# strategic issues in managing technology and Innovation

**Most people have tasted Pepsi Cola, Lay's Potato Chips, and Frito's Corn Chips,** but have they tried Quaker Soy Crisps or Gatorade Xtremo Thirst Quencher? These are just 2 of the more than 200 new product variations that PepsiCo annually adds to its already large global portfolio of products. Why does PepsiCo introduce so many new products when its current products are still in demand? According to PepsiCo's Chairman and CEO, Steven Reinemund, "Innovation is what consumers are looking for, particularly in the small, routine things of their life." This emphasis on product development seems to be paying off. PepsiCo's double-digit earnings have been consistent over the years and show no sign of slowing. (Its earnings increased 19% from 2002 to 2003 on a 7% increase in sales.) In 2004, PepsiCo was included in *Business Week*'s list of the 50 best-performing public companies.

PepsiCo constantly monitors its environment for changing tastes and fashions. It then tailors its products to suit those changes. When the public became concerned with obesity, its Frito-Lay division developed several low-fat chips and led its competitors by removing all trans fats from its Lay's, Ruffles, and Doritos brands. In June 2004, it introduced "low-carb" Doritos, Cheetos, and Tostitos. The company looks for new products both internally and externally. To capitalize on the growing market for New Age herbal-enhanced beverages, it acquired SoBe Beverages in 2001. Since then, PepsiCo has used brand extension to offer the energy drink SoBe No Fear to the school-aged market and SoBe Fuerte to the Hispanic market. Noting that the foreign-born segment of the 46 million U.S. Hispanic market didn't like PepsiCo's Latin-flavored versions of Lay's and Doritos chips, the company looked to its Mexican subsidiary, Sabritas. Not wanting to cannibalize Frito-Lay's core U.S. brands, the company limited the distribution of products such as Sabritones chile and lime puffed wheat snacks to smaller retail stores in Mexican-dominated areas. Despite no advertising and minimal distribution, U.S. sales of Sabritas brands doubled from $50 million in 2002 to $100 million in 2004. Distribution increased from 10% to one-third of the U.S. population. Because they were marketed as an ethnic specialty rather than as a Frito-Lay line extension, the Sabritas brands were able to win extra shelf space in grocery stores. Analysts agree that PepsiCo has developed a strong capability in product development. According to Robert van Brugge of Sanford C. Bernstein & Company, "They have been early to see trends and aggressive in targeting them."[1]

# Learning Objectives

*After reading this chapter, you should be able to:*

- List the differences between successful and unsuccessful innovations
- Understand the importance of lead users and market research as sources of new ideas
- Assess the importance of product and process R&D for success within an industry

- Decide when to innovate internally and when to use alliances
- Propose an appropriate structure and culture to support innovative ideas and products
- Apply appropriate techniques and measures to manage new product development

PepsiCo is a good example of a company successfully using its resources to create new products for new and existing markets. Properly managing technology and innovation is crucial in a fast-moving global environment. In the high-pressure toys and games industry, for example, about 40% of all products on the market are less than one year old.[2] Over the past 15 years, the top 20% of firms in an annual innovation poll conducted by *Fortune* magazine achieved double the shareholder returns of their peers.[3] Nevertheless, many large firms find it difficult to be continually innovative. A recent survey of business executives reveals that a significant majority are concerned that their companies are losing growth opportunities because they are not able to properly manage new technology (see **Table A–1**).[4] A survey of 700 companies by Arthur D. Little found that 85% of the executives were "dissatisfied with their ability to manage innovation."[5] Even innovative established companies, such as 3M, Procter & Gamble (P&G), and Rubbermaid, have experienced a slowing in their rate of successful new product introductions.[6]

In this chapter, we examine strategic issues in technology and innovation as they affect environmental scanning, strategy formulation, strategy implementation, and evaluation and control.

## A.1 The Role of Management

Due to increased competition and accelerated product development cycles, innovation and the management of technology are becoming crucial to corporate success. Research conducted by Forbes, Ernst & Young, and the Wharton School of Business found the most important driver of corporate value for both durable and non-durable companies to be innovation.[7] New product development is positively associated with corporate performance.[8] Approximately half the profits of all U.S. companies come from products launched in the previous 10 years.[9] What is less obvious is how a company can generate a significant return from investment in R&D as

| TABLE A–1 | A survey of business executives conducted by *Fortune* with the consulting firm Integral, Inc., revealed the percentages of those responding either **agree** or **strongly agree** to the following five statements: | |
| --- | --- | --- |
| Executives Fear Their Companies Are Becoming Less Innovative | Your company has recently lost relatively low-value customers in small market niches or low-end market segments. | 55% |
| | Your organization passes up growth opportunities it would have pursued when the company was smaller because the opportunities are now "too small to be interesting." | 60% |
| | There is a disconnect between the kind of innovations your frontline troops suggest and the types of innovations upper management invests in. | 64% |
| | When your organization sees a potentially disruptive technology, it defines it as a technical problem ("Will our customers accept the product?") instead of a market problem. | 58% |
| | New entrants have exploited opportunities where uncertainty over market size and customer needs resulted in inaction by your company. | 68% |

SOURCE: "Don't Leave Us Behind," *Fortune* (April 3, 2000), p. 250.

well as an overall sense of enthusiasm for innovative behavior and risk-taking. One way is to include innovation in the corporation's mission statement. See **Strategy Highlight A.1** for mission statements from well-known companies. Another way is by establishing policies that support the innovative process. For example, 3M has a policy of generating at least 25% of its revenue from products introduced in the preceding three years. To support this policy, this $13 billion corporation annually spends nearly $1 billion.[10]

The importance of technology and innovation must be emphasized by people at the very top and reinforced by people throughout a corporation. If top management and the board are not interested in these topics, managers below them tend to echo their lack of interest. When growth in sales and profits stalled at P&G several years ago, the new CEO, Art Lafley, realized that product development was no longer a core competency of the company. In 2002, just

# STRATEGY highlight A.1

## EXAMPLES OF INNOVATION EMPHASIS IN MISSION STATEMENTS

To emphasize the importance of technology, creativity, and innovation to overall future corporate success, some well-known firms have added sections to this effect in their published mission statements. Some of these are listed here:

**Intel:** "Delight our customers, employees, and shareholders by relentlessly delivering the platform and technology advancements that become essential to the way we work and live."

**Merck & Co:** "The mission of Merck is to provide society with superior products and services by developing innovations and solutions that improve the quality of life and satisfy customer needs, and to provide employees with meaningful work and advancement opportunities, and investors with a superior return."

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12 of the firm's 250-some brands generated half of P&G's sales and an even larger percentage of its profits.[11] Lafley urged product groups to "connect and develop" by pulling in experts from unrelated brands to help with new product creation. One example of the impact of Lafley's directive was the decision to enter the home car-care business. Instead of a project team trying to develop a new product on its own, P&G looked for and found expertise in different parts of the company. The company's PuR unit's water filter experts knew how to deionize water to get rid of minerals. Its Cascade brand unit already had a compound in its dishwasher detergent that reduced water spots. The project team combined both technologies to make the Mr. Clean AutoDry handheld sprayer, a device that sprays soap on cars and then rinses them without spotting. The result was a doubling of Mr. Clean brand sales in a year.[12]

Management has an obligation to not only encourage new product development but also develop a system to ensure that technology is being used most effectively, with the consumer in mind. Between 33% and 60% of all new products that reach the market fail to make a profit.[13] A study by Chicago consultants Kuczmarski & Associates of 11,000 new products marketed by 77 manufacturing, service, and consumer-product firms revealed that only 56% of all newly introduced products were still being sold five years later. Only 1 in 13 new product ideas ever made it into test markets. Although some authorities argue that this percentage of successful new products needs to be improved, others contend that too high a percentage means that a company isn't taking the risks necessary to develop a really new product.[14]

A study of 111 successful and 86 unsuccessful product innovations found that the *successful innovations* had some or all of the following features:

- They were moderately new to the market.
- They were based on tried-and-tested technology.
- They saved money, met customers' needs, and supported existing practices.

In contrast, the *unsuccessful innovations* had a different set of characteristics:

- They were based on cutting-edge or untested technology.
- They followed a "me-too" approach.
- They were created with no clearly defined solution in mind.[15]

The importance of top management's providing appropriate direction is exemplified by Steve Jobs' management of Apple Computer. Ever since he co-founded the company, Jobs has pushed Apple to provide not just a product but a complete system. For example, Apple decided in 2001 to make a digital music player, the iPod, that would be as easy to use for digital media as the Sony Walkman was for cassette tapes. Jobs realized, however, that the company could not succeed by just making and selling hardware. The digital player would be worthless without an online download store. By painstakingly negotiating digital-rights issues with reluctant record companies, he achieved something never before accomplished: providing easy, legal access to over 1 million songs. By 2004, Apple sold 3.7 million iPods valued at $1 billion in sales. Commenting on the iPod's success, Jobs explained, "We can invent a complete solution that works."[16]

## A.2 Environmental Scanning

Issues in innovation and technology influence both external and internal environmental scanning.

# EXTERNAL SCANNING

Corporations need to continually scan their external societal and task environments for new developments in technology that may have some application to their current or potential products. Research reveals that firms that scan their external environment are more innovative than those that focus inward on their core competencies as a way to generate new products or processes.[17] Stakeholders, especially customers, can be important participants in the new product development process.

## Technological Developments

Motorola, a company well known for its ability to invest in profitable new technologies and manufacturing improvements, has a sophisticated scanning system. Its intelligence department monitors the latest technological developments introduced at scientific conferences, in journals, and in trade gossip. This information helps it build "technology roadmaps" that assess where breakthroughs are likely to occur, when they can be incorporated into new products, how much money their development will cost, and which of the developments is being worked on by the competition.[18]

A company's focusing its scanning efforts too closely on its current product line is dangerous. Most new developments that threaten existing business practices and technologies do not come from existing competitors or even from within traditional industries. A new technology that can substitute for an existing technology at a lower cost and provide higher quality can change the very basis for competition in an industry. Managers therefore need to actively scan the periphery for new product ideas because this is where breakthrough innovations will be found.[19] Consider, for example, the impact of Internet technology on the personal computer software industry. Microsoft Corporation had ignored the developing Internet technology during the 1980s and early 1990s while battling successfully with IBM, Lotus, and WordPerfect to dominate operating system software via Windows 95 as well as word processing and spreadsheet programs via Microsoft Office. Ironically, just as Microsoft introduced its new Windows 95 operating system, newcomer Netscape used Java applets in its user-friendly, graphically oriented browser program with the potential to make operating systems unnecessary. By the time Microsoft realized the significance of this threat, Netscape had already established itself as the industry standard for browsers. Microsoft was forced to spend huge amounts of time and resources trying to catch up to Netscape's dominant market share with its own Internet Explorer browser.

One way to learn about new technological developments in an industry is to locate part of a company's R&D or manufacturing in those locations making a strong impact on product development. Large multinational corporations (MNCs) undertake between 5% and 25% of their R&D outside their home country.[20] For example, automobile companies like to have design centers in southern California and in Italy, key areas for automotive styling. Software companies throughout the world know that they must have a programming presence in California's Silicon Valley if they are to compete on the leading edge of technology. The same is true of the semiconductor industry in terms of manufacturing.[21]

## Impact of Stakeholders on Innovation

A company should look to its stakeholders, especially its customers, suppliers, and distributors, for sources of product and service improvements. These groups of people have the most to gain from innovative new products or services. Under certain circumstances, they may propose new directions for product development. Some of the methods of gathering information from key stakeholders are using lead users, market research, and new product experimentation.

**Lead Users.** Research by Von Hippel indicates that customers are a key source of innovation in many industries. For example, 77% of the innovations developed in the scientific

instruments industry came from the users of the products. Suppliers are often important sources as well. Suppliers accounted for 36% of innovations in the thermoplastics industry, according to Von Hippel.[22] One way to commercialize a new technology is through early and in-depth involvement with a firm's customers in a process called co-development.[23] This type of customer is called a "lead user."

Von Hipple proposes that companies should look to lead users for help in product development, especially in high-technology industries where things move so quickly that a product is becoming obsolete by the time it arrives on the market. These **lead users** are "companies, organizations, or individuals that are well ahead of market trends and have needs that go far beyond those of the average user."[24] They are the first to adopt a product because they benefit significantly from its use—even if it is not fully developed. At Dow Chemical, for example, scientists solicit feedback from customers before developing a new product in the lab. Once the product is ready for commercialization, Dow gives its lead users the first opportunity to use the product and suggest further development.[25]

At 3M, a product development team in 3M's Medical Surgical Markets Division was charged with creating a breakthrough in the area of surgical drapes—the material that prevents infections from spreading during surgery. At the time, 3M dominated the market but had not developed a new product improvement in almost a decade. After spending six weeks learning about the cause and prevention of infections, the project team spent six more weeks investigating trends in infection control. The team then worked to identify lead users—doctors in developing nations and veterinarians who couldn't afford the current expensive drapes. The team invited several lead users to a 2½-day workshop focused on "Can we find a revolutionary, low-cost approach to infection control?" The workshop generated concepts for six new product lines and a radical new approach to infection control. The team chose the three strongest concepts for presentation to senior management. 3M has successfully applied the lead user method in 8 of its 55 divisions.

Lead user teams are typically composed of four to six people from marketing and technical departments, with one person serving as project leader. Team members usually spend 12 to 15 hours per week on the project for its duration. For planning purposes, a team should allow four to six weeks for each phase and four to six months for the entire project. The four phases of the lead user process are:

1. **Lay the Foundation:** Identify target markets and the type and level of innovations desired.
2. **Determine the Trends:** Research the field and talk with experts who have a broad view of emerging technologies and leading-edge applications.
3. **Identify Lead Users:** Talk with users at the leading edge of the target and related markets to understand their needs.
4. **Develop the Breakthrough:** Host a two- to three-day workshop with several lead users and a half-dozen marketing and technical people. Participants first work in small groups and then as a whole to design the final concepts that fit the company's and the users' needs.[26]

**Market Research.** A more traditional method of obtaining new product ideas is to use **market research** to survey current users regarding what they would like in a new product. This method has been successfully used by companies, such as P&G, to identify consumer preferences. It is especially useful in directing incremental improvements to existing products. For example, the auto maker BMW solicits suggestions from BMW owners to improve its current offerings and to obtain ideas for new products.

Market research may not, however, necessarily provide the information needed for truly innovative products or services (radical innovation). According to Sony executive Kozo

Ohsone, "When you introduce products that have never been invented before, what good is market research?" For example, Hal Sperlich took the concept of the minivan from Ford to Chrysler when Ford refused to develop the concept. According to Sperlich,

> [Ford] lacked confidence that a market existed because the product didn't exist. The auto industry places great value on historical studies of market segments. Well, we couldn't prove there was a market for the minivan because there was no historical segment to cite. In Detroit most product-development dollars are spent on modest improvements to existing products, and most market research money is spent on studying what customers like among available products. In ten years of developing the minivan we never once got a letter from a housewife asking us to invent one. To the skeptics, that proved there wasn't a market out there.[27]

A heavy emphasis on being customer driven could actually prevent companies from developing innovative new products. A study of the impact of technological discontinuity (explained in **Chapter 5**) in various industries revealed that the leading firms failed to switch to the new technology not because management was ignorant of the new development but because they listened too closely to their current customers. In all of these firms, a key task of management was to decide which of the many product and development programs continually being proposed to them should receive financial resources. The criterion used for the decision was the total return perceived in each project, adjusted by the perceived riskiness of the project. Projects targeted at the known needs of key customers in established markets consistently won the most resources. Sophisticated systems for planning and compensation favored this type of project every time. As a result, the leading companies continued to use the established technology to make the products its current customers demanded, allowing smaller entrepreneurial competitors to develop the new, more risky technology.[28]

Because the market for the innovative products based on the new technology was fairly small at first, new ventures had time to fine-tune product design, build sufficient manufacturing capacity, and establish the product as the industry standard (as Netscape did with its Internet browser). As the marketplace began to embrace the new standard, the customers of the leading companies began to ask for products based on the new technology. Although some established manufacturers were able to defend their market share positions through aggressive product development and marketing activity (as Microsoft did against Netscape), many firms, finding that the new entrants had developed insurmountable advantages in manufacturing cost and design experience, were forced out of the market. Even the established manufacturers that converted to the new technology were unable to win a significant share of the new market.[29]

**New Product Experimentation and Acquisition.** Instead of using lead users or market research to test the potential of innovative products, some successful companies are using speed and flexibility to gain market information. These companies have developed their products by probing potential markets with early versions of the products, learning from the probes, and probing again.[30] For example, Seiko's only market research is surprisingly simple. The company introduces hundreds of new models of watches into the marketplace. It makes more of the models that sell; it drops those that don't.

The consulting firm Arthur D. Little found that the use of standard market research techniques has resulted in a success rate of only 8% for new cereals—92% of all new cereals fail. As a result, innovative firms, such as Keebler and the leading cereal makers, are reducing their expenditures for market research and working to reduce the cost of launching new products by making their manufacturing processes more flexible.[31]

Microsoft has successfully followed a strategy of monitoring the competition for new developments. It follows an *embrace and extend* strategy of imitating new products developed by pioneers, refining them, and outmarketing the competition. (This approach is nothing new.

P&G used Mr. Clean to defeat the newly introduced Lestoil.) Microsoft's distinctive competency is its ability to change directions and adjust priorities when the market changes.[32] Another approach to new product development is to simply acquire new technology from others. Cisco Systems, for example, kept itself on the cutting edge of making and selling Internet routers by buying a number of high-tech startups. In effect, Cisco outsourced its R&D to California's venture capitalists.[33]

## INTERNAL SCANNING

In addition to scanning the external environment, strategists should also assess their company's ability to innovate effectively by asking the following questions:

1. Has the company developed the resources needed to try new ideas?
2. Do the managers allow experimentation with new products or services?
3. Does the corporation encourage risk-taking and tolerate mistakes?
4. Are people more concerned with new ideas or with defending their turf?
5. Is it easy to form autonomous project teams?[34]

In addition to answering these questions, strategists should assess how well company resources are internally allocated and evaluate the organization's ability to develop and transfer new technology in a timely manner into the generation of innovative products and services. These issues are important, given that it takes on average seven ideas to generate a new commercial product, according to the Product and Development Management Association.[35]

### Resource Allocation Issues

A company must make available the resources necessary for effective research and development. Research indicates that a company's **R&D intensity** (its spending on R&D as a percentage of sales revenue) is a principal means of gaining market share in global competition.[36] The amount of money spent on R&D often varies by industry. For example, the computer software and drug industries spend an average of 11% to 13% of their sales revenue for R&D. Others, such as the food and the containers and packaging industries, spend less than 1%. A good rule of thumb for R&D spending is that a corporation should spend at a "normal" rate for that particular industry, unless its competitive strategy dictates otherwise.[37] Research indicates that consistency in R&D strategy and resource allocation across lines of business improves corporate performance by enabling the firm to better develop synergies among product lines and business units.[38]

Simply spending money on R&D or new projects does not, however, guarantee useful results. One study found that although large firms spent almost twice as much per R&D patent than did smaller firms, the smaller firms used more of their patents. The innovation rate of small businesses was 322 innovations per million employees versus 225 per million for large companies.[39] A recent study by the U.S. Small Business Administration reported that patents obtained by small firms were twice as likely to be among the top 1% of the most widely cited patents as patents obtained by large firms.[40] One explanation for this phenomenon is that large (especially older) firms tend to spend development money on extensions of their current products (incremental innovation) or to increase the efficiency of existing performance.[41] In contrast, small firms tend to apply technology to improving effectiveness through developing completely new products (radical innovation).[42] Other studies reveal that the maximum innovator in various industries often was the middle-sized firm. These firms were generally more effective and efficient than others in technology transfer. Very small firms often do not have sufficient resources to exploit new concepts (unless supported by venture capitalists with deep pockets), whereas the bureaucracy present in large firms rewards consistency over creativity.[43] From these studies,

Hitt, Hoskisson, and Harrison propose the existence of an inverted U-shaped relationship between size and innovation. According to Hitt et al., "This suggests that organizations are flexible and responsive up to some threshold size but encounter inertia after that point."[44]

In some cases, firms waste their R&D spending. For example, between 1950 and 1979, the U.S. steel industry spent 20% more on plant maintenance and upgrading for each ton of production capacity added or replaced than did the Japanese steel industry. Nevertheless, the top management of U.S. steel firms failed to recognize and adopt two breakthroughs in steel-making—the basic oxygen furnace and continuous casting. Their hesitancy to adopt new technology caused them to lose the world steel market.[45]

### Time-to-Market Issues

In addition to money, another important consideration in the effective management of R&D is **time to market**. During the 1980s, the time from inception to profitability of a specific R&D program was generally accepted to be 7 to 11 years. According to Karlheinz Kaske, CEO of Siemens AG, however, the time available to complete the cycle is getting shorter. Companies no longer can assume that competitors will allow them the number of years needed to recoup their investment. In the past, Kaske says, "ten to fifteen years went by before old products were replaced by new ones . . . now, it takes only four or five years."[46] Time to market is an important issue because 60% of patented innovations are generally imitated within four years at 65% of the cost of innovation.[47] In the 1980s, Japanese auto manufacturers gained incredible competitive advantage over U.S. manufacturers by reducing new products' time to market to only three years. (U.S. auto companies needed five years.)[48]

# A.3 Strategy Formulation

R&D strategy deals not only with the decision to be a leader or a follower in terms of technology and market entry (discussed in **Chapter 8**, in the R&D strategy section) but also with the source of the technology. Should a company develop its own technology or purchase it from others? The strategy also takes into account a company's particular mix of basic versus applied and product versus process R&D (discussed in **Chapter 5**). The particular mix should suit the level of industry development and the firm's particular corporate and business strategies.

## PRODUCT VERSUS PROCESS R&D

As illustrated in **Figure A–1**, the proportion of product and process R&D tends to vary as a product moves along its life cycle. In the early stages, **product innovations** are most important because the product's physical attributes and capabilities most affect financial performance. Later, **process innovations** such as improved manufacturing facilities, increasing product quality, and faster distribution become important to maintaining the product's economic returns. Generally, product R&D has been key to achieving differentiation strategies, whereas process R&D has been at the core of successful cost-leadership strategies.

Historically, U.S. corporations have not been as skillful at process innovations as have German and Japanese companies. The primary reason has been a function of the amount of money invested in each form of R&D. U.S. firms spend, on the average, 70% of their R&D budgets on product R&D and only 30% on process R&D; German firms, 50% on each form; and Japanese firms, 30% on product and 70% on process R&D.[49] The traditionally heavy emphasis by U.S. major home appliance manufacturers on process R&D is one reason they have such a strong position in the North American market. The emphasis on quality and durability, coupled with a reluctance to make major design changes simply for the sake of change, has resulted in products
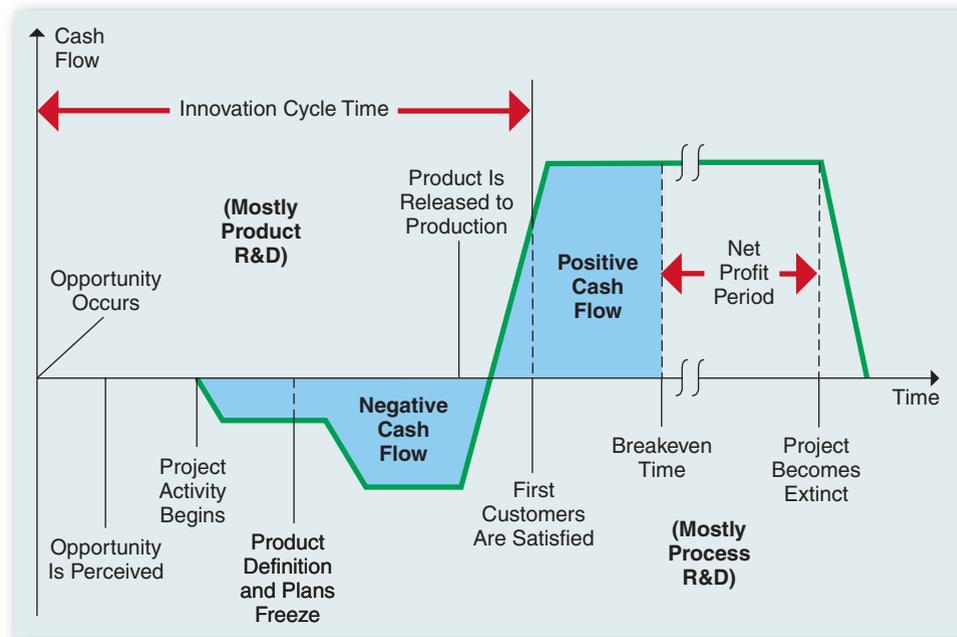
SOURCE: *Adapted from M. L. Patterson, "Lessons from the Assembly Line,"* Journal of Business Strategy *(May/June 1993), p. 43. Republished with permission, Emerald Group Publishing Limited.*

with an average life expectancy of 20 years for refrigerators and 15 years for washers and dryers. Even though quality has improved significantly over the past 20 years, the average washer, dryer, and refrigerator cost no more than they did 20 years ago and yet last almost twice as long.

To be competitive, companies must find the proper mix of product and process R&D. Research indicates that too much emphasis by a firm on efficiency-oriented process R&D can drive out product R&D.[50] Even though the key to the success of the U.S. major home appliance industry has been its emphasis on process innovation, significant product innovation is more likely to result in a first-mover advantage.[51] For example, Maytag's introduction of the Neptune, a new type of front-loading washing machine, gave it a significant marketing advantage even after Whirlpool and General Electric introduced their versions of the new product.

## TECHNOLOGY SOURCING

**Technology sourcing**, typically a make-or-buy decision, can be important in a firm's R&D strategy. Although in-house R&D has traditionally been an important source of technical knowledge (resulting in valuable patents) for companies, firms can also tap the R&D capabilities of competitors, suppliers, and other organizations through contractual agreements (such as licensing, R&D agreements, and joint ventures) or acquisitions. Each approach has advantages and disadvantages.[52] One example of technology acquisition was Motorola's purchase in 2004 of MeshNetworks, Inc., to obtain a Wi-Fi technology needed in Motorola's government contracting business.[53] When technological cycles were longer, a company was more likely to choose an independent R&D strategy not only because it gave the firm a longer lead time before competitors copied it but also because it was more profitable in the long run. In today's world of shorter innovation life cycles and global competition, a company may no longer have the luxury of waiting to reap a long-term profit.

Firms that are unable to finance alone the huge costs of developing a new technology may coordinate their R&D with other firms through a **strategic R&D alliance**. By the 1990s, more than 150 cooperative alliances involving 1,000 companies were operating in the United States, and many more were operating throughout Europe and Asia.[54] These alliances can be (1) joint programs or contracts to develop a new technology, (2) joint ventures establishing a separate company to take a new product to market, or (3) minority investments in innovative firms wherein the innovator obtains needed capital and the investor obtains access to valuable research. For example, the biotech company Amgen uses strategic alliances as part of its growth strategy. It uses its collegial corporate culture to court entrepreneurial ventures that are normally shy of big companies. "We're trying to have a small company feel," explains Amgen CEO Kevin Sharer. By 2003, Amgen had formed partnerships with 100 companies. It developed its latest drug, Cinacalcet, a treatment for a kidney-related condition called secondary hyperparathyroidism, from a license with one of its partners, NPS Pharmaceuticals.[55]

When should a company buy or license technology from others instead of developing it internally? Following the resource-based view of the firm discussed in **Chapter 5**, a company should buy technologies that are commonly available but make (and protect) those that are rare, valuable, and hard to imitate and that have no close substitutes. In addition, outsourcing technology may be appropriate when:

- The technology is of low significance to competitive advantage.
- The supplier has proprietary technology.
- The supplier's technology is better and/or cheaper and reasonably easy to integrate into the current system.
- The company's strategy is based on system design, marketing, distribution, and service—not on development and manufacturing.
- The technology development process requires special expertise.
- The technology development process requires new people and new resources.[56]

Licensing technology to other companies may be an excellent R&D strategy—especially in a turbulent high-tech environment where being the first firm to establish the standard dominant design may bring competitive advantage.[57] Matsushita successfully used this strategy to overcome the technologically superior Sony beta format with the VHS format for VCRs. When Matsushita freely licensed the VHS format to all other VCR makers, Sony was relegated to a minority position in the market, and Matsushita (through its Panasonic brand) became a dominant VCR manufacturer.[58] Licensing enables a company to enter foreign markets that might not otherwise be possible due to high tariffs, import prohibitions and restrictions, or the high cost and risk of investing in foreign factories. Licensing is an alternative international strategy in situations when exports or local production through a subsidiary or joint venture are impractical.[59]

A serious issue in the sourcing of new technology is the use of another company's intellectual property without paying for it. **Intellectual property** is special knowledge used in a new product or process developed by a company for its own use and is usually protected by a patent, copyright, trademark, or trade secret. It can be licensed to another firm for a fee. As mentioned earlier, making and selling an imitation of someone else's product (such as Nike shoes) is considered to be piracy. Both the recording industry and the motion picture industry are extremely threatened by the illegal duplication of their products.

The number of patents being issued in the United States is growing at 6% annually and running at nearly twice the level of a decade ago. Similar growth is happening elsewhere in the world. Patents are global. Although a U.S. patent does not function outside the United

# GLOBAL issue

## USE OF INTELLECTUAL PROPERTY AT HUAWEI TECHNOLOGIES

Xu Danhua, chief of the pre-research department at Huawei Technologies, works to develop products for digital homes. He is using technologies to link PCs, TVs, stereos, and other devices to the Internet and to each other throughout a building or an apartment. "I like to face the challenges of new technology," says Xu. "Huawei is a company that very quickly takes on the trends of the industry." This is a relatively new direction for a company that until recently was a low-cost manufacturer of equipment developed elsewhere. Huawei intends to sell sophisticated electronic products to international customers. According to the company's head of R&D, "Huawei is a global company with global markets in mind." To take advantage of skilled people in other parts of the world, it is building development centers in Europe, India, and the United States.

Cisco Systems, a maker of networking equipment, launched a lawsuit against Huawei in December 2002, alleging patent and copyright infringement and asking for an injunction to remove certain Huawei products from the market. Cisco had already lined up support from the Chinese government. Having just joined the World Trade Organization (WTO) in 2001, China was eager to shed its image as the world's leading haven for pirated goods. According to an official with China's Ministry of Information

Industry, "The government will not give any political help to Huawei."

Huawei protested its innocence but soon announced a global joint venture with Cisco's rival, 3Com Corporation. The venture provides Huawei with 3Com's distribution system, along with a strong base in the United States. When Cisco's Executive Vice President, Charles Giancarlo, was informed of the Huawei–3Com alliance, he said, "I was so mad I couldn't speak for three days." Keeping up the pressure, Cisco filed another suit in east Texas, near Huawei's Dallas office. Huawei typically undersells Western rivals by 30% or more and has a reputation for selling products that look and feel like Cisco's products. It was a major competitor in DSL equipment. "Huawei is a threat to everyone," says Christine Heckart, Vice President for Marketing at Juniper Networks. "They bid on everything that moves."

For Huawei, the lawsuits were part of a painful and risky transition from a position of cheap labor, government support, and lax intellectual property protection in China to the tougher rules of global markets. Eager to shed its "me-too" reputation, Huawei agreed to settle the lawsuit with Cisco Systems in 2004.

............................
SOURCES: Summarized from P. Burrows and B. Einhorn, "Cisco: In Hot Pursuit of a Chinese Rival," *Business Week* (May 19, 2003), pp. 62–63, and B. Einhorn, M. Kripalani, and J. Ewing, "Huawei: More Than a Local Hero," *Business Week* (October 11, 2004), pp. 180–184.

States, the same idea cannot in theory be patented anywhere else.[60] Countries joining the World Trade Organization (WTO) must agree to Trips (trade-related aspects of intellectual property rights), an international agreement that establishes minimum standards for the legal protection of intellectual property.[61] Because China has recently joined the WTO, a number of companies are attempting to enforce their patents in that country. See the **Global Issue** feature for an example of a Chinese company that was sued by Cisco Systems for intellectual property violations.

## IMPORTANCE OF TECHNOLOGICAL COMPETENCE

Firms that emphasize growth through acquisitions over internal development tend to be less innovative than others in the long run.[62] Research suggests that companies must have at least a minimal R&D capability if they are to correctly assess the value of technology developed by others. This is called a company's "absorptive capacity" and is a valuable by-product of routine in-house R&D activity.[63] **Absorptive capacity** is a firm's ability to recognize, assimilate, and utilize new external knowledge.[64] Firms that have absorptive capacity are able to use knowledge obtained externally to increase the productivity of their research expenditures.[65] Further, without this capacity, firms could become locked out in their ability to

assimilate the technology at a later time. Therefore, a company's absorptive capacity is a dynamic capability that influences the nature and sustainability of that company's competitive advantage.[66]

A corporation that purchases an innovative technology must have the **technological competence** to make good use of it. Some companies that introduce the latest technology into their processes do not adequately assess the competence of their people to handle it. For example, a survey conducted in the United Kingdom in the 1980s found that 44% of all companies that started to use robots met with initial failure, and that 22% of those firms abandoned the use of robots altogether, mainly because of inadequate technological knowledge and skills.[67] One U.S. company built a new plant equipped with computer-integrated manufacturing and statistical process controls, but the employees could not operate the equipment because 25% of them were illiterate.[68]

## CATEGORIES OF INNOVATION

Innovation can range from incremental to radical. As shown in **Figure A–2**, a corporation's *capabilities* (existing or new) interact with its *strategic scope* (limited or unlimited) to form four basic categories of innovation. A corporation may emphasize one of these categories or operate in all of them.[69]

**Quadrant 1: Improving Core Businesses:** This type of innovation focuses on incremental innovations that can be developed rapidly and inexpensively. It includes line extensions and more convenient packaging and is often a part of a horizontal growth strategy. Its potential weakness is market myopia—its emphasis on current products and customers. As illustrated earlier in this chapter, PepsiCo is the master of this type of innovation.

**Quadrant 2: Exploiting Strategic Advantages:** This type of innovation focuses on taking existing brands and product lines to new customers and markets without requiring major change in current capabilities. It means moving beyond the company's current strategic

**FIGURE A–2**
**Categories of Innovation**
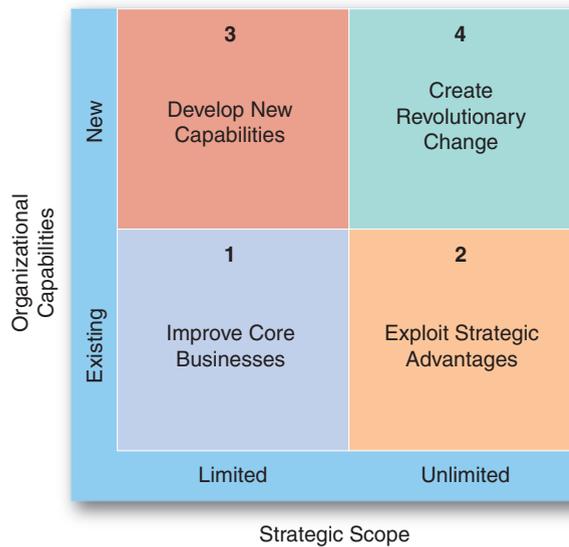


SOURCE: *Adapted from C. Hickman and C. Raia, "Incubating Innovation,"* Journal of Business Strategy *(May/June 2002), p. 15. Reprinted with permission, Emerald Group Publishing Limited.*

scope by leveraging capabilities by spreading them across a broader range of markets and customers via concentric diversification. Its potential weakness is the relative ease with which competitors with similar capabilities can imitate the innovation. Coleman and Toro are examples of companies that have leveraged their capabilities in camping (Coleman) and lawn (Toro) equipment to move into new products and new markets, such as Coleman gas grills and Toro snow blowers.

**Quadrant 3: Developing New Capabilities:** This type of innovation focuses on deepening customer satisfaction and loyalty to the brand or product line by adding new organizational capabilities without introducing major changes in strategic scope. The company may develop or purchase new technologies, talents, or businesses to better serve the firm's current scope of customers and markets. It may involve a vertical growth strategy. Its potential weakness is the investment cost and implementation time. Microsoft follows an embrace-and-extend policy to either acquire or imitate a new product in order to offer it to its current customers in the next version of Windows or Office software.

**Quadrant 4: Creating Revolutionary Change:** This type of innovation focuses on radical innovations that transcend current product lines or brands to make fundamental changes in both its strategic scope and its capabilities. This can mean a new business model and a revolutionary new future for the company. Its potential weakness is a high risk of failure. Sony Corporation is the master of radical innovation. Its pioneering products, such as the Walkman, the Airboard, and the robo-pet Aibo, introduce whole new product categories.

## PRODUCT PORTFOLIO

Developed by Hofer and based on the product life cycle, the 15-cell **product/market evolution matrix** (shown in **Figure A–3**) depicts the types of developing products that cannot be easily shown on other portfolio matrixes. Products are plotted in terms of their competitive positions and their stages of product/market evolution. As on the GE Business Screen, the circles represent the sizes of the industries involved, and the pie wedges represent the market shares of the firm's business product lines. Present and future matrixes can be developed to identify strategic issues. In response to **Figure A–3**, for example, we could ask why Product B does not have a greater share of the market, given its strong competitive position. We could also ask why the company has only one product in the developmental stage. A limitation of this matrix is that the product life cycle does not always hold for every product. Many products, for example, do not inevitably fall into decline but (like Tide detergent and Colgate toothpaste) are revitalized and put back on a growth track.

# A.4 Strategy Implementation

If a corporation decides to develop innovations internally, it must make sure that its structure and culture are suitable for such a strategy. It must make sufficient resources available for new products, provide collaborative structures and processes, and incorporate innovation into its overall corporate strategy.[70] It must ensure that its R&D operations are managed appropriately. It must establish procedures to support all six **stages of new product development**. (See **Table A–2**.) If, like most large corporations, the culture is too bureaucratic and rigid to support entrepreneurial projects, top management must reorganize so that innovative projects can be free to develop.

**Competitive Position**
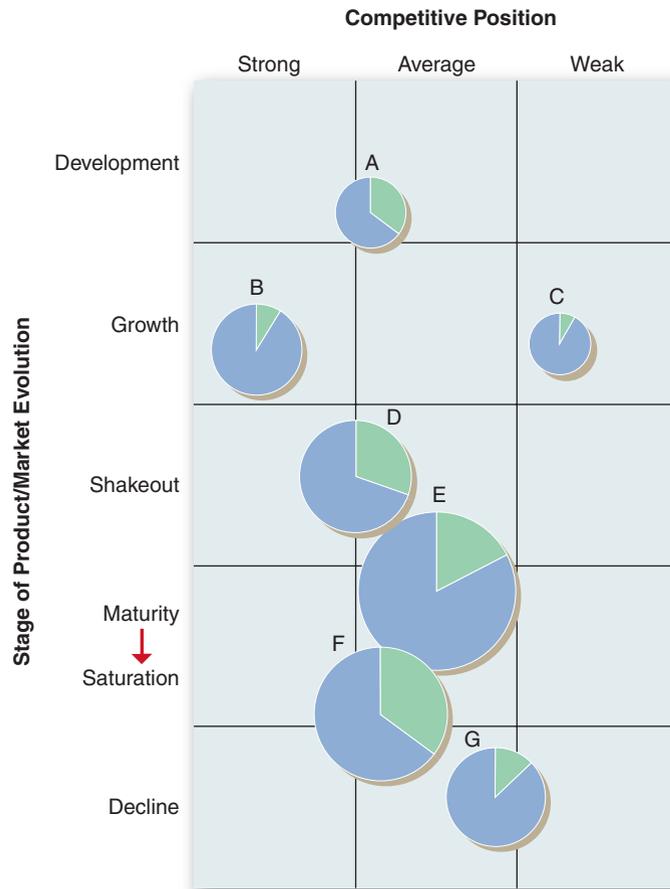


SOURCE: *C. W. Hofer and D. Schendel,* Strategy Formulation: Analytical Concepts *(St. Paul, MN: West Publishing Co., 1978), p. 34. From C. W. Hofer, "Conceptual Constructs for Formulating Corporate and Business Strategies" (Dover, MA: Case Publishing), no. BP-0041, p. 3. Copyright © 1977 by Charles W. Hofer. Reprinted by permission.*

| TABLE A–2 | |
| --- | --- |
| Six Stages of New Product Development | 1. **Idea Generation.** New product concepts are identified and refined. |
| | 2. **Concept Evaluation.** Screening techniques are used to determine the concept's validity and market opportunity. Preliminary market research is conducted, and a strategy is developed. A business plan is developed to present to management. |
| | 3. **Preliminary Design.** A new venture team is formed to prepare desired product specifications. |
| | 4. **Prototype Build and Test.** A functioning model of the product is built and subjected to numerous tests. |
| | 5. **Final Design and Pilot Production.** Final product and process designs are developed to produce small numbers of the product for use in test marketing. Suggestions from the users are fed back to the design team for possible inclusion in the final product. |
| | 6. **New Business Development.** The entire company is energized to launch the product. |

SOURCE: *Managing Corporate Culture, Innovation, and Intrapreneurship,* Howard W. Oden. Copyright © 1997 by Quorum Books. Reproduced with permission of Greenwood Publishing, Inc., Westport, CT.

## DEVELOPING AN INNOVATIVE ENTREPRENEURIAL CULTURE

To create a more innovative corporation, top management must develop an entrepreneurial culture—one that is open to the transfer of new technology into company activities and products and services. The company must be flexible and accepting of change. It should include a willingness to withstand a certain percentage of product failures on the way to success. It should be able to manage small, incremental innovations in existing products as well as radical advances that may alter the basis for competition in an industry.[71] Largeness is not a disadvantage. In his classic book *Diffusion of Innovations*, Rogers reveals that innovative organizations tend to have the following characteristics:

- Positive attitude toward change
- Decentralized decision making
- Complexity
- Informal structure
- Interconnectedness
- Organizational slack (unused resources)
- Large size
- System openness[72]

Such a culture has been noted in 3M Corporation and Texas Instruments, among others. R&D in these companies is managed quite differently from traditional methods. First, employees are dedicated to a particular project outcome rather than to innovation in general. Second, employees are often responsible for all functional activities and for all phases of the innovation process. Time is allowed to be sacrificed from regular duties to spend on innovative ideas. If the ideas are feasible, employees are temporarily reassigned to help develop them. These people may become project champions who fight for resources to make the project a success. Third, these internal ventures are often separated from the rest of the company to provide them with greater independence, freedom for short-term pressures, different rewards, improved visibility, and access to key decision makers.[73]

The innovative process often involves individuals at different organizational levels who fulfill three different types of entrepreneurial roles: product champion, sponsor, and orchestrator. A **product champion** is a person who generates a new idea and supports it through many organizational obstacles. A **sponsor** is usually a department manager who recognizes the value of the idea, helps obtain funding to develop the innovation, and facilitates its implementation. An **orchestrator** is someone in top management who articulates the need for innovation, provides funding for innovating activities, creates incentives for middle managers to sponsor new ideas, and protects idea/product champions from suspicious or jealous executives. Unless all these roles are present in a company, major innovations are unlikely to occur.[74]

Companies are finding that one way to overcome the barriers to successful product innovation is by using multifunctional teams with significant autonomy dedicated to a project. In a survey of 701 companies from Europe, the United States, and Japan, 85% of the respondents have used this approach, with 62% rating it as successful.[75] Research reveals that cross-functional teams are best for designing and developing innovative new products, whereas the more traditional bureaucratic structures seem to be best for developing modifications to existing products, line extensions, and me-too products.[76] Chrysler Corporation was able to reduce the development time for new vehicles by 40% by using cross-functional teams and by developing a partnership approach to new projects.[77] International Specialty Products, a maker of polymers, used "product express" teams composed of chemists and

representatives from manufacturing and engineering to cut development time in half. "Instead of passing a baton, we bring everyone into the commercialization process at the same time," explained John Tancredi, vice president for R&D. "We are moving laterally, like rugby players, instead of like runners in a relay race."[78]

## ORGANIZING FOR INNOVATION: CORPORATE ENTREPRENEURSHIP

**Corporate entrepreneurship** (also called intrapreneurship) is defined by Guth and Ginsberg as "the birth of new businesses within existing organizations, that is, internal innovation or venturing; and the transformation of organizations through renewal of the key ideas on which they are built, that is, strategic renewal."[79] A large corporation that wants to encourage innovation and creativity within its firm must choose a structure that will give the new business unit an appropriate amount of freedom while maintaining some degree of control at headquarters. Research reveals that corporate entrepreneurship has a positive impact on a company's financial performance.[80]

Burgelman proposes (see **Figure A–4**) that the use of a particular organizational design should be determined by (1) the strategic importance of the new business to the corporation and (2) the relatedness of the unit's operations to those of the corporation.[81] The combination of these two factors results in nine organizational designs for corporate entrepreneurship:

1. **Direct Integration:** A new business with a great deal of strategic importance and operational relatedness must be a part of the corporation's mainstream. Product champions—people who are respected by others in the corporation and who know how to work the system—are needed to manage these projects. Janiece Webb championed the incorporation of Internet web browsers in Motorola's mobile phones and is now in charge of Motorola's Personal Networks Group. Because Webb's unit only makes software, she works with other divisions to shape their "product maps," which show what they hope to bring to market and when.[82]

**FIGURE A–4**
Organizational Designs for Corporate Entrepreneurship



**Strategic Importance**

|  | Very Important | Uncertain | Not Important |
|---|---|---|---|
| **Unrelated** | **3** Special Business Units | **6** Independent Business Units | **9** Complete Spin-off |
| **Partly Related** | **2** New Product Business Department | **5** New Venture Division | **8** Contracting |
| **Strongly Related** | **1** Direct Integration | **4** Micro New Ventures Department | **7** Nurturing and Contracting |

(Vertical axis: **Operational Relatedness**)

SOURCE: *Reprinted from R. A. Burgelman, "Designs for Corporate Entrepreneurship in Established Firms." Copyright © 1984, by the Regents of the University of California. Reprinted from the* California Management Review, *Vol. 26, No. 3. By permission of The Regents. All rights reserved.*

2. **New Product Business Department:** A new business with a great deal of strategic importance and partial operational relatedness should be a separate department, organized around an entrepreneurial project in the division where skills and capabilities can be shared. Maytag Corporation did this when it built a new plant near its current Newton, Iowa, washer plant to manufacture the wholly new Neptune line of energy- and water-efficient front-loading washing machines.

3. **Special Business Units:** A new business with a great deal of strategic importance and low operational relatedness should be a special new business unit with specific objectives and time horizons. Teradyne tried this with a new product called Integra. The new product was based on a new, low-cost technology—something that might be good enough in a few years to replace Teradyne's current technology. Because the technology wasn't good enough for Teradyne's high-end applications, Teradyne's management treated Integra like an entrepreneurial venture. Integra's general manager, Marc Levine, reported to a board of directors composed of Teradyne's top executives. Instead of a budget, Levine had a business plan and venture capital (from Teradyne). This governance structure allowed Integra to operate autonomously by recruiting and purchasing from outside the company. According to Levine, "The idea was to think of this as a business from the start, not an R&D project. The board setup allows more of a coaching attitude." Says Teradyne's Vice President, Edward Rogas, "A division is always pressed to do the next logical thing—and make it compatible with the existing line. We told Marc: Be aggressive on the technology; do something no one else has done."[83]

4. **Micro New Ventures Department:** A new business with uncertain strategic importance and high operational relatedness should be a peripheral project that is likely to emerge in the operating divisions on a continuous basis. Each division thus has its own new ventures department. Xerox Corporation, for example, uses its SBUs to generate and nurture new ideas. Small product-synthesis teams within each SBU test the feasibility of new ideas. Those concepts receiving a "go" are managed by an SBU product-delivery team, headed by a chief engineer, that takes the prototype from development through manufacturing.

5. **New Venture Division:** A new business with uncertain strategic importance that is only partly related to present corporate operations belongs in a new venture division. It brings together projects that either exist in various parts of the corporation or can be acquired externally; sizable new businesses are built. Lucent established an internal venture capital operation to fund the ideas of researchers from its Bell Labs R&D unit that didn't fit into existing business units. One new venture, Visual Insights, sells software that can detect billing fraud by analyzing patterns in large amounts of data. Another, Veridicom, does fingerprint authentication.[84]

6. **Independent Business Units:** Uncertain strategic importance coupled with no relationship to present corporate activities can make external arrangements attractive. Hewlett-Packard established printers as an independent business unit in Boise, Idaho (far from its Palo Alto, California, headquarters), because management was unsure of the desktop printer's future. According to Richard Belluzzo, head of HP's printer business, "We had the resources of a big company, but we were off on our own. There wasn't central planning . . . , so we could make decisions really fast."[85]

7. **Nurturing and Contracting:** When an entrepreneurial proposal might not be important strategically to the corporation but is strongly related to present operations, top management might help the entrepreneurial unit to spin off from the corporation. This allows a friendly competitor, instead of one of the corporation's major rivals, to capture a small niche. Techtronix has extensively used this approach. Because of research revealing that related spin-offs tend to be poorer performers than nonrelated spin-offs (presumably owing to the

loss of benefits enjoyed with a larger company), it is especially important that the parent company continue to support the development of the spun-off unit in this cell.[86]

8. **Contracting:** As the required capabilities and skills of the new business are less related to those of the corporation, the parent corporation may spin off the strategically unimportant unit yet keep some relationship through a contractual arrangement with the new firm. The connection is useful in case the new firm eventually develops something of value to the corporation. For example, B.F. Goodrich offered manufacturing rights plus a long-term purchasing agreement to a couple of its managers for a specific raw material Goodrich still used (in declining quantities) in its production process but no longer wanted to manufacture internally.

9. **Complete Spin-off:** If both the strategic importance and the operational relatedness of the new business are negligible, the corporation is likely to completely sell off the business to another firm or to the present employees in some form of Employee Stock Ownership Plan (ESOP). The corporation could also sell off the unit through a leveraged buyout (executives of the unit buy the unit from the parent company with money from a third source, to be repaid out of the unit's anticipated earnings). Because 3M wanted to focus its development money on areas with more profit potential, it decided to spin off its money-losing data storage and medical imaging divisions as a new company called Imation.

Organizing for innovation has become especially important for corporations that want to become more innovative but whose age and size have made them highly bureaucratic, with a culture that discourages creative thinking. These new structural designs for corporate entrepreneurship cannot work by themselves, however. The entrepreneurial units must also have the support of management and sufficient resources. They must also have employees who are risk-takers, willing to purchase an ownership interest in the new venture, and a corporate culture that supports new ventures. This is in contrast to corporations in which top management makes only a superficial commitment to innovation by demanding new ideas without providing the culture necessary to support their development. See **Strategy Highlight A.2** for how *not* to develop an innovative organization.

# STRATEGY highlight A.2

## HOW *NOT* TO DEVELOP AN INNOVATIVE ORGANIZATION



In their book *Corporate Venturing*, researchers Block and MacMillan state that fostering an organizationwide commitment to new business development means more than paying lip service to innovation. They argue that a superficial commitment is almost worse than no commitment at all. They noted that unsuccessful companies tend to follow the following "rules of the road to certain failure":

1. Announce to the company that from now on, it is going to "become entrepreneurial."

2. Create a separate venture department charged with the job of developing new businesses. Hold no one else responsible.

3. Bring in a horde of consultants and self-professed experts to harangue management and employees at all levels to aggressively seek new business ideas.

4. Hold several one-day senior management retreats to discuss the need to become more entrepreneurial.

5. Make no further changes in management practices or the behavior of senior managers.

...........................

# A.5 Evaluation and Control

For innovations to succeed, appropriate evaluation and control techniques must be used to ensure that the end product is what was originally planned. Some of these techniques are the stage-gate process and the house of quality. Appropriate measures are also needed to evaluate the effectiveness of the R&D process. Today's global information technology enables executives to continually assess performance as a product moves from the idea to the finished product stage.

## EVALUATION AND CONTROL TECHNIQUES

The **stage-gate process** is a method of managing new product development to increase the likelihood of launching new products quickly and successfully. The process is a series of steps to move products through the six stages of new product development listed in **Table A–2**. A new concept cannot move beyond any stage until it has been evaluated thoroughly. The stage-gate process is used by companies such as IBM, 3M, General Motors, Corning, and P&G. Corning's managers believe that the process enables them to better estimate the potential payback of any project under consideration. They report that the stage-gate process reduces development time, allows identification of questionable projects, and increases the ratio of internally generated products that result in commercially successful products. It is especially useful for a major platform project (such as a line of new cars) that could be used to create multiple derivative products.[87]

The **house of quality** is another method of managing new product development.[88] Originally developed at Mitsubishi's Kobe shipyards, it is a tool to help project teams make important design decisions by getting them to think about what users want and how to get it to them most effectively.[89] It enhances communication and coordination among engineering, marketing, and manufacturing and ensures better product/customer fit. As shown in **Figure A–5**, the

FIGURE A–5   House of Quality



| CUSTOMER REQUIREMENTS | Importance | Weight of Door | Stiffness of Hinge | Tightness of Door Seal | Tightness of Window Seal |
|---|---|---|---|---|---|
| Easy to Open | 6 | – – | – | | |
| Stays Open on a Hill | 5 | – | + + | | |
| Does Not Leak | 10 | | | + + | + + |
| Isolates Occupant from Road Noise | 8 | + | | + + | + + |
| Crash Protection | 8 | + + | | | |

house of quality is a matrix that maps customer requirements against product attributes. The first step is to identify product requirements and to weight their relative importance from the customer's perspective. For example, market research identified five attributes that customers want from a car door. Each of these are listed in the left column of **Figure A–5**. The second step is to identify the engineering attributes in measurable terms. As shown in **Figure A–5**, engineering lists four attributes of the door. In the third step, the team fills in the body of the central matrix (the body of the house). Each cell in the matrix indicates both the direction and the strength of a relationship between an engineering attribute and a customer requirement. **Figure A–5** shows two negative signs between "easy to open" and "weight of the door," indicating that heavy doors are generally harder to open. The fourth step is to fill in the roof of the house by showing the interaction between design parameters. Thus, the negative sign between door weight and hinge stiffness indicates that a heavy door reduces the stiffness of the hinge. The final bit of information is depicted on the far right side of the house of quality and is a summary of the company's existing product compared with that of its competitors.

The house of quality provides a common framework within which the project team can interact. It makes the relationship between customer requirements and product attributes clear, emphasizes design trade-offs, highlights the competitive shortcomings of current products, and helps identify what steps should be taken to improve the design. It is very useful for cross-functional project teams and a good technique to ensure that both the customer's desires and production feasibility are included in the end result.[90]

## EVALUATION AND CONTROL MEASURES

Companies want to gain more productivity at a faster pace from their R&D activities. But how do we measure the effectiveness or efficiency of a company's R&D? This is a problem, given that a company shouldn't expect more than one in seven product ideas from basic research to make it to the marketplace. Some companies measure the proportion of their sales attributable to new products. For example, Hewlett-Packard measures how much of its revenues come from products introduced in the past three years.[91] At BellCore, the effectiveness of basic research is measured by how often the lab's research is cited in other scientists' work. This measure is compiled and published by the Institute for Scientific Information. Other companies judge the quality of research by counting how many patents they file annually.

Pittiglio Rabin Todd & McGrath (PRTM), a high-tech consulting firm, proposes an **index of R&D effectiveness**. The index is calculated by dividing the percentage of total revenue spent on R&D into new product profitability, which is expressed as a percentage. When this measure was applied to 45 large electronics manufacturers, only 9 companies scored 1.0 or higher, indicating that only 20% received a positive payback from their R&D spending. The top companies kept spending on marginal products to a minimum by running frequent checks on product versus market opportunities and canceling questionable products quickly. They also moved new products to market in half the time of the others. As a result, revenue growth among the top 20% of the companies was double the average of all 45 companies.[92]

A study of 15 multinational companies with successful R&D operations focused on three measures of R&D success: (1) improving technology transfer from R&D to business units, (2) accelerating time to market for new products and processes, and (3) institutionalizing cross-functional participation in R&D. The companies participated in basic, applied, and developmental research activities. The study revealed 13 **best practices** that all the companies followed.[93] Listed in **Table A–3**, they provide a benchmark for a company's R&D activities.

| TABLE A–3 | |
|---|---|
| Thirteen "Best Practices" for Improving R&D | 1. Corporate and business unit strategies are well defined and clearly communicated. |
| | 2. Core technologies are defined and communicated to R&D. |
| | 3. Investments are made in developing multinational R&D capabilities to tap ideas throughout the world. |
| | 4. Funding for basic research comes from corporate sources to ensure a long-term focus; funding for development comes from business units to ensure accountability. |
| | 5. Basic and applied research are performed either at a central facility or at a small number of labs, each focused on a particular discipline of science or technology. Development work is usually performed at business unit sites. |
| | 6. Formal, cross-functional teams are created for basic, applied, and developmental projects. |
| | 7. Formal mechanisms exist for regular interaction among scientists, and between R&D and other functions. |
| | 8. Analytical tools are used for selecting projects as well as for ongoing project evaluation. |
| | 9. The transfer of technology to business units is the most important measure of R&D performance. |
| | 10. Effective measures of career development are in place at all levels of R&D. |
| | 11. Recruiting of new people is from diverse universities and from other companies when specific experience or skills are required that would take a long time to develop internally. |
| | 12. Some basic research is performed internally, but there are also many university and third-party relationships. |
| | 13. Formal mechanisms are used for monitoring external technological developments. |

SOURCE: From "Benchmarking R&D Productivity," I. Krause and J. Liu, 1993 © MCB University Press Limited. Republished with permission of Emerald Group Publishing Ltd.

# End of Chapter SUMMARY

The management of technology and innovation is crucial in today's fast-moving global environment. In every industry, the leading competitors are the innovators. The list of today's innovators, well-known companies such as Dell, Southwest Airlines, and Starbucks, lead their industry now but will eventually cede this advantage to other companies with even better ideas. The real challenge for strategic management is *sustained innovation*.[94]

Royal Dutch/Shell had traditionally been better at investing in large, low-risk projects yielding a modest return than in small, high-risk projects with the potential to transform the entire industry. In an effort to emphasize radical innovation, the company introduced a new approach called *GameChanger*.[95] Six teams of six people each meet every week at the Exploration and Production Divisions in Houston, Texas, and in Rijswijk, the Netherlands, to consider ideas that have been sent to them by e-mail. Out of these GameChanger teams have come four business initiatives for the corporation. One of them is Shell's new "Light Touch" oil-discovery method—a way of using lasers to sense hydrocarbon emissions released naturally in the air from underground reserves.

Increasing numbers of companies are using the Internet to stimulate and manage innovation. The concept is for small entrepreneurial teams to drive innovation at a rate never before experienced in large corporations. According to Christensen, author of *The Innovator's*

*Dilemma*, "The trend now is to decentralize operations, to build idea factories, or idea markets. This is a way to bring the startup mentality inside."[96]

Companies such as Nortel Networks and P&G are adopting this "knowledge market" approach to innovation. Nortel allocates *phantom stock* to those who volunteer for special high-risk innovative projects. Nortel buys the stock as if the project were an IPO. Employees are paid in chits redeemable for cash when the project is finished and again after it has been on the market about a year. P&G has created a Corporate New Ventures (CNV) unit as an autonomous idea lab with a mission of encouraging new ideas for products and putting them into speedy production. Ideas bubbling up from P&G's worldwide workforce of 110,000 people are routed to the CNV innovation panel via *My Idea*, a corporate collaboration network. Employees submitting winning ideas are rewarded with stock options. CNV teams then analyze the ideas by using the Internet to analyze markets, demographics, and cost information to learn whether the idea is a feasible opportunity. Once the team agrees on an idea, a project is launched within days. The CNV has the authority to tap any resources in the company to bring a product to market. So far, CNV has generated 58 products into the market. One of these, a cleaning product called Swiffer, was commercialized in just 10 months, less than half the usual time. Swiffer is a disposable cloth that generates static electricity to attract dust and dirt. The idea for it was generated by P&G's paper and cleaning-agent experts during a discussion on the Internet. According to Craig Wynett, CNV President, "It was an exercise in speed, in breaking down the company's traditional division-by-division territories to come up with new ideas."[97]

## INFO-BITS

- Japan is the world's robotics leader, with 350,000 industrial robots in 2003. Germany is second, with 105,000, and the United States is third, with 104,000 robots.[98]
- In 2004, 607,000 household robots were in use. Most of these were vacuum cleaner and lawn mower robots. The

UN Commission for Europe and the International Federation of Robotics predict that 4.1 million domestic robots will be in use by the end of 2007.[99]

- In 2004, 692,000 companion or entertainment robots, such as Sony's dog-like Aibo, were in use throughout the world.[100]

## DISCUSSION QUESTIONS

1. How should a corporation scan the external environment for new technological developments? Who should be responsible?

2. What is technology research and how does it differ from market research?

3. What is the importance of product and process R&D to competitive strategy?

4. What factors help determine whether a company should outsource a technology?

5. How can a company develop an entrepreneurial culture?

## STRATEGIC PRACTICE EXERCISE

### How Creative Is Your Organization?

One of the keys to managing technology and innovation is to have a creative organization in which people are free to propose and try new ideas. The following questionnaire is taken from "Building a Creative Hothouse" by Barton Kunstler in the January–February 2001 issue of *The Futurist*. It is a simplified version of the Hothouse Assessment Instrument presented in greater detail in the Spring 2000 issue of *Futures*

*Research Quarterly*. This version describes many of the elements of a highly creative organization.

If you work or have worked full time in an organization, answer this questionnaire in light of your experience with that organization. If you have not worked full time anywhere, find someone who is working full time and ask that person to complete this questionnaire. Then discuss the person's answers with him or her.

To assess the level of creativity in your organization's culture, score your level of agreement or disagreement with the statements below as follows: **Strongly Agree** (5 points), **Mildly Agree** (4 points), **Neutral** (3 points), **Mildly Disagree** (2 points), **Strongly Disagree** (1 point).

**(1) VALUES**

1. ___ We believe that our work can change the world.

2. ___ The organization actively promotes a positive quality of life in our surrounding communities.

3. ___ People here really believe our products and services are vital to others' well-being.

4. ___ Virtually all who work here continually study and question the basic nature of their job and the technologies—human, organizational, technical—they work with.

5. ___ Working here fills me with a sense of personal well-being and commitment to my higher values.

**(2) MISSION AND VISION**

6. ___ Principles of justice and compassion directly and significantly influence strategy, design, and development.

7. ___ We explore the fundamental practices and principles of our industry and its disciplines as a source of creativity, values, and purpose.

8. ___ We can fail without fear for our jobs.

9. ___ My organization takes the long view.

10. ___ Employees are free to develop their own vision of what their jobs entail.

**(3) IDEAS**

11. ___ This organization cultivates the growth of knowledge into wisdom and views wisdom as a guide to action.

12. ___ Organizational structure is shaped by innovative, idea-driven approaches to our challenges and tasks.

13. ___ Organizational responses to crises are thoughtful and imaginative, not reactive and typical.

14. ___ The organization respects thinkers.

15. ___ I am respected for all my talents, whether or not they contribute to the bottom line.

**(4) EXCHANGE**

16. ___ My organization rewards those who display mastery at their jobs and seeks their advice, whatever their title or position.

17. ___ Institutionalized procedures enable anyone to make suggestions or raise objections.

18. ___ Intellectually exciting and stimulating conversation directly influences product development and delivery.

19. ___ "Idea people" share their vision with other employees and invite feedback.

20. ___ The group uses conflict as an opportunity for personal and organizational growth.

**(5) PERCEPTION**

21. ___ How we perceive our tasks, our expertise, and the group itself is a legitimate object of inquiry.

22. ___ Whole-minded thinking, including activities based on movement and heightening awareness of the five senses, is encouraged.

23. ___ Employees are taught and encouraged to think creatively.

24. ___ We continually re-vision our group's place within its industry and society as a whole.

25. ___ Clear problem-solving algorithms are taught, practiced, developed, and applied wherever a need is perceived, without regard to concerns of status, tradition, or company politics.

**(6) LEARNING**

26. ___ To be viewed as a "continuous learner" at work benefits one's career.

27. ___ We regularly challenge group norms, and anyone can initiate this process.

28. ___ My organization is constantly engaged in learning about itself and the environments in which it operates.

29. ___ The organization allocates resources toward employee involvement in cultural events as attendees, participants, or learners.

30. ___ Projects are undertaken by integrated teams whose members bring multiple disciplines and diverse perspectives to the task.

**(7) SOCIAL**

31. ___ Our relationships at work are relaxed, irreverent, warm, and crackling with ideas.

32. ___ People from different departments and organizational levels socialize together, either during or after work.

33. ___ Committee meetings are reasonably productive and amicable.

34. ___ When we form teams to work on special projects, the work is integrated into our day-to-day schedules.

35. ___ We always produce effective leadership when and where we need it.

**(8) FESTIVA**

36. ___ Social occasions are planned and designed in highly creative ways.

37. ___ The line between work and play is virtually nonexistent.

38. ___ Developments in art, politics, science, and other fields not directly related to our work are discussed in relation to their impact upon our organization and industry.

39. ___ We have a strong group vocabulary of terms and symbols that promotes communication, community, and creativity.

40. ___ We are encouraged to play whimsically with ideas, materials, and objects as well as with new ways of doing things.

_____ **TOTAL POINTS**

**Scoring Your Organization's Creativity**
**If You Scored: Organization Is in the Creative . . .**

| | |
|---|---|
| 40–79 | *Dead Zone*—a place where it is virtually impossible for creativity to flourish |
| 80–159 | *I-Zone*—where management thinks in terms of the next quarter and creativity is seldom transmitted from one person or department to another*<br>OR . . .<br>*O-Zone*—where creativity is valued but not consistently incorporated into the organization's strategy* |
| 160–200 | *Hot Zone*—where creativity is intense and productive |

SOURCE: B. Kunstler, "Building a Creative Hothouse," *The Futurist* (January–February 2001), pp. 22–29. Reprinted by permission of the World Future Society.

*NOTE:* I-Zone organizations score higher on Values, Ideas, Perception, and Social questions. O-Zone organizations score higher on Mission and Vision, Learning, Exchange, and Festiva questions.

## KEY TERMS

absorptive capacity (p. A-12)
best practice (p. A-21)
corporate entrepreneurship (p. A-17)
house of quality (p. A-20)
index of R&D effectiveness (p. A-21)
intellectual property (p. A-11)
lead user (p. A-6)
market research (p. A-6)

orchestrator (p. A-16)
process innovation (p. A-9)
product champion (p. A-16)
product innovation (p. A-9)
product/market evolution matrix (p. A-14)
R&D intensity (p. A-18)
sponsor (p. A-16)

stage-gate process (p. A-20)
stage of new product development (p. A-14)
strategic R&D alliance (p. A-11)
technological competence (p. A-13)
technology sourcing (p. A-10)
time to market (p. A-9)

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