product development (Simonson 1993; Thaler 1985), marketing's integration with other functional areas (Griffin and Hauser 1996), innovation metrics (Griffin and Page 1993, 1996; Hauser 1998), or the engineering aspects of product development (Ulrich and Eppinger 2000).

The subsequent sections review each of the research topics within their corresponding research fields. When the research area is prescriptive, we attempt to summarize what can be accomplished and where the greatest challenges exist. When the research area is descriptive, we attempt to summarize the knowledge available today, the important gaps in that knowledge, and how that knowledge might lead to prescriptions.

Table 1. Classification of Research in Innovation

Research Field	Research Topic
Product Development	Product Development Processes
	The Fuzzy Front End
	Design Tools
	Testing and Evaluation
	Product Portfolio Management
Organizations and Innovation	Contextual and Structural Drivers of Innovation
	Organizing for Innovation
	Adoption of New Tools and Methods
	Metrics-Based Management
Market Entry and Defense Strategies	Technological Evolution and Rivalry
	Strategies of Entry and Defense
	Rewards to Entrants
Consumer Response to Innovation	Consumer Innovativeness
	Growth of New Products
	Network Externalities

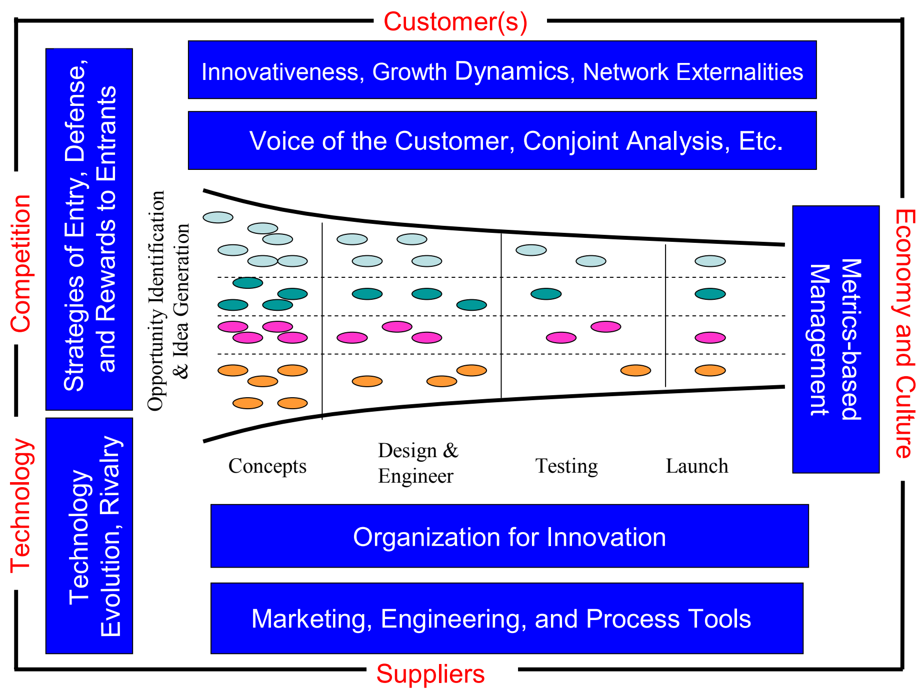


Figure 1

Product Development

We begin with product development (PD), because its outcomes (new products or platforms) provide the growth fuel for organizations. Research on other innovation topics is predicated on the introduction of new products to the marketplace. We build upon earlier reviews from the management literature (e.g., Brown and Eisenhardt 1995) by focusing on recent developments from a marketing science perspective. We begin with a brief review of product development processes, then discuss three stages of product development (research on the fuzzy front end, research on design tools, and research on testing and evaluation), and close with issues surrounding innovation strategy and portfolio management.

The emerging view in industry is of product development as an end-to-end process that draws on marketing, engineering, manufacturing, and organizational development. The core of this process is the product-development funnel of opportunity identification, design and engineering, testing, and launch, shown in the center of Figure 1. Each oval in the funnel represents a different product concept. The funnel recognizes that, for a single successful product launch, failures will be many, although some may be recycled, reworked, and improved to become successful products. The funnel also recognizes the current hypothesis that many firms are most successful if they have parallel product concepts in the pipeline at any given time, forming a portfolio of projects. These projects may relate to independent products, but increasingly they are based on coordinated platforms to take advantage of common components and/or economies of scope.

Product development success depends upon a deep understanding of customers and collaboration with suppliers, with an understanding of both technology and competition within the context of the firm's strategy and the overall economy and culture. These forces are shown along the boundaries of Figure 1. The research areas in marketing from Table 1 are shown as shaded boxes and are reviewed in this paper.

Product development processes

Risk is inherent in product development; few of the many concepts in a portfolio are likely to be successful. Information to evaluate alternative concepts is often imperfect, difficult to obtain, and hard to integrate into the organization. For each success, the process begins with 6 to 10 concepts that are evaluated and either rejected or improved as they move from opportunity identification to launch (Hultink et al. 2000). While risk is inherent, it can be managed.

Most firms now organize the work of product development as a series of gates in a process that has become known as a "stage-gate process" (Brown and Eisenhardt 1995; Cooper 1990, 1994). For example, in one "gate," the product development team might be asked to justify the advancement of a concept from idea generation to the design and engineering stage. While there are important practical considerations in the continuous improvement of stage-gate processes, the basic structure is well understood. Research has shown that use of a formal process is associated with increased success and shortened times for product development (Griffin 1997a). While stage-gate processes continue to remain important for practice, research opportunities for stage-gate processes consist of developing incremental improvements of process and decision-making at each gate (Hart et al. 2003).

The fundamental research opportunity is the study of alternatives to stage-gate processes. For example, one recent modification is a spiral process (Boehm 1988; Garnsey and Wright 1990). In a spiral process, the product development (PD) team cycles quickly through the stages from opportunity to testing. Ideas are winnowed in successive passes, with the goal that each successive pass through the process proceeds at greater speed and lower cost. The theory of spiral processes puts a premium on speed while forcing the team to get engineering and market feedback quickly and often. Proponents expect that spiral processes have real advantages for software development (frequent "builds") and for products in rapidly evolving markets (Cusumano and Yoffie 1998).

Another alternative to a strict stage-gate process is overlapping stages (Cooper 1994; Wheelwright and Clark 1992). For example, engineering design might begin before the end of idea generation, and testing might begin with products that are not yet fully engineered. Some firms now involve a "marketing engineer" at early stages of the PD process – a team member charged with facilitating the design for ultimate marketing. The theory of overlapping stages is similar to that for spiral processes – greater speed and more rapid feedback.

The discussion and debate in the field has reached the stage where research is necessary to determine which process is best for which contexts. For example, overlapping stages may be more appropriate than spiral processes for products with greater engineering requirements that must move linearly through the PD process. Cooper (1994) suggested that less-complex projects can use a simplified stage-gate process with fewer stages and gates. This research item was highlighted by Brown and Eisenhardt (1995) but remains unresolved. Based upon research to date, we suggest at least six contextual dimensions worth researching: (1) fast versus slow industry clock speed, (2) innovation within a current business versus opening a new business space, (3) radical versus incremental innovation (in technology and/or customer needs), (4) high versus low modularity, (5) low versus high product complexity, and (6) physical goods versus services.

Fast Versus Slow Clock Speed. These issues, well known in supply-chain management (e.g., Fine 1998), apply equally well to the choice of a PD process. Sequential processes have been successful in slow-moving industries such as consumer packaged goods, whereas spiral processes are being adopted by some fast-moving industries such as software and high technology. Some degree of sequential completion is required in a number of businesses affected by regulatory agencies. For example, the Food and Drug

Administration requires proof of certain outcomes before the various stages of clinical testing can begin.

Current Versus New Business. Innovation supporting current business lines is constrained by strategy, potential cannibalization, brand image, existing engineering and manufacturing resources, and current marketing tactics. Sequential processes can draw on engineering, customer, and market knowledge. However, innovation launched into the "white space" between business units often requires new resources, new knowledge, new strategy, and new ideas. The innovator must learn quickly about segments or customer needs and preferences. Spiral or overlapping processes may encourage and enable rapid experimentation and knowledge acquisition to innovate into this white space.

Radical Versus Incremental Innovation. Most product development efforts result in incremental innovations (Griffin 1997a). Sequential processes are effective for developing evolutionary products. Radical innovation — fivefold performance improvements along key customer needs or 30% or more in cost reduction — often requires products with an entirely new set of performance features (Leifer et al. 2000). As a result, the unknowns and risk are enormous compared to those in incremental development. Non-sequential processes provide a means to manage risk. For example, Veryzer (1998), in an exploratory study of eight firms, found formal, highly structured processes less appropriate for radical innovation.

High Versus Low Modularity and High Versus Low Product Complexity. When the design of a product or service can be decomposed into more-or-less independent components (a highly modular design) and/or when the product design is not complex, sequential processes may work well. However, consider a high-end copier, which requires thousands of components, or an automobile that requires many hundreds of person-years of effort to design. Such high complexity or integration requires intermediate "builds" to effect integration and test the boundaries of component performance. Software is an extreme example, where builds may occur weekly or even nightly. High integration and high complexity often require spiral processes.

Physical Goods Versus Services. The majority of all research on sequential PD processes has focused on physical goods. There has been less research on PD processes for services, which are intangible, perishable, heterogeneous, simultaneous, and coproduced. Menor, Tatkionda, and Sampson (2002) reviewed service development and suggested that the challenges for physical goods apply to services but with the added complexity of developing means to handle the unique nature of services within either sequential or spiral PD processes.

Finally, PD processes are only as good as the people who use them. Structured processes force evaluation, but evaluation imposes both monetary and time costs. Teams can be tempted to skip evaluations or, worse, justify advancement with faulty or incomplete data. There are substantial research opportunities to understand the optimal tradeoffs among evaluation costs, the motivations of teams for accuracy, and the motivations of teams for career advancement. For example, advancing a concept to the next stage in either a sequential or spiral process requires a handoff. New team members must have sufficient data to accept the handoff. In some instances, the old team members are now required to look for new projects – a disincentive to advancing a concept through the gate.

Research Challenges. The most critical research challenges in this area include:

- Improved development of non-sequential PD processes
- An understanding of which process is best in which situations
- An understanding of when it is appropriate to modify processes

- An understanding of the explicit and implicit rewards and incentives that encourage PD teams to either abide by or circumvent formal processes

The fuzzy front end

Conceptually, early decisions in product develop (PD) processes have the highest leverage. This is mitigated somewhat by spiral processes, but there is no doubt that the "fuzzy front end" of a PD process has a big effect on a product's ultimate success. If a firm can identify the best market opportunity, technological innovation, or set of unmet customer needs, then the remaining steps become implementation. While this conventional wisdom remains to be tested systematically, recent years have seen interesting research on the fuzzy front end of PD. Since Smith and Reinertsen (1992) coined the phrase, researchers in technology management have worked to identify factors associated with successfully completing the fuzzy front end and managing (or "defuzzifying") front-end processes more effectively (Khurana and Rosenthal 1997; Kim and Wilemon 2002; Koen et al. 2001). We focus on the two aspects of the fuzzy front end that can be addressed effectively with research in marketing – ideation and disruptive technology and radical innovation.

Ideation. Idea generation (ideation) has long been recognized as a critical start to the PD process. Early work on brainstorming led to structured processes based on memory-schema theory to encourage participants to "think outside the box." For example, the methodology developed by Synectics helps teams "take a vacation from the problem," while de Bono encourages lateral thinking and the "six-hats" method of seeing the problem from different perspectives (Adams 1986; Campbell 1985; de Bono 1995; Osborn 1953; Prince 1970). Many popular-press books propose alternative processes to foster the creation of unorthodox ideas. While these processes have proven effective in some situations, opportunities exist for comparative research to identify which methods work best when and behavioral research to identify why.

More recently, three streams of research have sought structure within ideation to create practical tools: templates, TRIZ, and incentives. Goldenberg and colleagues (e.g., Goldenberg, Lehmann, and Mazursky 2001; Goldenberg, Mazursky, and Solomon 1999a, 1999b, 1999c) proposed that most new product concepts come from thinking inside the box with creative templates that transform existing solutions into new solutions. The authors defined a template as a systematic means of changing an existing solution into a new solution. Templates consist of smaller steps called "operators": exclusion, inclusion, unlinking, linking, splitting, and joining. For example, the "attribute dependency" template operates on existing solutions by applying the inclusion and then the linking operators. Other templates include component control (inclusion and linking), replacement (splitting, excluding, including, and joining), displacement (splitting, excluding, and unlinking), and division (splitting and linking). The authors provided practical examples and presented evidence that templates account for most historic new products and enhance the ability of teams to develop new ideas.

TRIZ (Theory of Inventive Problem Solving) is another "in-the-box" system used widely by product development professionals (e.g., Altschuler 1985, 1996). TRIZ, based on patterns of previous patent success, asks PD teams to apply inventive principles to resolve tradeoffs between a limited set of "competing" physical properties (approximately 40 in number). Marketing has paid little attention to TRIZ, but research opportunities exist to study its relationship to the customer's voice in comparing the multiple technical alternatives generated.

Studying the role of incentives in the ideation process, Toubia (2004) used agency theory to demonstrate that some reward systems encourage further exploration, wider searches, and more effort than others. Based on the theory, he developed an ideation game in which participants are rewarded for the impact of their ideas, not the ideas themselves. The ideation game uses economic theories of mutual monitoring to reduce free-riding and minimize the cost of moderation. Early successes suggest that the game is fun, effective, and produces ideas of significantly higher quantity and quality.

Disruptive Technology and Radical Innovation. Selecting the right technology to develop is critical to product development success. Technology-strategy researchers have long conceptualized technological evolution as a series of S-curves (Foster 1986). That is, when a feature of interest, say capacity in disk drives, is plotted versus time, the technological frontier forms an S-shaped curve – a period of slow improvement during initial development, then a period of rapid improvement as the technology is adopted widely, and then a plateau. In theory, these S-curves overlap. For example, while one technology is in its rapid-improvement stage, a newer technology may be in its slow-improvement period. Later, when the older technology plateaus, the newer technology may be in its rapid-growth phase and pass the older technology in capability. See Figure 2.

Bower and Christensen (1995) and Christensen (1998) provide many examples where the newer technology surpasses the older technology and disrupts the industry. Often the newer technology is championed by an entrant that surpasses incumbents that cling to the older technologies. The theory is appealing, but anecdotal. There is no good evidence that all technologies follow S-curves (Danneels 2004). Furthermore, older technologies often coexist with newer technologies for many years; e.g., fluorescent lighting provides more light at lower cost, but incandescent lighting remains a viable technology (Sood and Tellis 2004). Faucet-based home water filtration is much less expensive per gallon, but the market for pitcher-based water filtration remains strong. Hybrid vehicles have significantly better fuel economy, but they remain a niche product and likely will remain so for many years to come. Hydrogen-powered vehicles are still in technology development. The research challenge is to identify a disruptive technology early enough to allow the technology transition to be managed (Danneels 2004).

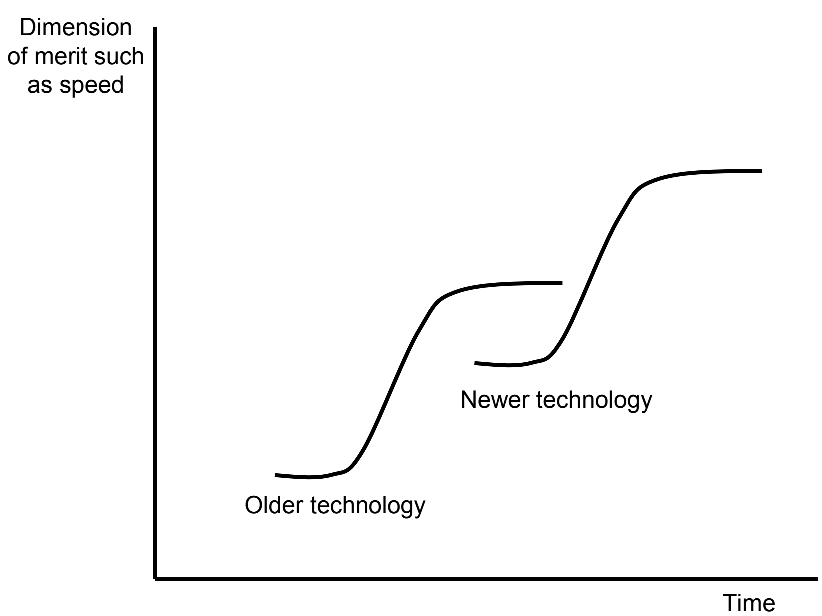


Figure 2

Marketing methods can add to this debate by recasting the focus from a product- or technology-centric one to a customer-centric one. For example, 3½" disk drives surpassed 5¼" disk drives in part because customers started demanding smaller size and lower power consumption for portable computers. Initial customers were willing to make tradeoffs accepting lower capacity for smaller size. Similarly, pitcher-based water is stored at refrigerator temperatures. Customers are willing to sacrifice filtration efficiency for better perceived taste. By building customer response directly into the theory of technological evolution, marketing researchers could transform the debate on disruptive technology and provide normative tools for technological strategy selection in the early stages of product development.

Radical innovations may or may not be disruptive in nature. However, with step-change leaps in performance or cost reductions, they have the potential to provide the firm with profits and long-term competitive advantage (Chandy and Tellis 1998; Sorescu, Chandy, and Prabhu 2003). Rather than starting from market needs, radical innovation most frequently starts from technology capability. These projects, due to their technology-development nature, spend a long time in the fuzzy front end. While there is an active stream of research and publications on this topic by innovation researchers, very little has been published in the marketing literature. The Radical Innovation Research Program at Rensselaer Polytechnic Institute has used qualitative, longitudinal research to identify key research hypotheses about managing radical innovation (Leifer et al. 2000). The research hypotheses suggest that it is important to identify the customers and markets who will find the innovation most appropriate first and to find ways to query these customers about concepts and technology that are outside their realm of experience (O'Connor and Veryzer 2001; Urban, Weinberg, and Hauser 1996; Urban et al. 1997). There are many challenges, relative to incremental products, when moving these technologies from the laboratory to the market (Markham 2002; O'Connor, Hendricks, and Rice 2002).

Research Challenges. While much is known about the fuzzy front end of product development, key research challenges remain. These include:

- An evaluation of the relative merits of structured ideation methods (in the box) versus mental-expansion ideation methods (out of the box)
- Methods for understanding initial applications and obtaining customer needs and wants for radical innovation, especially from lead users and in novel situations
- Proper definitions and practical tools to identify when technologies are disruptive and when they are not
- Practical tools to identify when new customer needs are becoming important and could thus lead to disruption in the market

Design tools

Suppose that the product development (PD) team has addressed the fuzzy front end to identify an attractive market to enter and has generated a series of high-potential ideas to enter the market. The market might be defined by a technology (digital video recorders), by a competitive class (TiVo, DIRECTV), by a set of high-level customer needs (control my television viewing experience), or by some combination of technology, competitive class, and customer needs. In both sequential and non-sequential processes, the PD team now seeks to design and position a product or product-line (platform) offering relative to these customer needs, technologies, and competitive classes.

The field of marketing has been extremely successful in the development, testing, and deployment of tools to aid in the design of new products. Methods include research on customer perceptions and preferences (Green and Wind 1975; Green and Srinivasan 1990; Srinivasan and Shocker 1973), product positioning and segmentation (Currim 1981; Green and Krieger 1989a, 1989b; Green and Rao 1972; Hauser and Koppelman 1979), and product forecasting (Bass 1969; Jamieson and Bass 1989; Kalwani and Silk 1982; Mahajan and Wind 1986, 1988; McFadden 1970; Morrison 1979). On conjoint analysis alone there are over 150 citations in the top marketing journals. In this section we highlight some of the new directions, including web-based methods for improving customer inputs to design, the customer-active paradigm, design for consideration, product-optimization design tools for improving product design decisions based on customer inputs, and distributed PD service exchange systems that help marketing and engineering simultaneously make better decisions.

Web-Based Methods for Improving Customer Inputs to Design. With the wide availability of web-based panels, more firms are moving their research on customer perceptions and preferences to the web. Such panels enable research to be accomplished much more rapidly and with an international scope. While early indications suggest that such web-based panels provide accuracy that is sufficient for product development, the evidence to date is anecdotal. There is ample opportunity for systematic studies of the reliability and the validity of web-based panels.

Web-based methods, coupled with rapid algorithms and more powerful computers, enable design tools to be interactive and interconnected (see review in Dahan and Hauser 2002). For example, Toubia, Hauser, and Simester (2004) and Toubia et al. (2003) have developed adaptive methods for both metric and choice-based conjoint analysis that appear to be accurate with far fewer questions than traditional methods. Such adaptive methods enable PD teams to explore more product features and to explore them iteratively in spiral processes. Other web-based methods, such as the idea pump, focus on qualitative input by encouraging customers to define both the questions and answers and thus identify breakthrough customer needs that lead to disruptive new products (see review in Dahan and Hauser 2002). Fast, dynamic programming algorithms can now search potential lexicographic screening rules so fast that lexicographic estimation problems that once took two days can now be solved in seconds (Martignon and Hoffrage 2002). These algorithms make non-compensatory conjoint analysis feasible. Finally, methods based on support-vector machines promise to handle complex interactions among product features (Evgeniou, Boussios, and Zacharia 2004; Evgeniou and Pontil 2004).

Customer-Active Paradigm for Designing Products. Von Hippel (1986, 1988) has long advocated using customers as a source of new product solutions and ideas. Recognizing the ability of customers to innovate, von Hippel and others have developed tools that enable customers to design their own products. In these tools, known variously as innovation toolkits, design palettes, user design, and configurators (Dahan and Hauser 2002; Thomke and von Hippel 2002; von Hippel 2001), customers are given a set of features and allowed to configure their own product. These toolkits are often quite sophisticated and include detailed engineering and cost models. For example, when a customer seeks to change the length of a truck bed, the design palette computes automatically the additional cost and the required changes in both the engine and the transmission. The design palette might even adjust the slope of the cab for aesthetic compatibility. While these toolkits are becoming widely available, research on their impact on customer decisions has just begun (Liechty, Ramaswamy, and Cohen 2001; Park, Jun, and MacInnis 2000). Virtual advisors are another source of customer input. For example, Urban and Hauser (2004) demonstrated how to "listen in" on customers who seek advice on new trucks. Customers reveal their unmet needs by the questions they ask.

Design for Consideration. Traditional preference measurements, such as voice-of-the-customer methods and conjoint analysis, are based on a compensatory view of customer decision-making. Models assume that customers are willing to sacrifice some performance on one feature, say personal computer speed, for another feature, say ease of use. For most product categories, this assumption is reasonable and provides valuable insight for new potential concepts. However, increasingly, product categories are becoming crowded. Over 300 make-model combinations of automobiles are available. Ninety-seven models of

PDAs are available from one university's supplier. Furthermore, customers are increasingly using web-based searches to screen products for inclusion in their consideration sets. J. D. Power (2002) reports that 62% of automobile purchasers search online. Such web-based searches often allow customers to sort products on key features. General Motors, in particular, considers its greatest design challenge in the 2000s to be the ability to design products that customers will consider. General Motors feels that if it can encourage more customers to consider GM vehicles, the engineering team will feel pressured to design automobiles and trucks that will win head-to-head evaluations within the consideration set. As a result, General Motors has invested heavily in web-based trusted advisors, directed customer relationship management, and other trust-based initiatives (Urban and Hauser 2004).

With good information-search tools available, and with the increasing number of alternatives being offered in many product categories, firms are studying when customers use decision heuristics, such as lexicographic, conjunctive, or disjunctive decision processes, to screen products (e.g., Bettman, Luce, and Payne 1998; Bröder 2000; Einhorn 1970; Gigerenzer and Goldstein 1996; Johnson and Meyer 1984; Martignon and Hoffrage 2002; Payne, Bettman, and Johnson 1993). Understanding decision heuristics helps PD teams identify the "must-have" features that will get their products into these consideration sets. Traditional models, which assume compensatory decision-making, may miss these features. While there has been extensive experimental and econometric research on non-compensatory decision-making (above citations plus Jedidi, Kohli, and DeSarbo 1996; Gensch 1987; Gensch and Soofi 1995; Roberts and Lattin 1997; Swait 2001), only recently have researchers begun to develop the measurement tools to identify noncompensatory processes and measure their impact as they relate to the identification of opportunities in product development.

Product-Feature and Product-Line Optimization. There is a long history of product optimization in marketing (see reviews in Green, Krieger, and Wind 2003 and Schmalensee and Thisse 1988). These methods have sought to identify either an optimal product positioning or an optimal set of product features. With the advent of more powerful computers, improved models of situational consumer decision-making processes, greater understanding of competitive response, and improved optimization algorithms in operations research, we expect to see a renewed interest in the use of math programming to inform product design. This convergence and the resulting renewed development of optimization tools may be enhanced by the advent of new distributed PD service exchange systems, which allow marketers and engineers to increase decision simultaneity.

Distributed PD Service Exchange Systems. Product development can be complex. For example, typical electromechanical products might require close to a million engineering decisions to bring them to market (Eppinger 1998; Eppinger et al. 1994). Even software products require disaggregated yet coordinated processes involving hundreds of developers (Cusumano and Selby 1995; Cusumano and Yoffie 1998). Furthermore, PD teams are often spread over many locations, use different software, and have different worldviews. Coordination is a challenge.

To reduce communication time and effort and to effect compatible analytical systems, researchers have developed distributed service exchange systems (Senin, Wallace, and Borland 2003; Wallace et al. 2000). These systems rely on service (and data) exchange with compatible objects rather than just a data exchange. For example, the voice-of-the-customer team might invest in a conjoint analysis of the features of a new computer (speed, data-storage capacity, price, etc.) and build a choice simulator that predicts sales as a function of these features. The physical modeler might build a computer-aided design (CAD) system in which physical characteristics of a disk drive are input, and capacity and speed are output. The systems modeler might have a platform model that takes the dimensions of the disk drive and models its interactions with other components of the computer. Each of these teams, and many others, require and generate information that is connected through a virtual integrative system – each node takes input from the others and provides the needed output. When these distributed objects are interconnected, the PD team can test conceptual design rapidly without needing to build the physical product. Such systems reduce dramatically the time required to cycle through the stages of the PD process. These distributed systems are particularly useful when coupled with spiral or overlapping PD processes. One of the most difficult tasks in designing these systems is creating the ability to access and work with nonnumeric data such as audio, video, and even text (Zahay, Griffin, and Fredericks 2004).

Other researchers are using engineering tools such as analytic target cascading, combined with marketing tools such as hierarchical Bayes choice-based conjoint analysis, to integrate product-line design (Michalek et al. 2004; Michalek, Feinberg, and Papalambros 2005). These tools are promising because they can be linked to marketing positioning strategy and decisions on the one hand and to specific engineering design and manufacturing decisions on the other hand.

Research Challenges. Research on the development of design tools is mature, but many challenges remain. Not only must these tools be consistent with both sequential and non-sequential processes, but they also need to be coordinated throughout the PD process(es) from the fuzzy front end to launch and profit management. There are many opportunities for incremental development of all extant design tools. The broader challenges are:

- Measures that are more adaptive and can engage the customer in new and interesting ways to take advantage of fast computers and web-based interviewing
- Practical methods to incorporate ideas from behavioral decision theory to enable firms to design products to enhance consideration
- Practical methods to optimize the product line's total offerings and integrate customer needs, engineering models, and competitive response
- Platforms that link engineering and marketing decision-making and constraints into integrated systems

Testing and evaluation

In both sequential and non-sequential product-development processes, designs must be tested before the firm ramps up investment. Interest continues on testing and evaluating product concepts, engineering solutions, and product positioning. Prior research on beta testing, pretest markets, prelaunch forecasting methods, information acceleration, and test markets has provided PD teams with the ability to evaluate designs accurately and at a cost much lower than that of a full-scale product launch. See critical reviews in Dolan and Matthews (1993), Narasimhan and Sen (1983), Ozer (1999), Shocker and Hall (1986), and Urban et al. (1997). Recent advances in modeling heterogeneous customer response with hierarchical Bayes and/or latent-structure analyses provide the potential to monitor and evaluate designs at a much greater level of detail and accuracy. For example, General Motors is exploring the use of hierarchical Bayes methods combined with continuous-time Markov models to evaluate the impact of new strategies as they affect the flow of customers from awareness to consideration to preference to dealer visits to purchase.

Research Challenges. Testing and evaluation is a relatively mature area of research in PD. Research challenges share many of the same characteristics as the challenges for design tools:

- Taking advantage of fast computers, web-based multimedia, and new adaptive algorithms
- Integrating marketing and engineering evaluation
- Incorporating optimization and coordination

Project portfolio management for product development

A firm's overall profitability results from the portfolio of products it commercializes over time and across product lines. Managing the portfolio means making strategic investments in markets, products, and technologies. The strategy literature has focused on the strategic portfolio. In this section we focus on selecting projects to fulfill strategic goals and on managing the set through the development process.

Research on the selection of a product portfolio suggests that success requires an effective process that includes both strategy and repeated review to create a balanced, profit-maximizing portfolio (Cooper, Edgett, and Kleinschmidt 1997, 1998, 1999). Top-performing firms use formal, explicit processes, rely on clear, well-defined procedures, apply these procedures consistently, and include active management teams. Although financial approaches dominate portfolio decisions, Cooper, Edgett, and Kleinschmidt (1999) suggested that scoring approaches, used in conjunction with strategic focus, yield the most profitable innovation portfolios.

While most research in marketing has focused on tools and methods to design a portfolio of products for a target market (or on game-theoretic insights into the characteristics of product portfolios), research in product development has begun to focus on project selection and set management as a means to obtain a balanced, profitable portfolio (Blau et al. 2004; Bordley 2003; Sun, Xie, and Cao 2004). Differences in ratios of line extensions, product improvements, and new-to-the-world (or radical) products impact financial outcomes (Sorescu, Chandy, and Prabhu 2003). Whether the project is a platform or derivative product and how architecturally modular the product is will impact the choice of product-development process and affect a firm's ability to obtain consumer reactions, and it may change the choice of the organizational home for the project (Ulrich 1995; Wheelwright and Clark 1992).

Finally, in a departure from explicit optimization, many firms have begun treating product development projects as options. Because data are often difficult to obtain, this approach is often referred to as "options thinking" rather than options analysis (Faulkner 1996; Morris, Teisberg, and Kolbe 1991). For example, General Electric and Motorola now use a three-horizon growth model to balance risk and to enhance a long-term perspective (Hauser 1998).

Research Challenges. The area of project portfolio selection and management is relatively new to marketing. The interesting challenges in this area are:

- Improving procedures to select projects to achieve a strategic portfolio
- Improving (and generalizing) methods to relate portfolio decisions to future performance outcomes
- Understanding how contextual differences in industry and in the characteristics of the portfolio goals affect project selection
- Developing methods to manage risk and long-term perspectives through options thinking methodologies

Summary: Product development

In this review, we have focused on product-development research that is primarily prescriptive. Due to space constraints, we have chosen not to review the many game-theoretic models of portfolio strategy. Game-theoretic models have provided important insight by simplifying product-development decisions to highlight strategic considerations. Many important and difficult research challenges remain to connect these strategic models to the prescriptive literature.

Prescriptive research focuses on how firms improve their product-development processes, develop better fuzzy-front-end ideas, use better design tools, test innovations effectively, and choose projects relative to a strategic portfolio. Our selective review of this area has focused on areas that have high potential for contributions by researchers in marketing science. However, to understand the challenges in these areas and in the broader area of innovation, we must recognize that product development takes place within the context of an organization and its strategy – the two areas we address next.

Organizations and Innovation

Innovation is driven by people, and (most) people work in organizations. As summarized in Table 1, we begin with research on the contextual and structural drivers of innovation. We then summarize research on how firms organize for innovation. Our third subsection addresses how the methods and tools from the previous section are adopted by organizations. Our fourth subsection addresses how metrics are used to coordinate and motivate people in organizations to innovate profitably.

Contextual and structural drivers of innovation

Many authors have explored the characteristics of organizations that enhance innovation capability (Burns and Stalker 1961; Damanpour 1991; Ettlie, Bridges, and O'Keefe 1984; Hage 1980). These authors argue that unique strategies and structures, such as self-directed new venture groups charged with moving the firm into a new market, lead to radical process and packaging adoption. On the other hand, incremental process adoption and new-product introduction tend to be promoted in more traditional organizational structures and in larger, complex, and decentralized organizations.

These findings relate to the question of whether the size of the organization matters, a perspective rooted in Schumpeter's (1942) idea of creative destruction, in which innovations destroy the market positions of firms committed to the old technology. This research is ongoing, with at least five competing schools of thought. Galbraith (1952) and Ali (1994) posited that large firms have advantages such as economies of scale and the ability to bear risk and access financial resources, which enable them to innovate. On the other hand, Mitchell and Singh (1993) suggested that small firms are better equipped to innovate, as large firms are gripped with inertia. Ettlie and Rubenstein (1987) suggested that the relationship is non-monotonic and that medium firms are best suited. Still another group (Pavitt 1990) argued that medium firms are most disadvantaged, as they bear the liabilities of both small and large firms but not the advantages. Perhaps the most interesting perspective is that of Griliches (1990), who analyzed the same data with a variety of models to suggest that the data fit most of these hypotheses and that the outcomes depend heavily on the pre-specification of the econometric function.

While size may be the most controversial of the drivers of innovation capability, researchers have explored many firm characteristics as they relate to innovative potential. This information was summarized by Vincent, Bharadwaj, and Challagalla (2004) based on a meta-analysis of 27 antecedents and three performance outcomes of organizational innovation in 83 studies between 1980 and 2003. They found that, in addition to 10 resource/capability factors, the following categories of factors affect innovation:

- Environment: competition (+), turbulence (+), unionization (–), and urbanization (+)
- Structure: clan culture (+), complexity (+), formalization (+), interfunctional coordination (+), and specialization (+)
- Demographic: age (+), management education (+), professionalism (+), and size (+)
- Method factors: use of dichotomous measures of innovation (–), use of cross-sectional data (+), studied process versus product innovation

In related research, Chandy and Tellis (1998) introduced the concept of "willingness to cannibalize" as a critical driver of a firm to introduce radical innovations. They found that this variable was influenced by specialized investments, presence of internal markets, product champion influence, and future market focus. Chandy, Prabhu, and Antia (2003) looked at the role of technological expectations on firms' investments in radical innovation and found that the fear of obsolescence is a more powerful motivator of investment in radical innovation than is the lure of enhancement. Moreover, dominant firms that fear obsolescence are much more aggressive in pursuing radical technologies than are their less-dominant counterparts with the same expectation.

Research Challenges. Whether firms wish to organize for innovation or they want to match organizational and innovation goals, they must understand the drivers of innovative potential. Some of the key unanswered issues are:

- Role of a firm's internal culture in influencing innovation, including factors such as willingness to cannibalize, visionary leadership, future market orientation, and customer orientation
- Differences in the drivers of innovation by innovation type (product versus process), category (products versus services), and other characteristics; of particular interest are interactions, rather than just main effects
- Impact of macroenvironmental factors such as research clusters, research incubators, and governmental policies (taxes, incentives, and regulation) on innovation
- Impact of cultures and ethnicity on innovative capabilities

Organizing for innovation

While many contextual and structural variables affect innovation capabilities, one structural factor that the firm can control is how it organizes for innovation. Although organization structure and culture are sticky and difficult to change, firms can affect many aspects of organization for innovation. We choose to review four sub-areas of organizational research that are relevant for innovation and ripe for study: overall organizational forms, teams, cross-boundary innovation management, and commitment.

Organizational Forms. Larson and Gobeli (1988) asked managers to evaluate five project-management structures against cost, schedule, and technical performance goals as mechanisms for organizing PD projects. They found that project-matrix and project-team structures performed favorably. More recently, researchers have advocated product development teams that are led by functional managers, project managers, or self-appointed champions. Clark and Fujimoto (1991) and Wheelwright and Clark (1992) recommended "heavy-weight" project managers as the best way to lead teams in mature, bureaucratic firms developing complex products (e.g., the auto industry). However, innovation also occurs in smaller firms, in geographically distributed teams, in fast-clock-speed industries, and for less-complex products. Champions are not consistently effective in other industries; more likely they are indirectly linked with success (Markham and Aiman-Smith 2001; Markham and Griffin 1998). Functional managers may be appropriate leaders for particular stages of innovation: For example, an R&D manager may effectively lead a radical innovation in the fuzzy front end.

Teams. The composition of teams as well as leadership is important to innovation. Cross-functional teams are associated with higher firm success and faster new-product development (Griffin 1997a, 1997b). But cross-functional teams require that people be drawn from and interact with many internal stakeholders in the firm. Ancona (1990) suggested that successful teams include people in at least five important roles: ambassadorial (representing the team to key stakeholders), scouting (scanning the environment external to the team for new information), sentry (actively filtering incoming information), guarding (actively filtering outgoing information), and task coordination. More recently, in light of enhanced web-based communication and increased geographic distribution, Sarin and Shepherd (2004) suggested that the influence of boundary management now is very different from that reported previously. Product development often takes place in virtual teams connected only by the Internet and working across geographic boundaries, time zones, and cultures. Because of this, specific sentry and scouting roles seem to be less important than in the past, with ambassadorial and coordination roles more important.

Cross-boundary Management. Innovation is increasingly being managed across boundaries with names such as co-development, development alliances, and development networks. Some co-development is done with competitors, some with suppliers, some with customers, and some with firms that have no relationship to the firm's current business but bring a needed capability to the partnership. While it is a "hot topic" in the practitioner literature, and some initial research exists in the strategy literature, virtually no one in marketing has entered this research arena to investigate the impact of these joint development projects on product preferences, brand image, channel management, pricing, or marketing communications.

Commitment. The form of organization is related to the propensity of some teams to balance the risks and rewards of innovation. In some cases, managers overvalue projects and innovations in which they have already invested. While such experience might be viewed as sunk costs, it affects careers and the motivations of managers. This research began with the work of Staw (1976), who showed that commitments to negative R&D decisions escalate with increasing responsibilities for those actions. This was explored further by Simonson and Staw (1992) and Boulding, Morgan, and Staelin (1997), who suggested strategies to deescalate commitment.

Research Challenges. Organization remains important for innovation, and many challenges remain for research in this area:

- Identifying when teams, cross-functional teams, virtual teams, or other organizational forms are best for innovating
- Identifying what variables mediate the choice of team and team structure for different product strategies and contexts
- Researching virtual teams and those that span geography, time zones, and cultures
- Understanding the best form(s) of team leadership for fast-clock-speed and distributed environments
- Investigating the best organizational forms for co-development projects
- Understanding how co-development influences marketing strategies, tactics, and outcomes
- Identifying the best organizational forms and incentive structures to motivate managers to kill futile projects

Adoption of new tools and methods

In the previous section, we reviewed many of the new tools for product development. Despite extensive research on the development of tools to enhance the end-to-end product development process, organizations still struggle with the execution of those processes (e.g., Anderson, Fornell, and Lehmann 1994; Griffin 1992; Howe, Gaeddert, and Howe 1995; Klein and Sorra 1996; Lawler and Mohrman 1987; Orlikowski 1992; Wheelwright and Clark 1992).

Failures often are due to communication breakdowns or suspicion among team members. For example, team members who are experts with an old tool fear losing status when a new tool is introduced. Another reason for failure is that benefits of the new tool are initially oversold. New methods are difficult to learn and implement and often divert effort from other aspects of product development (Repenning 2000, 2001). To overcome implementation problems, researchers have proposed boundary objects, communities of practice, and dynamic planning.

Boundary Objects. New methods are more likely to be used effectively if the PD team understands the dependencies across boundaries in the organization. Carlile (2002, 2004) has suggested that some objects, called boundary objects, effect communication among team members and enhance the adoption of new methods. Such boundary objects might be CAD/CAE tools, the House of Quality, conjoint simulators, or other tools that cross organizational boundaries.

Communities of Practice. Knowledge about product development tools is often embedded in social groups within the organization (Lave and Wenger 1990, Wenger 1998). To ease the adoption of new methods, organizations need to tap this distributed (often implicit) knowledge. In recent years, firms have developed communities of practice that share and evolve process and domain knowledge. Such communities are enhanced with web-based tools.

Dynamic Planning. Repenning and Sterman (2000, 2001, 2002) have cautioned that the adoption of new methods is an investment that needs to be amortized over multiple projects. If firms demand an immediate return on a single project, they will undervalue the new method. It is also important to understand the interrelationships between manager expectations and the allocation of effort within PD teams. Managers and PD teams need to manage expectations and allocate sufficient time to learn tools before evaluating their success in an organization.

Research Challenges. Many challenges for research on the adoption of new tools and methods remain, including:

- Understanding the organizational issues that explain why some tools and methods succeed and others do not
- Developing normative processes to aid the adoption of new tools and methods—such processes might combine boundary objects, communities of practice, and dynamic planning

Metrics-based management

Once a firm understands the drivers of innovation, selects the best organizational form, and structures its organization to adopt new tools (when relevant), it must coordinate and motivate the people who are on the front line of innovation. However, PD is complex. For example, Eppinger et al. (1994) and Eppinger (1998) suggested that typical electromechanical products require close to a million engineering decisions to bring them to market.

To address that complexity and to provide both managerial control and incentives for the product-development team, researchers have suggested that teams be managed by metrics. While quantitative metrics are tempting, they can lead to adverse behavior. Consider the strategy of rewarding team members for the success of a new product by tying implicit rewards (promotion, advancement, exciting projects) to the ultimate market success of a product. If team members are risk-averse, such incentives may motivate them to take fewer risks than are optimal and to bet on safe technologies, safe markets, and line extensions. Similarly, if team members are rewarded only for their own ideas and not for those from outside the firm, they will adopt a "not invented here" attitude and spend too much time on internal projects relative to exploring new technologies and new markets (Hauser 1998). Recent research has begun to address how to adjust team incentives and to select higher-level metrics to avoid some of this adverse behavior.

Relational Contracts. Research in agency theory suggests that formal incentive mechanisms are not sufficient to "induce the agent to do the right thing at the right time" (Gibbons 1997, p. 10). In real organizations, formal mechanisms are often supplemented with informal qualitative evaluations based on long-term implicit relationships (e.g., Baker, Gibbons, and Murphy 1999). This is particularly important when decisions are delegated to self-managed PD teams.

Balanced Incentives. Cockburn, Henderson, and Stern (2000) suggested that new tools and methods are adopted more quickly if they are complementary to methods already in use by an organization. They illustrated their suggestions with science-based drug discovery in the pharmaceutical industry, which requires organizations to adopt more high-powered incentives within the research organization. Perhaps the best-known example of balanced incentives is the balanced scorecard that is used extensively in industry and by the military (Kaplan and Norton 1992).

Priority Setting. Another stream of research takes the metrics as given and seeks to adjust the emphasis on alternative metrics to maximize the profit of the firm. By approximating the profit surface with a Taylor's Theorem expansion, it is feasible to apply adaptive control theory to adjust incentives in the direction that maximizes profit (Hauser 2001; Little 1966). For example, in one application, profits were increased dramatically by placing less emphasis on component reuse and more emphasis on customer satisfaction (Hauser 2001).

Research Challenges. Research opportunities in the area of metrics-based management include:

- Identifying the appropriate metrics based on explicit models of the product-development team's incentives (agents)
- Empirically testing hypotheses for relational contracts and balanced-incentive theory
- Developing practical models for setting and adjusting priorities for innovation

Summary: Organizations and innovation

Our review of organizations and innovation identifies many issues with great potential for research by marketing scientists. Many contextual issues are associated with the marketing tactics or product type (radical versus incremental, product versus service, etc.) that influence a firm's ability to innovate or to adopt innovations. The relationship between how organizations integrate across boundaries, especially those at the edge of the firm, and the integration of marketing concepts into a product-development organization are open fields for investigation.

Market Entry and Defense

The previous sections reviewed prescriptive methods and organizations that facilitate successful innovation. However, innovation rarely occurs in a vacuum. It is the strategic action of a firm that competes with rivals in a market. This section reviews whether, when, or how a firm should innovate, or, alternatively, how it should defend against innovation by competitors. We identify three subfields of research that addresses these issues: technological evolution and rivalry, strategies for entry and defense, and rewards to entrants.

Technological evolution and rivalry

To make wise decisions about the timing and technology with which to enter markets, firms need to understand the rate, shape, and dynamics of technological evolution. Research in this area seeks to inform managers about the potential of rival technologies, when such rival technologies will be commercialized, when to quit the existing technology, and when to invest in a rival technology.

Authors in the technology literature have typically focused on progress on a primary dimension of merit, often hypothesized as the most important customer need for a particular segment of consumers at the time the innovation emerges. Examples are brightness in lighting, resolution in computer monitors and printers, and recording density in desktop memory products. Based on this view, the dominant thinking in this field is that the plot of a technology's performance against time or research effort is S-shaped, as in Figure 2. The stylized model is that performance of successive technologies follows a sequence of ever higher S-curves that overlap with that of a prior technology just once (Foster 1986; Sahal 1981; Utterback 1994). Separate theories exist for each of the three major stages of the S-curve: introduction, growth, and maturity (see Abernathy and Utterback 1978; Utterback 1994). These theories describe each of the stages as emerging from the interplay of firms and researchers across the evolving dynamics of competing technologies.

There are at least four implicit assumptions in this literature. First, a "disruptive technology" is often identified post hoc, that is, after it has disrupted the business of incumbents (Danneels 2004). To make investment decisions, firms must be able to identify those early technologies that will disrupt an industry and those that will not. Second, the S-curve theory appears to be based on anecdotes rather than a single unified theory supported by large-sample cross-sectional evidence. Third, the theory ignores cases where new and old technologies coexist and improve steadily: Examples include (1) incandescent and LED lighting, (2) copper, fiber-optic, and wireless communications technologies, and (2) CRT, LCD, and plasma video displays. For example, in an initial study of 23 technologies across six categories, Sood and Tellis (2004) suggested that prototypical S-curves fit the data for only 26% of the technologies.

Fourth, evolution in technology might be due to changing preferences across needs rather than an S-curve on a single need. For example, in the classic disk-drive example (5¼" to 3½" disks), greater demand for portable computers meant that end customers were willing to accept lower capacity for smaller size and weight. When viewed from a compensatory model of consumer decision-making, perhaps measured with conjoint analysis, the new technology was an improvement in overall consumer utility relative to the previous technology. Such consumer-oriented perspectives complement rather than replace theories of technology supply and development.

Research Challenges. Disruptive technology has enjoyed substantial popularity in the trade press, where the S-curve appears to be well accepted. However, many research challenges exist to carefully critique, validate, and refine these concepts and theories so that they might enable mangers to make good decisions on market entry and defense. Among the research challenges are:

- Clearly delineating the types of innovations, such as platforms, that start a new technology (new S-curve) from those that sustain improvements in performance (advances along an S-curve)
- Testing the various assumptions in the current theories of the S-curve and technological disruptions
- Developing a single, strong, unified theory for the S-curve of technology growth, if the phenomenon is valid, and identifying the platform, design, and industry contexts across which it applies
- Developing new theories that describe how technologies evolve, compete, dominate, or coexist with a rival
- Integrating theories of technology evolution (S-curves) with marketing theories of the evolution of customer needs and strategic positioning

- Modeling predictions of whether and when an old technology is likely to mature or decline and a new technology is likely to show a jump in performance—so managers can avoid prematurely abandoning a promising technology

Strategies of entry and defense

Once a firm has a good understanding of technological evolution, it needs to decide how to exploit that evolution given its resources and the resources and strategies of its rivals. One of the best ways to achieve competitive advantage and gather monopoly profits is to lead the curve of technological evolution by successful innovation, which is then protected by patents. However, gaining patent protection is not always possible. Even with patent protection, rivals can find ways to innovate around a patent. Thus, practically, most innovation decisions must consider the potential for and patterns of entry by competitors.

We categorize entry and defense from at least four perspectives.

1. Preemption Strategy. In some cases, based on the technological frontier, an incumbent (or even an initial entrant) has sufficient information to anticipate future entry. This is the classical preemption strategy. The incumbent firm (or entrant) selects its product positioning (customer benefits) to maximize its profits while anticipating future entry. Such analyses usually assume sufficient symmetry among firms to obtain analytical solutions and, as such, do not rely on unique core competencies. In some cases, firms might preannounce new products, leapfrog generations of technologies, establish a product-line defense, or invest optimally in future product development. In other cases, firms might stay one step ahead of the competition by introducing innovations that cannibalize its own successful products.
2. Defensive Strategy. In some cases, despite attempts by the incumbent to preempt entrants, a new firm enters an existing market successfully offering new combinations of benefits to customers. This is the classical defensive strategy problem. The incumbent firm must readjust its product positioning and marketing tactics to maintain optimal profits. Such analyses normally assume asymmetric core competencies of firms and further assume that the entrant has entered optimally, anticipating the response by the defender.
3. Technological Races. In some cases, it is clear that a new technology is on the horizon, say hydrogen power for automobiles. However, realizing the benefits of the new technology with a product that satisfies customer needs at a reasonable cost requires R&D success. It is not clear, a priori, which firm will be first to market. Such analyses tend to focus on the strategic decisions made under the uncertainty of the technological race. Few analyses have considered how marketing can be used to enable the losers of technological races to enter and differentiate a market.
4. Competitive Positioning. Related analyses assume that the firms are already in the market and must select their price and positioning strategies. With perfect symmetry, the solutions are often ambiguous. However, slight asymmetries are often sufficient to establish stable equilibria to enable better understanding of how the markets will shake out or evolve.

Some illustrative studies and findings in this area are the following:

Hauser and Shugan (1983) proposed an optimal marketing mix defensive strategy for an incumbent under attack. These methods have been applied empirically (Hauser and Gaskin 1984) and have been shown to hold under equilibrium conditions (Hauser and Wernerfelt 1988). These authors' major theoretical conclusions are that, under attack, firms should build on their current strengths relative to the attacker and, except for highly segmented marketing, reduce price and spending on distribution and awareness advertising. Profits typically decrease due to the entrant, but the optimal defensive strategy will maintain them at the highest feasible level.

Purohit (1994) examined the level of innovation and type of strategy of an entrant. He concluded that increasing the level of innovation was the best response to entry by clones. The optimal level of innovation is determined by the strategy adopted by the firm: product replacement, line extension, or upgrading. Nault and Vandenbosch (1996) addressed the related problem of timing the launch of a new generation product. They concluded that when faced with entry, under most conditions, it is optimal for incumbents to launch the new generation product first. Bayus, Jain and Rao (2001) argued that pre-announcement of new products is a means by which firms can signal their investment in resources and intentional vaporware is a means of discouraging rivals from developing similar products.

Ofek and Sarvary (2003) studied the persistence of leadership in high tech markets. They found that technological competence can encourage a leader to invest for technology leadership, while the presence of reputation effects can encourage a leader to underinvest in technology, leading to alternating leadership between a duopoly of firms. Ofek and Turut (2004) examined the tradeoff between leap-frogging versus catch-up imitation when firms have the option of researching the market to reduce uncertainty. They found that firms may innovate "blindly" without such research even when its costs are negligible. Lauga and Ofek (2004) further explored on which attribute firms should innovate given uncertainty about market demand and the option of costly market research.

This area also has limited empirical research. Robinson (1988) examined firms' reactions to new entry using the PIMS data. He found that most incumbents do not react to entry in terms of marketing mix, product, or distribution, as the scale of entry of the new entrant is often too small. It takes at least a year to observe an incumbent's response. In contrast, Bowman and Gatignon (1995) found reactions to be quicker for incumbents with a higher market share or threatened by smaller competitors and those operating in markets which are growing fast or have frequent changes in products. Chandy and Tellis (2000) examined whether new entrants are more likely to introduce radical innovations than are incumbents. They found that before World War II, small firms and new entrants were more likely to introduce radical innovations. In contrast, the pattern has changed dramatically after World War II: Now large firms and incumbents are more likely to introduce radical innovations.

Research Challenges. This area has received growing attention in marketing science. However, many opportunities remain, especially for empirical research that seeks generalizations of firm behavior. Some of the important research challenges are:

- Developing empirical generalizations on what technology and marketing strategies firms actually use for entry and defense
- Understanding the effect of the degree of innovation (status quo, incremental innovation, or leapfrogging) on successful entry or defense
- Understanding the effect of product portfolios (status quo, line extensions, brand extensions, or new platforms) on successful entry and defense
- Untangling the mitigating effect of firm positions (incumbents versus entrants, strong versus weak market position, or low-cost versus high-technology positions) for effective entry and defensive strategies
- Understanding the impact of message (preannouncements, vaporware, positioning, framing) on successful entry and defense
- Determining whether and when firms should use a rapid entry strategy (sprinkler) versus a sequential entry strategy (waterfall) when considering entry in multiple markets or multiple countries

The strategies firms use are closely linked to the rewards they earn, another topic of intense research in innovation, which we consider next.

Rewards to entrants

The study of technology evolution relates to the firm's investment in technology development. Such investments are related to the firm's strategy with respect to entry and defense. Entering a market first often has advantages. For example, arguments in favor of early entry include shaping consumers' preferences, establishing consumer loyalty and/or switching costs, gaining cost and performance advantages from early sales, establishing and maintaining standards, and preempting preferred patents, locations, supplies, and channels. However, there are also advantages to waiting, if later entrants can learn from early entrants' mistakes, take advantage of later technology, and benefit from industry learning (cost and technology), especially if it is hard to preempt patents, locations, suppliers, or channels.

Early papers in marketing (e.g., Robinson and Fornell 1985; Urban et al. 1986) provided strong and consistent support suggesting market share rewards to pioneers. An average measure of this reward across several studies is about 16 market-share points for pioneers over late entrants and 10 market-share points for pioneers over early entrants (Tellis and Golder 2001). Pioneers also were shown to have advantages in terms of broader product line and the ability to hold higher prices, achieve lower costs, achieve broader distribution coverage, and enjoy lower price elasticity. Supporting studies have used survey data (PIMS and Assessor databases) and scanner data. Indeed, support for the generalization about a strong pioneering advantage became so strong that the popular press began to call it the first law of marketing (Ries and Trout 1993). Gurumurthy, Robinson, and Urban (1995), Kerin, Varadarajan, and Peterson (1992), and Lieberman and Montgomery (1988) have provided substantive reviews of the field.

In contrast to these studies, Golder and Tellis (1993) and Tellis and Golder (1996, 2001) used the historical method to study the advantages of pioneers. This method attempts to minimize survival bias and self-report bias. Their analyses suggested that such problems may have biased the past studies cited above; after correcting for such biases, they found that pioneers typically have low market share, mostly fail, and are rarely market leaders.

With the publication of the empirical studies, theoretical research emerged to explain the empirical findings. Early studies developed theories to explain why and how pioneers might have long-term advantages (Carpenter and Nakamoto 1989; Gurumurthy and Urban 1992; Schmalensee 1982), while more recent studies have developed theoretical models to explain the advantages of late market entry (e.g., Narasimhan and Zhang 2000; Shankar, Carpenter, and Krishnamurthi 1998).

Research Challenges. The area of rewards to entrants has been intensely studied in the past two decades. However, many challenges for research remain, including:

- Developing new data or methods to account for survival bias and self-report bias; one option might be explicit modeling of these biases through Bayesian methods
- Developing new data and analyses to examine whether advantages other than market share accrue to market pioneering, such as product line breadth, patents, prices, price elasticity, costs, distribution, and profits
- Assessing the link, if any, between network externalities (reviewed in a previous section) and the rewards to the order of market entry

- Researching the interrelationship of order of entry and organizational issues including the contextual and structural drivers of innovation, the choice of organizational structure, and the metrics by which the process is managed

Summary: Market entry and defense

Our review of research on market entry and defense indicates a wide range of topics, from the purely empirical to the purely theoretical. Much of this research has occurred in marketing, though some highly relevant topics (e.g., the S-curve of technological innovation) have been initiated in related disciplines. Our review also indicates a vast number of topics, many of them with substantial research. Even so, many opportunities for research remain. Such opportunities extend from better measures for phenomena to more generalization about them to more rigorous and complete theories to explain them.

Understanding how consumers will respond to innovation forms a central component in all phases of product development (review Figure 1) and informs research on organizations such as the role of gatekeepers and the interfunctional impact of marketing. The choice of market entry and defense strategies often depends upon models and data on consumer response. The last section of this paper reviews research on consumer response to innovations.

Consumer Response to Innovations

The success of innovations depends ultimately on consumers' acceptance of them. Research in many disciplines, but especially in marketing, has long sought to describe, explain, and predict how consumers (or customers) and markets respond to innovation. A vast body of research has developed on the behavioral and decision aspects of this quest (Gatignon and Robertson 1985, 1991) and on the dynamics by which new products diffuse through a population (Rogers 2003).

Within this vast domain, we identify three subfields that have been particularly well researched and offer the most promise for managerial applications and future research: consumer innovativeness, models of new-product growth, and network externalities. Research on consumer innovativeness describes the mental, behavioral, and demographic characteristics of innovators. Models of new-product growth help firms understand and manage new products over their early life cycles. Research on network externalities tries to understand the prevalence and effects of positive (or negative) feedback loops between consumers' adoption of a product and the product's value.

Consumer innovativeness

Consumer innovativeness is the propensity of consumers to adopt new products. As Hirschman (1980, p. 283) suggested, "Few concepts in the behavioral sciences have as much immediate relevance to consumer behavior as innovativeness." Research on consumer innovativeness focuses on the characteristics that differentiate consumers by the speed or willingness with which they adopt new products. We classify this research as either focusing on the measurement of innovativeness or its relatedness to other constructs.

Measurement. If innovativeness is a valid predictor for new product adoption, then measures of innovativeness should identify those consumers likely to adopt new products so that firms can target marketing efforts and enhance forecast accuracy. Several measures have been developed and used in practice. Roehrich (2004, p. 3) suggested that these innovativeness scales differ "in terms of their theoretical premise and internal structure." He categorized innovativeness scales as either (1) life innovativeness scales or (2) adoptive innovativeness scales.

The life innovativeness scales focus on the propensity to innovate and are not constrained within the context of new-product adoption. Kirton's (1976, 1989) innovators-adaptations inventory (KAI) is a popular example. However, because it taps newness in general, its predictive validity tends to be low (Roehrich 2004).

Adoptive innovativeness scales focus specifically on the adoption of new products. Raju's (1980) scale has good internal consistency but has been criticized for its structure (Roehrich 2004). Goldsmith and Hofacker's scale (1991) measures domain-specific innovativeness, but its discriminant validity has been questioned (Roehrich 2004). Baumgartner and Steenkamp (1996) developed a scale to measure consumers' tendency toward exploratory acquisition of products (rather than innovativeness per se). Exploratory acquisition is similar to the relatedness between innovativeness and information seeking (Baumgartner and Steenkamp 1996).

Currently there is a small but important effort to study the innovativeness of consumers across diverse cultures and countries. For example, Steenkamp, ter Hofstede, and Wedel (1999) studied 3,000 consumers across 11 countries of the European Union. Tellis, Yin, and Bell (2004) studied over 4,000 consumers across 15 major countries of the Americas, Europe, Asia, and Australia.

Relatedness to Other Constructs. Many researchers have used the measures of innovativeness to study its relationship to other constructs. Foxall (1988, 1995), Foxall and Goldsmith (1988), Goldsmith, Freiden, and Eastman (1995), Manning, Bearden, and Madden (1995), and Midgeley and Dowling (1993) studied the relationship between innovativeness and the adoption of innovations. Im, Bayus, and Mason (2003), Midgeley and Dowling (1993), and Venkatraman (1991) explored the relationship between innovativeness and demographics. Steenkamp, ter Hofstede, and Wedel (1999) and Hirschman (1980) researched the relationship between innovativeness and other related constructs. While some studies have shown that innovators are better educated, wealthier, more mobile, and younger, other studies have failed to validate these findings (Rogers 2003; Gatignon and Robertson 1991).

Despite extensive research, no consensus or empirical generalization has emerged in this area. Indeed, no author has published a meta-analysis of the antecedents or consequences of consumer innovativeness. The primary reason appears to be the lack of consensus on measures, scales, or methods of research.

Research Challenges. The key challenge is the lack of consensus among researchers on measures, scales, or methods of inquiry. Specific research opportunities include:

- Development of a parsimonious, unified scale for consumer innovativeness that encompasses the strengths of existing scales while avoiding their weaknesses
- Use of such a scale to study how or whether innovativeness varies across product category, geography, or culture
- Identification of within-country differences in innovation that might be due to ethnic, cultural, demographic, or historical factors
- Assessing the ability of innovativeness to predict the adoption of specific new products
- Incorporation measures of individual consumer innovativeness in models of new product growth (reviewed above)

Growth of new products

Consumer innovativeness critically affects the adoption of new products and their subsequent growth. The latter topic has enjoyed intensive study in marketing over the last 35 years, beginning with Bass (1969) and now totaling over 700 estimates of the parameters or applications of the model (Bass 2004; Van Den Bulte and Stremersch 2004).

The Bass model expresses the adoption of a new product as a function of spontaneous innovation of consumers (due to unmeasured external influence) and cumulative adoptions to date (due to unmeasured word of mouth). The basic model yields three parameters, which have been interpreted as the innovation rate (coefficient of external influence), the imitation rate (coefficient of internal influence), and the market potential. The ratio of these coefficients defines the shape of the curve and the speed of diffusion; their respective sizes are responsible for the typical S-shape for most consumer durables (Van Den Bulte and Stremersch 2004).

The Bass model has had great appeal and widespread use because it is simple, fits the data well, and enables intuitive interpretations of the key coefficients. Because the model is parsimonious, many interpretations and underlying theories have been proposed. Furthermore, the model's strength is its descriptive or retrospective use; predictions appear sensitive to new data points and are difficult to apply prior to major turning points.

Many researchers have explored refinements, including modeling:

- One or more of the three parameters as a function of relevant endogenous and exogenous variables (e.g., Kalish 1985)
- Dependence of diffusion on related innovations (e.g., Bayus 1987; Peterson and Mahajan 1978)
- Successive generations of an innovation (e.g., Bass and Bass 2004; Norton and Bass 1987)
- Adopter categories (e.g., Mahajan, Muller, and Srivastava 1990)
- Variation of parameters across countries and its explanation by sociological, economic, and cultural factors (e.g., Gatignon, Eliashberg, and Robertson 1989; Putsis et al. 1997; Takada and Jain 1991; Talukdar, Sudhir, and Ainslie 2002; Van Den Bulte and Stremersch 2004)
- Stages in the adoption process (e.g., Kalish 1985; Midgeley 1976)
- Effects of marketing variables on diffusion patterns and parameters (e.g., Horsky and Simon 1983; Kalish and Lilien 1986)
- Supply restrictions (Jain, Mahajan, and Muller 1991)
- Improvements in estimation, including maximum likelihood estimation (Schmittlein and Mahajan 1982), nonlinear estimation (Srinivasan and Mason 1986), Bayesian estimation (Sultan, Farley, and Lehmann 1990), and hierarchical Bayesian estimation (Talukdar, Sudhir, and Ainslie 2002)
- Repeat and replacement purchases (Lilien, Rao, and Kalish 1981; Mahajan, Sharma, and Wind 1984)

A detailed review of this area is available (Mahajan, Muller, and Bass 1990). Rogers (2003) put this stream of research in a broader review of research on the diffusion of innovations. Sultan, Farley, and Lehmann (1990) and Van Den Bulte and Stremersch (2004) provided meta-analyses of the estimates of the parameters of the Bass model. Mahajan, Muller, and Bass (1995) provided a summary of the empirical generalization of the research. These reviews suggest an emerging consensus on the following:

- A plot of sales over time in the early years of the product life cycle seems S-shaped; the S-shaped curve could emerge from social diffusion among consumers or due to increasing affordability among a heterogeneous population of consumers.
- The S-shaped curve seems to hold for successive generations of the product, where prevalent.
- The coefficient of innovation is relatively stable and averages about .03.

- The coefficient of imitation varies substantially across contexts, with an average of about .4.
- The ratio of the coefficients of imitation to innovation is increasing over calendar time, indicating a faster rate of diffusion of new products.

Although the extant literature on the growth of new products is enormous, recent research in the area suggests new directions. First, when weekly movie sales are plotted against time, the shape of the curve seems to decline exponentially, with a peak in one of the first few weeks (e.g., Eliashberg and Shugan 1997; Sawhney and Eliashberg 1996). This pattern holds for national and international sales (e.g., Elberse and Eliashberg 2003) and for theater and video sales (e.g., Lehmann and Weinberg 2000). A model based on the Erlang 2 distribution seems to fit weekly sales of movies better than the Bass model, suggesting additional forces may be differentially affecting movie sales, such as initial marketing efforts, the impact of the distribution chain (movie theaters), or repeat viewing.

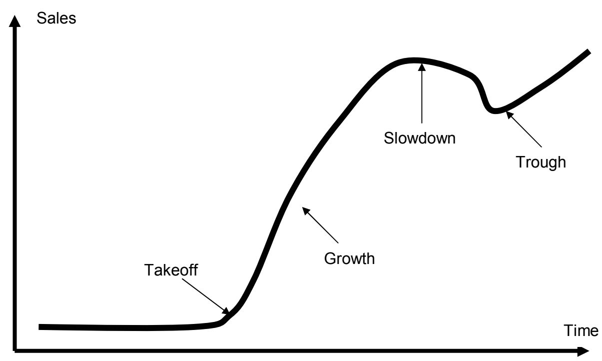
Second, the Bass curve seems to be punctuated by two distinct turning points: takeoff and slowdown as illustrated in Figure 3 (Agarwal and Bayus 2002; Golder and Tellis 1997; Kohli, Lehmann and Pae 1999). Takeoff is the sudden spurt in sales that follows a period of low sales after introduction. The slowdown is a sudden leveling in sales that follows a period of rapid growth. The slowdown is typically followed by what has been called a saddle, trough, or chasm (Goldenberg, Barak, and Muller 2002; Golder and Tellis 2004; Moore 1991). Extensive empirical studies over multiple categories of consumer durables suggest the following potential generalizations:

- New consumer durables have long periods of low growth before takeoff, steep growth after takeoff, and erratic growth after slowdown.
- The time to takeoff currently averages six years, the growth stage about eight years, and trough about five years.
- These patterns, especially time to takeoff, vary systematically and dramatically by country.
- New products take off and grow much faster in recent decades than in earlier ones.
- New electronic products have a much shorter time to takeoff and faster growth rate than other household durables.

Research Challenges. Despite substantial research, many challenges remain for future research, including:

- Exploring the generalizability of the S-shaped curve, the turning points, and the declining exponential growth curves across categories
- Developing an integrated model to predict the turning points in the S-shaped curve, such as compound hazard models, multivariate regime-switching models, or time-series models with structural breaks
- Exploring competing theories for the S-shaped curve and the turning points, such as social diffusion, heterogeneity in proximity (crossing the chasm), heterogeneity in income (affordability), informational cascades, or network externalities (see below)
- Comparing the patterns and dynamics of new-product growth across countries, cultures, and ethnic groups

Figure 3



Network externalities

Consumer acceptance of new products and their subsequent growth can be greatly affected by network externalities. Network externalities refer to an increase in the value of a product to a user based on either the number of users of the same product (direct network externality) or the availability of related products (indirect network externality) by other users. For example, fax machines exhibit a direct network externality because the value of each node (fax machine) increases with more users who can receive or send faxes. DVD players exhibit an indirect network externality because the value of each DVD player increases as more DVD titles for the player become available. More titles will become available if there are more DVD players. Similar indirect network externalities occur for HDTV sets and programming, alternative fuel vehicles and refueling stations, and computer hardware platforms.

Many economists have studied whether firms become monopolies or merely grow and stay dominant in markets due to network externalities (e.g., Church and Gandal 1992, 1993; Farrell and Saloner 1985, 1986; Katz and Shapiro 1985, 1986, 1992, 1994). Based on this line of research, courts have opined that Microsoft holds monopoly power in the market for operating systems in part because of network externalities. The reasoning is that Microsoft's Windows operating system and Office products are more attractive to customers because so many other customers own and use them. This hypothesized value comes from the help that a user can get from other users, from benefits that accrue to an organization that adopts a common operating system, from software vendors that find it in their interests to write software for operating systems with many users, and from channels of distribution, such as hardware manufacturers, that find economies of scale in distributing a popular product. A new stream of research in network effects has questioned the role of this phenomenon and whether it always leads to perverse effects and inefficient markets (Liebowitz and Margolis 1999; Tellis and Yin 2004).

Several studies in marketing have sought to estimate aspects of network effects, including existence (Nair, Chintagunta, and Dube 2003), product introduction (Bayus, Jain, and Rao 1997; Padmanabhan, Rajiv, and Srinivasan 1997), diffusion (Gupta, Jain, and Sawhney 1999), price competition (Xie and Sirbu 1995), marketing mix variables (Shankar and Bayus 2001), perception of quality (Hellofs and Jacobson 1999), and radical innovation (Srinivasan, Lilien, and Rangaswamy 2004).

Research Challenges. Important challenges for future research include:

- Understanding the role of quality, price, and product-line extensions versus network effects in fostering or hurting market efficiency
- Understanding the role of network externalities in the takeoff, growth, and decline of products
- Managing the marketing mix in the presence of network externalities
- Developing normative tools to help firms anticipate and manage network externalities
- Evaluating the strength of network externalities and evaluating whether and to what extent network externalities lead to long-run competitive advantages
- Understanding the interaction of network externalities with the product-development process, design tools, organizing for product development, strategies of entry and defense, and models of consumer and market response

Summary: Consumer response to innovations

Of the three topics considered in this section, the most focused, paradigmatic research has occurred on the growth of new products. However, integration of the three topics of research could provide new stimulus for research and new insights. For example, growth rates and the shape of the growth curve have predominantly been studied in independent products. They may change in the face of network externalities – an environment that seems to affect a larger proportion of new products. They also may change if firms can pinpoint innovative consumers. More important, models of consumer response typically make simplifying assumptions about consumer innovativeness in order to model aggregate behavior. Research on consumer innovativeness focuses on micro behavior and measures of individuals, with minimal concern for aggregate market outcomes. An integration of these two streams of research can allow for more insightful models with superior predictions.

Conclusion

Innovation is vitally important for consumers, firms, and countries. Research on innovation has proceeded in a number of disparate fields in a variety of disciplines. Some research areas are prescriptive; others descriptive. Some are mature; others nascent. Some fit squarely within marketing; others can be enlightened by or enlighten a marketing perspective. This paper seeks to summarize, review, and integrate key areas of research that are relevant to marketing science. We seek to highlight convergent learning from multiple fields and perspectives yet showcase the exciting opportunities for research that remain. We hope that relating various topics and integrating perspectives will enable cross-fertilization between marketing and other disciplines and promote productive research. Research in these areas is intense, interesting, and exciting. Research has solved major problems, discovered novel phenomena, and coalesced around important generalizations. Yet major challenges remain for future research. We hope our readers agree.

References

Abernathy, William J., and J. M. Utterback (1978), "Patterns of Industrial Innovation." *Technology Review* 80 (7), 40–7.

Adams, James L. (1986), *Conceptual Blockbusting: A Guide to Better Ideas,* 1st ed. Reading, Mass.: Addison-Wesley.

Agarwal, Rajshree, and Barry Bayus (2002), "The Market Evolution and Sales Takeoff of Product Innovations." *Management Science* 48 (August), 1024–52.

Ali, A. (1994), "Pioneering Versus Incremental Innovation: Review and Research Propositions." *Journal of Product Innovation Management* 11 (January), 46–56.

Altschuler, Genrich (1985), *Creativity As an Exact Science*. New York, N.Y.: Gordon and Breach.

Altschuler, Genrich (1996), *And Suddenly the Inventor Appeared*. Worcester, Mass.: Technical Innovation Center.

Ancona, Deborah Gladstein (1990), "Outward Bound: Strategies for Team Survival in an Organization." *Academy of Management Journal* 33 (2), 334–51.

Anderson, Eugene W., Claes Fornell, and Donald R. Lehmann (1994), "Customer Satisfaction, Market Share, and Profitability: Findings From Sweden." *Journal of Marketing* 58 (July), 53–66.

Baker, G., R. Gibbons, and K. J. Murphy (1999), "Informal Authority in Organizations." *Journal of Law Economics & Organization* 15 (March), 56–72.

Bass, Frank M. (1969), "A New Product Growth Model for Consumer Durables." *Management Science* 15 (January), 215–27.

Bass, Frank M. (2004), "Diffusion Theory in Marketing: A Historical Perspective." Presented to the AMA-Sheth Doctoral Consortium, Texas A&M University, College Station, Tex., June.

Bass, Portia I., and Frank M. Bass (2004), "The Embedded Model of the Norton-Bass Successive Technology Generations Model." Dallas, Tex.: University of Texas, Dallas, Working Paper.

Baumgartner, Hans, and Jan-Benedict E. M. Steenkamp (1996), "Exploratory Consumer Buying Behavior: Conceptualization and Measurement." *International Journal of Research in Marketing* 13 (2), 121–37.

Bayus, Barry L. (1987), "Forecasting Sales of New Contingent Products: An Application to the Compact Disc Market." *Journal of Product Innovation Management* 4 (December), 243–55.

Bayus, Barry L., Sanjay Jain, and Ambar G. Rao (1997), "Too Little, Too Early: Introduction Timing and New Product Performance in the Personal Digital Assistant Industry." *Journal of Marketing Research* 34 (February), 50–63.

Bayus, Barry L., Sanjay Jain, and Ambar G. Rao (2001), "Truth or Consequences: An Analysis of Vaporware and New Product Announcements." *Journal of Marketing Research* 38 (February), 3–11.

Bettman, James R., Mary Frances Luce, and John W. Payne (1998), "Constructive Consumer Choice Processes." *Journal of Consumer Research* 25 (3), 187–217.

Blau, Gary E., Joseph F. Pekny, Vishal A. Varma, and Paul Bunch (2004), "Managing a Portfolio of Interdependent New Product Candidates in the Pharmaceutical Industry." *Journal of Product Innovation Management* 21 (July), 227–45.

Boehm, B. (1988), "A Spiral Model of Software Development and Enhancement." *IEEE Computer*, 61–72.

Bordley, Robert (2003), "Determining the Appropriate Depth and Breadth of a Firm's Product Portfolio." *Journal of Marketing Research* 40 (4), 39–53.

Boulding, William, Ruskin Morgan, and Richard Staelin (1997), "Pulling the Plug to Stop the New Product Drain." *Journal of Marketing Research* 34 (February), 164–76.

Bower, Joseph L., and Clayton M. Christensen (1995), "Disruptive Technologies: Catching the Wave." *Harvard Business Review* (January-February), 43–53.

Bröder, Arndt (2000), "Assessing the Empirical Validity of the 'Take the Best' Heuristic as a Model of Human Probabilistic Inference." *Journal of Experimental Psychology: Learning, Memory, and Cognition* 26 (5), 1332–46.

Brown, Shona L., and Kathleen M. Eisenhardt (1995), "Product Development: Past Research, Present Findings, and Future Directions." *Academy of Management Review* 20 (2), 343–61.

Burns, Tom, and G. M. Stalker (1961), *The Management of Innovation.* Oxford, U.K.: Oxford University Press.

Campbell, Robert (1985), *Fisherman's Guide: A Systems Approach to Creativity and Organization*. Boston, Mass.: New Science Library.

Carlile, Paul R. (2002), "A Pragmatic View of Knowledge and Boundaries: Boundary Objects in New Product Development." *Organization Science* 13 (4), 442–55.

Carlile, Paul R. (2004), "Transferring, Translating and Transforming: An Integrative Framework for Managing Knowledge Across Boundaries." *Organization Science,* forthcoming.

Carpenter, Gregory S., and Kent Nakamoto (1989), "Consumer Preference Formation and Pioneering Advantage." *Journal of Marketing Research* 26 (August), 285–98.

Chandy, Rajesh K., Jaideep C. Prabhu, and Kersi D. Antia (2003), "What Will the Future Bring? Dominance, Technology Expectations, and Radical Innovation." *Journal of Marketing* 67 (3), 1–24.

Chandy, Rajesh K., and Gerard J. Tellis (1998), "Organizing for Radical Product Innovation: The Overlooked Role of Willingness to Cannibalize." *Journal of Marketing Research* 35 (November), 474–87.

Chandy, Rajesh K., and Gerard J. Tellis (2000), "The Incumbent's Cures? Incumbency, Size, and Radical Product Innovation." *Journal of Marketing* 64 (3), 1–17.

Christensen, Clayton (1998), *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail.* Boston, Mass.: Harvard Business School Press.

Church, Jeffrey, and Neil Gandal (1992), "Network Effects, Software Provision, and Standardization." *Journal of Industrial Economics* 60 (March), 85–104.

Church, Jeffrey, and Neil Gandal (1993), "Complementary Network Externalities and Technological Adoption." *International Journal of Industrial Organization* 11 (2), 239–60.

Clark, Kim, and Takahiro Fujimoto (1991), *New Product Performance*. Cambridge, Mass.: Harvard Business School Press.

Cockburn, Iain M., Rebecca M. Henderson, and Scott Stern (2000), "Untangling the Origins of Competitive Advantage." *Strategic Management Journal* 21 (October/November), 1123–37.

Cooper, Robert G. (1990), "Stage-Gate Systems: A New Tool for Managing New Products." *Business Horizons* 33 (3) (May-June), 44–54.

Cooper, Robert G. (1994), “Third-Generation New Product Processes.” *Journal of Product Innovation Management* 11 (January), 3–14.

Cooper, Robert G., Scott J. Edgett, and Elko J. Kleinschmidt (1997), “Portfolio Management in New Product Development: Lessons from the Leaders – II.” *Research-Technology Management* 40 (6), 43–52.

Cooper, Robert G., Scott J. Edgett, and Elko J. Kleinschmidt (1998), *Portfolio Management for New Products*. Reading, Mass.: Addison Wesley.

Cooper, Robert G., Scott J. Edgett, and Elko J. Kleinschmidt (1999), “New Product Portfolio Management: Practices and Performance.” *Journal of Product Innovation Management* 16 (September), 333–51.

Currim, Imran S. (1981), “Using Segmentation Approaches for Better Prediction and Understanding from Consumer Mode Choice Models.” *Journal of Marketing Research* 18 (August), 301–9.

Cusumano, Michael A., and Richard W. Selby (1995), *Microsoft Secrets: How the World's Most Powerful Software Company Creates Technology, Shapes Markets, and Manages People.* New York, N.Y.: Touchstone.

Cusumano, Michael A., and David B. Yoffie (1998), *Competing on Internet Time: Lessons From Netscape and Its Battle with Microsoft.* New York, N.Y.: The Free Press.

Dahan, Ely, and John R. Hauser (2002), “The Virtual Customer.” *Journal of Product Innovation Management* 19 (September), 332–54.

Damanpour, Fariborz (1991), “Organizational Innovation: A Meta-Analysis of Effects of Determinants and Moderators.” *Academy of Management Journal* 34 (September), 555–90.

Danneels, Erwin (2004), “Disruptive Technology Reconsidered: A Critique and Research Agenda.” *Journal of Product Innovation Management* 21 (4), 246–58.

de Bono, Edward (1995), *Mind Power*. New York, N.Y.: Dorling Kindersley.

Dolan, Robert J., and John M. Matthews (1993), “Maximizing the Utility of Customer Product Testing: Beta Test Design and Management.” *Journal of Product Innovation Management* 10 (4), 318–30.

Einhorn, Hillel J. (1970), “Use of Nonlinear, Noncompensatory Models As a Function of Task and Amount of Information.” *Organizational Behavior and Human Performance* 6, 1–27.

Elberse, Anita, and Jehoshua Eliashberg (2003), “Demand and Supply Dynamics for Sequentially Released Products in International Markets: The Case of Motion Pictures.” *Marketing Science* 22 (Summer), 329–42.

Eliashberg, Jehoshua, and Steven M. Shugan (1997), “Film Critics: Influences or Predictors?” *Journal of Marketing* 61 (April), 68–78.

Eppinger, Steven D. (1998), “Information-Based Product Development.” Presented to the Research Advisory Committee of the Center for Innovation in Product Development, MIT, Cambridge, Mass., January.

Eppinger, Steven D., Daniel E. Whitney, Robert P. Smith, and David A. Gebala (1994), “A Model-Based Method for Organizing Tasks in Product Development.” *Research in Engineering Design* 6 (1), 1–13.

Ettlie, J. E., W. P. Bridges, and R. D. O'Keefe (1984), “Organization Strategy and Structural Differences for Radical Versus Incremental Innovation.” *Management Science* 30 (June), 682–95.

Ettlie, J. E., and A. H. Rubenstein (1987), “Firm Size and Product Innovation.” *Journal of Product Innovation Management* 4 (2), 89–108.

Evgeniou, Theodoros, Constantinos Boussios, and Giorgos Zacharia (2004), "Generalized Robust Conjoint Estimation." Fontainebleau, France: INSEAD, Working paper.

Evgeniou, Theodoros, and Massimiliano Pontil (2004), "Optimization Conjoint Models for Consumer Heterogeneity." Fontainebleau, France: INSEAD, Working paper.

Farrell, Joseph, and Garth Saloner (1985), "Standardization, Compatibility and Innovation." *RAND Journal of Economics* 16 (Spring), 70–83.

Farrell, Joseph, and Garth Saloner (1986), "Installed Base and Compatibility: Innovation, Product Pronouncements and Predation." *American Economic Review* 76 (December), 940–55.

Faulkner, Terrence W. (1996), "Applying 'Options Thinking' to R&D Valuation." *Research Technology Management* 39 (3) (May-June), 50–6.

Fine, Charles (1998), C*lockspeed: Winning Industry Control in the Age of Temporary Advantage*. Reading, Mass.: Perseus Books.

Foster, Richard (1986), *Innovation: The Attacker's Advantage*. New York, N.Y.: Summit Books.

Foxall, Gordon R. (1988), "Consumer Innovativeness: Novelty-Seeking, Creativity, and Cognitive Style." *Research in Consumer Behavior* 3, 79–113.

Foxall, Gordon R. (1995), "Cognitive Styles of Consumer Initiators." *Technovation* 15 (5), 269–89.

Foxall, Gordon R., and Ronald E. Goldsmith (1988), "Personality and Consumer Research: Another Look." *Journal of the Market Research Society* 30 (April), 111–25.

Galbraith, J. K. (1952), *American Capitalism*. Boston, Mass.: Houghton Mifflin.

Garnsey, Elizabeth, and Stephen M. Wright (1990), "Technical Innovation and Organizational Opportunity." *International Journal of Technology Management* 5 (3), 267–81.

Gatignon, Hubert, Jehoshua Eliashberg, and Thomas S. Robertson (1989), "Modeling Multinational Diffusion Patterns: An Efficient Methodology." *Marketing Science* 8 (3), 231–47.

Gatignon, Hubert, and Thomas Robertson (1985), "A Propositional Inventory for New Diffusion Research." *Journal of Consumer Research* 11 (March), 849–67.

Gatignon, Hubert, and Thomas Robertson (1991), "Innovative Decision Processes." In *Handbook of Consumer Behavior,* eds. Thomas S. Robertson and Harold S. Kassarjian, 316–48.

Gensch, Dennis H. (1987), "A Two-Stage Disaggregate Attribute Choice Model." *Marketing Science* 6 (Summer), 223–31.

Gensch, Dennis H., and Ehsan S. Soofi (1995), "Information-Theoretic Estimation of Individual Consideration Sets." *International Journal of Research in Marketing* 12 (May), 25–38.

Gibbons, Robert (1997), "Incentives and Careers in Organizations." In *Advances in Economic Theory and Econometrics*, eds. D. Kreps and K. Wallis, 1–37. Cambridge, U.K.: Cambridge University Press.

Gigerenzer, Gerd, and Daniel G. Goldstein (1996), "Reasoning the Fast and Frugal Way: Models of Bounded Rationality." *Psychological Review* 1003, 4, 650–69.

Goldenberg, Jacob, Libai Barak, and Eitan Muller (2002), "Riding the Saddle: How Cross-Market Communications Can Create a Major Slump in Sales." *Journal of Marketing* 66 (April), 1–16.

Goldenberg, Jacob, Donald R. Lehmann, and David Mazursky (2001), "The Primacy of the Idea Itself As a Predictor of New Product Success." *Management Science* 47 (January), 69–84.

Goldenberg, Jacob, David Mazursky, and Sorin Solomon (1999a), "Toward Identifying the Inventive Templates of New Products: A Channeled Ideation Approach." *Journal of Marketing Research* 36 (May), 200–10.

Goldenberg, Jacob, David Mazursky, and Sorin Solomon (1999b), "Templates of Original Innovation: Projecting Original Incremental Innovations from Intrinsic Information." *Technology Forecasting and Social Change* 61, 1–12.

Goldenberg, Jacob, David Mazursky, and Sorin Solomon (1999c), "Creative Sparks." *Science* 285 (September 3), 1495–96.

Golder, Peter N., and Gerard J. Tellis (1993), "Pioneer Advantage: Marketing Logic or Marketing Legend?" *Journal of Marketing Research* 30 (May), 158–70.

Golder, Peter N., and Gerard J. Tellis (1997), "Will It Ever Fly? Modeling the Takeoff of Really New Consumer Durables." *Marketing Science* 16 (3), 256–70.

Golder, Peter N., and Gerard J. Tellis (2004), "Growing, Growing, Gone: Cascades, Diffusion, and Turning Points in the Product Life Cycle." *Marketing Science* 23 (Spring), 207–20.

Goldsmith, Ronald E., Jon B. Freiden, and Jacqueline K. Eastman (1995), "The Generality/Specificity Issue in Consumer Innovativeness Research." *Technovation* 15 (10), 601–13.

Goldsmith, Ronald E., and Charles F. Hofacker (1991), "Measuring Consumer Innovativeness." *Journal of Academy of Marketing Science* 19 (Summer), 209–22.

Green, Paul E., and Abba Krieger (1989a), "Recent Contributions to Optimal Product Positioning and Buyer Segmentation." *European Journal of Operational Research* 41 (July), 127–41.

Green, Paul E., and Abba Krieger (1989b), "A Componential Segmentation Model with Optimal Product Design Features." *Decision Science* 20 (2), 221–38.

Green, Paul E., Abba Krieger, and Jerry Wind (2003), "Buyer Choice Simulators, Optimizers, and Dynamic Models." In *Market Research and Modeling: Progress and Prospects, A Tribute to Paul E. Green,* eds. Jerry Wind and Paul E. Green. Norwell, Mass.: Kluwer Academic Publishers.

Green, Paul E., and Vithala R. Rao (1972), *Applied Multidimensional Scaling*. New York, N.Y.: Holt, Rinehart and Winston.

Green, Paul E., and V. Srinivasan (1990), "Conjoint Analysis in Marketing: New Developments With Implications for Research and Practice." *Journal of Marketing* 54, 3–19.

Green, Paul E., and Jerry Wind (1975), "New Way to Measure Consumers' Judgments." *Harvard Business Review* (July-August), 107–17.

Griffin, Abbie (1992), "Evaluating QFD's Use in U.S. Firms As a Process for Developing Products." *Journal of Product Innovation Management* 9 (March), 360–73.

Griffin, Abbie (1997a), "PDMA Research on New Product Development Practices: Updating Trends and Benchmarking Best Practices." *Journal of Product Innovation Management* 14 (November), 429–58.

Griffin, Abbie (1997b), "Modeling and Measuring Product Development Cycle Time." *Journal of Engineering and Technology Management* 14 (March), 1–24.

Griffin, Abbie, and John R. Hauser (1996), "Integrating Mechanisms for Marketing and R&D." *Journal of Product Innovation Management* 13 (May), 191–215.

Griffin, Abbie, and Albert L. Page (1993), "An Interim Report on Measuring Product Development Success and Failure." *Journal of Product Innovation Management* 10 (September), 291–308.

Griffin, Abbie, and Albert L. Page (1996), "The PDMA Success Measurement Project: Recommended Measures for Product Development Success and Failure." *Journal of Product Innovation Management* 13 (November), 478–96.

Griliches, Zvi (1990), "Patent Statistics As Economic Indicators: A Survey." *Journal of Economic Literature* 28 (December), 1661–1707.

Gupta, Sachin, Dipak C. Jain, and Mohanbir S. Sawhney (1999), "Modeling the Evolution of Markets with Indirect Network Externalities: An Application to Digital Television." *Marketing Science* 18 (3), 396–416.

Gurumurthy, Kalyanaram, William T. Robinson, and Glen L. Urban (1995), "Order of Market Entry: Established Empirical Generalizations, Emerging Empirical Generalizations, and Future Research." *Marketing Science* 14 (Summer), G212–G221.

Gurumurthy, Kalyanaram, and Glen L. Urban (1992), "Dynamic Effects of the Order of Entry on Market Share, Trial Penetration, and Repeat Purchases for Frequently Purchased Consumer Goods." *Marketing Science* 11 (Summer), 235–350.

Hage, Jerald (1980), *Theories of Organizations*. New York, N.Y.: John Wiley & Sons.

Hart, Susan, Erik Jan Hultink, Nikolaos Tzokas, and Harry R. Commandeur (2003), "Industrial Companies' Evaluation Criteria in New Product Development Gates." *Journal of Product Innovation Management* 20 (January), 22–36.

Hauser, John R. (1998), "Research, Development, and Engineering Metrics." *Management Science* 44 (December), 1670–89.

Hauser, John R. (2001), "Metrics Thermostat." *Journal of Product Innovation Management* 18 (May), 134–53.

Hauser, John R., and Steven P. Gaskin (1984), "Application of the 'Defender' Consumer Model." *Marketing Science* 3 (Fall), 327–51.

Hauser, John R., and Frank S. Koppelman (1979), "Alternative Perceptual Mapping Techniques: Relative Accuracy and Usefulness." *Journal of Marketing Research* 16 (November), 495–506.

Hauser, John R., and Steven M. Shugan (1983), "Defensive Marketing Strategy." *Marketing Science* 2 (Fall), 319–60.

Hauser, John R., and Birger Wernerfelt (1988), "Competitive Price and Positioning Strategies: Existence and Uniqueness of Price Equilibria in Defender." *Marketing Science* 7 (Winter), 76–93.

Hellofs, Linda, and Robert Jacobson (1999), "Market Share and Consumers' Perceptions of Quality: When Can Firms Grow Their Way to Higher Versus Lower Quality?" *Journal of Marketing* 63 (January), 16–25.

Henard, David H., and David M. Szymanski (2001), "Why Some New Products Are More Successful Than Others." *Journal of Marketing Research* 38 (3), 362–75.

Hirschman, Elizabeth C. (1980), "Innovativeness, Novelty Seeking, and Consumer Creativity." *Journal of Consumer Research* 7 (3), 283–95.

Horsky, Dan, and Leonard S. Simon (1983), "Advertising and the Diffusion of New Products." *Management Science* 1 (Winter), 31–47.

Howe, Roger J., Dee Gaeddert, and Maynard A. Howe (1995), *Quality on Trial: Bringing Bottom-Line Accountability to the Quality Effort*. New York, N.Y.: McGraw-Hill.

Hultink, Erik Jan, Susan J. Hart, Henry S. J. Robben, and Abbie Griffin (2000), "New Consumer Product Launch: Strategies and Performance." *Journal of Strategic Marketing* 7 (September), 153–74.

Im, Subin, Barry L. Bayus, and Charlotte H. Mason (2003), "An Empirical Study of Innate Consumer Innovativeness, Personal Characteristics, and New Product Adoption Behavior." *Journal of the Academy of Marketing Science* 31 (1), 61–73.

J. D. Power and Associates (2002), *New Autoshopper.com Study.* Agoura Hills, Calif.: J. D. Power and Associates.

Jain, Dipak, Vijay Mahajan, and Eitan Muller (1991), "Innovation Diffusion in the Presence of Supply Restrictions." *Marketing Science* 10 (Winter), 83–90.

Jamieson, Linda F., and Frank M. Bass (1989), "Adjusting Stated Intention Measures to Predict Trial Purchase of New Products: A Comparison of Models and Methods." *Journal of Marketing Research* 26 (August), 336–45.

Jedidi, Kamel, Rajiv Kohli, and Wayne S. DeSarbo (1996), "Consideration Sets in Conjoint Analysis." *Journal of Marketing Research* 33 (August), 364–72.

Johnson, Eric J., and Robert J. Meyer (1984), "Compensatory Choice Models of Noncompensatory Processes: The Effect of Varying Context." *Journal of Consumer Research* 11 (June), 528–41.

Kalish, Shlomo (1985), "A New Product Adoption Model with Price, Advertising, and Uncertainty." *Management Science* 31 (December), 1569–85.

Kalish, Shlomo, and Gary L. Lilien (1986), "A Market Entry Timing Model for New Technologies." *Management Science* 32 (April), 194–105.

Kalwani, Manohar U., and Alvin J. Silk (1982), "On the Reliability and Predictive Validity of Purchase Intention Measures." *Marketing Science* 1 (Summer), 243–86.

Kaplan, Robert S., and David P. Norton (1992), "The Balanced Scorecard — Measures That Drive Performance." *Harvard Business Review* 70 (January/February), 71–9.

Katz, Michael L., and Carl Shapiro (1985), "Network Effects, Competition, and Compatibility." *American Economic Review* 75 (June), 425–40.

Katz, Michael L., and Carl Shapiro (1986), "Technology Adoption in the Presence of Network Effects." *Journal of Political Economy* 94 (4), 822–41.

Katz, Michael L., and Carl Shapiro (1992), "Product Introduction With Network Externalities." *Journal of Industrial Economics* 60 (March), 55–83.

Katz, Michael L., and Carl Shapiro (1994), "Systems Competition and Network Effects." *Journal of Economic Perspectives* 8 (Spring), 93–115.

Kerin, Roger A., Rajan Varadarajan, and Robert A. Peterson (1992), "First-Mover Advantage: A Synthesis, Conceptual Framework, and Research Propositions." *Journal of Marketing* 56 (4), 33–52.

Khurana, Anil, and Stephen R. Rosenthal (1997), "Integrating the Fuzzy Front End of New Product Development." *Sloan Management Review* 38 (2), 103–20.

Kim, Jongbae, and David Wilemon (2002), "Strategic Issues in Managing Innovation's Fuzzy Front End." *European Journal of Innovation Management* 5 (1), 27–39.

Kirton, Michael (1976), Adaptors and Innovators — A Description and Measure." *Journal of Applied Psychology* 61 (5), 622–35.

Kirton, Michael (1989), *Adaptors and Innovators: Styles of Creativity and Problem-Solving*. London, U.K.: Routledge.

Klein, K., and J. Sorra (1996), "The Challenge of Innovation Implementation." *Academy of Management Review* 21 (4), 1055–80.

Koen, Peter, Greg Ajamian, Rober Burkart, and Allen Clamen (2001), "Providing Clarity and a Common Language to the 'Fuzzy Front End.'" *Research-Technology Management* 44 (2), 46–55.

Kohli, Rajeev, Donald Lehmann, and Jae Pae (1999), "Extent and Impact of Incubation Time in New Product Diffusion." *Journal of Product Innovation Management* 16 (March), 134–45.

Larson, Erik W., and David H. Gobeli (1988), "Organizing for Product Development Projects." *Journal of Product Innovation Management* 5 (September), 180.

Lauga, Dominique, and Elie Ofek (2004), "Product Innovation in the Face of Marketing Demand Uncertainty." Cambridge, Mass.: Harvard Business School, Working Paper.

Lave, J., and S. Wenger (1990), *Situated Learning*. Cambridge, U.K.: Cambridge University Press.

Lawler, E., and S. Mohrman (1987), "Quality Circles: After the Honeymoon." *Organizational Dynamics* 15 (4) (Spring), 42–54.

Lehmann, Donald R., and Charles B. Weinberg (2000), "Sales Through Sequential Distribution Channels: An Application to Movies and Videos." *Journal of Marketing* 64 (3), 13–33.

Leifer, Richard, Christopher M. McDermott, Gina Colarelli O'Connor, Lois S. Peters, Mark Rice, and Robert W. Veryzer (2000), *Radical Innovation: How Mature Companies Can Outsmart Upstarts*. Cambridge, Mass.: Harvard Business School Press.

Lieberman, Marvin B., and David B. Montgomery (1988), "First-Mover Advantages." *Strategic Management Journal* 9 (5), 41–58.

Liebowitz, S. J., and Stephen Margolis (1999), *Winners, Losers and Microsoft*. Oakland, Calif.: The Independent Institute.

Liechty, John, Venkatram Ramaswamy, and Steven Cohen (2001), "Choice-Menus for Mass Customization: An Experimental Approach for Analyzing Customer Demand With an Application to a Web-Based Information Service." *Journal of Marketing Research* 38 (May), 183–96.

Lilien, Gary L., Ambar G. Rao, and Shlomo Kalish (1981), "Bayesian Estimation and Control of Detailing Effort in a Repeat Purchase Diffusion Environment." *Management Science* 27 (May), 493–506.

Little, John D. C. (1966), "A Model of Adaptive Control of Promotional Spending." *Operations Research* 14 (November-December), 1075–98.

Mahajan, Vijay, Eitan Muller, and Frank M. Bass (1990), "New Product Diffusion Models in Marketing: A Review and Directions for Future Research." *Journal of Marketing* 54 (January), 1–26.

Mahajan, Vijay, Eitan Muller, and Frank M. Bass (1995), "Diffusion of New Products: Empirical Generalizations and Managerial Uses." *Marketing Science* 14 (Summer), G79–G88.

Mahajan, Vijay, Eitan Muller, and Rajendra K. Srivastava (1990), "Determination of Adopter Categories by Using Innovation Diffusion Models." *Journal of Marketing Research* 27 (February), 37–50.

Mahajan, Vijay, Subhash Sharma, and Yoram Wind (1984), "Parameter Estimation in Marketing Models in the Presence of Influential Response Data: Robust Regression and Applications." *Journal of Marketing Research* 21 (August), 268–77.

Mahajan, Vijay, and Jerry Wind (1986), *Innovation Diffusion Models of New Product Acceptance*. Cambridge, Mass.: Ballinger Publishing Company.

Mahajan, Vijay, and Jerry Wind (1988), "New Product Forecasting Models, Directions for Research and Implementation." *International Journal of Forecasting* 4 (3), 341–58.

Manning, Kenneth C., William O. Bearden, and Thomas J. Madden (1995), "Consumer Innovativeness and the Adoption Process." *Journal of Consumer Psychology* 4 (4), 329–45.

Markham, Stephen K. (2002), "Moving Technologies from Lab to Market." *Research-Technology Management* 45 (6), 31–42.

Markham, Stephen K., and Lynda Aiman-Smith (2001), "Product Champions: Truths, Myths and Management." *Research Technology Management* 44 (May), 44–50.

Markham, Stephen K., and Abbie Griffin (1998), "The Breakfast of Champions: Associations Between Champions and Product Development Environments, Practices and Performance." *Journal of Product Innovation Management* 15 (September 1), 436–54.

Martignon, Laura, and Ulrich Hoffrage (2002), "Fast, Frugal, and Fit: Simple Heuristics for Paired Comparisons." *Theory and Decision* 52 (1), 29–71.

McFadden, Daniel L. (1970), "Conditional Logit Analysis of Qualitative Choice Behavior." In *Frontiers of Econometrics*, ed. P. Zarembla, 105–42. New York, N.Y.: Academic Press.

Menor, Larry J., Mohan V. Tatkionda, and Scout E. Sampson (2002), "New Service Development: Areas for Exploitation and Exploration." *Journal of Operations Management* 20 (2), 135–57.

Michalek, Jeremy J., Fred M. Feinberg, Feray Adiguzel, Peter Ebbes, and Panos Y. Papalambros (2004), "Realizable Product Line Design Optimization: Coordinating Marketing and Engineering Models via Analytic Target Cascading." Ann Arbor, Mich.: University of Michigan, Ann Arbor, Working Paper.

Michalek, Jeremy J., Fred M. Feinberg, and Panos Y. Papalambros (2005), "Linking Marketing and Engineering Product Design Decisions via Analytical Target Cascading." *Journal of Product Innovation Management* 22 (1), forthcoming.

Midgeley, David F. (1976), "A Simple Mathematical Theory of Innovative Behavior." *Journal of Consumer Research* 3 (June), 31–41.

Midgeley, David F., and Grahame R. Dowling (1978), "Innovativeness: The Concept and Its Measurement." *Journal of Consumer Research* 4 (March), 229–42.

Midgeley, David F., and Grahame R. Dowling (1993), "A Longitudinal Study of Product Form Innovation: The Interaction Between Predispositions and Social Messages." *Journal of Consumer Research* 19 (March), 611–25.

Mitchell, W., and K. Singh (1993), "Death of the Lethargic: Effects of Expansion into New Technical Subfields on Performance in a Firm's Base Business." *Organizational Science* 4 (2), 152–80.

Montoya-Weiss, Mitzi, and Roger Calantone (1994), "Determinants of New Product Performance: A Review and Meta-Analysis." *Journal of Product Innovation Management* 11 (September), 397–417.

Moore, G. A. (1991), *Crossing the Chasm: Marketing and Selling High-Tech Goods to Mainstream Customers.* New York, N.Y.: Harper Business.

Morris, Peter A., Elizabeth Olmsted Teisberg, and Lawrence Kolbe (1991), "When Choosing R&D Projects, Go with the Long Shots." *Research Technology Management* 34 (1) (January-February), 35–40.

Morrison, Donald G. (1979), "Purchase Intentions and Purchase Behavior." *Journal of Marketing* 43 (Spring), 65–74.

Nair, Harikesh, Pradeep Chintagunta, and Jean-Pierre Dube (2003), "Empirical Analysis of Indirect Network Effects in the Market for Personal Digital Assistants." Chicago, Ill.: University of Chicago, Working Paper.

Narasimhan, Chakravarthi, and Subrata K. Sen (1983), "New Product Models for Test Market Data." *Journal of Marketing* 47 (Winter), 11–24.

Narasimhan, Chakravarthi, and Z. John Zhang (2000), "Market Entry Strategy Under Firm Heterogeneity and Asymmetric Payoffs." *Marketing Science* 19 (Fall), 313–25.

Nault, Barrie R., and Mark B. Vandenbosch (1996), "Eating Your Own Lunch: Protection Through Preemption." *Organization Science* 7 (May/June), 342–58.

Norton, J., and F. M. Bass (1987), "A Diffusion Theory Model of Adoption and Substitution for Successive Generations of High-Technology Products." *Management Science* 33 (9), 1069–86.

O'Connor, Gina Colarelli, Richard Hendricks, and Mark P. Rice (2002), "Assessing Transition Readiness for Radical Innovation." *Research-Technology Management* 45 (6), 50–6.

O'Connor, Gina Colarelli, and Robert W. Veryzer (2001), "The Nature of Market Visioning for Technology-Based Radical Innovation." *Journal of Product Innovation Management* 18 (July), 231–46.

Ofek, Elie and Miklos Sarvary (2003), "R&D, Marketing, and the Success of Next-Generation Products," *Marketing Science* 22, 3 (Summer), 355-70.

Ofek, Elie, and Ozge Turut (2004), "To Innovate or Imitate? R&D Decision and the Role of Market Research." Cambridge, Mass.: Harvard Business School, Working Paper.

Orlikowski, Wanda J. (1992), "The Duality of Technology: Rethinking the Concept of Technology in Organizations." *Organization Science* 3 (3), 398–427.

Osborn, A. J. (1953), *Applied Imagination*. New York, N.Y.: Charles Scribner's Sons.

Ozer, Muanmmer (1999), "A Survey of New Product Evaluation Models." *Journal of Product Innovation Management* 16 (January), 77–94.

Padmanabhan, V., Surendra Rajiv, and Kannan Srinivasan (1997), "New Products, Upgrades, and New Releases: A Rationale for Sequential Product Introduction." *Journal of Marketing Research* 34 (November), 456–72.

Park, C. Whan, Sung Youl Jun, and Deborah J. MacInnis (2000), "Choosing What I Want Versus Rejecting What I Do Not Want: An Application of Decision Framing to Product Option Choice Decisions." *Journal of Marketing Research* 37 (May), 187–202.

Pavitt, K. (1990), "What We Know About the Strategic Management of Technology." *California Management Review* 32 (Spring), 17–26.

Payne, John W., James R. Bettman, and Eric J. Johnson (1993), *The Adaptive Decision Maker*. Cambridge, U.K.: Cambridge University Press.

Peterson, Robert A., and Vijay Mahajan (1978), "Innovation Diffusion in a Dynamic Potential Adopter Population." *Management Science* 24 (15), 1589–97.

Prince, George M. (1970), *The Practice of Creativity*. New York, N.Y.: Harper & Row Publishers.

Purohit, Devavrat (1994), "What Should You Do When Your Competitors Send in the Clones?" *Marketing Science* 13 (Fall), 392–411.

Putsis, William P. Jr., Sridhar Balasubramaniam, Edward H. Kaplan, and Subrata Sen (1997), "Mixing Behavior in Cross-Country Diffusion." *Marketing Science* 16 (4), 354–69.

Raju, P. S. (1980), "Optimum Stimulation Level: Its Relationship to Personality, Demographics and Exploratory Behavior." *Journal of Consumer Research* 7 (December), 272–82.

Repenning, Nelson (2000), "A Dynamic Model of Resource Allocation in Multi-Project Research and Development Systems." *The System Dynamics Review* 16 (3), 173–212.

Repenning, Nelson (2001), "Understanding Fire Fighting in New Product Development." *Journal of Product Innovation Management* 18 (September), 285–300.

Repenning, Nelson, and John Sterman (2000), "Getting Quality the Old-Fashioned Way: Self-Confirming Attributions in the Dynamics of Process Improvement." In *The Quality Movement and Organization Theory*, eds. R. Cole and W. R. Scott, 237–70. Thousand Oaks, Calif.: Sage Publications.

Repenning, Nelson, and John Sterman (2001), "Nobody Ever Gets Credit for Fixing Defects That Didn't Happen: Creating and Sustaining Process Improvement." *California Management Review* 43 (4), 64–88.

Repenning, Nelson, and John Sterman (2002), "Capability Traps and Self-Confirming Attribution Errors in the Dynamics of Process Improvement." *Administrative Science Quarterly* 47 (2), 265–95.

Ries, Al, and Jack Trout (1993), *The 22 Immutable Laws of Marketing.* New York, N.Y.: HarperBusiness.

Roberts, John H., and James M. Lattin (1997), "Consideration: Review of Research and Prospects for Future Insights." *Journal of Marketing Research* 34 (August), 406–10.

Robinson, William T. (1988), "Sources of Market Pioneer Advantages: The Case of Industrial Goods Industries." *Journal of Marketing Research* 25 (February), 87–94.

Robinson, William T., and Claes Fornell (1985), "Sources of Market Pioneer Advantage in Consumer Goods Industries." *Journal of Marketing Research* 22 (August), 305–17.

Roehrich, Gilles (2004), "Consumer Innovativeness: Concepts and Measurements." *Journal of Business Research* 57 (June), 671–95.

Rogers, Everett M. (2003), *Diffusion of Innovations.* New York, N.Y.: Simon and Schuster.

Sahal, Devendra (1981), "Alternative Conceptions of Technology." *Research Policy* 10 (1), 2–24.

Sarin, Shikhar, and Dean A. Shepherd (2004), "Boundary Management by New Product Development Teams: The Effect on Internal Support and Performance." Presented to ISBM New Priorities and Challenges for Business-to-Business Marketers, Harvard Business School, Boston, August.

Sawhney, Mohanbir S., and Jehoshua Eliashberg (1996), "A Parsimonious Model for Forecasting Gross Box-Office Revenues of Motion Pictures." *Marketing Science* 15 (2), 113–31.

Schmalensee, Richard (1982), "Product Differentiation Advantages of Pioneering Brands." *American Economic Review* 72 (June), 349–65.

Schmalensee, Richard, and Jacques Thisse (1988), "Perceptual Maps and the Optimal Location of New Products: An Integrative Essay." *International Journal of Research in Marketing* 5 (4), 225–49.

Schmittlein, David, and V. J. Mahajan (1982), "Maximum Likelihood Estimation for an Innovation Diffusion Model of New Product Acceptance." *Marketing Science* 1 (Winter), 57–8.

Schumpeter, J. A. (1942), *Capitalism, Socialism, and Democracy*. New York, N.Y.: Harper.

Senin, Nicola, David R. Wallace, and Nicholas Borland (2003), "Object-Based Simulation in a Service Marketplace." *ASME Journal of Mechanical Design* 125.

Shankar, Venkatesh, and Barry L. Bayus (2001), "Network Effects and Competition: An Empirical Analysis of the Home Video Game Industry." College Park, Md.: University of Maryland, Working Paper.

Shankar, Venkatesh, Gregory S. Carpenter, and Lakshman Krishnamurthi (1998), "Late Mover Advantage: How Innovative Late Entrants Outsell Pioneers." *Journal of Marketing Research* 35 (February), 54–70.

Shocker, Allan D., and William G. Hall (1986), “Pretest Market Models: A Critical Evaluation.” *Journal of Product Innovation Management* 3 (June), 86–108.

Simonson, Itamar (1993), “Get Closer to Your Customers by Understanding How They Make Choices.” *California Management Review* 35 (4) (Summer), 68–84.

Simonson, Itamar, and Barry M. Staw (1992), “De-Escalation Strategies: A Comparison of Techniques for Reducing Commitment to Losing Courses of Action.” *Journal of Applied Psychology* 77 (4), 419–26.

Smith, Preston G., and Donald G. Reinertsen (1992), “Shortening the Product Development Cycle.” *Research-Technology Management* 35 (3), 44–9.

Sood, Ashish, and Gerard J. Tellis (2004), “Understanding the Seeds of Growth: Technological Evolution and Product Innovation.” Los Angeles, Calif.: University of Southern California, Working Paper.

Sorescu, Alina B., Rajesh K. Chandy, and Jaideep C. Prabhu (2003), “Sources and Financial Consequences of Radical Innovation: Insights from Pharmaceuticals.” *Journal of Marketing* 67 (4), 82–93.

Srinivasan, Raji, Gary L. Lilien, and Arvind Rangaswamy (2004), “First In, First Out? The Effects of Network Externalities on Pioneer Survival.” *Journal of Marketing* 68 (January), 41–55.

Srinivasan, V., and Charlotte H. Mason (1986), “Nonlinear Least Squares Estimation of New Product Diffusion Models.” *Marketing Science* 5 (Spring), 169–78.

Srinivasan, V., and Allen D. Shocker (1973), “Estimating the Weights for Multiple Attributes in a Composite Criterion Using Pairwise Judgments.” *Psychometrika* 38 (December), 473–93.

Staw, Barry M. (1976), “Knee-Deep in the Big Muddy: A Study of Escalating Commitment to a Chosen Course of Action.” *Organizational Behavior and Human Performance* 16 (1), 27–44.

Steenkamp, Jan-Benedict E. M., Frenkel ter Hofstede, and Michel Wedel (1999), “A Cross-National Investigation into the Individual and National Cultural Antecedents of Consumer Innovativeness.” *Journal of Marketing* 63 (April), 55–69.

Sultan, Fareena, John U. Farley, and Donald R. Lehmann (1990), “A Meta-Analysis of Applications of Diffusion Models.” *Journal of Marketing Research* 27 (February), 70–7.

Sun, Baohong, Jinhong Xie, and H. Henry Cao (2004), “Product Strategy for Innovators in Markets with Network Effects.” *Marketing Science* 23 (2), 243–54.

Swait, Joffre (2001), “A Noncompensatory Choice Model Incorporating Cutoffs.” *Transportation Research* 35 (Part B), 903–28.

Takada, Hirokazu, and Dipak C. Jain (1991), “Cross-National Analysis of Diffusion of Consumer Durable Goods in Pacific Rim Countries.” *Journal of Marketing* 55 (April), 48–54.

Talukdar, Debu, Karunakaran Sudhir, and Andrew Ainslie (2002), “Identifying Similarities in Diffusion Patterns Across Countries and Products: A Bayesian Variance Components Approach.” *Marketing Science* 21 (1), 97–116.

Tellis, Gerard J., and Peter N. Golder (1996), “First to Market, First to Fail? Real Causes of Enduring Market Leadership.” *Sloan Management Review* 37 (2), 65–75.

Tellis, Gerard J., and Peter N. Golder (2001), *Will and Vision: How Latecomers Grow to Dominate Markets.* New York, N.Y.: McGraw-Hill.

Tellis, Gerard J., Stefan Stremersch, and Eden Yin (2003), “The International Takeoff of New Products: Economics, Culture, and Country Innovativeness.” *Marketing Science* 20 (2), 188–208.

Tellis, Gerard J., and Eden Yin (2004), "Network Effects versus Quality in the Success of New High-Tech Products." Los Angeles, Calif.: University of Southern California, Working Paper.

Tellis, Gerard J., Eden Yin, and Simon Bell (2004), "Global Consumer Innovativeness: Country Differences and Individual Commonalities." Los Angeles, Calif.: University of Southern California, Working Paper.

Thaler, Richard (1985), "Mental Accounting and Consumer Choice." *Marketing Science* 4 (Summer), 199–214.

Thomke, Stefan, and Eric von Hippel (2002), "Customers As Innovators: A New Way to Create Value." *Harvard Business Review* 80 (4) (April), 74–81.

Toubia, Olivier (2004), "Idea Generation, Creativity, and Incentives." Center for Innovation in Product Development, MIT, Cambridge, Mass.: Working Paper.

Toubia, Olivier, John R. Hauser, and Duncan Simester (2004), "Polyhedral Methods for Adaptive Choice-Based Conjoint Analysis." *Journal of Marketing Research,* forthcoming.

Toubia, Olivier, Duncan I. Simester, John R. Hauser, and Ely Dahan (2003), "Fast Polyhedral Adaptive Conjoint Estimation." *Marketing Science* 22 (Summer), 273–303.

Ulrich, Karl (1995), "The Role of Product Architecture in the Manufacturing Firm." *Research Policy* 24 (3), 419–40.

Ulrich, Karl, and Steven D. Eppinger (2000), *Product Design and Development*. New York, N.Y.: McGraw-Hill.

Urban, Glen L., Theresa Carter, Steven Gaskin, and Zofia Mucha (1986), "Market Share Rewards to Pioneering Brands: An Empirical Analysis and Strategic Implications." *Management Science* 32 (June), 645–59.

Urban, Glen L., and John R. Hauser (2004), " 'Listening In' to Find and Explore New Combinations of Customer Needs." *Journal of Marketing* 68 (April), 72–85.

Urban, Glen L., John R. Hauser, William J. Qualls, Bruce D. Weinberg, Jonathan D. Bohlmann, and Roberta A. Chicos (1997), "Validation and Lessons from the Field: Applications of Information Acceleration." *Journal of Marketing Research* 34 (February), 143–53.

Urban, Glen L., Bruce Weinberg, and John R. Hauser (1996), "Remarket Forecasting of Really-New Products." *Journal of Marketing* 60 (January), 47–60.

Utterback, James M. (1994), *Mastering the Dynamics of Innovation*. Boston, Mass.: Harvard Business School Press.

Van Den Bulte, Christophe, and Stefan Stremersch (2004), "Social Contagion and Income Heterogeneity in New Product Diffusion: A Meta-Analysis Test." *Marketing Science,* forthcoming.

Venkatraman, Meera P. (1991), "The Impact of Innovativeness and Innovation Type on Adoption." *Journal of Retailing* 67 (1), 51–67.

Veryzer, Robert W. Jr. (1998), "Discontinuous Innovation and the New Product Development Process." *Journal of Product Innovation Management* 15 (July), 304–21.

Vincent, Leslie H., S. G. Bharadwaj, and G. N. Challagalla (2004), "Does Innovation Mediate Firm Performance? A Meta-Analysis of Determinants and Consequences of Organizational Innovation." Atlanta, Ga.: Georgia Institute of Technology, Working Paper.

von Hippel, Eric (1986), "Lead Users: A Source of Novel Product Concepts." *Management Science* 32 (7), 791–805.

von Hippel, Eric (1988), *The Sources of Innovation*. New York, N.Y.: Oxford University Press.

von Hippel, Eric (2001), “User Toolkits for Innovation.” *Journal of Product Innovation Management* 18 (4), 247–57.

Wallace, David, Shaun Abrahamson, Nicola Senin, and Peter Sferro (2000), “Integrated Design in a Service Marketplace.” *Computer-Aided Design* 32 (2), 97–107.

Wenger, Etienne (1998), *Communities of Practice: Learning, Meaning, and Identity*. New York, N.Y.: Cambridge University Press.

Wheelwright, Steven C., and Kim B. Clark (1992), *Revolutionizing Product Development*. New York, N.Y.: The Free Press.

Xie, J., and Marvin Sirbu (1995), “Price Competition and Compatibility in the Presence of Positive Demand Externalities.” *Management Science* 41 (May), 909–26.

Zahay, Debra, Abbie Griffin, and Elisa Fredericks (2004), “Sources, Uses and Forms of Data in the New Product Development Process.” *Industrial Marketing Management,* forthcoming.