Strategy and Technology

OUTLINE

- Recognize the important role of technical standards in creating success in high-tech industries.
- Know the ways in which technical standards can emerge.
- Examine the concepts of network effects, positive feedback loops, and customer switching costs.
- Know a variety of strategies for winning a format war.
- Be aware of the cost structure of high-technology industries and its impact on strategy.
- Recognize the importance of intellectual property rights for high-tech firms, and understand the methods by which firms protect those rights.
- Examine the advantages and disadvantages of being a first mover or a follower in a high-tech industry.
- Understand the cycle of development of new technologies that underlies technological paradigm shifts.
- Examine strategies that can be used by first movers and existing firms to manage during a time of technological paradigm shift.

Opening Case

The Format War in Smart-phones: There is a format war unfolding in the smartphone business as a number of companies battle for dominance in what is fast evolving into the next large high-technology market.

Smart-phones are wireless handsets with extended data capabilities that allow users to browse the Internet, send e-mails, and run a growing number of applications from spreadsheets and restaurant locators to games and music players. The development of smart-phones is rapidly transforming wireless handsets into powerful general-purpose computing devices that can perform many of the functions we typically associate with desktop and laptop computers. A key feature of smart-phones is the operating system that resides on the device and runs all of the onboard functions and applications.

The main competitors in this market include Research in Motion, with its Blackberry phones; Apple, with its iPhone; Nokia, which owns the Symbian operating system for smart-phones; Microsoft, with its Windows mobile offering; and Google, with the Google phone. In 2008, some $45 billion worth of smart-phones were sold worldwide. Despite a global economic slowdown, forecasts call for sales of close to $100 billion by 2013, when one-third of all phones sold will be smart-phones. While Research in Motion, Apple, and Nokia make both the phone and the operating system and sell the integrated bundle to end users, Microsoft and Google make just the operating system and partner with various hardware manufacturers to sell the phone to end users. All companies sell their phones in conjunction with wireless service providers.

One of the key developments in the market was the introduction of the Apple iPhone. This revolutionary device, with its elegant touch screen interface, Apple operating system, and multimedia capabilities, helped to redefine the smart-phone business and rapidly started to create a mass market for these devices. Prior to the iPhone, most adopters had been business users. Now, increasingly, they are consumers. By the end of 2008, Nokia's Symbian operating system had a 46% share of the market, followed by Apple with a 17% share, RIM with a 15%

share, and Microsoft with a 13.6% share. Apple, however, is growing most rapidly and gaining ground on its rivals.

Observers wonder whether the same trends toward operating system standardization seen in the PC industry will also play out in the smart-phone business, with the market ultimately settling on one or two dominant systems. Certainly, Apple's strategy with its iPhone is consistent with the attainment of such a goal. Apple has realized that applications add value to the iPhone. Toward this end, Apple has provided tools to developers to help them develop applications and a novel way of distributing those applications—Apple's online App store. Apple's hope is that more applications will drive adoption of more iPhones, and that adoption of more iPhones, because it increases the size of the addressable market, will result in more applications being written to run on the iPhone than competing devices. The result could be a positive feedback loop, similar to the one that led to the dominance of Microsoft in the PC operating system business. Apple is not having it all its own way, however. Other companies are pursuing a similar strategy. Google, for example, has opened its own online store for applications, and Microsoft has a large base of developers who are writing applications to run on Windows Mobile devices.

I. Overview
   A. **Technology** refers to "the body of scientific knowledge used in the production of goods or services." **High-technology industries** (also called high-tech industries) are ones in which the scientific knowledge used by companies in the industry is advancing rapidly, leading to rapid changes in the attributes of goods and services.
   B. Examples of high-tech industries include the computer industry, telecommunications, consumer electronics, pharmaceuticals, power generation, and aerospace, among others.
   C. High-technology industries deserve special consideration because they are an ever-increasing part of our economy, many traditionally low-technology industries and products are becoming more high-tech, and high-tech firms face a similar competitive situation.

II. Technical Standards and Format Wars
   A. **Technical standards** are "a set of technical specifications that producers adhere to when making the product or component," and they can be a source of differentiation, leading to competitive advantage.
      1. Competitive struggles over control of technical standards are called **format wars**.
      2. Examples of technical standards include the layout of a computer keyboard, the dimensions of shipping containers such as trucks and railcars, and the components included in a personal computer.
      3. When an industry relies upon a common set of features or design characteristics, such as the Wintel design for personal computers; this is called a **dominant design**. Each dominant design may be made up of a set of related technical standards.

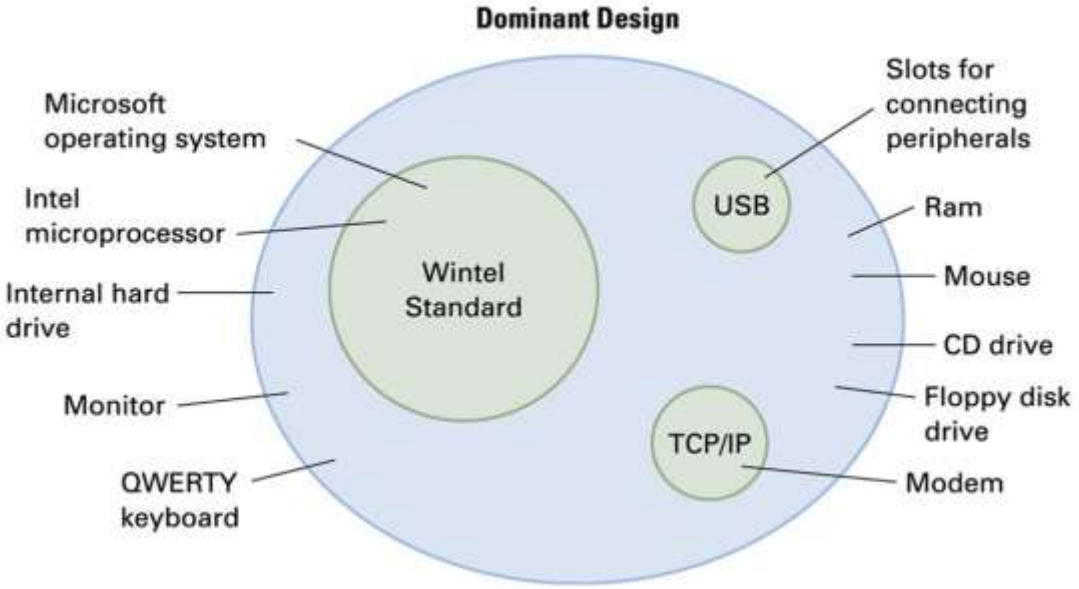

Figure 7.1: Technical Standards for Personal Computers

B. Standards provide economic benefits to those companies that adhere to them.
   1. Standards guarantee compatibility, such as the ability to use the same software programs on different brands of PCs.
   2. Standards help reduce consumer confusion. When consumers sense that the technology is still evolving they may delay purchase, which can cause the technology itself to fail to gain initial acceptance in the market.
   3. Standards serve to reduce production costs by facilitating mass production, along with its consequent economies of scale and lower costs. Both manufacturers and components suppliers are able to benefit from standards, reducing the cost of components as well.
   4. Standards reduce the risk associated with supplying complementary products. Makers of complementary products, such as software providers for the PC industry, will hesitate to invest in producing complementary products until standards are reached. A low supply of complementary products can reduce sales of the product.

C. Standards emerge in an industry in several ways. When standards are set by the government or industry group, they are part of the **public domain**, meaning that any company can use that standard in their products.
   1. Companies may lobby the government to mandate an industry standard. An example would be the digital TV broadcast standards put forth by the FCC.
   2. Companies may band together to cooperatively establish standards without government intervention, as DVD manufacturers did.
   3. Standards may also be selectively chosen by consumers, who use market demand as a selection mechanism. Microsoft and Intel both use proprietary standards, which are protected through patents.

D. **Network effects** arise in industries where the number of complementary products is a primary determinant of standards. For example, the success of VCRs is driven by the standard VHS format for tapes, creating a positive feedback loop in which demand for VCRs led to demand for tapes, and the increased availability of tapes led to further

demand for VCRs.

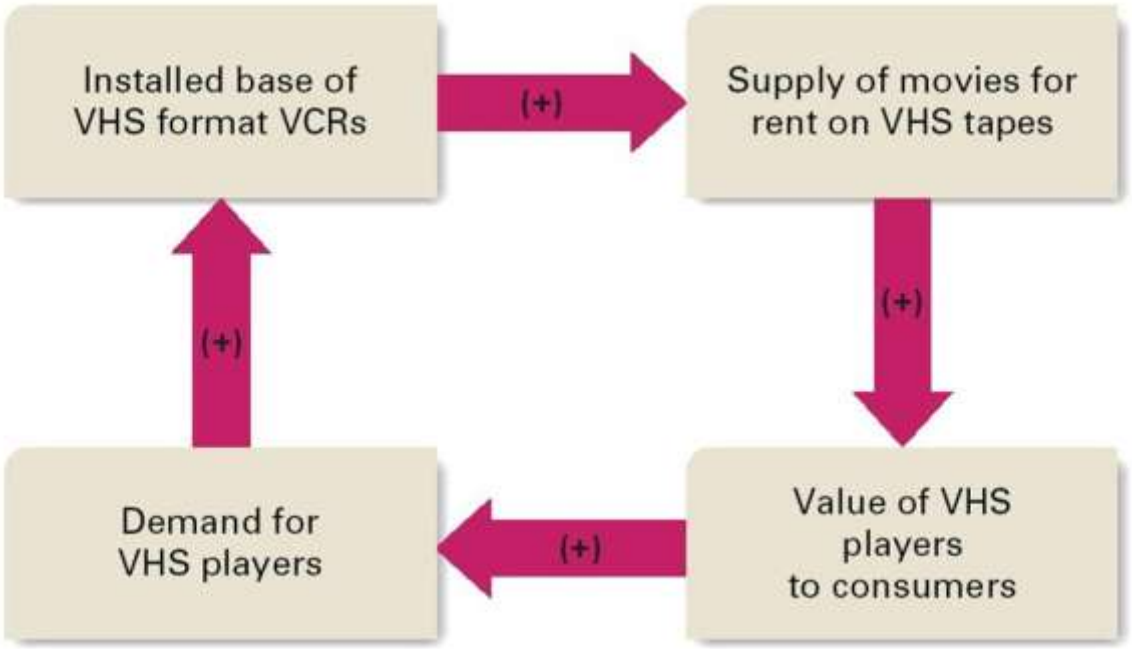

Figure 7.2: Positive Feedback in the Market for VCRs

1. In a format war, the winner will be the company that best exploits positive feedback loops. Microsoft beat Apple by creating "open" computer code for its operating system; Matsushita beat Sony in VHS tapes by licensing its technology to competitors.

Strategy in Action 7.1

How Dolby Became the Standard in Sound Technology

Inventor Ray Dolby's name has become synonymous with superior sound in homes, movie theaters, and recording studios. The technology produced by his company, Dolby Laboratories, is part of nearly every music cassette and cassette recorder; prerecorded videotape; and, most recently, DVD movie disk and player. Since 1976, close to 1.5 billion audio products that use Dolby's technology have been sold worldwide. More than 44,000 movie theaters now show films in Dolby Digital Surround Sound, and some 50 million Dolby Digital home theater receivers have been sold since 1999. Dolby technology has become the de facto industry standard for high-quality sound in the music and film industry. How did Dolby build this technology franchise?

The story goes back to 1965, when Dolby Laboratories was founded in London by Ray Dolby (the company's headquarters moved to San Francisco in 1976). Dolby, who had a Ph.D. in physics from Cambridge University in England, had invented a technology for reducing the background hiss in professional tape recording without compromising the quality of the material being recorded. In 1968, Dolby reached an agreement to license his noise-reduction technology to KLH, a highly regarded American producer of audio equipment (record players and tape decks) for the consumer market. Soon other manufacturers of consumer equipment started to approach Dolby to license the technology. Dolby briefly considered manufacturing record players and tape decks for the consumer market, but as he later commented, "I knew that if we entered that market and tried to make something like a cassette deck, we would be in competition with any licensee that we took on. . . . So we had to stay out of manufacturing in that area in order to license in that area."

Dolby adopted a licensing business model and then had to determine what licensing fee to charge. He decided to charge a modest fee to reduce the incentive that manufacturers would have to develop their own technology. Then there was the question of which companies to license to. Dolby wanted the Dolby name associated with superior sound, so he needed to make sure that licensees adhered to quality standards. Therefore, the company set up a formal quality control program for its licensees' products. Licensees have to agree to have their products tested by Dolby, and the licensing agreement states that they cannot sell products that do not pass Dolby's quality tests. By preventing products with substandard performance from reaching the market, Dolby has maintained the quality image of products featuring Dolby technology and trademarks. Today, Dolby Laboratories tests samples of hundreds of licensed products every year under this program. By making sure that the Dolby name is associated with superior sound quality, Dolby's quality assurance strategy has increased the power of the Dolby brand, making it very valuable to license.

Another key aspect of Dolby's strategy was born in 1970 when Dolby began to promote the idea of releasing prerecorded cassettes encoded with Dolby noise-reduction technology so that they would have low noise when played on players equipped with Dolby noise-reduction technology. Dolby decided to license the technology on prerecorded tapes for free, instead collecting licensing fees just from the sales of tape players that used Dolby technology. This strategy was hugely successful and set up a positive feedback loop that helped to make Dolby technology ubiquitous. Growing sales of prerecorded tapes encoded with Dolby technology created a demand for players that contained Dolby technology, and as the installed base of players with Dolby technology grew, the proportion of prerecorded tapes that were encoded with Dolby technology surged, further boosting demand for players incorporating Dolby technology. By the mid-1970s, almost all prerecorded tapes were encoded with Dolby noise-reduction technology. This strategy remains in effect today for all media recorded with Dolby technology and encompasses not only videocassettes but also videogames and DVD releases encoded with Dolby Surround or Dolby Digital.

As a result of its licensing and quality assurance strategies, Dolby has become the standard for high-quality sound in the music and film industries. Although the company is small—its revenues were $327 million in 2005—its influence is large. It continues to push the boundaries of sound-reduction technology (it has been a leader in digital sound since the mid-1980s) and has successfully extended its noise-reduction franchise, first into films, then into DVD and videogame technology, and finally onto the Web, where it has licensed its digital technology to a wide range of media companies for digital music delivery and digital audio players, such as those built into personal computers and hand-held music players. Dolby has also licensed its technology for use in next-generation DVD players—high-definition DVDs.[8]

2. Companies that fail to adopt the dominant design as it emerges may find themselves **locked out** of the market. Customers may be unwilling to bear the **switching costs** of changing to an alternate technology unless the benefits of doing so outweigh the costs.
3. As a new technology becomes more widely adopted, there comes a point at which the prior technology becomes outmoded. For example, CDs replaced the long-playing record.

III. Strategies for Winning a Format War

A. It's clear that firms benefit when they exploit network effects and when positive

feedback loops are in operation, so companies must find a way to make the effects work in their favor and against their competitors. Therefore, they must build an installed base as rapidly as possible, leveraging the positive feedback loop, forcing customers to bear switching costs, and locking the market into their technology.

B. One important step for firms to take in winning a format war is to ensure a supply of complementary products.
   1. One way for companies to ensure a supply of complements is to diversify into the production of complements themselves.
   2. Another way is to create incentives for others to produce complements, such as reducing licensing fees or providing technical assistance.

C. Another important step is to leverage **killer applications**, those uses of a product that are so compelling to consumers that they kill demand for competing formats. The killer applications can either be developed by the company itself or by other firms.

D. A third strategy for winning a format war is for the companies to price and market their products aggressively.
   1. One common pricing strategy is to price the product low and the complements high, such as the way Hewlett-Packard prices printers at cost, and then charges substantial markup on ink cartridges.
   2. Aggressive marketing strategies include substantial up-front marketing and point-of-sale promotion to encourage first-time buyers.

E. Yet another strategy involves cooperation with competitors in order to ensure compatibility and lock out alternative technologies.

F. Another strategy requires licensing the format so that the licensing firm may profit from licensing fees while also boosting demand and speeding adoption of the format. A relatively low licensing fee reduces the financial incentive for competitors to develop their own alternative formats.

G. These five strategies may be used in combination, depending upon the unique demands of the situation. Care is needed to select the optimal mix of strategies, as well as to ensure that strategies are working together and not counteracting each other.

IV. Costs in High-Technology Industries

A. In most high-tech industries, the fixed costs of product development are very high, whereas the marginal costs—the costs of producing one extra unit of the product—are very low. The initial costs of R&D and building manufacturing capacity contribute to the high fixed costs, whereas the marginal costs might be just a small amount, especially in a mass production environment where the product might be a DVD or a piece of software.

B. The high fixed costs and low marginal costs of high-tech industries stands in contrast to many traditional industries, where the marginal costs tend to increase as production rises. Figure 7.3 graphically illustrates how the differing relationships between fixed and marginal costs lead to different levels of profitability.

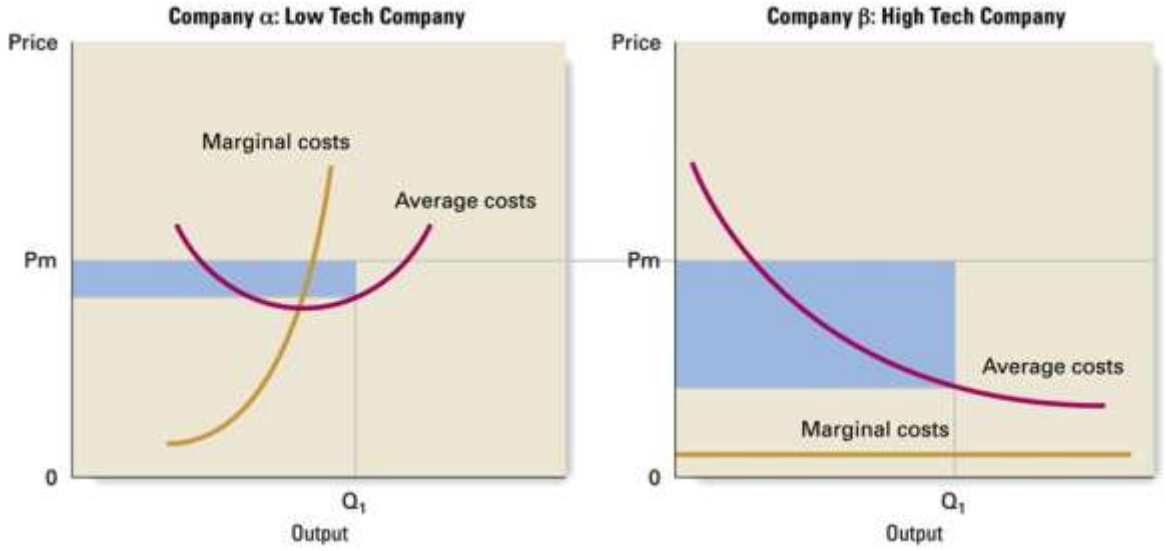

Figure 7.3: Cost Structures in High-Technology Industries

C. The implication for strategy is that companies should try to switch from an industry with increasing marginal costs to one where marginal costs are lower in order to increase profitability.

Strategy in Action 7.2

Lowering the Cost of Ultrasound Equipment Through Digitalization

The ultrasound unit has been an important piece of diagnostic equipment in hospitals for some time. Ultrasound units use the physics of sound to produce images of soft tissues in the human body. They can produce detailed three-dimensional color images of organs and, by using contrast agents, track the flow of fluids through an organ. A cardiologist, for example, can use an ultrasound in combination with contrast agents injected into the bloodstream to track the flow of blood through a beating heart. In additional to the visual diagnosis, ultrasound also produces an array of quantitative diagnostic information of great value to physicians.

Modern ultrasound units are sophisticated instruments that cost around $250,000 to $300,000 each for a top-line model. They are fairly bulky instruments, weighing some 300 pounds, and are wheeled around hospitals on carts.

A few years back, a group of researchers at ATL, one of the leading ultrasound companies, came up with an idea for reducing the size and cost of a basic unit. They theorized that it might be possible to replace up to 80% of the solid circuits in an ultrasound unit with software, in the process significantly shrinking the size and reducing the weight of machines and thereby producing portable ultrasound units. Moreover, by digitalizing much of the ultrasound (replacing hardware with software), they could considerably drive down the marginal costs of making additional units and would thus be able to make a good profit at much lower price points.

The researchers reasoned that a portable and inexpensive ultrasound unit would find market opportunities in totally new niches. For example, a small, inexpensive ultrasound unit could be placed in an ambulance or carried into battle by an army medic, or purchased by family physicians for use in their offices. Although they realized that it would be some time, perhaps decades, before such small, inexpensive machines could attain the image quality and diagnostic sophistication of top-of-the-line machines, they saw the opportunity in terms of creating market niches that previously could not be served by ultrasound companies because of the high costs and bulk of the product.

The researchers ultimately became a project team within ATL and were then spun out of ATL as an entirely new company, SonoSite. In late 1999, they introduced their first portable product, weighing just six pounds and costing around $25,000. SonoSite targeted niches that full-sized ultrasound products could not reach: ambulatory care and foreign markets that could not afford the more expensive equipment. In 2005, the company sold $150 million worth of its product.

In the long run, SonoSite plans to build more features and greater image quality into the small hand-held machines, primarily by improving the software. This could allow the units to penetrate U.S. hospital markets that currently purchase the established technology, much as client-server systems based on PC technology came to replace mainframes for some functions in business corporations.[b]

D. Another strategic implication is that companies should deliberately drive prices down to drive volume up, leading to increased profitability.

V. Managing Intellectual Property Rights

A. **Intellectual property** refers to the product of any intellectual and creative effort, which would include products such as music, film, books, graphic arts, manufacturing and other processes, and new technology of any type.

B. Intellectual property is a very important driver of economic progress and social wealth. That is, nations where many individuals or firms are creating valuable intellectual property will prosper, as will the individuals or firms. However, the creation of intellectual property is often expensive, risky, and time-consuming. The costs of a new technology may be in the hundreds of millions of dollars, and the failure rate may be close to 90 % in some industries.

C. Because of the expense and risk, few would undertake the creation of intellectual property unless they expected some economic return. Therefore, patents, copyrights, and trademarks are used to give incentives for its creation.

1. Protection of intellectual property rights is an important strategy for high-tech firms, and they may use lawsuits against competitors, both to stop actual violations and as a deterrent against future violations.
2. The protection of intellectual property rights has been complicated in recent years due to **digitalization**, or the rendering of creative output in digital form, which is common today for artistic works and computer software.
3. Digitalization lowers the cost of copying and distributing intellectual property, aided by the Internet, making the marginal costs almost zero.
4. The low cost of copying and distributing creates an opportunity for **piracy**, the theft of intellectual property. Piracy is quite common in the computer software and music recording industries, costing each of those industries billions of dollars in lost sales annually.
5. Companies in the software and music industries don’t rely solely on legal protection— they also protect their works with encryption software. However, sophisticated pirates know how to defeat the encryption.

D. Digital rights can be effectively managed through the use of several tactics.

1. One strategy relies on giving something away for free to boost sales of complementary products, just as companies do to win format wars.
2. Another strategy is to keep prices so low that customers have little incentive to steal.

Strategy in Action 7.3

Battling Piracy in the Videogame Industry

Over the past decade, the videogame industry has grown into a global colossus worth more than $25 billion a year in revenues. For the three biggest players in the industry, Sony with its PlayStation, Microsoft with Xbox, and Nintendo, this potentially represents a huge growth engine, but the engine is threatened by a rise in piracy, which cost the videogame industry an estimated $4 billion in 2005.

The piracy problem is particularly serious in East Asia (except for Japan), where videogame consoles are routinely "chipped"—sold with modified chips, called mod chips, that override the console's security system, allowing it to play illegally copied games and CDs. Importers or resellers, who charge a small markup for making the modification, illegally install the mod chips. In some areas, such as Hong Kong, it is almost impossible to find a console that hasn't been modified.

Because they allow users to play illegally copied games, consoles with mod chips offer a gaping gateway for software pirates, and they directly threaten the profitability of console and game makers. The big three in the industry all follow a razor and blades business model, where the console (razor) is sold at a loss, and profit is made on the sale of the game (razor blades). In the case of Microsoft's Xbox, estimates suggest the company loses as much as $200 on each Xbox it sells. To make profits, Microsoft collects royalties on the sale of games developed under license, in addition to producing and selling some games itself. Games typically retail for about $50, and Microsoft must sell six to twelve games to each Xbox user to recoup the $200 loss on the initial sale and start making a profit. If those users are purchasing pirated games and playing them on "chipped" Xbox consoles, Microsoft collects nothing in royalties and may never reach the breakeven point. Sony and Nintendo face similar problems. In East Asia, some 70% of game software sold in the region may be pirated thanks to the popularity of "chipped" consoles and the low price of pirated games, which may sell for one-third the price of the legal game.

Historically, all the big videogame companies tried to deal with the piracy problem in East Asia by ignoring the market. Sony launched its PlayStation II in East Asia two years after its Japanese launch, and Microsoft delayed its East Asian launch for a year after it launched elsewhere in the world. But this tactic is increasingly questionable in a region where there may soon be more gamers than in the United States. Industry estimates suggest that Asian gamers spent more on videogame software in 2005 than U.S. gamers did, much of it on low-priced pirated games.

Another tactic that both Sony and Microsoft are now using is to regularly alter the hardware specifications of its consoles, rendering the existing mod chips useless. But the companies have found this is just a temporary solution: within a few weeks, mod chips made to override the new specifications are available on the market.

A third tactic is to push local authorities to legally enforce existing intellectual property rights law that in theory outlaws the mod chip practice. For example, Microsoft, Sony, and Nintendo joined forces to sue the Hong Kong company, Lik Sang, which sells mod chips through its website and is one of the world's largest distributors of the chips. Some observers question the value of this tactic, however; they argue that if Lik Sang is shut down, many others in Hong Kong may be willing to take its place. What is needed, they argue, is concerted government action to stop the pirates, and so far East Asian governments have not been quick to act.

A final way of dealing with piracy is to change the business model. All three main players in the industry are now starting to push online games, where customers pay a subscription fee to play online, as opposed to a one-time fee to purchase a game. This business model makes piracy much less of an issue and it may drive growth forward in places like China, where piracy is endemic. Indeed, current estimates suggest that there are already 29 million gamers in China, most of whom play pirated games, and that this figure will increase to 55 million by 2009. If a good percentage switch to online gaming, the revenues could be significant.[c]

VI. Capturing First-Mover Advantages

A. Companies in high-tech industries strive to be a **first mover**—that is, the first to develop a new product.
   1. First movers initially have a monopoly position, which can be very profitable if consumers adopt the new technology.
   2. Once a first mover has been profitable with a new product, imitators rush into the market, lowering returns for all competitors.

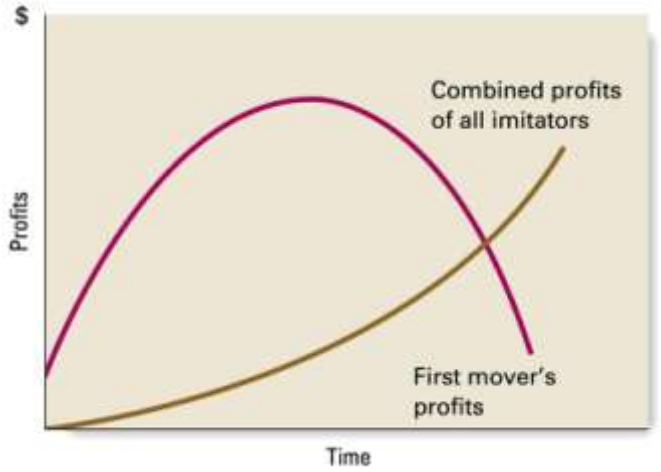

Figure 7.4: The Impact of Imitation on the Profits of a First Mover

3. In spite of imitators, some first movers have been able to turn that initial advantage into an enduring advantage. For example, Cisco was the first to create an Internet router and still dominates that market. They do this by slowing the rate of imitation.
4. However, there are also first-mover disadvantages, which occur when a first mover pursues an inappropriate strategy.

B. First movers have five key advantages.
   1. They can exploit network effects and positive feedback loops.
   2. They can establish brand loyalty.
   3. They can increase production earlier than rivals, and thus benefit from cost savings due to scale economies and learning effects.
   4. They can create customer switching costs.
   5. They can accumulate valuable knowledge about customers, distribution, technology, and so on.

C. First movers also have four potential disadvantages.
   1. They have to bear the costs of initial development and marketing, called pioneering costs. Later entrants can free-ride on the pioneer's investment.
   2. They make more mistakes than do later entrants.
   3. They risk building the wrong resources and capabilities because they are focusing on an atypical customer segment, the innovators and early adopters.
   4. They may invest in inferior technology. Later entrants may be able to leapfrog the first mover and introduce products based on a more sophisticated technology, due to the rapidly changing nature of the technology.

D. First movers can exploit their advantages in a number of ways.
   1. In order to choose an appropriate strategy, the first mover must answer three key questions.
      a. Does the company possess the complementary assets needs to exploit the new innovation? **Complementary assets** might include competitive, expandable manufacturing facilities, the ability to ride quickly down the experience curve, marketing know-how, access to distribution networks, a customer support network, and sufficient capital.

b. What is the height of barriers to imitation? **Barriers to imitation** might include patents and a secret development process.
c. Are there **capable competitors** that could rapidly imitate the innovation? Competitors are capable if they have excellent R&D skills and access to complementary assets.

2. The first mover can choose to develop and market the innovation itself if the firm has complementary assets, barriers to imitation are high, and capable competitors are few. If this strategy can be sustained, it will lead to the highest level of profits—but it may not be possible.
3. The first mover can use a joint venture or strategic alliance to develop and market the innovation with other companies if the firm lacks complementary assets, barriers to imitation are high, and there are several capable competitors. The joint venture partner should be a firm that possesses the required complementary assets.
4. The first mover can license the innovation to others and let them develop the market if the firm lacks complementary assets, barriers to imitation are low, and there are many capable competitors. A modest licensing fee will discourage development of competing innovations.

VII. Technological Paradigm Shifts

A. **Technological paradigm shifts** occur when new technology revolutionizes the structure of an industry. This alters the nature of competition and requires the use of new strategies. An example is the current trend toward digital photography in replacing chemical photography.
B. Paradigm shifts occur when an industry is mature, with technology approaching its "natural limit" and when a new technology has begun to be adopted by customers who are poorly served by the existing technology.
   1. The **technology S-curve** (shown in Figure 7.5) describes the relationship between performance of a technology and time. Early on, new technologies improve rapidly in performance, but the effect diminishes over time, and ultimately approaches a natural limit beyond which only smaller, incremental improvements can be made.

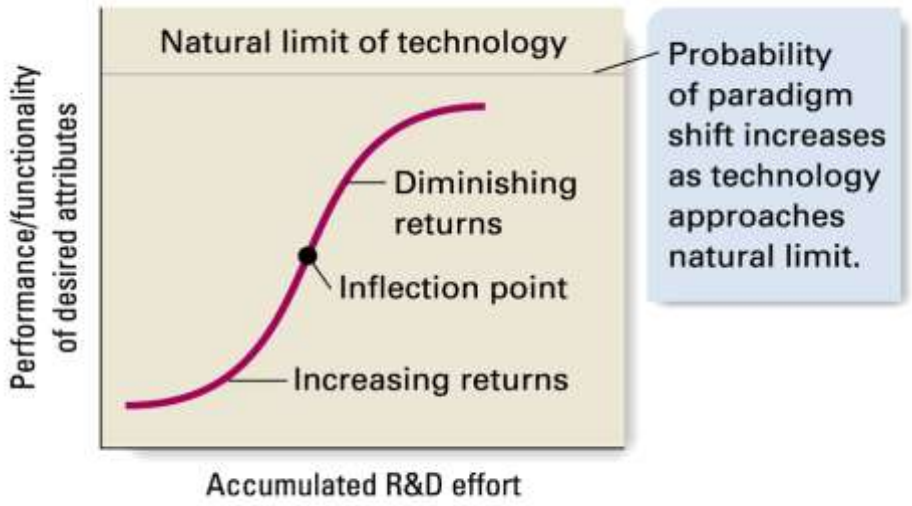

Figure 7.5: The Technology S-Curve

2. When a technology approaches its natural limit, researchers begin to investigate possible alternative technologies, increasing the chances that a paradigm shift will

occur.

3. This means that a technology that has just been developed will not be as useful as the existing technology until after a period of refinement and improvement. Therefore, new technologies are sometimes mistakenly dismissed by competitors.

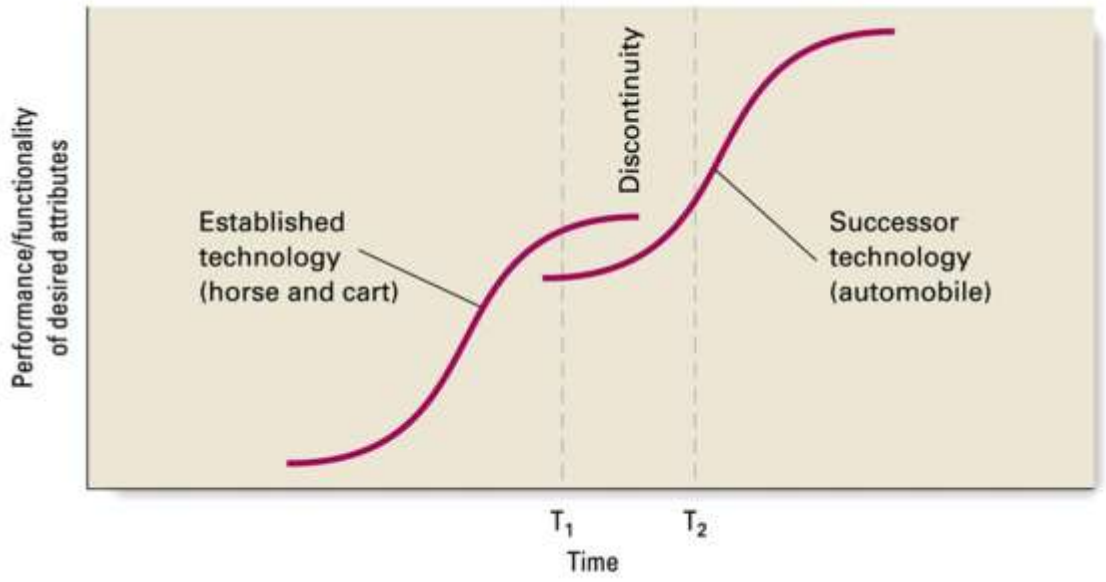

Figure 7.6: Established and Successor Technologies

4. In many situations, the old technology is dying out just as a host of new technologies are being developed. It's often very difficult for established companies to decide which of the possible alternatives will ultimately be successful.

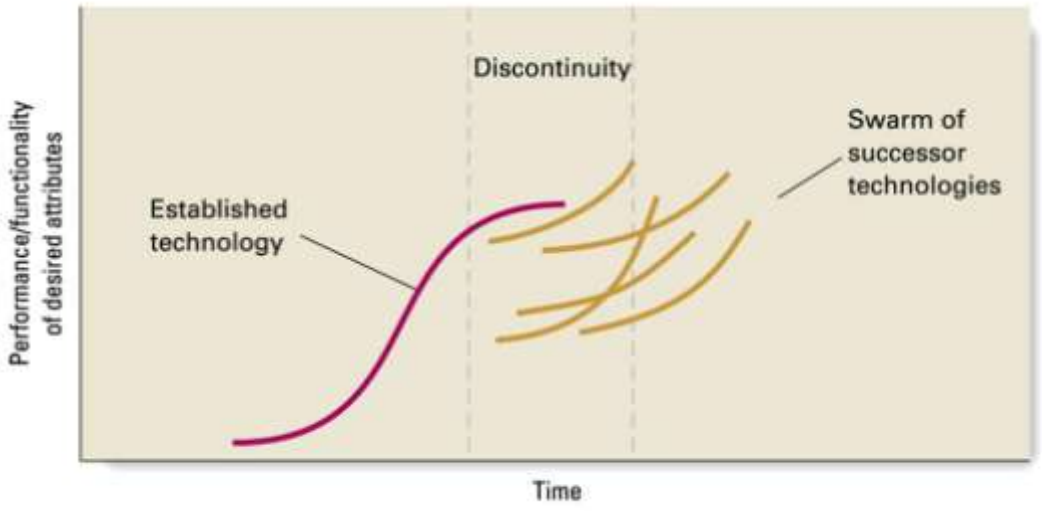

Figure 7.7: Swarm of Successor Technologies

C. Clayton Christensen has developed a theory about **disruptive technologies**, or a new technology that gets its start away from the mainstream of the industry, and then invades the main market, causing a paradigm shift.

1. Christensen claims that established companies are often aware of the new

alternatives, but they listen to their customers, and their customers don't want the new technology, because it's not yet efficient.

2. As the performance of the new technology improves, customers do want it, but it's too late for the established firms to accumulate the technical knowledge in time to meet rising market demand.

Strategy in Action 7.4

Disruptive Technology in Mechanical Excavators

Excavators are used to dig foundations for large buildings, trenches to lay large pipes for sewers and the like, and foundations and trenches for residential construction and farm work. Prior to the 1940s, the dominant technology used to manipulate the bucket on a mechanical excavator was based on a system of cables and pulleys. Although these mechanical systems could lift large buckets of earth, the excavators themselves were quite large, cumbersome, and expensive. Thus, they were rarely used to dig small trenches for house foundations, irrigation ditches for farmers, and the like. In most cases, these small trenches were dug by hand.

In the 1940s, a new technology made its appearance: hydraulics. In theory, hydraulic systems had certain advantages over the established cable and pulley systems. Most important, their energy efficiency was higher: for a given bucket size, a smaller engine would be required for a hydraulic system. However, the initial hydraulic systems also had drawbacks. The seals on hydraulic cylinders were prone to leaking under high pressure, effectively limiting the size of the bucket that could be lifted using hydraulics. Notwithstanding this drawback, when hydraulics first appeared, many of the incumbent firms in the mechanical excavation industry took the technology seriously enough to ask their primary customers whether they would be interested in products based on hydraulics. Because the primary customers of incumbents needed excavators with large buckets to dig out the foundations for buildings and large trenches, their reply was no. For this customer set, the hydraulic systems of the 1940s were not reliable or powerful enough. Consequently, after consulting with their customers, the established companies in the industry made the strategic decision not to invest in hydraulics. Instead, they continued to produce excavation equipment based on the dominant cable and pulley technology.

It was left to a number of new entrants, which included J. I. Case, John Deere, J. C. Bamford, and Caterpillar, to pioneer hydraulic excavation equipment. Because of the limits on bucket size imposed by the seal problem, these companies initially focused on a poorly served niche in the market that could make use of small buckets: residential contractors and farmers. Over time, these new entrants were able to solve the engineering problems associated with weak hydraulic seals, and as they did so, they manufactured excavators with larger buckets. Ultimately, they invaded the market niches served by the old-line companies: general contractors that dug the foundations for large buildings, sewers, and so on. At this point, Case, Deere, Caterpillar, and their kin rose to dominance in the industry, while the majority of established companies from the prior era lost share. Of the thirty or so manufacturers of cable-actuated equipment in the United States in the late 1930s, only four survived to the 1950s.[d]

3. Christensen identifies other factors that make it difficult for established firms to adopt a new technology, including the assumption that new technologies only serve a small market niche, the necessity of adopting a new business model, and the lack of a new network of suppliers and distributors.

D. What can established companies do to remain competitive when disruptive technologies emerge?
   1. Companies should understand the process of technological disruption, and particularly the rapidity with which a new technology can replace an older one. Awareness of the process could lead to better strategic decisions.
   2. Established companies should invest in newly emerging technologies, hedging their bets by investing in several alternatives. They might also enter into joint ventures with new-technology companies, or acquire them.
   3. Established companies should separate the new technology into its own autonomous division. This allows the new technology to develop in spite of what is often significant internal opposition. Autonomy also helps the division develop a new business model, with a radically different value chain.

E. What should new entrants do to gain an advantage over established enterprises?

1. New entrants must deal with problems such as the raising of capital, the management of rapid growth, and moving their technology from a small niche to a mass market.
2. Another concern of new entrants is the choice of whether to partner with an established company or go it alone.

CLOSING CASE

Blu-Ray versus HD DVD

Between 2004 and 2008, there was a format war in the consumer electronics industry between two different versions of next generation high-definition DVD players and discs. In one camp, there was Sony with its Blu-ray format; in the other was Toshiba, who was championing the rival HD DVD format. Both high-definition formats offer a dramatic improvement in picture and sound quality over established DVD technology and are designed to work with high-definition television sets. However, although each new format plays old DVDs, the two standards are incompatible with each other. Blu-ray players will not accept DVDs formatted for HD DVD, and vice versa.

Format wars like this have occurred many times in the past. VHS versus Betamax in the videocassette market and Windows versus Macintosh in PC operating systems are classic examples. If history is any guide, format wars tend to be "winner-take-all contests," with the loser being vanquished to a niche (as in the case of Apple's Macintosh operating system) or exiting the market altogether (as in the case of Sony's Betamax format). Format wars are high-stakes games.

Aware of this, both Sony and Toshiba worked hard to ensure that their format gained an early lead in sales. A key strategy of both companies was to line up film studios and get them to commit to issuing discs based on their format.

Initially, it looked as if Sony had the early advantage. Prior to the technology being launched in the market, Columbia Pictures and MGM (both owned by Sony), along with Disney and Fox Studios, all committed exclusively to Blu-ray. By late 2005, several other studios that had initially committed exclusively to HD DVD, including Warner Brothers and Paramount, also indicated that they would support Blu-ray as well. Warner and Paramount cited Blu-ray's momentum among other studios and its strong copyright protection mechanisms. This left just Universal Studios committed exclusively to HD DVD.

To further strengthen its hand, Sony announced that it would incorporate Blu-ray technology in its next generation PS3 gaming console and its Vaio line of PCs. HP and Dell also indicated that they would support the Blu-ray format. Sony even licensed the Blu-ray format to several other consumer electronics firms, including Samsung, in a bid to increase the supply of Blu-ray players in stores.

Then things began to go wrong for Sony. The company had to delay delivery of its P3 gaming console by a year due to engineering problems, which sapped some of the momentum from Blu-ray. Microsoft took advantage of this misstep, announcing that it would market an HD DVD player that would work with its own gaming console, Xbox 360. In mid-2006, the first Blu-ray and HD DVD players hit the market: the Blu-ray players were more expensive, as much as twice the price of entry level HD DVD players. According to Toshiba, HD DVD players and discs are cheaper to manufacture, although Sony disputes this. To complicate matters, one of the first Blu-ray players, made by Sony licensee Samsung, was shipped with a bad chip that marred its image quality.

By late 2006, some firms were beginning to hedge their bets. HP reversed its earlier position and said that it would support both standards. Then in mid-2007, Toshiba persuaded Paramount to switch from Blu-ray and exclusively back the HD DVD format, paying it $150 million to do so. Paradoxically, Sony claimed that the Paramount defection was a sign that it was winning. The fact that Toshiba had to pay Paramount $150 million showed how desperate they were, claimed Sony.

As it turned out, Sony was right. By late 2007, sales of Blu-ray DVDs were outselling HD DVDs by a margin of two to one, primarily thanks to the P3, which after arriving late to the market, was selling reasonably well. To further accelerate its lead, Sony cut prices on stand-alone Blu-ray players. Then in early 2008, Warner announced that henceforth it would back Blu-ray exclusively, citing Blu-ray's market momentum. This proved to be the coup de grace for HD DVD. Very quickly, the remaining fence sitters backed Blu-ray, and HD DVD was effectively dead. Some wonder, however, whether Sony's triumph might be something of a pyrrhic victory, for another technology was emerging that promised to make HD DVD players obsolete: video on demand and video downloads onto computer hard drives over the Internet.

Case Discussion Questions

1. Why did both Sony and Toshiba perceive it to be so important to get an early lead in sales?
2. What strategies and assets enabled Sony to win this format war?
3. What might Toshiba have done that might have led to a different outcome?
4. The companies that developed first generation DVD technology decided not to compete on technology, instead harmonizing their technology under the auspices of the DVD Forum. Why do you think they chose a different approach this time around?
5. What are the risks associated with fighting a format war like this?