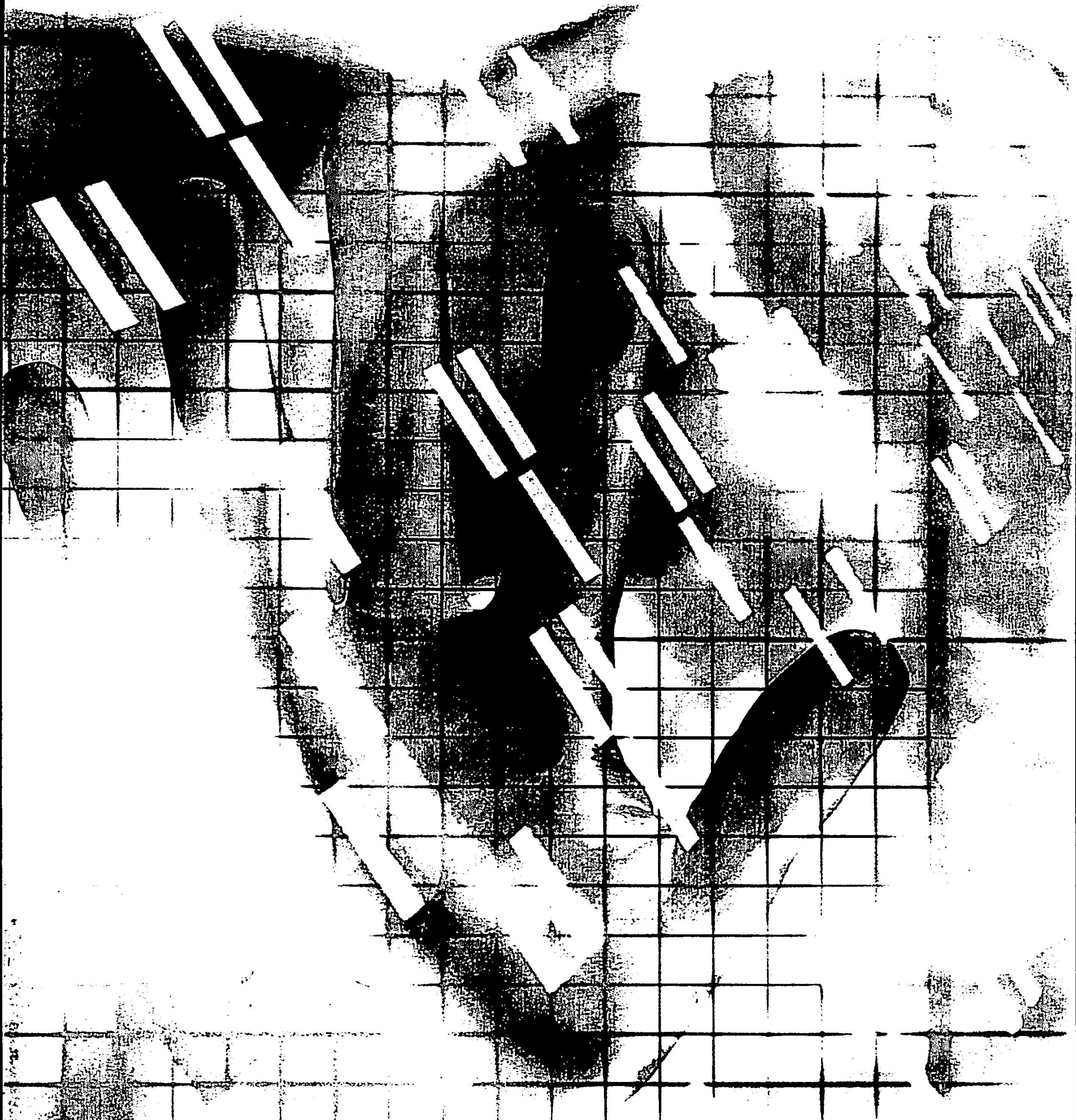
STRATEGIC MANAGEMENT of TECHNOLOGICAL INNOVATION



MELISSA A. SCHILLING

Chapter Four

Standards Battles and Design Dominance

The Rise of Microsoft

Since the early 1980s, Microsoft's Windows has controlled an overwhelming share of the personal computer operating system market. An operating system is the main program on a computer, which enables it to run other programs. Operating systems are responsible for recognizing the input from a keyboard, sending output to the display, tracking files and directories on the disk drives, and controlling peripheral devices. Because the operating system determines how other software applications must be designed, Microsoft's dominance in the operating system market made it extraordinarily powerful in the software industry. However, Microsoft's emergence as a software superpower was due largely to the unfolding of a unique set of circumstances. Had these events played out differently, Microsoft's dominance might have never been.

In 1980, the dominant operating system for personal computers was CP/M. CP/M was invented by Gary Kildall and marketed by Kildall's company, Digital Research. Kildall had been retained by Intel in 1972 to write software for Intel's 4004, the first true microprocessor in that it could be programmed to do custom calculations. Later that year, Intel began to sell the 8008 to designers who would use it as a computer, and Kildall was hired to write a programming language for the chip, called PL/M (Programming Language/Microcomputers).[1]

Then Memorex and Shugart began offering floppy disks (which IBM had invented) as a replacement for punch cards, and Kildall acquired one of these drives. However, no existing program would make the disk drive communicate with Intel's microprocessor, so he wrote a disk operating system that he called Control Program/Microprocessor (CP/M).[2] CP/M could be adapted to any computer based on Intel microprocessors.

Before 1980, IBM, the world's largest computer producer, had not been interested in developing a personal computer. IBM managers could not imagine the personal computer market ever amounting to more than a small niche of hobbyists. However, when businesses began adopting Apple computers to do basic accounting or word processing, IBM began to get nervous. IBM suddenly realized that the personal computer market might become a significant industry, and if it wanted to be a major player in that market it needed to act fast. IBM's managers did not believe they had time to develop their own microprocessor and operating system, so they based their personal computer on Intel microprocessors and planned to use Kildall's CP/M operating system. There are many stories of why Kildall did not sign with IBM. One story is that Kildall was out flying his plane when IBM came around, and though the IBM managers left their names with Kildall's wife, Dorothy McEwen, they did not state the nature of their business, and Kildall did not get back to them for some time. Another version of the story posits that Kildall was reluctant to become tied into any long-term contracts with the massive company, preferring to retain his independence. Yet a third version claims that Kildall was simply more interested in developing advanced technologies than in the strategic management of the resulting products. Whatever the reason, Kildall did not sign with IBM.

Pressed for time, IBM turned to Bill Gates, who was already supplying other software for the system, and asked if he could provide an operating system as well. Though Gates did not have an operating system at that time, he replied that he could supply one. Gates bought a 16-bit operating system (basically a clone of CP/M) from Seattle Computer Company, and reworked the software to match IBM's machines. The product was called Microsoft DOS. With DOS bundled on every IBM PC (which sold more than 250,000 units the first year), the product had an immediate and immense installed base. Furthermore, the companies that emerged to fulfill the unmet demand for IBM PCs with clones also adopted Microsoft DOS to ensure that their products were IBM PC-compatible. Because it replicated CP/M, Microsoft DOS was compatible with the range of software that had been developed for the CP/M operating system. Furthermore, after it was bundled with the IBM PC, more software was developed for the operating system, creating an even wider availability of complementary goods. Microsoft DOS was soon entrenched as the industry standard, and Microsoft was the world's fastest-growing software company.

"We were able to get the technology out into the market early to develop a standard. We were effective in soliciting software vendors to write to that platform to solidify the standard," said B. J. Whalen, Microsoft product manager. "Once you get it going, it's a snowball effect. The more applications you have available for a platform, the more people will want to use that platform. And of course, the more people that want to use that platform, the more software vendors will want to write to that platform."

Later Microsoft would develop a graphical interface named Windows that closely replicated the user-friendly functionality of Apple computers. By bundling Windows with DOS, Microsoft was able to transition its base of DOS customers over to the Windows system. Microsoft also worked vigorously to ensure that compatible applications were developed for DOS and Windows, making applications itself and also encouraging third-party developers to support the platform. Microsoft was able to leverage its dominance with Windows into a major market share in many other software markets (e.g., word processing, spreadsheet programs, presentation programs) and influence over many aspects of the computer

OVER

dominant design
A single pro or process a tecture that inates a proc category— usually 50 p cent or more the market. dominant de is a "de facto standard," m ing that whil may not be officially enforced or acknowledge it has become standard for t industry.

software and hardware industries. However, had Kildall signed with IBM, or had Compaq and other computer companies been unable to clone the IBM personal computer, the software industry might look very different today.

Discussion Questions

1. What factors led to Microsoft's emergence as the dominant personal computer operating system provider? Is Microsoft's dominance due to luck, skill, or some combination of both?
2. How might the computing industry look different if Gary Kildall had signed with IBM?
3. Does having a dominant standard in operating systems benefit or hurt consumers? Does it benefit or hurt computer hardware producers?

OVERVIEW

dominant design
A single product or process architecture that dominates a product category—usually 50 percent or more of the market. A dominant design is a "de facto standard," meaning that while it may not be officially enforced or acknowledged, it has become a standard for the industry.

The previous chapter described recurrent patterns in technological innovation, and one of those patterns was the emergence of a **dominant design.** As Anderson and Tushman pointed out, the technology cycle almost invariably exhibits a stage in which the industry selects a dominant design. Once this design is selected, producers and customers focus their efforts on improving their efficiency in manufacturing, delivering, marketing, or deploying this dominant design, rather than continuing to develop and consider alternative designs. In this chapter, we first will examine why industries experience strong pressure to select a single technology design as dominant. We then will consider the multiple dimensions of value that will shape which technology designs rise to dominance.

WHY DOMINANT DESIGNS ARE SELECTED

Why do many markets coalesce around a single dominant design rather than support a variety of technological options? One primary reason is that many industries exhibit increasing returns to adoption, meaning that the more a technology is adopted, the more valuable it becomes.[3] Complex technologies often exhibit increasing returns to adoption in that the more they are used, the more they are improved. A technology that is adopted usually generates revenue that can be used to further develop and refine the technology. Furthermore, as the technology is used, greater knowledge and understanding of the technology accrue, which may then enable improvements both in the technology itself and in its applications. Finally, as a technology becomes more widely adopted, complementary assets are often developed that are specialized to operate with the technology. These effects can result in a self-reinforcing mechanism that increases the dominance of a technology regardless of its superiority or inferiority to competing technologies. Two of the primary sources of increasing returns are (1) learning effects and (2) network externalities.

Learning Effects

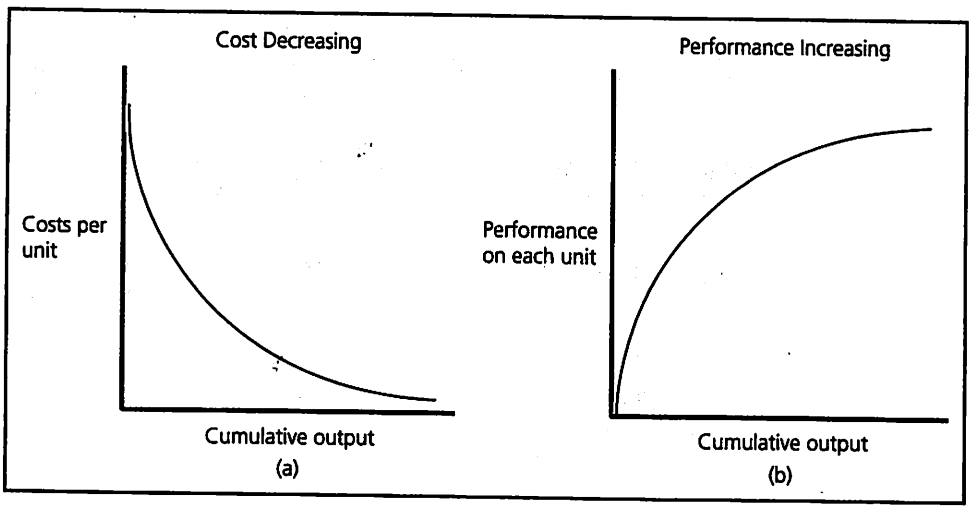
Ample empirical evidence shows that the more a technology is used, the more it is developed and the more effective and efficient it becomes.[4] As a technology is adopted, it generates sales revenues that can be reinvested in further developing and refining the technology. Furthermore, as firms accumulate experience with the technology, they find ways to use the technology more productively, including developing an organizational context that improves the implementation of the technology. Thus, the more a technology is adopted, the better it should become.

One example of learning effects is manifest in the impact of cumulative production on cost and productivity—otherwise known as the *learning curve*. As individuals and producers repeat a process, they learn to make it more efficient, often producing new technological solutions that may enable them to reduce input costs or waste rates. Organizational learning scholars typically model the learning curve as a function of cumulative output: performance increases, or cost decreases, with the number of units of production, usually at a decreasing rate (see Figure 4.1). For example, in studies of industries as diverse as aircraft production and pizza franchises, researchers have consistently found that the cost of producing a unit (for example, a pizza or an airplane) falls as the number of units produced increases.

The standard form of the learning curve is formulated as $y = ax^{-b}$, where y is the number of direct labor hours required to produce the xth unit, a is the number of direct labor hours required to produce the first unit, x is the cumulative number of units produced, and b is the learning rate. This pattern has been found to be consistent with production data on a wide range of products and services, including the production of automobiles, ships, semiconductors, pharmaceuticals, and even heart surgery techniques.[5] Learning curves have also been identified using a variety of performance measures, including productivity, total costs per unit, accidents per unit, and waste per unit.[6]

Though learning curves are found in a wide range of organizational processes, there are substantial differences in the rates at which organizations learn.[7] Both managers

FIGURE 4.1
Standard Learning Curve Forms



network externalities
Also termed *positive consumption externalities*, this is when the value of a good to a user increases with the number of other users of the same or similar good.

and scholars are very interested in understanding why one firm reaps great improvement in a process while another exhibits almost no learning. Many studies have examined various reasons for this variability, including looking at how the firm's learning rate is affected by process-improvement projects, intentional innovation, or contact with customers and suppliers.[8] The results suggest the learning rate can be influenced by factors such as the nature of the task, firm strategy, and the firm's prior experience.

Prior Learning and Absorptive Capacity

A firm's investment in prior learning can accelerate its rate of future learning by building the firm's absorptive capacity.[9] Absorptive capacity refers to the phenomenon whereby as individuals learn, they also increase their future ability to assimilate information. A firm's prior related experience shapes its ability to recognize the value of new information, and to utilize that information effectively. For example, in developing a new technology, a firm will often try a number of unsuccessful configurations or techniques before finding a solution that works well. This experimentation builds a base of knowledge in the firm about how key components behave, what alternatives are more likely to be successful than others, what types of projects the firm is most successful at, and so on. This knowledge base enables the firm to more rapidly assess the value of related new materials, technologies, and methods. The effects of absorptive capacity suggest that firms that develop new technologies ahead of others may have an advantage in staying ahead. Firms that forgo investment in technology development may find it very difficult or expensive to develop technology in a subsequent period. This explains, in part, why firms that fall behind the technology frontier find it so difficult to catch up.

At the aggregate level, the more firms that are using a given technology and refining it, the more absorptive capacity that is being generated related to that technology, making development of that technology (and related technologies) more effective and efficient. Furthermore, as firms develop complementary technologies to improve the productivity or ease of utilization of the core technology, the technology becomes more attractive to other firms. In sum, learning effects suggest that early technology offerings often have an advantage because they have more time to develop and become enhanced than subsequent offerings. (However, as we shall discuss in Chapter Five, it is also possible to be *too early* to a market!)

network externalities Also termed *positive consumption externalities*, this is when the value of a good to a user increases with the number of other users of the same or similar good.

Network Externalities

Many markets are characterized by **network externalities**, or positive consumption externalities.[10] In a market characterized by network externalities, the benefit from using a good increases with the number of other users of the same good. The classic examples of markets demonstrating network externality effects are those involving physical networks, such as railroads or telecommunications. Railroads are more valuable as the size of the railroad network (and therefore the number of available destinations) increases. Similarly, a telephone is not much use if only a few people can be called with it—the amount of utility the phone provides is directly related to the size of the network.

installed base
The number of users of a particular good. For instance the installed base of a particular video game console refers to the number of those consoles that are installed in homes worldwide.

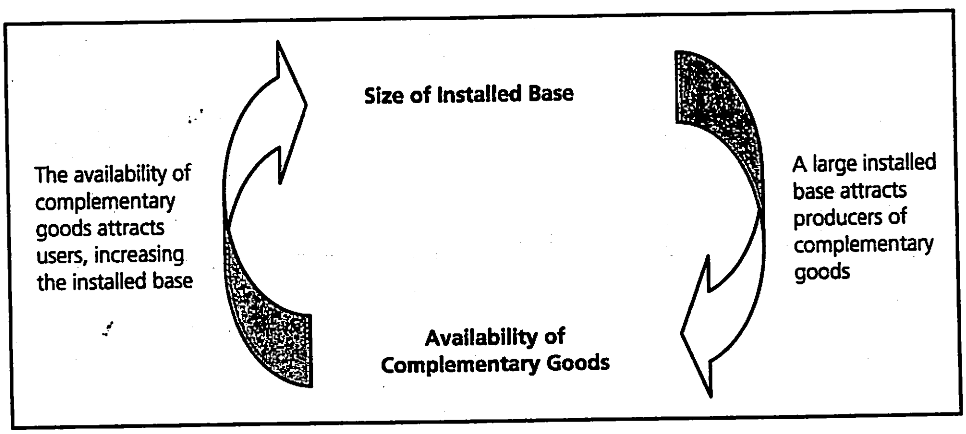
complementary goods
Additional goods and services that enable or enhance the value of another good. For example, the value of a video game console is directly related to the availability of complementary goods such as video games, peripheral devices, and services such as online gaming.

Network externalities can also arise in markets that do not have physical networks. For example, a user's benefit from using a good may increase with the number of users of the same good when compatibility is important. The number of users of a particular technology is often referred to as its **installed base.** A user may choose a computer platform based on the number of other users of that platform, rather than on the technological benefits of a particular platform, because it increases the ease of exchanging files. For example, many people choose a computer that uses the Windows operating system and an Intel microprocessor because the "Wintel" (*Win*dows and In*tel*) platform has the largest installed base, thus maximizing the number of people with which the user's files will be compatible. Furthermore, the user's training in a particular platform becomes more valuable as the size of the installed base of the platform increases. If the user must invest considerable effort in learning to use a computer platform, the user will probably choose to invest this effort in learning the format he or she believes will be most widely used.

Network externalities also arise when **complementary goods** are important. Many products are only functional or desirable when there is a set of complementary goods available for them (e.g., videotapes for VCRs, film for cameras, etc.). Some firms make both a good and its complements (e.g., Kodak produces both cameras and film), whereas others rely on other companies to provide complementary goods or services for their products (e.g., computer manufacturers often rely on other vendors to supply service and software to customers). Products that have a large installed base are likely to attract more developers of complementary goods. This was demonstrated in the opening vignette: Once the Windows operating system had the largest installed base, most producers of complementary software applications chose to design their products to be optimized to work with Windows. Since the availability of complementary goods will influence users' choice among competing platforms, the availability of complementary goods influences the size of the installed base. A self-reinforcing cycle ensues (see Figure 4.2).

The effect of this cycle is vividly demonstrated by Microsoft's dominance of the operating system market, and later the graphical user interface market. Microsoft's early advantage in installed base led to an advantage in the availability of complementary goods. These network externality advantages enabled Windows to

FIGURE 4.2
The Self-Reinforcing Cycle of Installed Base and Availability of Complementary Goods



Theory in Action A Standards Battle in Digital Audio Formats

In 1982, Sony Corporation and Philips Electronics had joined forces for the development and launch of the compact disc, the digital format that replaced the vinyl LP. The compact disc remained the dominant standard in the audio consumer market for more than 20 years, and Sony and Philips split the royalties from every compact disc player ever sold. However, by the late 1990s, the compact disc market was saturated, and the consumer electronics industry was eager for the introduction of a new generation of audio technology. A successful new audio format was expected to usher in a new era of growth in the audio electronics market. The new format would also help combat music piracy by making it difficult to share music over the Internet.

In 1996, a group of record companies and consumer electronics manufacturers including Hitachi, JVC, Matsushita, Mitsubishi, Pioneer, Seagram's Universal Music Group, and Time Warner, gathered to form a consortium to back a new audio standard called DVD audio. DVD audio players and disks were planned to replace the compact disc standard by offering higher-fidelity music with surround sound. Actual players would not reach the market, however, until 2000. In 1999, Sony and Philips unveiled their own high-fidelity audio format. However, their new format would be an extension to the compact disc format, enabling Sony and Philips to continue to control the royalties for the new disks and players.[11]

Sony and Philips Super Audio CD systems were initially priced much higher than the consortium's DVD audio players ($5,000 for a Super Audio CD player versus $1,000 for a DVD audio player), consistent with Sony and Philips claim that the system was targeting audiophiles rather than the mass market. However, the price of both systems began to drop and rapidly converge after their introduction, and many feared a format war (akin to the VHS versus Beta video format battle) was inevitable. Ultimately, many manufacturers decided to hedge their bets by producing universal players that would support both formats. By the end of 2002, major manufacturers such as Pioneer and Yamaha had introduced universal players priced at less than $1,000.

lock several would-be contenders such as Geoworks and NeXT (and, some would argue, Apple) out of the market.

Firms can also attempt to influence the selection of a dominant design by building coalitions around a preferred technology.[12] This is aptly illustrated in the accompanying Theory in Action.

While the preceding has emphasized the emergence of dominant designs through market forces, occasionally a dominant design is put in place through government regulation.

Government Regulation

In some industries, the consumer welfare benefits of having compatibility among technologies has prompted government regulation, and thus a legally induced adherence to a dominant design. This has often been the case for the utilities, telecommunications, and television industries, to name a few.[13] For example, in 1953 the U.S. Federal Communications Commission (FCC) approved the National Television Systems Committee (NTSC) color standard in television broadcasting to ensure that individuals with monochrome television sets would be able to receive the color television programs broadcast by networks (though they would see them in black and white). That standard was still in place in 2003. Similarly, in 1998, while a battle was being fought in the United States over wireless technology formats, the European Union (EU) adopted a single wireless telephone standard (the general standard for mobile communications, or GSM). By choosing a uniform standard, the EU could avoid the proliferation of incompatible standards and facilitate exchange both within and across national borders. Where government regulation imposes a single standard on an industry, the technology design embodied in that standard necessarily dominates the other technology options available to the industry. The consumer welfare impact of dominant designs is explored further in the Theory in Action section at the end of this chapter.

The Result: Winner-Take-All Markets

All these forces can encourage the market toward natural monopolies. While some alternative platforms may survive by focusing on niche markets, the majority of the market may be dominated by a single (or few) design(s). A firm that is able to lock in its technology as the dominant design of a market usually earns huge rewards and may dominate the product category through several product generations. When a firm's technology is chosen as a dominant design, not only does the firm have the potential to earn near-monopoly rents in the short run, but the firm also is in a good position to shape the evolution of the industry, greatly influencing what future generations of products will look like. However, if the firm supports a technology that is not chosen as the dominant design, it may be forced to adopt the dominant technology, effectively forfeiting the capital, learning, and brand equity invested in its original technology. Even worse, a firm may find itself locked out of the market if it is unable to adopt the dominant technology. Such standards battles are high-stakes games—resulting in big winners and big losers.

path dependency
When end results depend greatly on the events that took place leading up to the outcome. It is often impossible to reproduce the results that occur in such a situation.

Increasing returns to adoption also imply that technology trajectories are characterized by **path dependency,** meaning that relatively small historical events may have a great impact on the final outcome. Though the technology's quality and technical advantage undoubtedly influence its fate, other factors, unrelated to the technical superiority or inferiority, may also play important roles.[14] For instance, timing may be crucial; early technology offerings may become so entrenched that subsequent technologies, even if considered to be technically superior, may be unable to gain a foothold in the market. How and by whom the technology is sponsored may also impact adoption. If, for example, a large and powerful firm aggressively sponsors a technology (perhaps even pressuring suppliers or distributors to support the technology) that technology may gain a controlling share of the market, locking out alternative technologies.

The influence of a dominant design can also extend beyond its own technology cycle. As the dominant design is adopted and refined, it influences the knowledge that is accumulated by producers and customers, and it shapes the problem-solving techniques used in the industry. Firms will tend to use and build on their existing knowledge base rather than entering unfamiliar areas.[15] This can result in a very "sticky" technological paradigm that directs future technological inquiry in the area.[16] Thus, a dominant design is likely to influence the nature of the technological discontinuity that will eventually replace it.

Such winner-take-all markets demonstrate very different competitive dynamics than markets in which many competitors can coexist relatively peacefully. These markets also require very different firm strategies to achieve success. Technologically superior products do not always win—the firms that win are usually the ones that know how to manage the multiple dimensions of value that shape design selection.

MULTIPLE DIMENSIONS OF VALUE

The value a new technology offers a customer is a composite of many different things. We first consider the value of the stand-alone technology, and then show how the stand-alone value of the technology combines with the value created by the size of the installed base and availability of complementary goods.[17] In industries characterized by **increasing returns**, this combination will influence which technology design rises to dominance.

increasing returns
When the *rate of return* (not just gross returns) from a product or process increases with the size of its installed base.

A Technology's Stand-alone Value

The value a new technology offers to customers can be driven by many different things, such as the functions it enables the customer to perform, its aesthetic qualities, its ease of use, and so on. To help managers identify the different aspects of utility a new technology offers customers, W. Chan Kim and Renee Mauborgne developed a "Buyer Utility Map."[18] They argue that it is important to consider six different utility levers, as well as six stages of the buyer experience cycle, to understand a new technology's utility to a buyer.

The stages they identify are *purchase, delivery, use, supplements, maintenance,* and *disposal.* The six utility levers they consider are *customer productivity, simplicity, convenience, risk, fun and image,* and *environmental friendliness.* Creating a grid with stage and levers yields a 36-cell utility map (see Figure 4.3). Each cell offers an opportunity to offer a new value proposition to a customer.

A new technology might offer a change in value in a single cell or in a combination of cells. For example, when retailers establish an online ordering system, the primary new value proposition they are offering is greater *simplicity* in the *purchase* stage. On the other hand, as shown in Figure 4.3, the introduction of the Honda Insight hybrid-electric vehicle offered customers greater productivity (in the form of gas savings), image benefits and environmental friendliness in the customer's use, supplements, and maintenance stages while providing the same simplicity and convenience of regular gasoline-only powered vehicles.

Kim and Mauborgne's model is designed with an emphasis on consumer products, but their mapping principle can be easily adapted to emphasize industrial products or different aspects of buyer utility. For example, rather than having a single entry for customer productivity, the map could have rows for several dimensions of productivity such as speed, efficiency, scalability, reliability, and so on. The map provides a guide for managers to consider multiple dimensions of technological value and multiple stages of the customer experience. Finally, the new benefits have to be considered with respect to the cost to the customer of obtaining or using the technology—it is the ratio of benefits to cost that determines value.

FIGURE 4.3
The Buyer Utility Map with Honda Insight Example

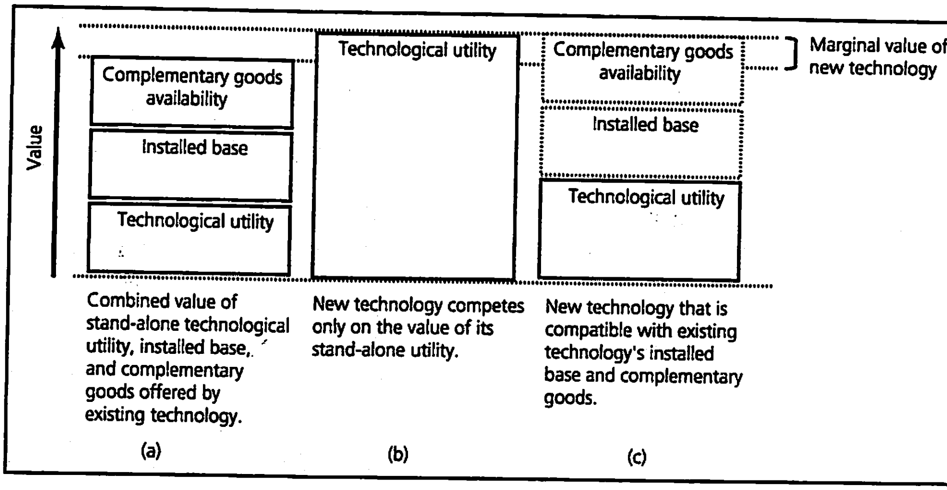
Source: Adapted from W. C. Kim and R. Mauborgne, "Knowing a Winning Business Idea When You See One," *Harvard Business Review*, September–October 2000.

	Purchase	Delivery	Use	Supplements	Maintenance	Disposal
Customer productivity			Save money on gasoline			
Simplicity			Operates like a regular combus-tion engine vehicle			
Convenience			Does not have to be plugged into electrical outlet	Can purchase fuel at regular gas stations	Maintenance is similar to regular combustion engine vehicle	
Risk						
Fun and image			Connotes image of environmental responsibility			
Environmental friendliness			Emits lower levels of pollutants	Requires less use of fossil fuels		

Network Externality Value

In industries characterized by network externalities, the value of a technological innovation to users will be a function not only of its stand-alone benefits and cost, but also the value created by the size of its installed base and the availability of complementary goods (see Figure 4.4(a)).[19] Thus, the value to consumers of using the Windows operating system is due in part to the technology's stand-alone value (for example, the ability of the operating system to make it easy for consumers to use the computer), the installed base of the operating system (and thus the number of computers with which the user can easily interact), and the availability of compatible software. Visualizing the value of technological innovations in this way makes it clear why even innovations that offer significant improvements in technological functionality often fail to displace existing technologies that are already widely adopted: Even if a new innovation has a significant advantage in functionality, its overall value may be significantly less than the incumbent standard. This situation is poignantly illustrated in the case of NeXT computers. In 1985, Steve Jobs and five senior managers of Apple Computer founded NeXT Incorporated. They unveiled their first computer in 1988. With a 25MHz Motorola 68030, 8MB of RAM, the machine was significantly more powerful than most other personal computers available. It offered advanced graphics capability and even ran an object-oriented operating system (called NextStep) that was considered extremely advanced. However, the machine was not compatible with the IBM-compatible personal computers (based on Intel's microprocessors and Microsoft's operating system) that had become the dominant standard. The machine thus would not run the vast majority of

FIGURE 4.4
Components of Value



software applications on the market. A small contingent of early adopters bought the NeXT personal computers, but the general market rejected them due to a dire lack of software and uncertainty about the company's viability. The company discontinued its hardware line in 1993 and ceased development of NextStep in 1996.

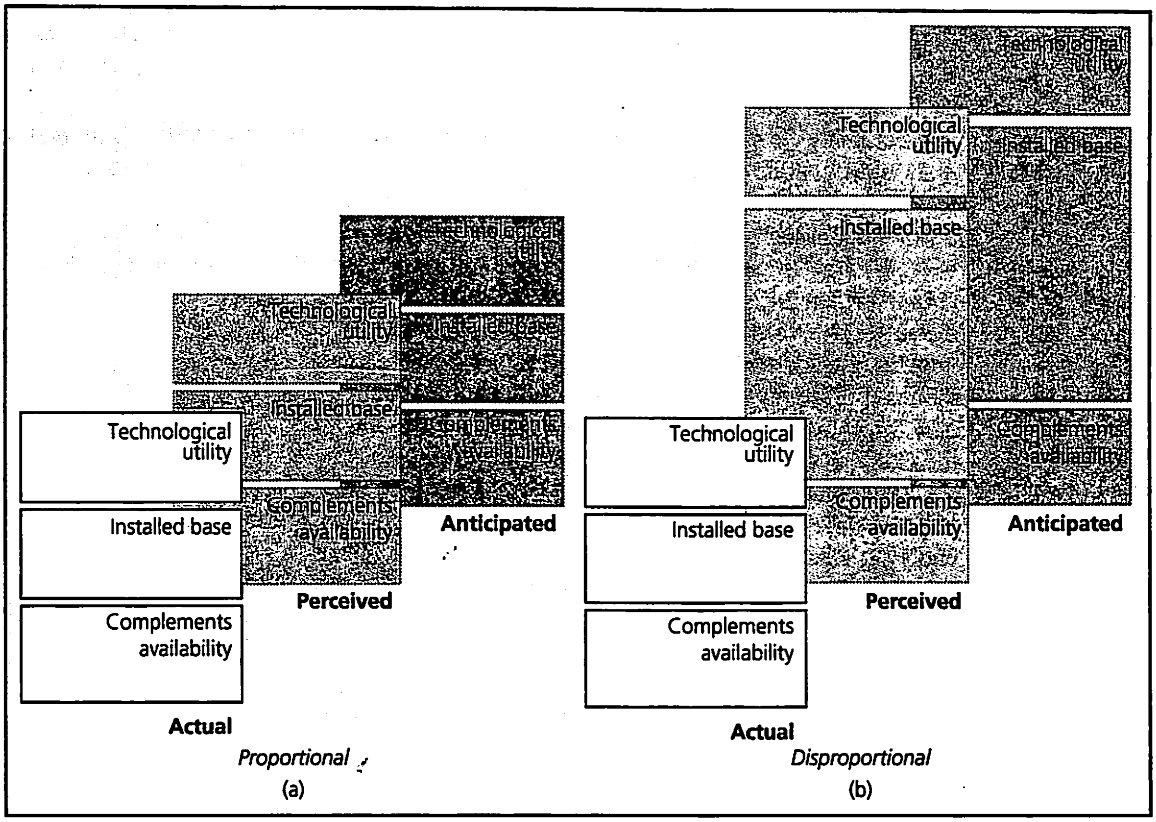
As shown in Figure 4.4(b), it is not enough for a new technology's stand-alone utility to exceed that of the incumbent standard. The new technology must be able to offer greater overall value. For the new technology to compete on its stand-alone utility alone, that utility must be so great that it eclipses the combined value of an existing technology's stand-alone utility, its installed base, and its complementary goods.

In some cases, the new technology may be made compatible with the existing technology's installed base and complementary goods as in Figure 4.4(c). In this case, a new technology with only a moderate functionality advantage may offer greater overall value to users. Sony and Philips are employing this strategy with their new audio format, Super Audio CD (SACD), a high-density multichannel audio format based on a revolutionary "scalable" bit-stream technology known as Direct Stream Digital (DSD). Anticipating that users would be reluctant to replace their existing compact disc players and compact disc music collections, Sony and Philips made the new Super Audio CD technology (discussed in the Theory in Action section earlier in the chapter) compatible with existing compact disc technology. The Super Audio CD players include a feature that enables them to play standard CDs, and the recorded Super Audio CDs include a CD audio layer in addition to the high-density layer, enabling them to be played on standard CD systems. Customers can thus take advantage of the new technology without giving up the value of their existing CD players and music libraries.

When users are comparing the value of a new technology to an existing technology, they are weighing a combination of objective information (e.g., actual technological benefits, actual information on installed base or complementary goods), subjective information (e.g., perceived technological benefits, and perceived installed base or complementary goods), and expectations for the future (e.g., anticipated technological benefits, anticipated installed base and complementary goods). Thus, each of the primary value components described above also has corresponding perceived or anticipated value components (see Figure 4.5). In Figure 4.5(a), the perceived and anticipated value components map proportionately to their corresponding actual components. However, as depicted in Figure 4.5(b), this need not be the case. For instance, perceived installed base may greatly exceed actual installed base, or customers may expect that a technology will eventually have a much larger installed base than competitors and thus the value accrued from the technology's installed base is expected to grow much larger than it is currently.

Firms can take advantage of the fact that users rely on both objective and subjective information in assessing the combined value offered by a new technology. For example, even a technology with a small installed base can achieve a relatively large mind share through heavy advertising by its backers. Producers can also shape users' expectations of the future installed base and availability of complements through announcements of preorders, licensing agreements, and distribution arrangements. For example, when Sega and Nintendo were battling for dominance in the 16-bit video game console market, they went to great lengths to manage impressions of their installed base and market share, often to the point of deception. At the end of 1991,

FIGURE 4.5
Actual, Perceived, and Expected Components of Value



Nintendo claimed it had sold 2 million units of the Super Nintendo Entertainment System in the U.S. market. Sega disagreed, arguing that Nintendo had sold 1 million units at most. By May 1992, Nintendo was claiming a 60 percent share of the 16-bit market, and Sega was claiming a 63 percent share![20] Since perceived or expected installed base may drive subsequent adoptions, a large perceived or expected installed base can lead to a large actual installed base.

Such a tactic also underlies the use of "vaporware"—products that are not actually on the market and may not even exist but are advertised—by many software vendors. By building the impression among customers that a product is ubiquitous, firms can prompt rapid adoption of the product when it actually is available. Vaporware may also buy a firm valuable time in bringing its product to market. If other vendors beat the firm to market and the firm fears that customers may select a dominant design before its offering is introduced, it can use vaporware to attempt to persuade customers to delay purchase until the firm's product is available. The video game console industry also provides an excellent example here. When Sega and Sony introduced their 32-bit video game consoles (the Saturn and PlayStation, respectively), Nintendo was still a long way from introducing its next-generation console. In an effort to forestall consumer purchases of 32-bit systems, Nintendo began aggressively promoting its development of a 64-bit system (originally named Project Reality) in 1994, though the product would not actually reach the market until September 1996. The project underwent so many delays that some industry observers dubbed it "Project Unreality."[21] Nintendo was successful in persuading many customers to wait for its Nintendo 64, and the system was ultimately relatively successful.

Nintendo, however, was never able to reclaim dominance over the video game industry. By the time the Nintendo 64 had gained significant momentum, Sony was developing its even more advanced PlayStation2. Sony's experience in VCRs and compact discs had taught it to manage the multiple dimensions of value very well: Sony's PlayStation2 offered more than double the processing power of the Nintendo 64, it was backward compatible (helping the PlayStation2 tap the value of customers' existing PlayStation game libraries), and Sony sold it for a price that many speculated was less than the cost of manufacturing the console ($299). Sony also invested heavily to ensure that many game titles would be available at launch, and it used its distribution leverage and advertising budget to ensure the product would seem ubiquitous at its launch.

Competing for Design Dominance in Markets with Network Externalities

Graphs illustrate how differing technological utilities and network externality returns to market share impact the competition for design dominance. The following figures examine whether network externalities create pressure for a single dominant design versus a few dominant designs by considering the rate at which value increases with the size of the installed base, and how large of an installed base is necessary before most of the network externality benefits are achieved. In Figure 4.6(a), the curve represents the increase in network externality benefits of a technology as its market share rises. Initially, the benefits may increase slowly. For example, whether a cell phone can reach 1 percent of the population or 5 percent is fairly insignificant—the reach of the phone service has to become much wider before the phone has much value. However, beyond some threshold level, the network externality returns to market share begin to increase rapidly, until at some point, most of the benefits have been obtained and the rate of return decreases. In Figure 4.6(b), a base level of technological utility has been added to the graph, shifting the entire graph up. This becomes relevant later when two technologies that have different base levels of technological utility are considered.

When two technologies compete for dominance, customers will compare the overall value yielded (or expected) from each technology, as discussed in the previous section. In Figure 4.7, two technologies, A and B, each offer similar technological utility, and have similarly shaped network externality returns curves. The curve for

FIGURE 4.6
Network Externality Returns to Market Share

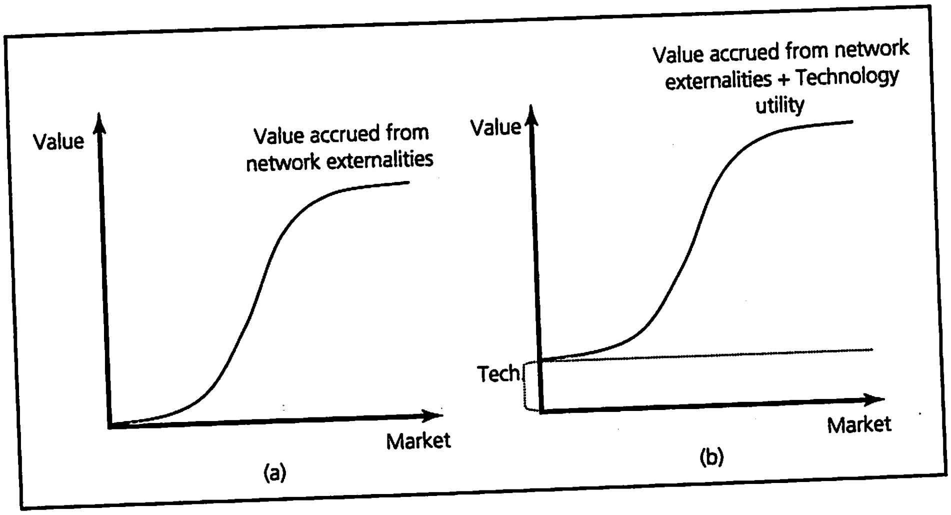
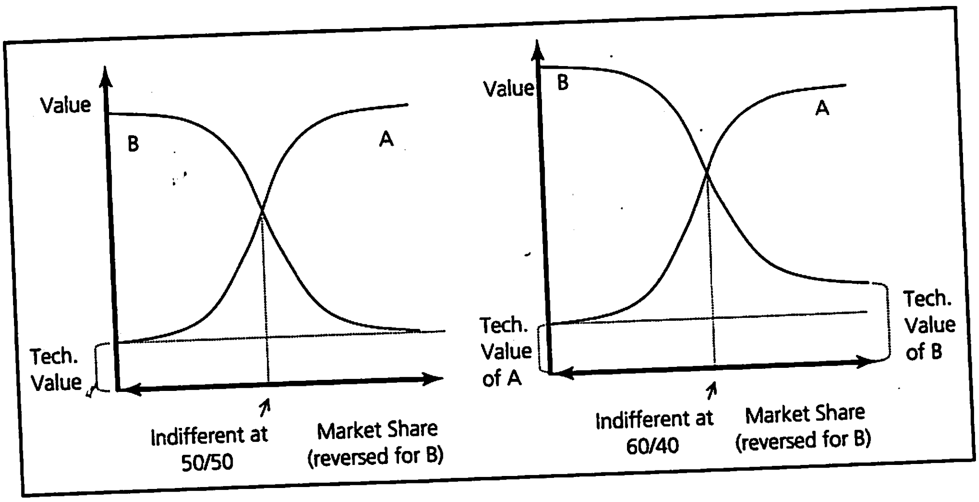


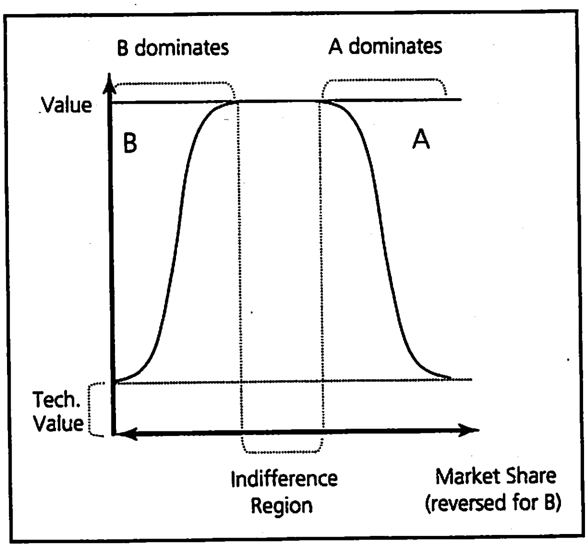
FIGURE 4.7
Network Externality Returns and Technological Utility: Competing Designs



B is drawn with the market share dimension reversed so that we can compare the value offered by the two different technologies at different market share splits, that is, when A has a 20 percent market share, B has an 80 percent market share, and so on. This graph shows that at every point where A has less than 50 percent market share (and thus B has greater than 50 percent market share), B will yield greater overall value, making B more attractive to customers. On the other hand, when A has greater than 50 percent market share (and B thus has less than 50 percent market share), A yields more overall value. When each technology has exactly 50 percent market share, they yield the same overall value. However, if both technologies earn similar network externality returns to market share, but one technology offers greater stand-alone utility, the indifference point will be shifted in its favor. In the righthand graph in Figure 4.7, technology B offers a greater level of stand-alone technological utility, shifting its overall value curve up. In this graph, technology A must have greater than 60 percent market share (and B must have less than 40 percent market share) for A to offer more overall value than B.

Another interesting scenario arises when customers attain their desired level of network externality benefits at lower levels of market share, depicted graphically in Figure 4.8. In this case, customers may face a relatively large indifference region within which neither technology clearly dominates. This may be the case with the video game console industry: While customers may experience some network externality benefits to a console having significant share (more game titles, more people to play against), those benefits might be achieved by a console without attaining a majority of the market. For example, while Sony has a majority share of the U.S. video game market and neither Nintendo's GameCube nor Microsoft's Xbox has greater than a 20 percent market share, there is still an abundance of game titles for all three consoles and a significant pool of people to play games against. Such markets may not experience great pressure to select a single dominant design; two or more platforms may successfully coexist.

FIGURE 4.8
Network Externality Value Is Fully Tapped at Minority Market Share Levels

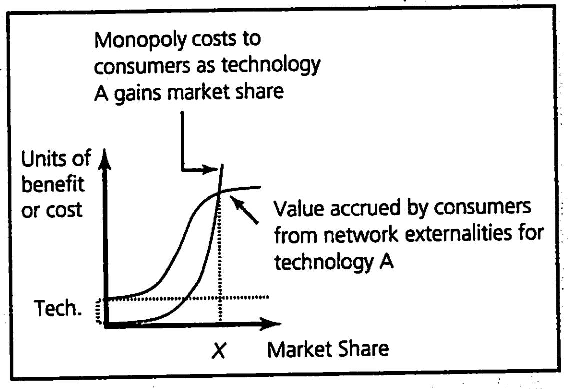


Theory in Action Are Winner-Take-All Markets Good for Consumers?

Traditionally, economics has emphasized the consumer welfare benefits of competitive markets; however, increasing returns make this a complicated issue. This is exemplified by the antritrust suits brought against Microsoft. While some analysts argued that Microsoft had clearly engaged in anticompetitive behavior and had damaged consumers, others argued that Microsoft had behaved appropriately, and that its overwhelming share of the personal computer operating system market was good for consumers since it created greater compatibility among computers and more software applications. So how does a regulatory body decide when a firm has become too dominant? One way to think about this is to compare the network externality returns to market share with corresponding monopoly costs. Network externality returns refers to the value customers reap as a larger portion of the market adopts the same good (e.g., there is likely to be greater availability of complementary goods, more compatibility among users, more revenues can be channeled into further developing the technology, etc.). Monopoly costs refer to the costs users bear as a larger portion of the market adopts the same good (e.g., a monopolist may charge higher prices, there may be less product variety, innovation in alternative technologies may be stifled, etc.). Network externality returns to market share often exhibit the s-shape described in the previous section. Monopoly costs to market share, however, are often considered to be exponentially increasing. Plotting them on the same graph (as in Figure 4.9) reveals how network externality benefits and monopoly costs trade off against one another.

In Figure 4.9, so long as technology A's market share remains less than X, the combination of technological utility and network externality benefits exceeds the monopoly costs, even if X represents a very large share of the market. However, as technology A's market share climbs beyond X, the monopoly costs now exceed the value of the technology utility

FIGURE 4.9
Network Externality Benefits and Monopoly Costs



and network externality benefits. A number of factors can shift where these two curves cross. If the technology utility for A were higher, the curves would cross at a point greater than X. If the network externality returns curve began to flatten at a lower market share (as was demonstrated earlier with the video game console industry), then the curves would cross at a market share less than X.

The steepness of the monopoly cost curve is largely a function of the firm's discretionary behavior. A firm can choose not to exploit its monopoly power, thus flattening the monopoly costs curve. For instance, one of the most obvious assertions of monopoly power is typically exhibited in the price charged for a good. However, a firm can choose not to charge the maximum price that customers would be willing to pay for a good. For example, many people would argue that Microsoft does not charge the maximum price for its Windows operating system that the market would bear. However, a firm can also assert its monopoly power in more subtle ways, by controlling the evolution of the industry through selectively aiding some suppliers or complementors more than others, and many people would argue that in this respect, Microsoft has taken full advantage of its near-monopoly power.

Summary of Chapter

1. Many technologies demonstrate increasing returns to adoption, meaning that the more they are adopted, the more valuable they become.
2. One primary source of increasing returns is learning curve effects. The more a technology is produced and used, the better understood and developed it becomes, leading to improved performance and reduced costs.
3. Another key factor creating increasing returns is network externality effects. Network externality effects arise when the value of a good to a user increases with the size of the installed base. This can be due to a number of reasons, such as need for compatibility or the availability of complementary goods.
4. In some industries, the consumer welfare benefits of having a single standard have prompted government regulation, such as the European Union's mandate to use the GSM cellular phone standard.
5. Increasing returns can lead to winner-take-all markets where one or a few companies capture nearly all the market share.
6. The value of a technology to buyers is multidimensional. The stand-alone value of a technology can include many factors (such as productivity, simplicity, etc.) and the technology's cost. In increasing returns industries, the value will also be significantly affected by the technology's installed base and availability of complementary goods.
7. Customers weigh a combination of objective and subjective information. Thus, a customer's perceptions and expectations of a technology can be as important as (or more important than) the actual value offered by the technology.
8. Firms can try to manage customers' perceptions and expectations through advertising and public announcements of preorders, distribution agreements, and so on.
9. The combination of network externality returns to market share and technological utility will influence at what level of market share one technology will dominate another. For some industries, the full network externality benefits are attained at a minority market share level; in these industries, multiple designs are likely to coexist.

Discussion Questions

1. What are some of the sources of increasing returns to adoption?
2. What are some examples of industries not mentioned in the chapter that demonstrate increasing returns to adoption?
3. What are some of the ways a firm can try to increase the overall value of its technology, and its likelihood of becoming the dominant design?
4. What determines whether an industry is likely to have one or a few dominant designs?
5. Are dominant designs good for consumers? Competitors? Complementors? Suppliers?

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