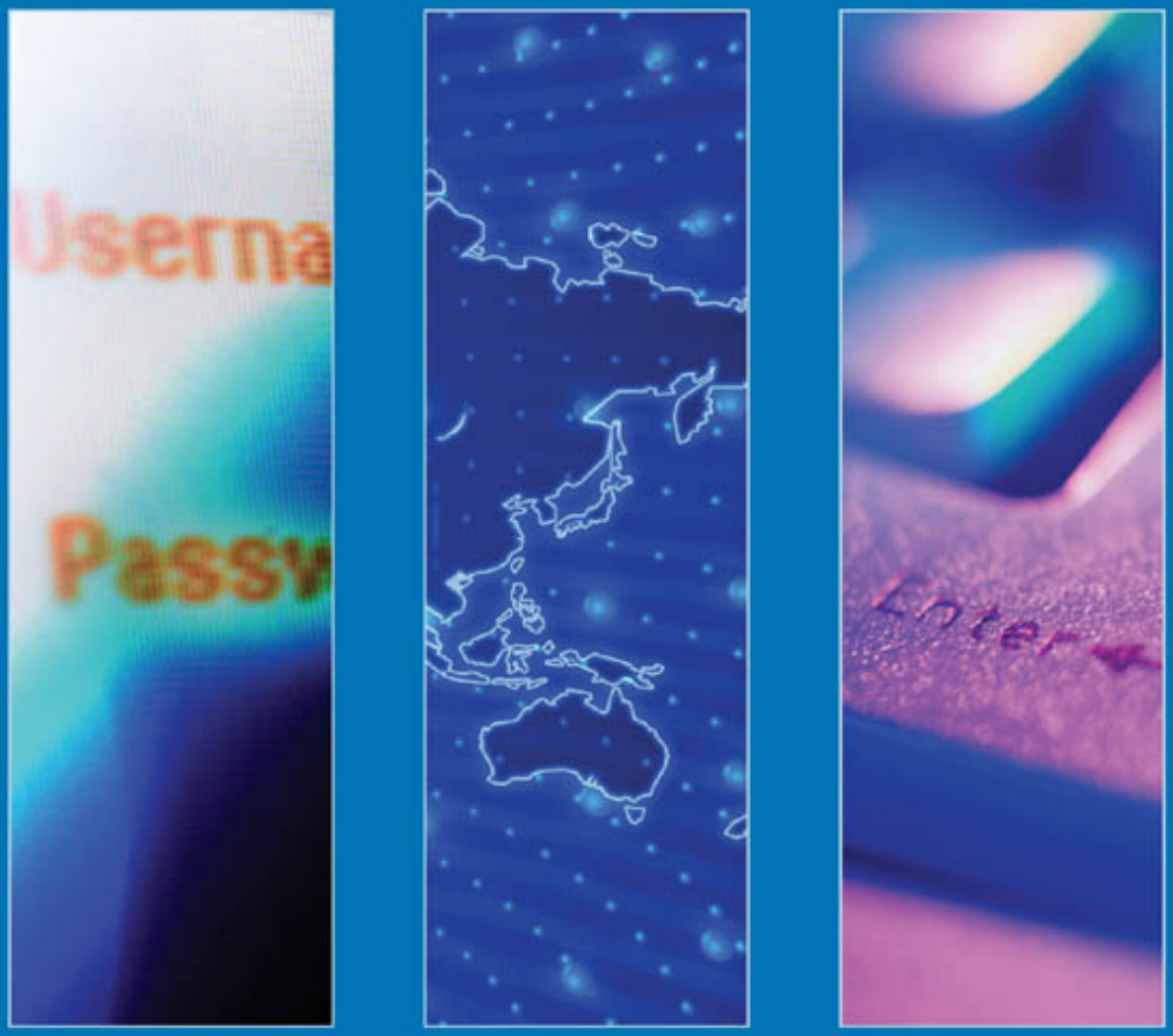

PEARSON NEW INTERNATIONAL EDITION

Marketing of High-Technology Products and Innovations

Mohr Sengupta Slater

Third Edition

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Pearson New International Edition

Marketing of High-Technology
Products and Innovations
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Introduction to the World of High-Technology Marketing

"Cars" of the Future

By Jamie Hoffman

In 1908, Henry Ford's famous Model T rolled off the assembly line. Within 100 years the automobile revolutionized society, putting people on wheels. Today, the average U.S. household owns 2.28 vehicles. Yet with gas prices on the rise, concerns about the environment mounting, and traffic congestion plaguing cities large and small, inventors and entrepreneurs are teaming up to transform personal automotive travel. In the very near future, popular transportation options will include personal jet-packs, flying cars, and carbon-free, stackable cars!

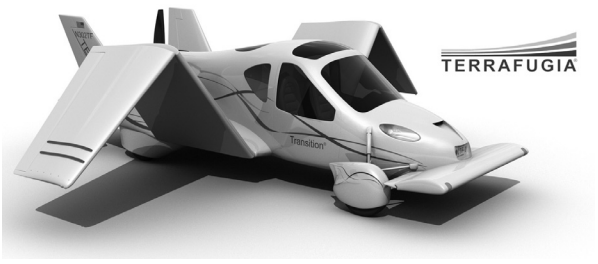


Photo reprinted with permission of Terrafugia, Inc., Woburn, Mass.

Futuristic Fliers

Thanks to the Terrafugia's Transition® "personal air vehicle," aggravating rush-hour traffic will become history. Brave commuters can take to the skies in a two-person light sport aircraft with automated retractable wings. Using lighter and stronger materials and more efficient engines, the vehicle aims to be classified by the FAA as the easier-to-fly light sport aircraft. Requiring only 1,500 feet to take off, the Transition will run on premium unleaded gas, fly at 120 mph, and have a range of 100–500 miles with 30 miles per gallon (mpg) in the air. On the ground, the vehicle will get 40 highway miles per gallon and 30 city mpg.[1] Other companies offer flying cars as well, such as the pioneer in this market, the Moller Skycar (www.moller.com/skycar.htm) available since 1999.

Want to fly to work, but prefer feeling the wind in your face? Try the Jet Pack T-73 created by Jet Pack International, LLC. With a range of 11 miles and maximum flying time of nine minutes, commuters can blast to work at 83 miles per hour (mph) at 250 feet above ground. The T-73 will hold 5 gallons of Jet A fuel and will retail around $200,000 (including training).[2]

(continued)

Photo reprinted with permission of Jet Pack International, LLC, Denver, Colo.

Conventional Alternatives

Now, for those who want eco-friendly transportation combined with adrenaline, but aren't quite ready to take to the skies, check out the Tesla Roadster™. The Roadster sports a base price of $109,000 and proves that a 100% electric sports car can perform just as well as the traditional models but with zero emissions. Speeding from zero to 60 mph in 3.9 seconds, the Roadster has a manual transmission, and a 248 horsepower (hp) motor with over 300 pound-feet of zero-rpm torque. The battery provides for a 220-mile range, earning the equivalent gas mileage of 256 mpg, and takes 3.5 hours to recharge.[3] Who knew being fast and being green could be achieved in one vehicle?

For those more comfortable staying grounded and keeping some change in their pockets, consider the Aptera. Designed by physicist Steve Fambro, the Aptera seats two, weighs 850 pounds, has a drag coefficient of 0.11 (compared to a typical car's drag of 0.30–0.35), maxes out at 95 mph, and impressively gets 230 mpg! Aptera is developing several versions: The classic hybrid design will sport a 12 hp diesel/19 kW electric motor combination and will be priced around $29,000; the all-electric version will be priced around $26,000 and will have a 120-mile range.[4]

For those uninterested in buying a car but still needing access to a low-cost vehicle on an as-needed basis, consider Smart Cities' foldable, electric CityCar developed at MIT's Media Lab. Designed to mitigate the negative external effects of the traditional vehicle, not only is the CityCar electric but like airport luggage carts, it is "stackable," fitting six to eight cars into a single conventional parking place. The CityCar will be available to rent at transportation hubs and can be returned when finished.[5]

Tesla Roadster™

Photo reprinted with permission of Tesla Motors, Inc., San Carlos, Calif.

Aptera

Photo reprinted with permission of Aptera Motors, Carlsbad, Calif.

CityCar

CityCar photo reprinted with permission of Franco Vairani/MIT Smart Cities, Cambridge, Mass.

India's Tata Motors recently announced an extremely low-cost automobile with a small carbon footprint: the Nano. Dubbed "India's Model T," the four-door, two-cylinder family car can fit four passengers and has lower emissions than most two-wheeled Indian vehicles—at an astounding price of only US$2,500! Touting a lean design that minimizes weight and increases fuel efficiency, as well as safety design features that protect occupants, the Nano is sure to raise a stir in India and abroad. The company has said it expects the car to revolutionize the auto industry, and analysts believe the Nano may force other manufacturers to lower their own pricing. There also is speculation that the process innovations necessary to produce a car at such a low price will threaten the operating models of market leaders. French automaker Renault SA and its Japanese partner Nissan Motor Company are trying to determine if they can sell a compact car for less than $3,000.[6]

Nano

Photo reprinted with permission of Tata Motors, Mumbai, India.

In December 2007, the world faced a constellation of powerful factors with potentially devastating consequences:

- Global warming
- Inexorable increases in the global population and the attendant pressures on food systems, health care, and education
- Environmental degradation and the depletion of natural resources
- Terrorism and its impact on global politics
- Increasing divergence between the "haves" and the "have-nots" across the globe

What are the possible solutions to these seemingly intractable problems? Radical innovations in technologies are certainly a key part of the solution, offering exciting possibilities and developments. (Of course, these technological innovations must be coupled with courageous political and regulatory decisions, and changes in individual and societal behavior as well.) Innovations in green building technologies, transportation and fuel technologies, alternative energy solutions, technologies to bring potable water and the power of information to impoverished areas of the world—all offer tantalizing promises for a different future. Yet, despite their promise, all too many inventions do not achieve commercial success.

Indeed, the world of high technology is filled with both promise and peril. Promise arises from the potential advantages that these new technologies offer: to alleviate human suffering, to enhance people's lives, to make businesses more efficient and effective, to solve social problems, to chart unexplored territories—seemingly infinite possibilities. On the other hand, the peril arises not only from the risks of the technology—say, through unintended consequences or the misuse of technology—but also from the risks faced by a new technology; the largest risk is commercial failure and the inability to deliver on its promise.

Responsible high-technology marketing provides a balanced assessment of the promises and perils of new technologies. In particular, the role of marketing is to inform the development and commercialization efforts of high-tech companies, ultimately enhancing the odds that the new technologies will deliver on their promise and avoid downside risks.

Yet, think about the origins of many high-tech companies. Genentech pioneered drugs based on recombinant DNA technology in 1976; Google's breakthrough search engine in 1998 was based on an algorithm that ranked websites based on their relevance or importance. Regardless of the specific industry—biotechnology, telecommunications, information technology, consumer electronics—the origins of many high-tech companies are frequently found in their scientific or engineering developments. As a result, they often mistakenly believe that marketing is superfluous; the superiority of their technological innovations should be sufficient to convince buyers to adopt their new products. Although they might pay lip service to the importance of marketing, they may lack the skills and competencies to develop effective marketing strategies. As a result, the role of, and need for, marketing is often misunderstood or downplayed in their organizations. They often lack marketing expertise or relegate the role of marketing to second-class status (i.e., beneath the role of engineering/R&D).

Even high-tech companies that understand the importance of marketing face uncertainty and complications in their marketing decision making. Technical people may have a hard time becoming market focused and understanding how to interact with their nontechnical customers. Marketing activities are sometimes either an afterthought to the product/technology development process or are not accorded the same importance as product/technology development. Cross-functional collaboration between engineers and marketers is a necessity but is extremely difficult to implement well. A further complication is that many people hired to do "marketing" lack an understanding of how to market in high-tech industries. Even well-known high-tech companies such as Microsoft and Intel—who are perceived as being very sophisticated marketers—have expressed publicly that they are not sufficiently "market driven."

Due to these and other complicating factors, the failure rates of more innovative products are higher than the failure rates of products in general[7] —usually well over 50%.[8] In the funding of high-tech start-ups, venture capitalists often follow a 4-3-3 rule for their technology investment portfolios. Out of 10 investments, they expect 4 to fail, 3 to break even, and 3 to generate profits exceeding all the losses on the other seven projects.[9] A robust set of empirical studies demonstrates: Technological superiority alone is insufficient for ensuring the success of high-tech products; rather, high-tech companies must complement their technological prowess with a set of marketing competencies in order to maximize their odds of success.

One important marketing competency is to think beyond the technology itself, and to gain sophisticated insights about the customers who will adopt and use the technology. As Andy

Grove, the former chairman of Intel and one of technology's big thinkers, has said: "You know that old saying that 'railroads are not in the railroad business, they are in the transportation business'? We are facing something similar to that."[10] To successfully market technology solutions, high-tech companies must have an intimate understanding of their customers' underlying needs and problems, their customers' ways of doing business, and their customers' environments and mind-sets.

Marketing strategies and tools help high-technology companies maximize their odds of success. Given the high degree of uncertainty in high-tech markets, the margin for error in decision making is likely smaller than for conventional markets. As a result, high-tech firms must execute basic marketing principles flawlessly.[11] For example, knowing how to select the appropriate target market, communicate clearly the benefits the innovation offers relative to other solutions, design an effective and efficient distribution channel, and develop solid relationships and alliances are critical marketing competencies. In addition to these marketing basics, high-tech firms must also understand how to adapt marketing principles to the nuances of high-tech environments. The complex, high-velocity high-tech environment necessitates modifications in marketing research tools, supply chain management, and strategy formulation. You will learn strategies and tools to successfully design and implement best-practices marketing in the high-tech environment.

We make a distinction between the marketing *of* high-technology innovations and the use of technology *for* marketing purposes. When people hear the phrase *high-tech marketing,* they frequently think of things like advertising on the Internet, using social networking sites like MySpace or Facebook to market consumer products, or conducting a paid search campaign using a platform like Google AdWords. By its very nature, marketing requires the use of technologies. For example, Web 2.0 technologies (including the collaborative, user-generated websites known as wikis, RSS feeds, social networking sites, and the many other technological innovations characterized by the increased connectivity and communities of users on the Internet) are a key tool in any company's marketing arsenal—whether it is a high-tech company or not. So, naturally, the role of these tools in a high-tech company's marketing efforts is addressed. We discuss the use of technology for marketing purposes, with a primary focus on the marketing of high-tech innovations (be they breakthrough or incremental, product or process, disruptive or sustaining).

A first step in developing proficiency in high-tech marketing is for companies to develop a common understanding of what is meant by the term *marketing* and the broad scope of activities and expenditures (investments) that marketing encompasses.

THE LEXICON OF MARKETING[12]

Marketing is the set of activities, processes, and decisions to create, communicate, and deliver products and services that offer value to customers, partners, and society at large.[13] At its heart, marketing is a *philosophy of doing business* that reflects shared values and beliefs about the importance of creating value for customers by solving meaningful problems. This philosophy relies on customer- and market-based information to guide internal decision making and to resolve internal conflicts.

Marketing is not something that is undertaken after engineering has developed the new innovations. Among other things, a well-developed marketing competency includes proactive consideration of the customer in the development process; it helps to guide technical specifications, determine appropriate market segments, establish cost targets to meet pricing objectives, and identify partners that will play a critical role in the value delivery process. In other words, it brings the voice of the customer into the firm.

Table 1 shows three levels—strategic, functional, and tactical—that encompass the scope and types of marketing activities and decisions.

TABLE 1 Scope of Marketing Activities

1. ***Strategic:*** Proactive decisions to guide the thrust of the company's efforts in the marketplace, including the best opportunities in the market and how to best develop and position the company's products.
   - In which market will we compete?
   - Which segments will we target?
   - What value will we offer customers in our target segment?
   - What will our competitive position in the marketplace be (relative to the established technologies and ways of doing things)?
2. ***Functional:*** Focus on marketing as a functional area of responsibility, specifically including the product/technology development function.
   - What will our decisions be regarding product, price, place, and promotion?
   - How will personnel in different departments (marketing, R&D, operations, customer service, manufacturing/production, product development teams, etc.) interact to make marketing decisions?
3. ***Tactical:*** Development and implementation of marketing tools, executed consistently with strategic and functional decisions.
   - How will we create and use marketing brochures, websites, and other collateral materials?
   - Which trade shows will we attend, where will we place advertisements, and how will we share information about our products?

Source: Adapted from Jakki Mohr, Stanley Slater, and Sanjit Sengupta, "Foundations for Successful High-Technology Marketing," in *Managing Technology and Innovation: An Introduction,* eds. R. Verburg, R. J. Ortt, and W. M. Dicke (London: Routledge, 2006), pp. 84–105.

Strategic Activities and Decisions

Strategic decisions chart the firm's direction in the marketplace, addressing issues such as what market segments the company competes in, what its competitive position will be, and relatedly, what its value proposition will be. In some larger high-tech companies, a strategic planning group or a formal marketing department may have primary responsibility for answering these questions. In other companies, these questions may be addressed by the top management team (such as the company's founders) or by a product development group.

Less important than the "who" in answering these questions is the need to proactively address them. Despite the need for strategic direction in allocating the firm's resources across customer market segments and across product development efforts, many high-tech companies do not proactively answer these questions. When a company lacks direction about the answers to these questions, its efforts are diffused across multiple market segments and product development projects. Although a company may think this diffused approach hedges its bets in the marketplace, it is typically a recipe for disaster. Because of the lack of focus, the company never truly understands customers' needs in any one segment; as a result, it is less likely to succeed than a company that has proactively defined a clear strategic direction.

To effectively operate at the strategic level, the company must ensure that responsibility for strategic guidance is formally vested with some group in the organization (be it a marketing department, product management group, strategic planning group, or top management team). Moreover, the company must commit to developing a competency in research and analysis for market segmentation, targeting, and positioning. Finally, the company must be willing to implement the decisions arising from the strategic planning process with focus, discipline, and requisite resources. In addition, an increasingly important aspect of a winning marketing strategy is corporate social responsibility,

through which a company's strategies explicitly address social and global problems, to provide not only economic profits but social benefits as well.

Functional Activities and Decisions

The second level of marketing activities encompasses what is traditionally known as the **marketing mix**, or the "4 P's of marketing": product, price, promotion, and place (see Table 2). Note that the product development arena is considered to be a subset of the marketing function. The critical management issue in the marketing mix is ensuring consistency in all decisions that support the product's position in the marketplace. For example, a product positioned as high quality must have a price that conveys that image, high-end distribution channel members that provide appropriate levels of support and service, and advertising message and media focused on the premium image.

The responsibility for these diverse marketing functions is scattered across many units in most organizations. Typically, a product development group—comprised of scientists, engineers, or programmers, for example—is charged with research-and-development activities. Some companies also vest the product development group with other marketing activities such as collecting market research, conducting market segmentation, or targeting and positioning activities. After product development, responsibility for product launch may be passed to product management, who coordinates with sales and "marcomm" (marketing communications); product managers may also perform

TABLE 2 The 4 P's of the Marketing Mix

1. ***Product:*** Decisions that address the new product development process (innovation management), licensing strategies with potential partners, intellectual property rights, services provided to augment the revenue stream from base-products, product name/brand decisions, development of complementary products by partners, creation of industry standards, packaging, and so forth. The critical need is to develop a stream of products with the right set of features to satisfy customer needs in a compelling yet simple fashion.
2. ***Price:*** Decisions that establish price points for the company's products, and address issues related to the cost to produce/manufacturer the goods, margins along the distribution channel, competitor's prices (pricing relative to a specific firm's market position), customer value, total cost of ownership for the customer, prices for product bundles, and profitability.
3. ***Promotion:*** Decisions that include advertising (both media and messaging decisions), sales promotion (price deals, trade incentives, etc.), personal selling (recruiting, training, compensating sales people), and public relations/publicity (garnering favorable trade press, attending trade shows, engaging in cause-related marketing, etc.). Specific issues can include developing a strong brand name, decisions about the timing and focus of new product pre-announcements, co-branding decisions with potential business partners (including cooperative advertising with channel members), leveraging the Internet and other new media to gain awareness, developing collateral materials, and so forth.
4. ***Place:*** Decisions that focus on distribution channels and supply chain management—getting the right product to the right customers at the right time. Good channel strategy is focused on effectively meeting end-user customer needs in a cost-efficient fashion. However, successful channels can be difficult to attain if channel partners have different objectives, if margins create conflicts between channel members, and if new channels (such as the Internet) cannibalize revenues from existing channels. Best-practices supply chain management is demand-driven; it harmonizes upstream logistics and manufacturing with end-user requirements.

Source: Adapted from Jakki Mohr, Stanley Slater, and Sanjit Sengupta, "Foundations for Successful High-Technology Marketing," in *Managing Technology and Innovation: An Introduction,* eds. R. Verburg, R. J. Ortt, and W. M. Dicke (London: Routledge: 2006), pp. 84–105.

other marketing activities noted above. Some high-tech companies may have a formal marketing department, whose responsibilities may vary widely depending on the level of marketing sophistication and the degree to which marketing is viewed as a strategic function. Even with a formal marketing function, the input of the marketing personnel is sometimes neither solicited nor (if solicited) respected/valued by personnel in other functional areas. Some of the disparaging comments can be found in the form of jokes, which can capture common stereotypes.[14] For example:

Q: What is marketing?
A: What you do when your products aren't selling themselves.

The implication of this joke is that marketing is not something companies should have to bother about unless the product is not good enough to "sell itself."

When marketing is viewed as a philosophy of doing business, the focus is less on which "function" performs a specific marketing task, and more on how every person and department in the company works together to provide value to the customer. As the famous management guru Peter Drucker stated, "There are only two functions in any organization: marketing and innovation, both of which create a relationship with the customer."[15] Given this perspective, only two types of people exist in any organization: those who serve the customer, and those who serve those who serve customers.[16]

A high-tech company that effectively coordinates its efforts across functional units to deliver superior customer value is more likely to be successful than firms that optimize decisions within each functional area in a piecemeal or independent fashion. When individual departments have independent goals and objectives, they can experience incompatibility, conflict, and, ultimately, the erosion of a customer-based focus. Regardless of the functional area involved, all personnel must understand the idea of a **moment of truth**:[17] each touch point—every interaction a customer has with a company, whether calling technical support, visiting a retail partner, asking a billing question or seeking general information—can either strengthen or undermine the relationship.

Tactical Activities and Decisions

At the tactical level, the actual implementation of specific marketing tools is accomplished—such as the development of marketing collateral materials and a website, decisions regarding which trade shows to attend, where to place advertisements, and so forth. Many high-tech companies equate "marketing" with only these tactical considerations, and they relegate marketing input to reactive development of communications messages. Hence, the plea, "We need to hire a marketing person," essentially means hiring someone to operate at the tactical level. Companies that operate only at this tactical level likely have not made some of the harder strategic decisions to guide the company's efforts, and in that sense, are less likely to be successful in the marketplace (regardless of how effective their advertising or trade show strategies may be).

Companies that view marketing as a strategic consideration recognize that success in high-tech markets comes from proactive consideration of where the best opportunities in the market lie, and how to best develop and position the company's products to enhance the odds of success. They work to facilitate collaborative cross-functional interaction between not only marketing and development teams, but all functional areas. And, the tactical considerations are executed in a manner consistent with the strategic foundation of the company.

With a shared understanding of marketing in general, the discussion now moves to exploring the specific realm of high-technology marketing.

DEFINING *HIGH TECHNOLOGY*

Technology is a broad concept that relates to how people use tools and knowledge—usually the product of science and engineering—to create solutions to problems.[18] **High technology** generally refers to cutting-edge or advanced technology—which means that the definition shifts over time. What was "high tech" in the 1960s—for example, a color TV—would be considered primitive technology by today's standards. This fuzzy definition has led to companies describing nearly all new products as high tech.

Innovation generally refers to introducing something new, with the intent either to increase value (either to customers or producers) or to solve some problem. These new "things" can include ideas, methods, digital content, or devices. Not all innovations are high tech in nature; later in this chapter are descriptions of the common classifications for the various types of innovations.

The traditional domains of "high tech" include areas such as information technology, computer hardware, software, telecommunications and Internet infrastructure, and consumer electronics, among others. In addition, "high tech" can encompass a broad cross section of industries including biotechnology, pharmaceuticals, medical equipment, nanotechnology, robotics, and, with the focus on using technology to solve global problems, it can also include energy and transportation technologies and green building technologies—clearly a wide range of industries and products. Hewlett-Packard's former CEO Carly Fiorina has explained, "Tech is truly becoming part of the fabric of life. Think about the big problems we have to solve now—health care, homeland security, synchronizing the world's information systems to facilitate the flow of goods and services and to prevent the flow of undesirables—all of those are technology opportunities."[19]

At least two reasons motivate the need to understand and define the domain of high technology. First, because of technology's role in the economy, economists and policy makers try to classify the economic output and purchases that are driven by high-tech industries. Second, because of the need to modify and adapt standard marketing strategies for the high-tech environment, we must specify which arenas are "high tech," and hence fall into the domain of this book.

Given their ubiquitous nature, categorizing technological innovations—say, by placing industries on a continuum ranging from low-tech industries on one end to high-tech on the other—is not as easy as one might expect. For example, although some might perceive industries such as agriculture or heavy industry to be relatively low tech, when innovations in genetically modified organisms in seed stock or innovations in nanotechnology in heavy materials are considered, those industries might be labeled high tech. Even definitions offered by experts—high-tech firms are those that are "engaged in the design, development and introduction of new products and/or innovative manufacturing processes through the systematic application of scientific and technical knowledge"[20] —are sufficiently vague that classifications are tough.

This section, therefore, presents three tools used to clarify the domain of high tech: (1) government-based classifications, (2) classifications based on shared industry characteristics, and (3) various types of innovations.

Government-Based Classifications

Motivated by the desire to classify and measure economic activity (such as employment, industry output, and so forth), most government definitions of high technology follow either an input-based or output-based approach.

Input-based definitions classify industries as high tech based on certain criteria such as the number of technical employees, the amount of R&D outlays, or the number of patents filed in a given industry. For example, the U.S. Bureau of Labor Statistics (BLS) classifies industries based on their proportion of scientists, engineers, and technicians; firms that employ a high proportion of scientific, technical, and engineering personnel (where "high" is twice the 4.9% average for all industries) comprise high-tech industries. Similarly, the Organisation for Economic Cooperation and Development (OECD) defines high tech in terms of the ratio of R&D expenditures to value added of a particular industry.[21] The National Science Foundation examines the R&D intensity, or R&D spending-to-net-sales

ratios.[22] Appendix A at the end of this chapter provides the list of industries classified as high tech (Level I, Level II, Level III) using the BLS approach. Technically, because these industries are categorized based on employment of technical and scientific personnel, they are "technology-oriented-occupation intensive."

Output-based approaches define an industry as high tech if its output (product) embodies new or leading-edge technologies, as determined by a panel of experts. For example, the U.S. Census Bureau identifies 10 major technology areas that produce such products: biotechnology; life sciences technology; optoelectronics; information and communications; electronics; flexible manufacturing; advanced materials (semiconductors, optical fiber cable, for example); aerospace; weapons; and nuclear technology.[23] Similarly, the American Electronic Association uses the U.S. government's NAICS (North American Industry Classification System) to classify 45 high-tech industries into three major output-based groupings: High-Tech Manufacturing, Communications Services, and Software and Computer-Related Services.[24]

Table 3 provides an overview of the strengths and weaknesses of defining high technology in these two ways. For the 14 industries with the highest levels of technical employment, categorized as Level I industries (with more than 5 times higher technical employment than the average of all industries), the alternative classification approaches show relatively high consistency. In other words, these industries would be classified as high tech regardless of which approach is used. For example, almost all Level I industries are also R&D intensive, and all Level I goods-producing industries have some products defined as high tech by the output-based approach used by Census Bureau.

TABLE 3 Strengths and Weaknesses of Government Approaches to Defining *High Technology*

Input-Based Approaches

Strengths:

- Data are generally easily obtainable.
- Classification is objective.
- Correlation between input-based classifications is reasonably high for Level I* industries.
- Data on the high-tech service sector is included.

Weaknesses:

- Because thresholds for "high" levels (say, R&D spending or technical employment) are not obvious, classifications may be deemed somewhat arbitrary.
- Classifications may include industries with products not commonly thought of as high-tech.
- Classifications may omit very new industries (e.g., biotechnology and nanotechnology are not on the list of high-tech industries).
- Different input-based measures will result in different classifications.

Output-Based Approaches

Strengths:

- Classification tends to have face value (the list of industries matches popular conceptions of high-tech).
- Relatively good correlation exists between input and output methods for Level I industries.

Weaknesses:

- Somewhat post-hoc: Judgments are somewhat subjective.
- Output-based approaches are generally not as comprehensive as input-based approaches.
- Relatively low correlation exists between input and output methods for Level II and Level III industries.

*Level I industries have 5 times or greater technical employment as the average of all industries; Level II industries have 3.0–4.9 times and Level III industries have 2.0–2.9 times greater technical employment as the average of all industries; industries are listed in Appendix A.

However, for the 12 Level II industries (with 3.0–4.9 times the average technical employment), there is relatively low consistency among the various approaches. Some industries classified in this category have no products on the high-tech output list (e.g., oil and gas extraction, or audio and video equipment manufacturing). Moreover, R&D employment in Level II (and in Level III) industries can be high or low. And, in some cases, an industry classified as high tech using an output approach is not classified as a Level I or Level II industry based on the input approach (e.g., telecommunications). One important point is that whether or not a company uses high-tech production methods is *not* considered useful in identifying high-tech industries.[25]

Rather than focusing on objective inputs (that could lead to misclassifications) or on subjective classifications of outputs, a different approach relies on examining common characteristics that high-tech markets share. One benefit of this approach is that it is based on a manager's assessment of the uncertainty surrounding the product or service that he or she manages. Moreover, this approach is directly tied to the implications for high-tech marketing strategies.

Common Characteristics of High-Tech Environments

As shown in Figure 1, high-tech environments manifest a set of common characteristics[26]—most notably, (1) market uncertainty, (2) technological uncertainty, and (3) competitive volatility[27]—with specific implications for marketing.

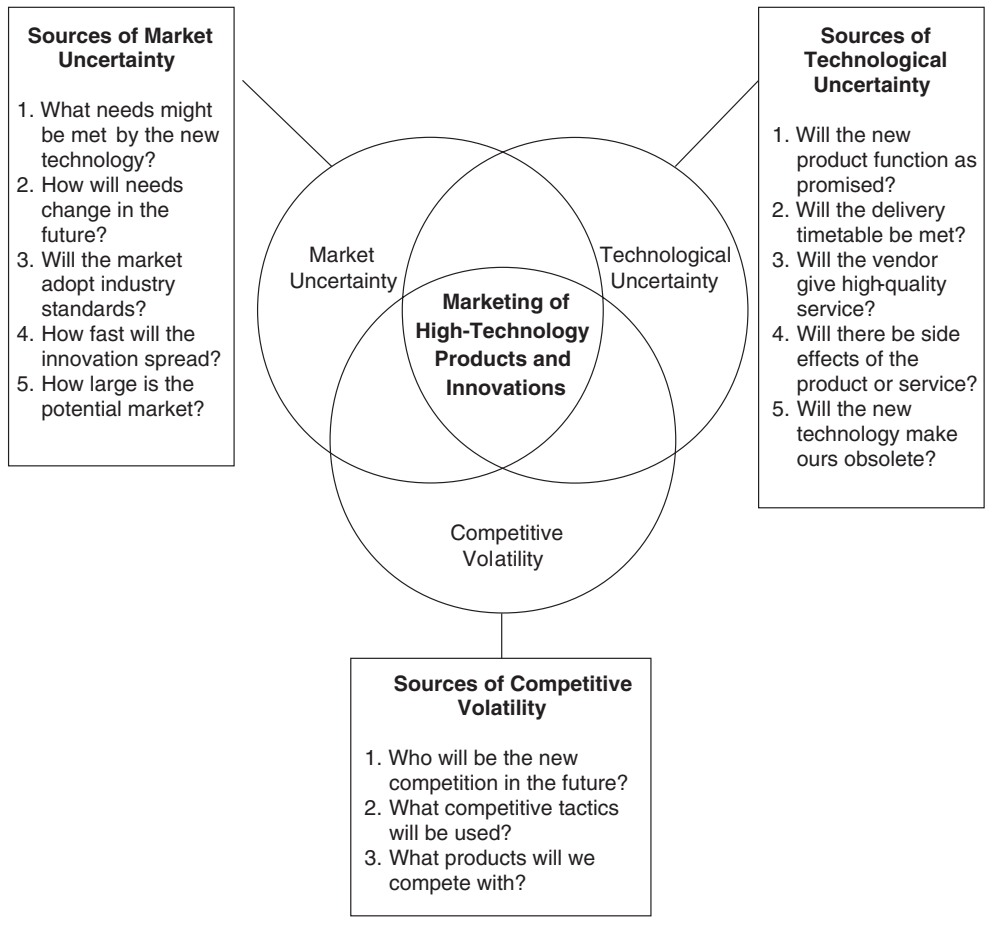


FIGURE 1 Characterizing High-Tech Marketing Environments

Although one or two of the three characteristics might be present in some environments, the simultaneous presence of all three factors characterizes most high-tech environments. For example, the decision about purchasing a new home might provoke customer anxiety (one of the three characteristics: market uncertainty), but if sellers aren't also simultaneously considering a radically new way of offering homes for sale (e.g., Internet channel), then it would not be characterized as high tech. Similarly, customer needs may change rapidly in some areas (such as clothing styles or music), but such purchase decisions generally do not include both a high degree of customer anxiety and totally new ways of meeting customer needs. Finally, although competitive turbulence may be present in many industries (e.g., restaurants in college towns), the new competitors don't typically offer a radically new way of meeting customer needs. These situations highlight the fact that the *intersection* of these three characteristics is what typifies a high-tech marketing environment.

In addition, a series of other characteristics, such as network externalities and unit-one costs, also pose complications for high-tech marketing; these additional characteristics are covered later in this chapter.

MARKET UNCERTAINTY **Market uncertainty** refers to ambiguity about the type and extent of customer needs that can be satisfied by a particular technology,[28] and arises from five sources.

First, market uncertainty arises from consumer fear, uncertainty, and doubt (known as the *FUD factor*)[29] about what needs or problems the new technology will address, as well as how well it will meet those needs. Anxiety about these factors means that customers may delay adopting new innovations, require a high degree of education and information about the new innovation, and need postpurchase reassurance to assuage any lingering doubt. For example, when a business decides to automate its sales force with computers, employees are bound to have some apprehension about learning new skills, wondering if the new mode of working will be better than the old one, and so forth. Hence, marketers must take steps to allay such apprehension both before and after the sale.

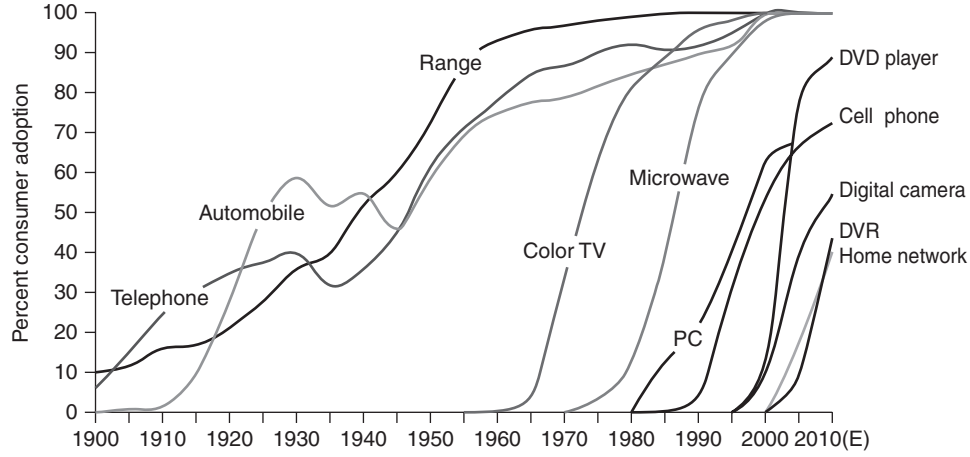
Second, customer needs often change rapidly, and in an unpredictable fashion, in high-tech environments. For example, customers today may want to treat their illnesses with a particular medical regimen but next year may desire a completely different approach to the same health problems. Such uncertainties make satisfying consumer needs a moving target.

Third, customer anxiety is perpetuated by competing—and incompatible—technological standards for new products. For example, in 2007 the new high-definition DVD players were being produced in two competing formats: the Blu-ray format developed by Sony and the HD-DVD format developed by Toshiba. High-definition movies were available in either one format or the other; movies purchased in one format would not play on the incompatible high-definition players in the other format. Questions about which format would become the **dominant design**—the format that would emerge as the agreed-upon standard—hampered customer adoption, as buyers delayed purchase to minimize the odds of making a "wrong" choice. (In February 2008, Toshiba settled the issue by announcing that it would no longer produce HD-DVD products.)[30]

Therefore, coalescing disparate product development efforts around a common industry standard can help reduce the perceived risk for customers, in turn serving as a catalyst for adoptions. Having a common industry standard not only maximizes the value customers get from their investment in high-tech products, but it also stimulates the development of complementary products to create a robust industry infrastructure. A firm that pursues a unique or proprietary system in its product development faces a very different market adoption process, with very different consequences, from one that develops a system based on open standards available to multiple players in an industry. (For example, music downloads from various sites are not all compatible with all types of digital music players.) This topic of industry standards is so important that a later section of this chapter is devoted to it.

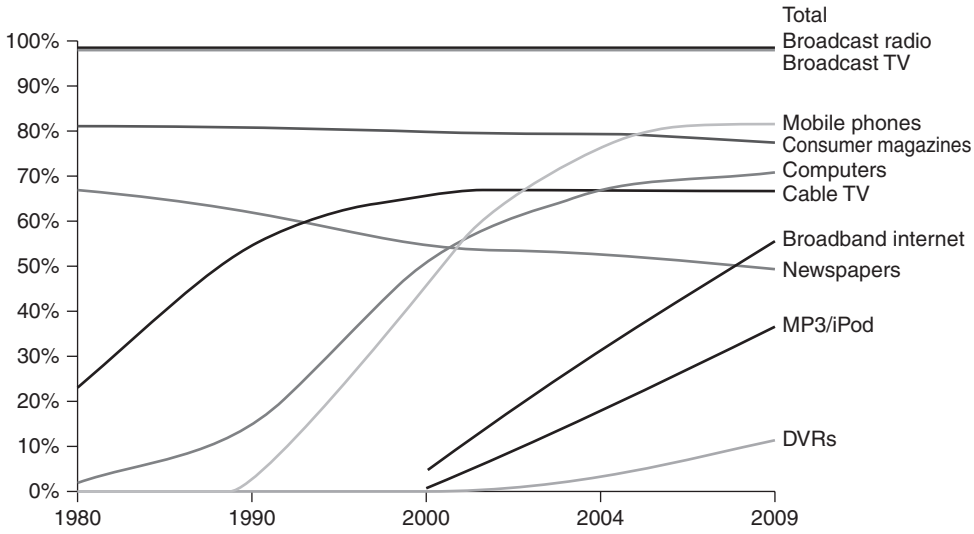
A fourth factor, due in large part to the prior three factors, is uncertainty among both consumers and manufacturers over how fast the innovation will spread. Figure 2 shows cumulative adoption figures for two different categories of products—durable goods technologies and media. In many cases, the market for high-tech innovations is slower to materialize than most would predict.[31] For example, despite its hype, WiMax (or wireless Internet access over long-range distances

Panel A: For Durable Technologies



Source: Benchmark Data Overview, Forrester Research, June 2004.

Panel B: For Media Products



Based on number of households with the electronic device (e.g., TV set, DVD player); survey results based on share of the population who indicated using the medium in a given year (e.g., read newspapers, went to a movie) or estimates based on circulation or unit data.

Source: Communications Industry Forecast, 2005–2009.

FIGURE 2 Cumulative Adoption Patterns

that can maintain a connection while consumers are mobile) and muni WiFi (short for *municipal wireless:* free or cheap wireless Internet access for all citizens of a city or town) were listed as two of the biggest emerging technology disappointments of 2007.[32] Yet, for other technologies, the sales takeoff is astoundingly fast. For example, sales of the Wii video game console, made by Nintendo, took off much faster than predicted. The Wii sold more than 6 million units in the United States between its release in November 2006 and January 2008, with 981,000 units sold in November 2007 alone—more than double sales of the Sony PlayStation 3 and outpacing the Microsoft Xbox 360 by 211,000.[33]

The fifth dimension of market uncertainty, related to the uncertainty over speed of adoption, is the inability for manufacturers to estimate the size of the market. Obviously, market forecasts are crucial for cash flow planning, production planning, and staffing. Although Nintendo increased Wii production by 80% after the product launch to meet unexpectedly high market demand, chronic shortages continued to plague its sales through the early part of 2008. Nintendo of America president Reggie Fils-Aime said the company did not expect such a craze for the Wii. "We went into the launch of the Wii with very high expectations. We had expected to be in the upper range of console launches," Fils-Aime said. "But this is unheard of."[34]

Although lost sales are certainly costly to a company, just as serious is the situation of excess inventory that ties up working capital and, at the extreme, results in obsolete products that must be written off. Hence, market forecasting is an important competency that high-tech companies must develop.

Further complicating a company's ability to forecast the pace and size of adoption is what Geoffrey Moore[35] refers to as the *chasm* that high-tech products must cross in appealing to a mainstream market. When radical innovations appear in the marketplace, they appeal to "visionaries" in the market who are willing to adopt the new technology despite the often high price tag such items carry. For example, the early adopters of Apple's new iPhone were willing to pay a high initial price, despite the expected price reductions that were bound to come within a few months. Moreover, the visionaries are also typically willing to accept any inconveniences or hassles that can accompany being an early adopter. For early adopters of software, the hassle factor might come in glitches and incompatibilities with other system components. The visionaries are willing to accept such inconveniences for the psychological and substantive benefits they do receive.

However, such benefits are not sufficient for the majority of the market to adopt a new technology. "Pragmatists" comprise the majority of the market, and they require a different set of benefits and inducements to adopt new products. The **chasm**, then, represents the gulf between these two distinct segments for technology products. Visionaries are quick to appreciate the new development, but the pragmatists need more hand-holding. The transition between these two markets can be rocky at best, with many high-tech firms never crossing the chasm. Many high-tech firms find it hard to abandon their "techie" roots and talk to this group in customer-friendly terms. The inability to predict whether, and the degree to which, the mainstream market will adopt the product—and the rate of such adoption—given the presence of the chasm, makes it extremely difficult for manufacturers to estimate the size of the market.

TECHNOLOGICAL UNCERTAINTY **Technological uncertainty** is not knowing whether the technology—or the company providing it—can deliver on its promise to meet specific needs.[36] Five factors give rise to technological uncertainty. The first comes from questions about whether the new innovation will function as promised. For example, when new pharmaceuticals are introduced, patients might experience anxiety about whether the new treatment will be as effective for them as currently available treatments. Although early adopters are willing to be the guinea pigs on the bleeding edge of technology,[37] they might face major glitches in the functioning of the new product.

The second source of technological uncertainty relates to the timetable for development (and subsequent market availability) of the new product. In high-tech industries, product development commonly takes longer than expected, causing headaches for both buyers and sellers. For example,

people have been talking about the Semantic Web since Tim Berners-Lee introduced the concept in 1999. At a very basic level, the idea of the Semantic Web is to make information actually "understandable" by computers. It would use common programming standards, based in part on XML's (E**x**tensible **M**ark-up **L**anguage) customized tagging schemes and RDF's (**R**esource **D**escription **F**ramework) flexible approach to representing data—so that through machine-to-machine interaction, people are freed of some of the tedious work involved in information search and use. Finally, in the fall of 2007, Radar Networks announced a Semantic Web application called Twine, which was built with Semantic Web technologies and was hyped as the "first mainstream Semantic Web application"[38] that would enable people to share knowledge and information. This lag of roughly eight years from vision to initial market application is not uncommon for many breakthrough technologies.

At the extreme, product delays can mean that customers get frustrated and possibly cancel orders, competitors beat the company to market, and the company faces financial disaster. For example, the Airbus 380, which made its maiden voyage in late 2007, was plagued by delays dating from 2005. Part of the reason was the sheer complexity of the A380. The cabin wiring alone amounted to more than 330 miles (531 km) of wiring with more than 40,000 connectors. Unfortunately, two incompatible versions of computer-aided design (CAD) software were used in the development process—one by the German unit in Hamburg and another by the French in Toulouse. The problem wasn't discovered until late in the process, and the solution—developing a new computer-design tool—meant yet more delays. These delays "knocked 26% off the value of the shares of the parent company, EADS, led to the resignation of three executives, and triggered investigations into the share dealings of executives and board members."[39]

A third factor in technological uncertainty arises from concerns about the supplier of the new technology: If a customer has problems, will the supplier provide prompt, effective service? When (if?) a technician arrives, will the problem even be "fixable"? For example, in the fall of 2007, Skype (the Voice-over-Internet Protocol, or VoIP, service provider that allows customers to download a free software package onto their computer and then use their broadband connection to make phone calls for free anywhere in the world) faced a disabling computer glitch in its system: A standard Microsoft Windows update led to a chain of events that overwhelmed its network and millions of users lost their service. In Skype's case, the peer-to-peer nature of its network meant that there was no quick way to recover from the failure. The result was that users lost their trust in the company, and it had to be regained.[40]

Fourth, the very real concern over unanticipated consequences or side effects also creates technological uncertainty. For example, some new companies (e.g., 23andMe and Navigenics) are offering consumers the ability to run their genetic profile for roughly $1,000 and a saliva sample. Yet, with the power of genomic information comes a burden: What do people and companies do with the information? Will a consumer who finds out that that she has a genetic predisposition for breast cancer find that information useful, or or will she live in fear of fulfilling her genetic destiny? If she decides to take a drug tailored to her genetic profile (pharmacogenomics) such as Herceptin, will it create a new set of risks and initiate a new trajectory of calculations? Will insurance companies and employers misuse the information?[41]

As another example of unintended consequences with a somewhat paradoxical outcome, some experts believe that the shift to biofuels is not accomplishing the desired outcome (minimizing oil independence), but rather, is costing an enormous sum of money and causing corn prices to skyrocket nearly 70% in the six months between late fall 2006 and early 2007. Indeed, in 2007, the United States used nearly 20% of its total corn crop for the production of ethanol—a number that was expected to rise to 25% in 2008 due to ambitious goals regarding ethanol use in the United States. The increased demand for corn in biofuels has caused a ripple effect, seen first in the price of animal feed, particularly poultry and pork. Poultry feed is about two-thirds corn; as a result, the cost to produce poultry—both meat and eggs—rose 15% due to corn prices. Corn syrup—used in soft drinks—will also get more expensive. In Mexico (which gets much of its corn from the United States), the price of corn tortillas doubled in one year, setting off large protest marches in Mexico City.[42]