Introduction to the special issue: Marketing of high-technology products and innovations

Article

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INTRODUCTION TO THE SPECIAL ISSUE: MARKETING OF HIGH-TECHNOLOGY PRODUCTS AND INNOVATIONS

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We are pleased to introduce this special issue of the *Journal of Marketing Theory and Practice* on the marketing of high-technology products and innovations. The papers featured in this special issue are varied in focus, theory, methods, and implications. Prior to describing the papers in more detail, we describe the reason for the special issue.

Today's information-intensive economy places increased importance on high-technology products, and this is shown in high-tech firms' increasingly expanded role in the global economy. In 2003, five of the top ten global brands were high-tech firms: Microsoft, IBM, GE, Intel, Nokia. (The other five global brands were Coca-Cola, Disney, McDonald's, Marlboro, and Mercedes.) In addition to the expanded role of "traditional" high-tech firms (such as those in computer hardware and software, telecommunications, consumer electronics, and information technology), other firms across a wide range of industries are increasingly innovating and relying on technology to deliver their value propositions. For example, services industries must have a technology infrastructure in order to track customer relationships, retailers must have an e-commerce infrastructure to compete effectively, and even rather staid, traditional manufacturing industries must rely on technological innovations as well as e-business processes to stay abreast of market trends.

To be more specific, high-technology products are characterized by a combination of the following (Mohr 2001):

- A high degree of *market uncertainty*, marked by customer anxiety ("fear, uncertainty, and doubt," e.g., Moore 1991) about how to use the product and what needs it will fill (which, in turn, affect how quickly the new technology will be adopted by the marketplace, leading to uncertainties in forecasting sales and manufacturing capacity);
- A high degree of *technological uncertainty*, marked by ambiguity over whether the product will function as promised, whether it will be delivered on time, and potential unintended/ unforeseen consequences;
- A high degree of competitive volatility, in which new technological break-throughs are frequently introduced by industry outsiders, whose innovations and business strategies often change the "rules of the game:'
- High R&D expenditures, which complicate pricing decisions and profitability forecasts (particularly when combined with uncertain sales revenues);

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- Rapid obsolescence of products, where innovations supercede prior versions of a product;

- The presence of network externalities, in which the value any particular customer gets from adopting/using the new innovation is exponentially related to the number of other adopters (as in instant messaging applications, for example).

As a result of these characteristics, marketing must be adapted and modified to effectively handle the complicated environment in which customer adoption decisions, and the firm's marketing decisions are made (e.g., John, Weiss, and Dutta 1999).

Moreover, many high-tech firms tend to be engineering-oriented (or product-driven), and exhibit a culture in which engineering knowledge is valued more than marketing acumen. This creates something of a double-jeopardy environment, where the need for marketing skills is greater than in other industry contexts, yet it is less likely to be found or valued.

For these reasons, this special issue is devoted to understanding the complexities of high-technology marketing. In this introduction, we overview the papers in the special issue and point to fruitful areas for future research on high-technology marketing.

Overview of Papers in the Special Issue

The special issue is comprised of papers representing a diverse set of authors, topics, theories, methods, and research contexts. The authors represent an array of nationalities, coming from Canada, Australia, New Zealand, and the United States. Although predominantly "Western" in their origins, the diverse range of geographic backgrounds lends a useful perspective in the ubiquity of high-tech issues in various economies, business environments, and scholarly research agendas. Additionally, although the majority of the authors come from a "functional" background in marketing, other disciplines are also represented by the authors whose research is featured in the special issue, including environmental science, ocean physics/marine geophysics, and entrepreneurship. Two of the papers are co-authored by business executives.

As shown in Figure 1, the topics covered by the papers can be arrayed along two dimensions: whether the perspective of the research represents the customer or the firm; and whether the research is empirical or conceptual. Four of the papers take the perspective of the high-technology marketing firm; two examine issues from the perspective of the adopting consumer. The majority of the papers (four) are based on empirical research, while two develop a conceptual framework. Table 1 provides a more specific summary of the papers in this special issue.

FIGURE 1
PAPER REPRESENTED IN THIS SPECIAL ISSUE

Perspective / Method	Organizational	Consumer
Conceptual	Barlow Hills and Sarin: "From Market Driven to Market Driving: An Alternate Paradigm for Marketing in High Technology Industries"	Sarin, Sego, and Chanvarashuth: "Strategic Use of Bundling for Reducing Consumers' Perceived Risk Associated with the Purchase of New High Tech Products"
Empirical	Stewart, Mullarkey, and Craig : "Innovation or Multiple Copies of the Same Lottery Ticket: The Effect of Widely Shared Knowledge on Organizational Adaptability" Athaide, Stump, and Joshi: "Understanding New Product Co-Development Relationships in Technology-Based, Industrial Markets" Danov, Smith and Mitchell: "Relationship Prioritization for Technology Commercialization"	McDonald, Corkindale, and Sharp: "Behavioral Versus Demographic Predictors of Early Adoption: A Critical Analysis and Comparative Test"

Two of the papers focus on the value of being market-oriented in high-tech arenas. The first of these (Barlow Hills and Sarin) is conceptual; it argues that due to the unique characteristics of a high-tech environment, a market-orientation can lead to myopia with respect to future needs in the marketplace. Therefore, Barlow Hills and Sarin (2002) suggest that firms in high-tech environments should be "*market-driving*" as opposed to "market-driven." Market-driving is represented by "a firm's ability to lead fundamental changes in the evolution of industry conditions by influencing the value creation process at the product, market, or industry levels" (see also Jaworski, Kohli, and Sahay 2000). Market driving results when a firm's actions (innovations in product, process, strategy, or market-definition) drive changes in customer behavior, needs, and preferences, which in turn, compel other industry players to alter their behaviors in response. The primary objective of market-driving firms is to influence the evolution of their industry in a direction consistent with their own strengths and abilities, and to derive long-term advantage from such an evolution. The authors

TABLE 1:
SUMMARY OF PAPERS IN SPECIAL ISSUE

Authors	Topic	Theory	Independent Variables	Dependent Variables	Context/Sample	Findings
Barlow Hills and Sarin	Develops paradigm for high tech marketing based on idea of "marketing driving"	Market-orientation, customer learning and pioneering advantage	N/A (conceptual manuscript)		Qualitative research with n= 86 (62.3% response rate) to refine concept of "market driving"	Market-driving firms exhibit: A) Three underlying dimensions: 1) Create value through innovative activities (in product, process, strategy, market definition). 2) Function as change agents in the industry. 3) Lead others into uncharted territories proactively. B) Three different levels: 1) Industry 2) Product 3) Market Market-driving behavior differs in significant ways from market orientation, customer leading, and pioneering.
Stewart, Craig, Mullarkey	Examines the impact of heterogeneity of information flows on organizational adaptability.	Biological metapopulation theory, market orientation	Information processes (acquisition, transmission, conceptual use, and instrumental use)	New product performance, new product novelty	n=62 marketing executives involved in a new product launch in the past 12 months	Organizations should encourage different and heterogeneous combinations of information processes to succeed in turbulent environments which characterize marketing of high-technology products.
Athaide, Stump, and Joshi	Examines conditions under which new product co-development relationships between buyer & seller are formed, and affect on relationship satisfaction.	Transaction cost analysis, agency theory, relationship marketing	Buyer knowledge, Relationship history, Degree of product customization.	"Degree of new product-co-development," "Satisfaction with relationship"	n=334 (23% response rate) small/ medium sized US firms across a range of technology-based industries (software, high-tech manufacturing equipment, environmental equipment, etc.) Sellers responded on a relationship with one buyer during the development of a new product. Key informant = marketing managers.	Extent of new product co-development is positively associated with: 1) perceived buyer knowledge 2) prior relationship history 3) greater product customization Buyer knowledge moderates the relationship between new product co-development and relationship satisfaction: under higher levels of buyer knowledge, the relationship between co-development efforts and satisfaction is more strongly positive than under low levels of buyer knowledge.
Danov, Smith, and Mitchell	Considers the initiation and management of stakeholder relationships and the sequence or order in which key stakeholder relationships should be developed.	Stakeholder theory, network theory, transaction cognition theory	Investment in the new relationships of the relationship web, and transaction value to the investor in the start-up firm.	Market – based power	Mathematical conceptual model – manufacturer of ground-effect machine, two key suppliers and three major customers	Stakeholder sequence model can show which stakeholder relationships should be developed at specific stages of project development for high-tech start up firms.;

Sarin, Sego, and Chanvarasuth	Develops propositional inventory for the use of bundling strategies to lower consumers' perceived risk of adopting new technologies	Prospect theory, mental accounting	Bundling characteristics	Consumers' perceived risk	N/A (conceptual)	Develops a series of propositions relating bundling strategies to consumers' perceived risk of adopting new high-tech products. Consumers' perceived risk is reduced when a new high-tech product is: (a) bundled with an established product, (b) presented as a tie-in rather than as an anchor product in the bundle, (c) bundled with a credible brand; and when the bundle represents an incremental (versus radical) innovation, and if the bundle offers a high (versus low) discount to consumers.
McDonald, Corkindale, and Sharp	Considers the efficacy of traditional psychographic and demographic variables versus behavioral variables on predictors of early adopters.	Adoption/diffusion of innovation (Rogers), philosophy of science	Demographics, Innovativeness, Behavioral variables (ownership of similar types of product, media habits)	Adoption of new innovation, Awareness of innovation	n=1042 heads of households in a major city in Australia; asked about awareness/usage of compact fluorescent lightglobes (a dynamically continuous innovation)	1. Demographics: a. Adopters not significantly: i. younger than nonadopters but rather, were more middle-aged and older; ii. different in income levels (adopters not higher income households compared to nonadopters); iii. different in the family life cycle; iv. different in occupational status. b. Adopters were more highly educated than nonadopters. 2. Media: a. Early adopters relied less upon mass media than later adopters. 3. Behavioral: a. Adopters had higher ownership of energy saving products (compost bins, home insulation), were more likely to watch science-based TV programs than nonadopters, were more likely to belong to conservation groups (such as Greenpeace), and own their own homes. 4. Personality: a. Adopters were not significantly different from nonadopters on the Innovativeness scale.

argue that this evolution cannot be achieved through market orientation, customer leading, or pioneering behavior.

A key contribution of this first paper is that the distinctive nature of high-technology markets (characterized by high levels of uncertainty and volatility, questions over product standards, and the presence of increasing returns/network effects, for example) creates conditions under which the market-driving approach is particularly applicable. For example, Barlow Hills and Sarin (2003) posit that market-driving behavior can ultimately reduce the competitive volatility found in high-tech markets, can increase the availability of complementary products (minimizing technological uncertainty) and can improve the probability that the products developed by an industry network to support a particular technological format are mutually compatible.

A related paper, empirical in nature, examines potential limitations of a market orientation in changing and turbulent environments (Stewart, Craig, and Mullarkey 2003). The key question examined in this research is "*What is the level of diversity of information/knowledge required to create organizational adaptability under changing environmental conditions*?" Stewart, Craig, and Mullarkey base their hypotheses on biological meta-population theory, which argues that variation/heterogeneity of genetic information is critical to the adaptability and on-going survival of a species; such variation can arise either from mutation or gene in-flows from other populations and results in recombination and adaptation. More specifically, a high level of gene flow within a population creates a situation where the population converges to more homogeneous genetic composition. On the other hand, lower levels of gene flow create differences in genetic composition across sub-units in the population, which results in a higher level of genetic diversity. Stewart, et al. cite examples such as endangered species that often have low diversity of genetic information and are therefore at risk of extinction due to their decreased ability to adapt to changes in the environment. While homogeneity can be an advantage in stable conditions, it is deleterious under changing conditions. The analogy used by Stewart, Craig, and Mullarkey (2003) is that the survival value of a homogeneous population is akin to attempting to win the lottery by having multiple copies of the same ticket.

Like natural organisms, diversity within organizations must match the variety/complexity of the environment to allow for sufficient adaptation. Because organizations are hypothesized to adapt to environments by sharing and using information in new and different ways, Stewart, Craig, and Mullarkey examine information flows within the organization, and how information flows affect adaptability in different environmental conditions. In contrast to the literature on market orientation—which suggests that widely shared (homogenous) information is key to new product success and inter-functional coordination, and, therefore, has a positive effect on innovation—meta-population theory suggests that radically-innovative products are *less* likely to be produced by firms that promote strongly unifying and cohesive knowledge sharing through a strong market orientation.[1] Hence, in contrast to the recommendations of the market-orientation literature, firms in highly turbulent environments shouldn't necessarily strive for consensus (consensus implies that individuals share equivalent views of the meaning of information, and therefore, can't provide sufficient novelty of insights to provide for adaptation). These authors argue that if organizational sub-units operate autonomously (in other words, they are highly differentiated), then the organization will exhibit greater flexibility.

Using data from a sample of 62 marketing executives involved in new product launch decisions, their findings show that to achieve organizational adaptability (as measured by new product novelty and success), an organization should encourage many different (i.e., heterogeneous) combinations of information. In other words, it doesn't make sense to rely on multiple copies of the same lottery ticket to win! This paper offers insights into how high-tech firms can adapt rapidly to the fast-paced changes in their environment, based on their flows and use of information. It is particularly relevant to the idea of avoiding core rigidities, in which a firm's established routines and procedures blind it from new insights and ways of doing things.

The next two papers in this special issue, both empirically-based, examine inter-firm relationships in high-technology environments. Athaide, Stump, and Joshi examine the *antecedents to and outcomes of the co-development of an innovative new product by a buyer and a seller* (where a seller and buyer enter into a relationship to mutually undertake the development of an innovative product). Grounded in agency theory, transaction cost analysis, and the relationship marketing literatures, these authors argue that new product co-development relationships represent a bilateral agency situation, where the performance of the seller's agency role involves the delegation of some of its product development duties and responsibilities to the buyer. Thus, co-development relationships can mitigate information asymmetry in that they provide an environment where sellers can cooperatively develop and share the capabilities of newer technologies while buyers impart important and often tacit information about their needs.

Furthermore, from a transaction cost analysis perspective, co-developing products often involves the reciprocal investment

[1] Indeed, some authors have found that a greater emphasis on dispersion of shared knowledge across functions reduced the level of innovative products (Lukas and Ferrel 2000). Moreover, Brown and Eisenhardt (1998) and Moorman and Miner (1997) also offer findings showing that the value of cohesion/shared levels of organizational memory can negatively affect adaptability/new product creativity in turbulent market environments.

of transaction-specific assets, such that each side provides "hostages" to assure fidelity and performance. Instead of being a situation with asymmetric dependence, co-development represents a level of interdependence which can resolve the safeguarding problem often found in such relationships. Moreover, because the co-development leads each party's involvement to be more transparent to the other, internal information asymmetries can be reduced and this can extend the environmental scanning ability of both sides.

Athaide, Stump, and Joshi's model examines three antecedents—perceived buyer knowledge, prior relationship history, and product customization—and one outcome—satisfaction. Based on data collected from 334 marketing managers of small- and medium-sized enterprises across a range of technology-based industries, their findings show that as marketing managers perceive buyers to be more knowledgeable (i.e., the buyers have more sophisticated insights about the potential of new technologies and are willing to adopt product offerings that incorporate them), there is a greater incidence of co-development. This might be particularly useful when suppliers are working with lead-users to commercialize technologies, or in the design phase of developing new high-tech products.

This positive association with new product co-development is also found for longer relationship history and greater new product customization. In terms of outcomes, this study shows that buyer knowledge moderates the relationship between new product co-development and relationship satisfaction: under higher levels of buyer knowledge, there is a stronger relationship between co-development efforts and satisfaction than under low levels of buyer knowledge.

The second of the two papers in this set (which empirically examine relationship marketing strategies in high-tech environments) develops a *stakeholder sequence model* to determine the order in which high-tech start-ups should develop stakeholder relationships (Danov, Smith, and Mitchell). Although stakeholder sequence is important for all start-ups, Danov, Smith, and Mitchell argue that, because technology-based innovations typically involve complex supplier, partner, distributor, customer, financial, regulatory, and other relationships—often in multi-sector and global contexts— stakeholder sequence is particularly important in high-tech start-ups. For example, greater equity might be raised in first-level financing, if an entrepreneur already has secured a lead user customer. The basic premise is that a start-up firm must attract key stakeholders at the right time in order to maximize the odds of success.

Danov, Smith, and Mitchell develop a mathematical model to determine the efficient/effective sequence in which relationships should be developed. The model's key parameters include transaction value (attractiveness of the exchange offer), business potential (present value of the potential future cash inflows), and the total number of relationships to be managed. Although many of the parameters in the model may be difficult to estimate—and the model ideally requires that calculations on all possible transaction sequences be evaluated—the authors show how to estimate the parameters in the context of a company commercializing ground-effect machine technology.[2] The application begins by selecting a few intuitively appealing sequences of relationship development, and then evaluates these sequences by varying key parameters in a spreadsheet.

While managers and entrepreneurs currently make relationship sequence decisions intuitively based on prior experience and heuristics (or by default, rather than consciously), even the approximate solution arising from the use of this model helps to make the process more explicit and precise—and therefore less risky; in other words, the decision becomes less art and more science. The use of their model, focusing on the sequence/order of relationship development, helps a firm to develop proactive relationship strategies (rather than reactively developing relationships in response to stakeholder demands).

The final set of papers in this special issue examines consumer's responses to high-technology marketing. The first of these, conceptual in nature, examines bundling strategies used by high-tech firms (Sarin, Sego, and Chanvarasuth). The second empirically examines conventional wisdom with respect to adoption and diffusion of innovation (McDonald, Corkindale, and Sharp).

Sarin, Sego, and Chanvarasuth (2003) offer a compelling argument about the need to identify strategies which can help to lower the *perceived risk* that consumers experience in the decision to adopt high-technology products. Due to increasing returns effects or network externalities, an increase in the number of people using a product leads to the product becoming more valuable to current and potential users, which in turn, drives the development of complementary products that add further value to the user's investment. According to this paper, successful bundling strategies are key to acquiring and retaining early adopters for high-tech products. Yet, due

[2] The aerodynamic ground effect is the result of the increase in lift and decrease in drag for a plane flying close to the surface. A ground-effect machine, then, is a high-speed amphibious vehicle that utilizes the aerodynamic ground effect, and can operate either as a boat or airplane, flying between 2-7 feet off the ground (or water) in dynamic air cushion mode, cruising between 60-120 miles per hour. These vehicles are faster than boats, significantly lower in price, and less expensive to operate than helicopters or similar sized airplanes. They do not require a pilot's license or airport infrastructure, and they can operate on and over all surfaces including ice. They are superior to hydrofoils and are environmentally friendly; possible commercial applications could include passenger, cargo, or mail transport, tourism and recreation services, high-speed water taxi, emergency, ecological, patrol, and search and rescue services.

to the uncertainties associated with adopting new technology, the risks to the consumer of early adoption are often perceived as great.

Hence, Sarin, Sego, and Chanvarasuth examine the use of *bundling strategies* (selling two or more products/services at a single price) to reduce consumers' perceived risk. (Risk is defined as consumer perceptions about the probability and magnitude of potential negative consequences resulting from a purchase.) Bundles can add value through integration of products in the bundle (selling complementary or related products together in a single unit) or through bundle discounts (price promotion). Bundling a new high-tech product with complementary products can signal the availability of complementary products, compatibility between products, and conformance to a common technological standard. In this way, bundles get at the core issues affecting perceived risk in high-tech markets.

More specifically, Sarin, Sego, and Chanvarasuth develop a series of propositions examining what characteristics of a product bundle may help reduce consumers' perceived risk. The characteristics they examine include: brand credibility of both the new high-tech product as well as the established product, level of innovation, bundle positioning (is the high-tech product considered to be the "anchor" in the bundle, or the tie-in product?), and bundle discounts, and their relationship to consumers' perceived risk.

The final paper in this special issue scrutinizes a cornerstone of marketing theory—adoption and diffusion of innovation—through a new lens. McDonald, Corkindale, and Sharp question the conventional wisdom arising from the theory of the adoption and diffusion of innovations. Taking a philosophy of science perspective, they note that if the theory of the adoption and diffusion of innovation is to be truly useful, it must have some way to predict which consumers will adopt first, have an answer about why they will adopt first, and predict/explain the eventual penetration level of an innovation. Yet, the predominant focus on demographics and psychographics in empirical research to date has proven to be inconclusive in predicting early adoption. Importantly, an assessment of the characteristics of early adopters can be best known only on a post hoc basis, when a comparison of the characteristics between early and later adopters can be made. In other words, these authors argue that simple statements along the lines of "early adopters are younger or more highly educated than the population as a whole" do not provide valid insights into understanding adoption when the population as a whole is not the target of interest; rather, the specific target of interest is the adopting population. McDonald, Corkindale, and Sharp note that these concerns are especially problematic in the case of discontinuous innovations, where predictions are most difficult.

Studying the adoption decision for compact fluorescent lightglobes (CFL),[3] the authors first conducted qualitative research (focus groups with purchasers/users of CFLs; those who were aware of the product but non-purchasers, and nonpurchasers/unaware) to generate hypotheses about adoption behavior. They then empirically tested those hypotheses with a sample of 1042 heads of households in a major city in Australia. Their findings demonstrated that demographics were not significantly related to adoption behavior; rather the key predictors explaining adoption were behavioral variables related to either: (a) purchase of similar/related products (in the case of compact fluorescent lightglobes, membership in conservation groups, ownership of energy-saving products such as compost bins and home insulation) or (b) indicators of the expected utility from using the innovation (i.e., owning versus renting one's home, or elderly people with high-ceilinged homes who would have to change the bulbs less frequently). They use these findings to argue that the search for demographic correlates of early adoption may not be the most fruitful avenue of inquiry, and advocate a focus on behavioral correlates of early adoption.

Summary

The papers in this special issue help push the field of high-tech marketing forward in terms of their collective contributions and insights. Each paper makes a contribution in enhancing our understanding of and appreciation for how marketing of high-tech products presents different challenges to firms than marketing for more traditional products. These challenges are many and multifaceted, emanating from, among others, the nature of the products, the players involved, and the strategies where competition in the market is played out.

Clearly, this special issue merely begins to address the multitude and complexity of issues high-tech marketers must understand. Marketing scholars can push this field forward by continuing the efforts represented here. The following paragraphs offer suggestions for additional research on high-tech marketing focused on network externalities, forecasting models, customer technology adoption decisions, the offering of services as part of a firm's high-tech product marketing strategies, understanding of high-tech industry clusters, and public policy and societal implications.

First, given the increasing importance placed on understanding network externalities, researchers and managers alike would benefit from an enhanced understanding of how to develop and manage companies whose products are affected by the size of the installed base (i.e., number of existing customers).

[3] Compact fluorescent lightglobes last up to eight times as long as traditional incandescent globes and use about 60% less electricity. Although they are priced higher (10-30 times higher) than a simple incandescent bulb, they provide savings on both electricity costs and effort in replacing bulbs frequently.

Recent work by Frels, Shervani, and Srivastava (2003) in this area highlights that product performance alone does not determine organizational adoption decisions for a high-tech product; rather, the relative strength of the product's networks (in terms of users, complementary products, and producers) are more influential in adoption decisions. Relatedly, Lee and O'Connor (2003) study effective marketing strategies in high-tech markets characterized by network externalities. Their conceptual framework examines the possible effects of various new product launch strategies on firm performance as a function of the size of the installed base and the speed with which that installed base is developed. Understanding how firms maneuver in such markets to develop their networks, and their interdependencies, continues to be an under-researched, yet important topic. (See also Schilling 2002, 2003).

A second area in high-tech marketing ripe for additional research is forecasting for high-tech products. As noted by Pae and Lehmann (2003),

> "Advancing technology seems an inevitable force. ... For people who forecast technological change and substitution in general, and for managers in industries in which technologies are periodically upgraded in particular, there is a continuing need for simple and accurate forecasting models." (p. 36).

The forecasting model they develop shows that the longer the time that elapses between adjacent generations of technology, the slower the adoption of the subsequent technology. This finding suggests that, the longer the time between generations, the greater resistance to upgrades. This is consistent with work by Weiss (Grenadier and Weiss 1997; Weiss 1994) who shows that the migration path offered by companies to customers of subsequent generations of technology must account for customers' expectations about the pace and magnitude of advancements in new generations.

Relatedly, work by Goldenberg, Libai, and Muller (2002) examines the slump (what they refer to as a "saddle," also known as the "chasm" in Geoffrey Moore's work) that affects the diffusion of high-tech products; there is a rapid take-off of early sales of a new product, followed by a slowdown, which is then followed by a more gradual subsequent sales take-off. Understanding the factors that contribute to this slump aids high-tech managers in more accurate forecasting, and in understanding strategies to avoid the slump. The key factor these authors examine is the level of communication between the early market adopters and the main market adopters. With higher levels of communication between these two groups of customers, the sales slump is less pronounced.

Studies such as these highlight the fact that traditional forecasting models may not be well-equipped to handle the complexities of high-tech markets. Related to the development of forecasting models that can handle the complexities of high-tech markets, researchers in this area are also attempting to better understand the factors that affect adoption decisions of radical innovations (e.g., Srinivasan, Lilien, and Rangaswamy 2002) and other high-tech products (Stremersch, Weiss, Dellaert, and Frambach 2003). Some recent work in this area tends to focus on organizational adoption decisions of e-business technologies (or technologies that are used to automate business processes to enhance the effectiveness and efficiency of the organization, such as supply chain management software, customer relationship management programs, and sales force automation systems) (Grewal 2001; Speir and Venkatesh 2002; Wu, Mahajan, and Balasubramanian 2003). This research underscores the fact that adoption decisions are greatly affected by perceived risk and knowledge of the factors related to the successful utilization of a given technology. The high failure rates in adoption/implementation of high-tech products highlight the need for better understanding of the barriers and contributing factors related to successful adoption and implementation of technology.

It appears that a major omission in the area of high-tech marketing research is understanding how high-tech firms balance their strategies between products and services. The fact that margins for high-tech products are continually forced down (by myriad factors, e.g., Mohr 2001) has led high-tech firms to focus on revenue from the provision of services. Firms large and small alike have learned that over time, sales of services can be a sustainable source of revenue—with higher margins than from product sales alone. Yet, the academic research on the intersection of technology and services tends to take the perspective of how services firms use technologies to migrate their customers to self-service technologies as a way to save on costs and to offer customers enhanced convenience (e.g., Bitner, Ostrom, and Meuter 2002; Meuter, Ostrom, Roundtree, and Bitner 2000). This perspective could usefully be augmented with one examining traditional high-tech firm's strategies with respect to the balance of products and services revenues (Mohr, Sengupta, and Slater 2004).

An additional area of recent inquiry in high-tech marketing addresses the ability of large, established firms to sustain a culture of innovativeness. In addition to the book by Leifer, et al. (2000), Rajesh Chandy's extensive research provides insight into this issue. In brief, the findings from his stream of research show that, contrary to suffering from an "incumbent's curse," dominant firms are a major source of radical product innovations (Chandy and Tellis 2000). Although some aspects of a firm's dominance in the marketplace—greater investments and stronger market position in the existing product generation—reduce the firm's motivation to invest in radical innovation, dominant firms have a greater ability to invest in expensive radical innovations by virtue of their greater wealth (Chandy, Prabhu and Antia 2003; Sorescu, Chandy, and Prabhu 2003).

The role of managerial expectations also plays a role in larger firms' ability to innovate. When managers expect the new

technology will make their existing products obsolete (i.e., they are paranoid), they aggressively pursue investments in radically new technologies. On the other hand, managers from dominant firms who believe that the new technology is likely to enhance the performance of its existing products (i.e., increase sales of their existing products) actually invest less aggressively in new technologies than managers who believe otherwise (Chandy, Prabhu and Antia 2003). This fear of obsolescence builds on prior work exploring the corporate mindset of being "willing to cannibalize" (Chandy and Tellis 1998). Organizations that have strong, autonomous SBUs that compete internally for resources, strong product champion roles, and a focus on future markets more than current markets have a stronger willingness to cannibalize, and are more likely to introduce radically new innovations.

Moving from the firm or customer level as the focal unit of analysis, some recent research on high-tech markets focuses on the industry as the unit of analysis, and in particular, industry clusters that seem to drive many high-tech markets (Ganeson, Rindfleisch, and Malter 2002; Porter 1998). Because of the importance of knowledge flows to sustainable high-tech industries, the idea of co-locating in industry clusters can facilitate synergies in high-tech product innovations and development. Ganeson, Rindfleisch, and Malter (2002) demonstrate that the strength of firm ties and the frequency of communication with other firms are significantly related to knowledge acquisition and new product development in the U.S. optics industry cluster. Additional research exploring the nature and dynamics of industry clusters would be useful.

The field of high-tech marketing must also concern itself with public policy and societal issues. A recent special issue of the *Journal of Public Policy and Marketing* (Spring 2003) was devoted to the effect on consumer welfare of the information technology revolution (Sappington and Silk 2003). Another example of public policy research in high-tech marketing can be found in Dickson and Wells' (2001) analysis of the origins of U.S. antitrust policy; they highlight the public policy implications of markets characterized by network externalities. One question addressed in their analysis asks: "...what are the limits to the public interest and the welfare of the economy of promoting competition among multiple [competing] standards?" This question invites the possibility that development of consumer "lock-in" (arising from dominant designs in winner-take-all markets) may not be as detrimental to consumer welfare as the benefits of compatibility.

The societal impacts of technology also warrant increased attention. Given that many technologies have proven to have unintended consequences, research on such effects could usefully inform marketing strategies. For example, one such issue can be found in the "digital divide" (in which there is unequal access to technology across different groups of customers in society). Recent work by Terri Albert is focused on understanding whether it is mere access that leads to such an effect, or whether issues related to different segments' readiness to embrace technology are the critical factors (Albert and Colby 2003).

In summary, the area of high-tech marketing continues to be an important, yet under-researched, area in the marketing discipline. Given the myriad complexities that characterize high-tech markets, the issues faced by firms and customers are unique and not well-addressed by standard marketing research. The papers in this special issue offer insights that will assist in moving the field forward, and (it is hoped) will stimulate additional research in this area.

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