Strategic Innovation Management

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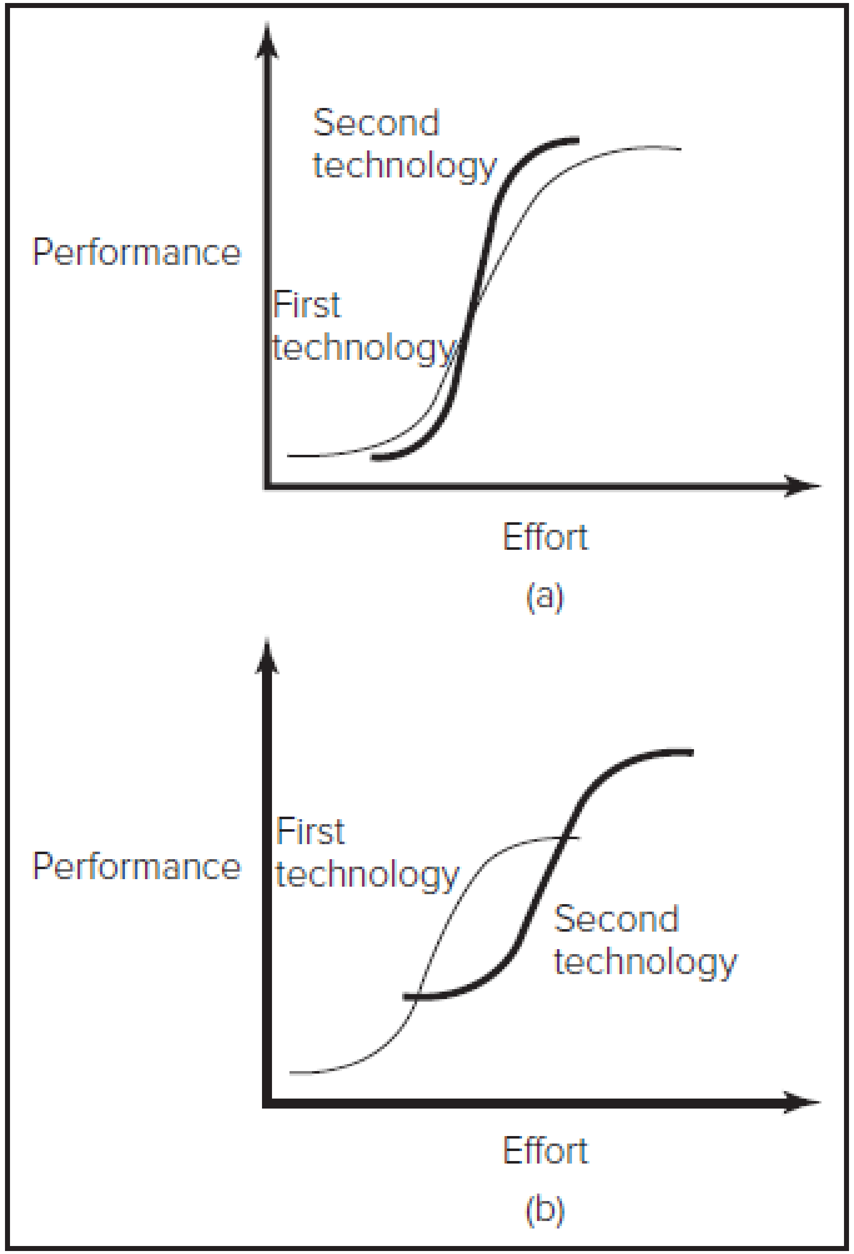
Lecture 4. Standards battles and design dominance

- 1. Selection of a dominant design
- 2. Multiple dimensions of value
- 3. Competing for design dominance in markets with network externalities

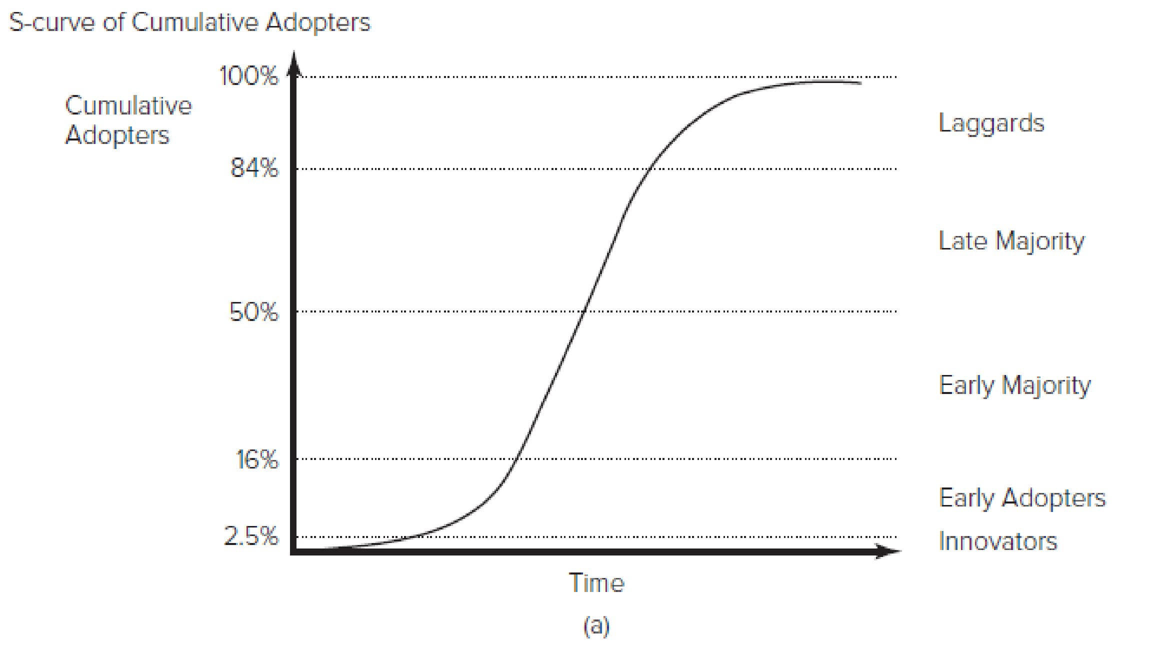
- The main **objective** of this lecture is to understand the emergence of a dominant design, its importance and consequences.

TECHNOLOGY CYCLES

- The s-curve model suggests that technological change **is cyclical**: Each new s-curve shows an initial period of turbulence, followed by rapid improvement, then diminishing returns, and ultimately is displaced by a new technological discontinuity.
- Utterback and Abernathy observed that a technology passed through distinct phases. In the first phase (what they termed the ***fluid phase***), there was considerable uncertainty about both the technology and its market.
- Products or services based on the technology might be crude, unreliable, or expensive, but might suit the needs of some market niches. In this phase, firms experiment with different form factors or product features to assess the market response.



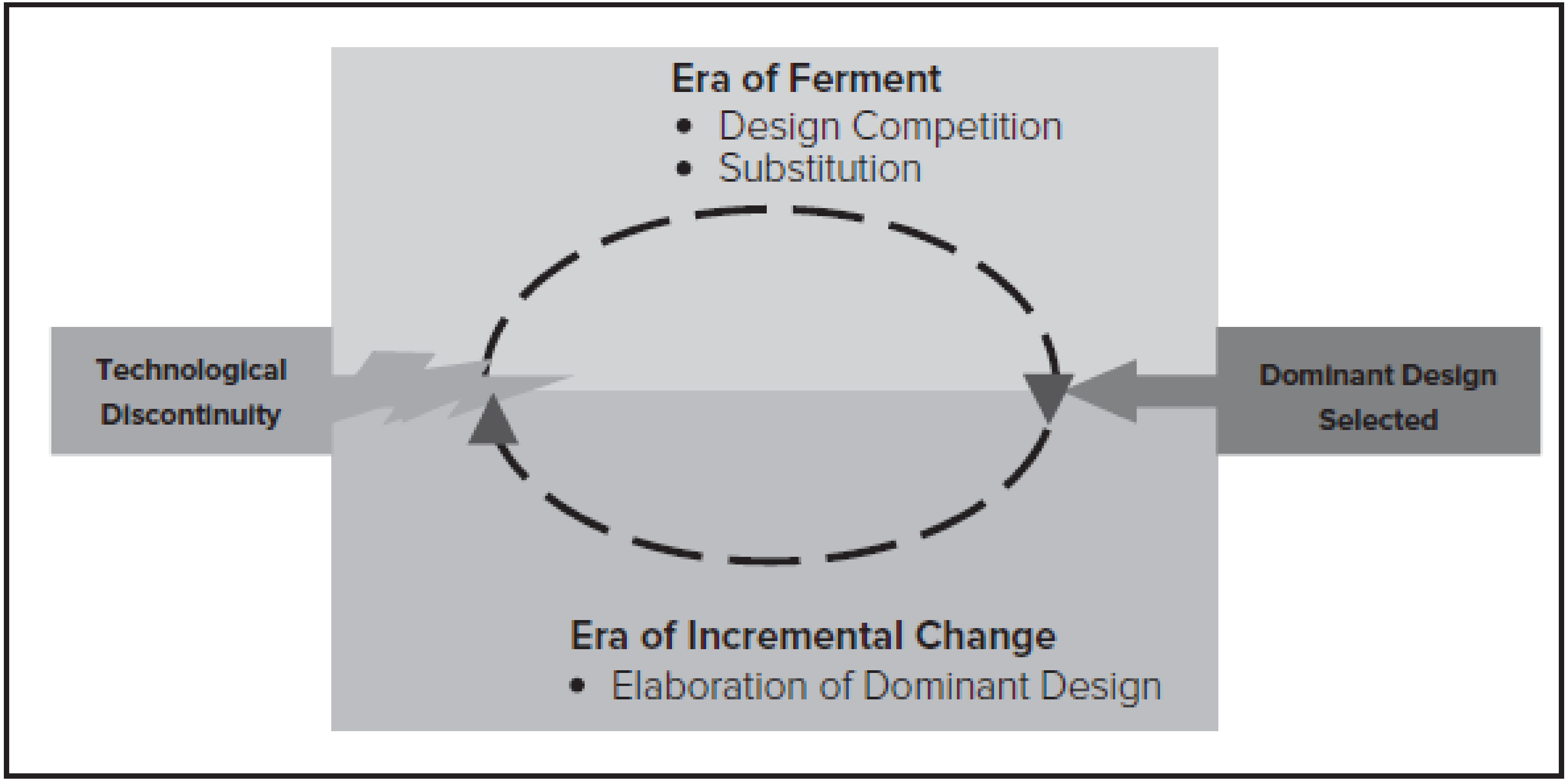
- Eventually, however, producers and customers begin to arrive at some consensus about the desired product attributes, and a **dominant design** emerges.
- The dominant design establishes a stable architecture for the technology and enables firms to focus their efforts on process innovations that make production of the design more effective and efficient or on incremental innovations to improve components within the architecture. Utterback and Abernathy termed this phase the **specific phase** because innovations in products, materials, and manufacturing processes are all specific to the dominant design.



- For example, in the United States the vast majority of energy production is based on the use of fossil fuels (e.g., oil, coal), and the methods of producing energy based on these fuels are well established. On the other hand, technologies that produce energy based on renewable resources (e.g., solar, wind, hydrogen) are still in the fluid phase. Organizations such as Royal Dutch/Shell, General Electric, and Ballard Power are experimenting with various forms of solar photocell technologies, wind-turbine technologies, and hydrogen fuel cells in efforts to find methods of using renewable resources that meet the capacity and cost requirements of serving large populations.

- Building on the Utterback and Abernathy model, Anderson and Tushman studied the history of the U.S. minicomputer, cement, and glass industries through several cycles of technological change. Like Utterback and Abernathy, Anderson and Tushman found that each technological discontinuity inaugurated **a period of turbulence and uncertainty** (which they termed the ***era of ferment***) breakthrough capabilities, but there is little agreement about what the major subsystems of the technology should be or how they should be configured together.
- Furthermore, as later researchers noted, during the era of ferment different stakeholders might have different concepts of what purpose the technology should serve, or how a business model might be built around it. Thus, **while the new technology displaces the old** (Anderson and Tushman refer to this as ***substitution***), **there is considerable design competition as firms experiment with different forms of the technology**.

The technology cycle



- The rise of a dominant design signals the transition from the era of ferment to the ***era of incremental change***. In this era, firms focus on efficiency and market penetration. Firms may attempt to achieve greater market segmentation by offering different models and price points. They may also attempt to lower production costs by simplifying the design or improving the production process. This period of accumulating small improvements may account for the bulk of the technological progress in an industry, and it continues until the next technological discontinuity.
- Understanding the knowledge that firms develop during different eras lends insight into why successful firms often resist the transition to a new technology, even if it provides significant advantages. During the era of incremental change, many firms cease to invest in learning about alternative design architectures and instead invest in refining their competencies related to the dominant architecture. Most competition revolves around improving components rather than altering the architecture; thus, companies focus their efforts on developing component knowledge and knowledge related to the dominant architecture. As firms' routines and capabilities become more and more wedded to the dominant
- While many industries appear to conform to this model in which a dominant design emerges, **there are exceptions**. In some industries, heterogeneity of products and production processes are a primary determinant of value, and thus a dominant design is undesirable. For example, art and cuisine may be examples of industries in which there is more pressure to do things differently than to settle upon a standard.

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.** 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.

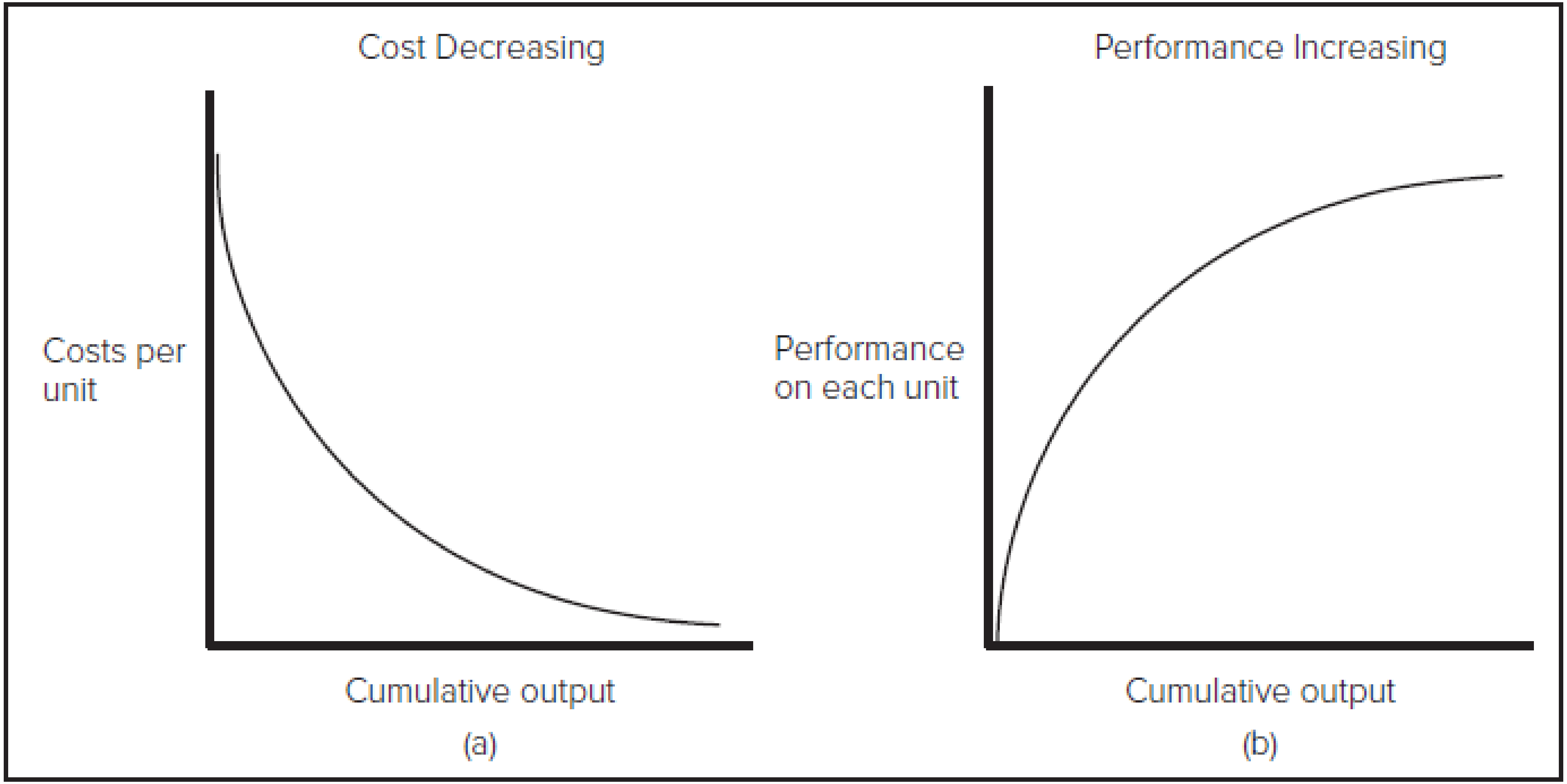
Furthermore, as the technology is used, greater knowledge and understanding of the technology accrue, which may then enable improvements both in the technology itself and in its applications. Finally, as a technology becomes more widely adopted, complementary assets are often developed that are specialized 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.

1. Learning effects

- Sufficient empirical evidence shows that the more a technology is used, **the more it is developed and the more effective and efficient it becomes.** 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**

Standard Learning-Curve Forms



- A firm’s investment in prior learning can accelerate its rate of future learning by building the firm’s absorptive capacity.
- **Absorptive capacity** refers to the phenomenon whereby as firms accumulate knowledge, 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.

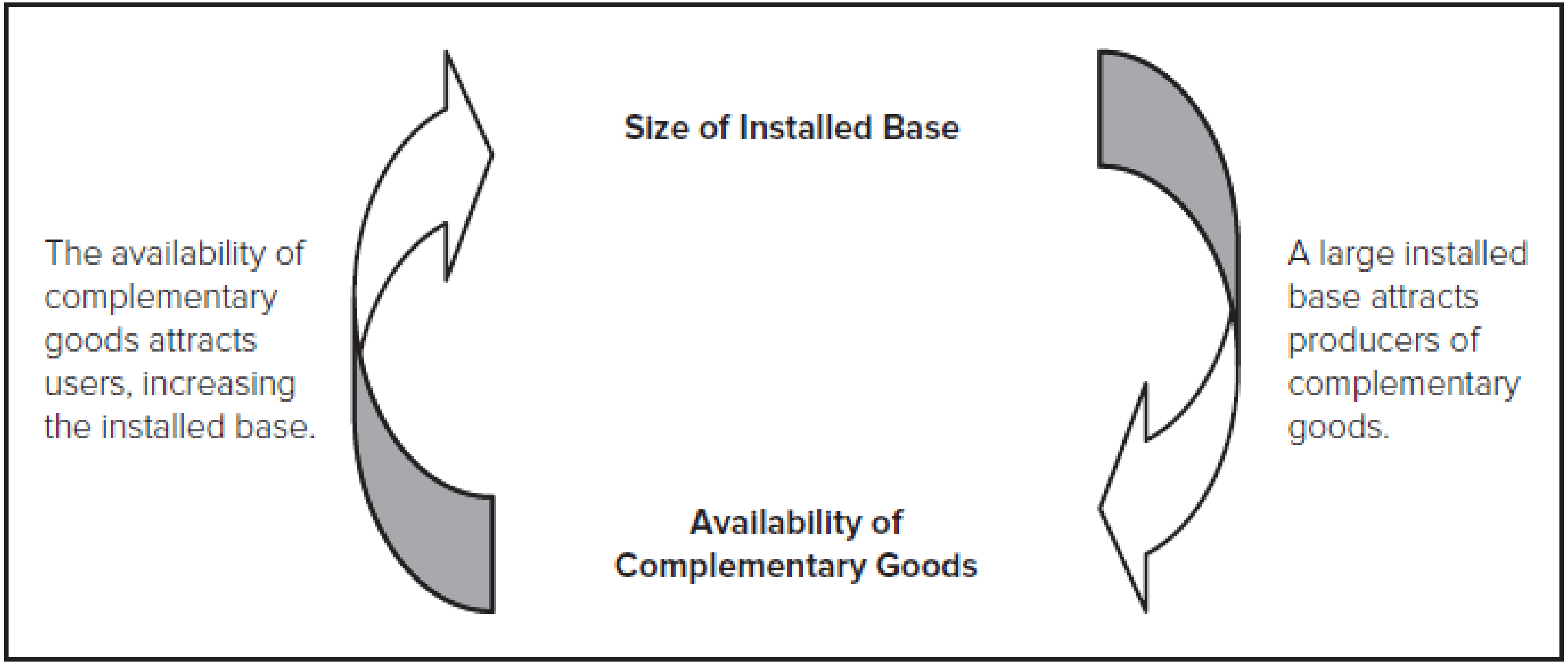
2. Network Externalities

Many markets are characterized by **network externalities**, or positive consumption externalities. **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.

- 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" (*Windows* and *Intel*) 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 (videotapes for VCRs, film for cameras, etc.). Some firms make both a good and its complements (e.g., Kodak produced 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 is demonstrated in the **Theory in Action about Microsoft**: 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.

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



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. In industries characterized by **increasing returns**, this combination will influence which technology design rises to dominance.
- **1. A Technology's Stand-Alone Value**
- **2. Network Externality Value**

1. 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, and its ease of use. 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.”**
- 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 stages and levers yields a 36-cell utility map. Each cell provides an opportunity to offer a new value proposition to a customer.

The Buyer Utility Map with Toyota Prius Example

	Purchase	Delivery	Use	Supplements	Maintenance	Disposal
Customer productivity	Price of Prius slightly higher than comparable nonhybrid models		Offers speed and power comparable to nonhybrid models	Can stop less often for gas, saving money and time		
Simplicity	Buyer may feel less able to assess value of vehicle		Operates like a regular combus-tion engine vehicle	Refuels like a regular combustion engine vehicle		Hybrids have larger batteries that would have to be recycled and disposed of at end of life
Convenience		Will be sold through traditional dealer channels	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			Buyer might face a higher risk of product failure because it embodies a new technology		Buyer might have difficulty finding replacement parts because of new technology	Prius might be more difficult to resell or have lower resell value
Fun and image		Connotes image of environmental responsibility				
Environmental friendliness	Buyers feel they are helping support the development of more environ-mentally friendly cars		Emits lower levels of pollutants	Requires less use of fossil fuels		

2. 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 of the value created by the size of its installed base and the availability of complementary goods. 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.**

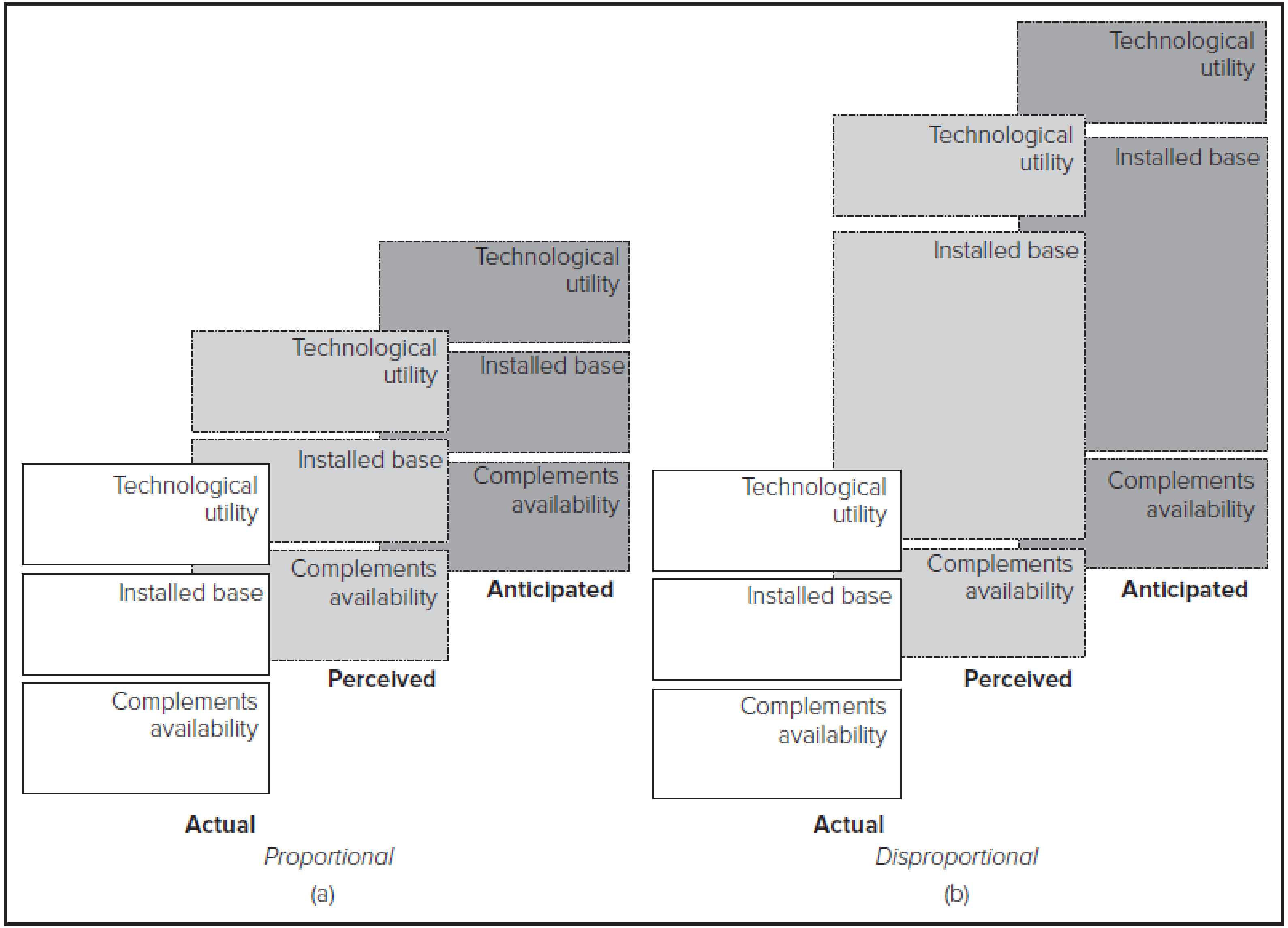
When users are comparing the value of a new technology to an existing technology, they are weighing a combination of objective information (e.g., actual technological benefits, actual information on installed base or complementary goods), subjective information (e.g., perceived technological benefits, 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. I

n Figure (a), the perceived and anticipated value components map proportionately to their corresponding actual components. However, as depicted in Figure (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.

Actual, Perceived, and Expected Components of Value



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.**

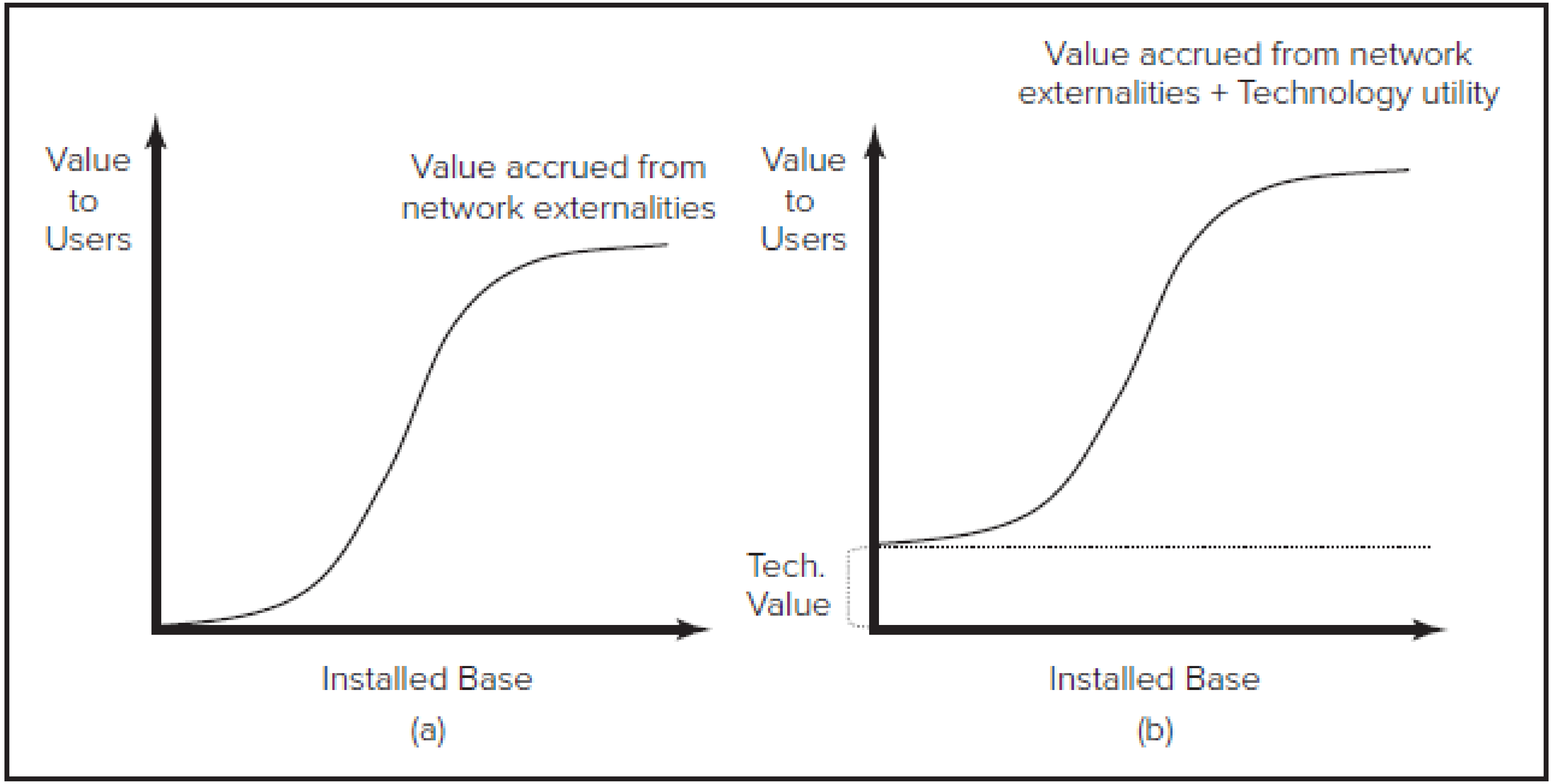
For example, when **Sega and Nintendo** were battling for dominance in the 16-bit video game console market, they went to great lengths to manage impressions of their installed base and market share, often to the point of deception. At the end of 1991, Nintendo claimed it had sold 2 million units of 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! **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.**

Competing for Design Dominance in Markets with Network Externalities

- Graphs illustrate how differing technological utilities and network externality returns to installed base or 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. As explained earlier, when an industry has network externalities, the value of a good to a user increases with the number of other users of the same or similar good. However, it is rare that the value goes up linearly—instead, the value is likely to increase in an s-shape as shown in Figure (a). 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 begin to increase rapidly, until at some point, most of the benefits have been obtained and the rate of return decreases.

- Consider **the example of operating systems**: If an operating system has too small of an installed base, few software developers will write applications for it and thus it will be of little value to consumers. An increase from a 1 percent market share to a 2 percent market share makes little difference—developers are still unlikely to be attracted to the platform. Once the operating system exceeds some threshold level of adoption, however, it becomes worthwhile to develop software applications for it, and the value of the operating system begins to increase rapidly. Once the operating system achieves a large share of the market, the user has probably obtained most of the network externality value. There is likely to be a large range of quality software available for the operating system, and incremental increases in available software have less marginal impact on the value reaped by the customer.

- Next we consider the stand-alone functionality of the technology. In Figure (b), a base level of technological utility has been added to the graph, which shifts the entire graph up. For example, an operating system that has an exceptionally easyto-use interface makes the technology more valuable at any level of installed base. This becomes relevant later when two technologies that have different base levels of technological utility are considered.



Network Externality Returns to Market Share

Summary

- 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 (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.

Questions:

- 1. What are some of the sources of increasing returns to adoption?
- 2. What are some examples of industries not mentioned in the lecture 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?

- **Literature:**

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Thank you for your attention!