

# Chapter One

## Strategy and Competition

“However beautiful the strategy, you should occasionally look at the results.”  
—Winston Churchill

### Chapter Overview

#### **Purpose**

The purpose of this chapter is to introduce the student to a variety of strategic issues that arise in the manufacturing function of the firm.

#### **Key Points**

1. *Manufacturing matters.* This writer contends that the loss of the manufacturing base in the U.S. economy is not healthy and will eventually lead to an overall loss in the standard of living and quality of life in this country. It counters the argument that our evolution into a service economy is a natural and healthy thing.
2. *Strategic dimensions.* Along with cost and/or product differentiation, other dimensions along which firms distinguish themselves include (a) quality, (b) delivery speed, (c) delivery reliability, and (d) flexibility.
3. *Global competition.* How do we measure our success and economic health on a global scale? One way is to examine classical measures of relative economic strength, which include (a) balance of trade, (b) share of world exports, (c) creation of jobs, and (d) cost of labor. However, such macro measures do not adequately explain why certain countries dominate certain industries. National competitive advantage is a consequence of several factors (factor conditions, demand conditions, related and supporting industries, firm strategy structure, and rivalry), although productivity also plays an important role.
4. *Strategic initiatives.* We discuss several strategic initiatives that have allowed many companies to shine in their respective arenas. These include (a) business process reengineering, (b) just-in-time manufacturing and purchasing systems, (c) time-based competition, and (d) competing on quality.
5. *Product and process life cycles.* Most of us understand that products have natural life cycles: start-up, rapid growth, maturation, stabilization, or decline. However, it is rarely recognized that processes too have life cycles. Initially, new manufacturing processes have the characteristics of a job shop. As the process matures, automation is introduced. In the mature phases of a manufacturing process, most major operations are automated. A firm needs to match the phases of product and process life cycles to be the most successful in its arena.

6. *Learning and experience curves.* These are helpful in forecasting the decline in unit cost of a manufacturing process as one gains experience with the process. Learning curves are more appropriate when modeling the learning of an individual worker, and experience curves are more appropriate when considering an entire industry.
7. *Capacity growth planning.* Another important strategic issue in operations is determining the timing and sizing of new capacity additions. Simple models (make or buy problem) and more complex exponential growth models are explored in Section 1.11. In addition, some of the factors that determine appropriate location of new facilities is explored.

*Strategy* is a long-term plan of action designed to achieve a particular goal, most often winning. Its root is from the Greek *stratēgos*, which referred to a “military commander” during the age of Athenian Democracy. Strategy was originally conceived in the military context. Two famous books dealing with military strategy are *The Prince* by Machiavelli and *The Art of War* by Sun Tzu.

Hence, we can see that business strategy relates closely to military strategy. Companies fight on an economic battlefield, and long-term strategies determine winners and losers. Business strategy is the highest level of corporate activity that bundles together the disparate functional area strategies. Business strategy sets the terms and goals for a company to follow.

Perhaps the reason that chief executive officers (CEOs) are compensated so highly in the United States is the realization that the strategic vision of the CEO is often the difference between the success and failure of a company. The strategic visions of industry giants such as Henry Ford, Jack Welch, and Bill Gates were central to the success of their companies that have, at one time or another, dominated their competition.

Perhaps the most dramatic example is Apple Corporation. With the introduction of the iPod in 2002 and the iPhone in 2007, Apple transformed itself from a failing computer company to a major force in portable computing and telecommunications. The fascinating transformation of the firm is described in the Snapshot Application on the next page.

Success requires a vision, and visions must be articulated so all of the firm’s employees can share in that vision. The formal articulation of the vision is known as the company mission statement. A good mission statement should provide a clear description of the goals of the firm and is the first step toward formulating a coherent business strategy. Poor mission statements tend to be wordy and full of generalities. Good mission statements are direct, clear, and concise. In their book, Jones and Kahaner (1995) list the 50 corporate mission statements that they perceive as the best. One example is the Gillette Corporation. Their mission statement is: “Our Mission is to achieve or enhance clear leadership, worldwide, in the existing or new core consumer product categories in which we choose to compete.” They then go on to list exactly which areas they perceive as their core competencies. Intel defines their mission as: “Do a great job for our customers, employees, and stockholders by being the preeminent building block supplier to the computing industry.” The statement then provides details on “Values and Objectives.” In many cases, their objectives are quite specific (e.g., “Lead in LAN products and Smart Network Services”). Certainly, the award for conciseness has to go to the General Electric Corporation, whose mission statement is three words: “Boundaryless . . . Speed . . . Stretch.” The commentary following the statement provides an explanation of exactly what these words mean in the context of the corporation.

# Snapshot Application

## APPLE ADOPTS A NEW BUSINESS STRATEGY AND SHIFTS ITS CORE COMPETENCY FROM COMPUTERS TO PORTABLE ELECTRONICS

Apple Computer was the kind of success story one sees in the movies. Two youngsters, Steve Wozniak and Steve Jobs, grew up with an interest in hobbyist computers. Working from a garage, they founded Apple Computer in April 1976, and soon after, introduced a build your own hobbyist computer called the Apple I. The firm was incorporated a year later with the help of Mike Markula, and the Apple II was introduced in April 1977, ushering in the world of personal computing. Perhaps it was the fact that it was selected as the platform for Visicalc, the first spreadsheet program, that led to its success, as much as the superior capabilities of the hardware.

While personal computers have become a common part of our everyday lives, we forget that they are a relatively new invention. The nature of the personal computer marketplace was dramatically altered by the introduction of the first PC by IBM in 1981. IBM's open architecture allowed for inexpensive clones to enter the market, and crowd out Apple's significantly more expensive products. By the turn of the century, Apple's future looked to be in doubt.

Apple's subsequent transformation and rebirth is a fascinating bit of business history. Around 2001, an independent consultant, Tony Fadell, was shopping around his concept of an MP3 music player linked to a music sales service. At that time, MP3 players were not new; one could "rip" music from one's CD collection, and load the songs on the player. While no one else was interested in Fadell's idea, he was hired by Apple and assigned to a team of 30 people, including designers, programmers, and hardware engineers.

When Apple decided to go ahead with the MP3 player concept, they also decided that they needed a new design to separate themselves from the rest of the marketplace. Apple subcontracted much of the development and design work to PortalPlayer, who devoted all of their resources to the project. Steve Jobs himself was intimately involved with the design and function of the new player. The iPod was a huge success and has been redesigned over several models and generations. The most current reports record worldwide sales of over 350 million units.

While the iPod was a huge success, Apple did not rest on its laurels. In 2007, Apple launched the first iPhone. Again, the concept of a smartphone was not new. Several companies, notably Motorola, Samsung, Palm, and Nokia, had smartphones on the market for several years prior. But as with the iPod, Apple again produced an innovative product with unique features. Apple continues to improve upon the iPhone and introduces a new generation of the product virtually every year. As of this writing, sales have reached over 500 million worldwide.

Apple's most recent product, the iPad, was also an instant success and essentially defined a new market category. This tablet computer, introduced in March 2010, is convenient for web surfing and reading e-books, and again, has become the product the competition measures itself against. Apple registered more than 1 million sales of the iPad in the first three months alone. As a testament to Apple's phenomenal success in portable computing, the market capitalization of Apple surpassed that of the software behemoth Microsoft in 2010.

**Source:** Various websites and L. Kahney "Inside Look at the Birth of the iPod" July 2004 (<http://www.wired.com>).

Once having articulated a vision, the next step is to plan a strategy for achieving that vision. This is the firm's business strategy. The overall business strategy includes defining

1. The market in which the enterprise competes.
2. The level of investment.
3. The means of allocating resources to and the integrating of separate business units.
4. Functional area strategies, including
  - The marketing strategy
  - The financial strategy
  - The operations strategy

Broadly defined, the operations strategy is the means by which the firm deploys its resources to achieve its competitive goals. For manufacturing firms, it is the sum total of all decisions concerning the production, storage, and distribution of goods. Important operations strategy decisions include where to locate new manufacturing facilities, how large these facilities should be, what processes to use for manufacturing

and moving goods through the system, and what workers to employ. Service firms also require an operations strategy. The United States continues to be a leader in financial services, which must be supported by effective and reliable operations departments in order to remain competitive. The Disney theme park's continuing record of success is due in part to its careful attention to detail in every phase of its operations.

Does the American culture place too much emphasis on marketing (selling the product) and finance (leveraged buyouts, mergers, stock prices) and too little on operations (making and delivering the product)? Years ago, this was certainly the case. However, we are quick learners. The enormous success of the Japanese auto industry, for example, provided strong motivation for the American big three to close their inefficient plants and change the way things were done. The dramatic differences that were brought to light by Womack, Jones, and Roos (1990) have largely been eliminated. Today, the best American auto plants rival their Japanese counterparts for quality and efficiency.

Still, a coherent operations strategy is essential. When the Apple Macintosh was introduced, the product was extremely successful. However, the company was plagued with backorders and failed to keep up with consumer demand. According to Debbi Coleman, Apple's former director of worldwide manufacturing:

Manufacturing lacked an overall strategy which created problems that took nine months to solve . . . we had extremely poor forecasting. Incoming materials weren't inspected for defects and we didn't have a mechanism for telling suppliers what was wrong, except angry phone calls. Forty percent of Mac materials were coming from overseas and no one from Apple was inspecting them before they were shipped. . . . One of the biggest tasks that high-tech manufacturers face is designing a manufacturing strategy that allows a company to be flexible so it can ride with the highs and lows of consumer and business buying cycles. (Fallon, 1985)

Although it is easy to be critical of American management style, we must be aware of the factors motivating American managers and those motivating managers from other cultures. For example, the Japanese have not achieved their dramatic successes without cost. Sixteen-hour work days and a high rate of nervous breakdowns among management are common in Japan.

Measuring a firm's success by the performance of its share price can result in short-sighted management practices. Boards of directors are more concerned with the next quarterly report than with funding major long-term projects. In fact, Hayes and Wheelwright (1984) make a compelling argument that such factors led to a myopic management style in the United States, characterized by the following:

1. Managers' performance is measured on the basis of **return on investment (ROI)**, which is simply the ratio of the profit realized by a particular operation or project over the investment made in that operation or project.
2. Performance is measured over short time horizons. There is little motivation for a manager to invest in a project that is not likely to bear fruit until after he or she has moved on to another position.

In order to improve ROI, a manager must either increase the numerator (profits) or decrease the denominator (investment). In the short term, decreasing the denominator by cutting back on the investment in new technologies or new facilities is easier than trying to increase profits by improving efficiency, the quality of the product, or the productivity of the operating unit. The long-term effects of decreasing investment are devastating. At some point, the capital costs required to modernize old factories become more than the firm can bear, and the firm loses its competitive position in the marketplace.

It would be encouraging if the problems of U.S. industries arising from overemphasis on short-term financial performance were decreasing, but sadly, they appear to be worsening. Because of gross mismanagement and questionable auditing practices, two giants of American industry were brought down in 2001: Enron and Arthur Andersen. “Enron went from the No. 7 company on the Fortune 500 to a penny stock in a stunning three weeks because it apparently lied on its financial statements,” said Representative John D. Dingell, one-time member of the House Energy Committee. While other parts of the world have experienced spectacular problems as well (such as the Asian financial crisis that hit in the late 1990s), few Americans can understand how a company that had recently expanded and profited from the energy crisis, and an American icon such as Arthur Andersen, could both be brought down so quickly and completely. It is our continual focus on short-term performance and the incentive system we have built up around this objective that led to these crises.

Measuring individual performance over the short term is a philosophy that seems to pervade American life. Politicians are elected for two-, four-, or six-year terms. There is a strong incentive for them to show results in time for the next election. Even university professors are evaluated yearly on their professional performance in many institutions, even though most serious academic projects extend over many years.

## 1.1 MANUFACTURING MATTERS

A question that is being debated and has been debated by economists for several decades is the importance of a strong manufacturing base. The decline of manufacturing domestically has led to a shift in jobs from the manufacturing sector to the service sector. Because there are major disparities in labor costs in different parts of the world, there are strong incentives for American firms to locate volume manufacturing facilities overseas to reduce labor costs. Is a strong manufacturing base important for the health of the economy?

There is little debate that manufacturing jobs have been steadily declining in the United States. The growth of manufacturing overseas, and in China in particular, is well documented. If we compare the proportion of nonagriculture jobs in the United States in service versus manufacturing in 1950 versus 2002, the change is quite dramatic. In 1950, manufacturing jobs accounted for 34 percent of nonagriculture labor and service jobs accounted for 59 percent. In 2002, however, manufacturing jobs only accounted for 13 percent of nonagriculture jobs, while service jobs soared to 82 percent of the total (Hagenbaugh, 2002).

One mitigating factor in the loss of manufacturing was the dramatic rise in manufacturing productivity during this same period. Average annual manufacturing productivity growth was 2.57 percent annually during the 1980s and 3.51 percent annually during the 1990s (Faux, 2003). This dramatic rise in manufacturing productivity has had the effect of offsetting the loss of high-paying manufacturing jobs at home, thus partially accounting for the success of the U.S. economy in the latter part of the first decade of the century.

An argument put forth by several scholars (e.g., Daniel Bell, 1976) is that we are simply evolving from an industrial to a service economy. In this view, the three stages of economic evolution are (1) agrarian, (2) industrial, and (3) service. In the early years of our country, we were primarily an agrarian economy. With the industrial revolution, a large portion of the labor force shifted from agriculture to manufacturing. In recent years it seems that there is less interest in manufacturing. These scholars would argue

that we are merely entering the third stage of the evolutionary process: moving from an industrial economy to a service economy.

It is comforting to think that the American economy is healthy and simply evolving from an industrial to a service economy. One might even argue that manufacturing is not important for economic well-being. According to economist Gary S. Becker (1986), “Strong modern economies do not seem to require a dominant manufacturing sector.”

It is far from clear, however, that we evolved from an agrarian economy to an industrial economy. Although fewer American workers are employed in the agricultural sector of the economy, agricultural production has not declined. Based on U.S. Department of Commerce data, Cohen and Zysman (1987) state that “agriculture has sustained, over the long term, the highest rate of productivity increase of any sector.” By utilizing new technologies, agriculture has been able to sustain growth while consuming fewer labor hours. Hence, the figures simply do not bear out the argument that our economy has shifted from an agricultural one to an industrial one.

The argument that the economy is undergoing natural stages of evolution is simply not borne out by the facts. I believe that all sectors of the economy—agricultural, manufacturing, and service—are important and that domestic economic well-being depends upon properly linking the activities of these sectors.

The return on innovations will be lost if new products are abandoned after development. The payoff for research and development (R&D) can come only when the product is produced and sold. If manufacturing is taken offshore, then the “rent on innovation” cannot be recaptured. Furthermore, manufacturing naturally leads to innovation. It will be difficult for the United States to retain its position as a leader in innovation if it loses its position as a leader in manufacturing.

That manufacturing naturally leads to innovation is perhaps best illustrated by the Japanese experience in the video market. After Japan had captured the lion’s share of the world market for televisions, the next major innovation in consumer video technology, the videocassette recorder (VCR), (at least, the inexpensive consumer version) was developed in Japan, not the United States. Virtually all VCRs sold were manufactured in Asia.

A more recent book by Pisano and Shih (2012) underscores many of the same themes that appeared in Cohen and Zysman (1987). They point to other products that were invented in the United States but whose base of manufacturing is now overseas. An example is the PV (photovoltaic) cell (more commonly known as the solar cell). PV cells were invented in Bell Labs, but only a very small percentage of the world demand is filled by American companies.

One of the more disturbing trends discussed by Pisano and Shih (2012) is the widening trade deficit in manufactured goods. The foreign trade deficit has continued to increase, resulting in the United States going from the largest creditor nation in the 1970s to the largest debtor nation today. The overwhelming source of this deficit is the continued negative trade balance in manufactured goods (the trade balance in services is actually increasing).

Where to locate manufacturing as well as R and D facilities is one of the key management decisions a firm must make. During the 1990s we saw an exodus of domestic manufacturing to China. The offshoring movement was rampant, not only in the United States but in most developed countries. The primary driver of this exodus is wage rates, but other factors were relevant as well. Favorable tax treatments, proximity to natural resources, and proximity to markets are also reasons companies locate facilities offshore.

In recent years, the advantage of offshoring is decreasing. For example, as the standard of living in China has improved, manufacturing wage rates have risen. When



the disadvantages of offshoring are taken into account, the best course of action is no longer obvious. These disadvantages include longer lead times, infrastructure deficiencies, local politics, and quality problems.

An example cited in *Reshoring Manufacturing* (2013) is the start-up company ET Water Systems. In 2005 the firm moved manufacturing operations to China in search of lower labor costs. However, the disadvantages of locating offshore became apparent as the company started suffering losses due to several factors, including the cost of funds tied up in goods in transit, the disconnect between manufacturing and design, and recurring quality problems. When the firm's chief executive, Mark Coopersmith, carefully looked at the total cost difference between manufacturing in China versus California he was amazed to discover that California was only 10% more expensive than China. He concluded that this cost difference was more than offset by the advantages of locating manufacturing domestically. ET Water Systems closed their plant in China and reshored the manufacturing function to General Electronics Assembly in San Jose.

Unfortunately, ET's experience is rare. More companies are continuing to choose the offshoring option. However, that reshoring is occurring at all is a positive step. Perhaps more companies will come to the same conclusion that ET Water Systems did when taking into account the full spectrum of the costs of offshoring.

In order to get some idea of the extent of reshoring compared to offshoring, Porter and Rivkin (2012) conducted an extensive survey of Harvard Business School alumni who made location decisions for their companies in 2011. They found that only 9% of the respondents were considering moving offshore activities back to the United States, 34% were planning on keeping their facilities where they were, and 57% were considering moving existing facilities out of the United States. Their results suggest that offshoring still dominates both staying put and reshoring. The respondents' main reasons for offshoring were lower wages, proximity to customers, better access to skilled labor, higher labor productivity, lower taxes, proximity of suppliers, and proximity to other company operations. The respondents' main reasons for staying put or reshoring were proximity to the U.S. market, less corruption, greater safety, better intellectual property protection, similar language and culture, better infrastructure, and proximity to other company operations.

Has offshoring been a help or a hindrance to the U.S. economy? The answer is not simple. On one hand, offshoring has resulted in loss of jobs domestically, lower average domestic wages which in turn have yielded a lower tax base and a smaller domestic market. On the other hand, offshoring has improved the bottom line for many domestic firms, and have resulted in lower costs of manufactured goods for the American consumer.

## Manufacturing Jobs Outlook

The U.S. Bureau of Labor Statistics (a subsidiary of the Department of Labor) provides up-to-date information on the prospects for jobs in the manufacturing sector by industry. According to the *Occupational Outlook Handbook* (OOH), 2010–2011 Edition (<http://www.bls.gov/oco/>), even though manufacturing jobs are expected to decline overall, there are some areas of growth and opportunity. Consider the individual sectors:

1. *Aerospace products and parts*. This sector is projected to grow, but more slowly than the economy in general. Earnings are higher here than in most other manufacturing industries, as workers must be highly skilled. Opportunities will result from a large number of anticipated retirements.
2. *Chemical (except pharmaceuticals and medicines)*. The chemical industry continues to be a major employer of professionals, producing over 500,000 jobs.

However, employment is projected to decline and competition for better jobs to increase over the coming years.

3. *Computer and Electronic Products.* Employment is projected to decrease nearly 20 percent in the decade 2008–2018 due to productivity improvements and movement of jobs to lower wage countries.
4. *Food Manufacturing.* The jobs picture in this industry is stable, but production workers continue to have the highest incidences of injury and illness among all industry, with seafood product preparation and packaging being the worst sector in this regard.
5. *Machinery.* Productivity improvements will lead to fewer jobs overall, but opportunities will arise as a result of anticipated retirements. Machinery manufacturing has some of the most highly skilled, and highly paid, production jobs in manufacturing.
6. *Motor Vehicles and Parts.* Almost half the jobs are located in Michigan, Indiana, and Ohio, but jobs continue to shift away from this area to the South. Average earnings continue to be high in this sector, but employment is expected to decline in coming years.
7. *Pharmaceuticals and Medicine.* This continues to be a growth area, with earnings higher than in other manufacturing industries. Job prospects are particularly favorable for candidates with advanced degrees.
8. *Printing.* Most printing establishments are very small, with 70 percent employing under 10 people. Traditional printing is a declining industry due to increased computerization, but digital press operators will continue to be in demand.
9. *Steel.* Steel continues to be a declining industry domestically, with fewer jobs projected as a result of consolidation and automation. Opportunities will be best for engineers and skilled production and maintenance workers.
10. *Textiles, Textile Products, and Apparel.* About half the jobs are located in three states: California, North Carolina, and Georgia. Employment is expected to decline rapidly because of technological advances and imports of apparel and textiles from lower wage countries.

## 1.2 A FRAMEWORK FOR OPERATIONS STRATEGY

Classical literature on competitiveness claims that firms position themselves strategically in the marketplace along one of two dimensions: lower cost or product differentiation (Porter, 1990).

Often new entrants to a market position themselves as the low-cost providers. Firms that have adopted this approach include the Korean automakers (Hyundai, Daewoo, Kia), discount outlets such as Costco, and retailers such as Wal-Mart. While being the low-cost provider can be successful over the near term, it is a risky strategy. Consumers ultimately will abandon products that they perceive as poor quality regardless of cost. For example, many manufacturers of low-cost PC clones popular in the 1980s are long gone.

Most firms that have a long record of success in the marketplace have differentiated themselves from their competitors. By providing uniqueness to buyers, they are able to sustain high profit margins over time. One example is BMW, one of the most profitable auto firms in the world. BMW continues to produce high-performance, well-made cars that are often substantially more expensive than those of competitors in their class. Product differentiation within a firm has also been a successful strategy. Consider the success of General Motors in the early years compared to Ford. GM was able to successfully capture different market segments at the same time by forming five distinct



divisions, while Henry Ford's insistence on providing only a single model almost led the company to bankruptcy (Womack et al., 1990).

### Strategic Dimensions

However, cost and product differentiation are not the only two dimensions along which firms distinguish themselves. The following additional factors relate directly to the operations function:

- Quality
- Delivery speed
- Delivery reliability
- Flexibility

What does *quality* mean? It is a word often bandied about, but one that means different things in different contexts. Consider the following hypothetical remarks.

1. "That hairdryer was a real disappointment. It really didn't dry my hair as well as I expected."
2. "I was thrilled with my last car. I sold it with 150,000 miles and hardly had any repairs."
3. "I love buying from that catalogue. I always get what I order within two days."
4. "The refrigerator works fine, but I think the shelves could have been laid out better."
5. "That park had great rides, but the lines were a mess."
6. "Our quality is great. We've got less than six defectives per one million parts produced."

In each case, the speaker is referring to a different aspect of quality. In the first case, the product simply didn't perform the task it was designed to do. That is, its function was substandard. The repair record of an automobile is really an issue of reliability rather than quality, *per se*. In the third case, it is delivery speed that translates to quality service for that customer. The fourth case refers to a product that does what it is supposed to do, but the consumer is disappointed with the product design. The product quality (the rides) at the amusement park were fine, but the logistics of the park management were a disappointment. The final case refers to the statistical aspects of quality control.

Hence the word *quality* means different things in different contexts. A Honda Civic is a quality product and so is a Ferrari Testarosa. Consumers buying these products are both looking for quality cars but have fundamentally different objectives. The fact is that everyone competes on quality. For this reason, Terry Hill (1993) would classify quality as an order qualifier rather than an order winner. An option is immediately eliminated from consideration if it does not meet minimum quality standards. It is the particular aspect of quality on which one chooses to focus that determines the nature of the competitive strategy and the positioning of the firm.

*Delivery speed* can be an important competitive weapon in some contexts. Some firms base their primary competitive position on delivery speed, such as UPS and Federal Express. Mail-order and Web-based retailers also must be able to deliver products reliably and quickly to remain competitive. Building contractors that complete projects on time will have an edge.

*Delivery reliability* means being able to deliver products or services when promised. Online brokerages that execute trades reliably and quickly will retain customers. Contract manufacturers are measured on several dimensions, one being whether they can deliver on time. As third-party sourcing of manufacturing continues to grow, the successful contract manufacturers will be the ones that put customers first and maintain a record of delivering high-quality products in a reliable fashion.

Flexibility means offering a wide range of products and being able to adjust to unexpected changes in the demand of the product mix offered. Successful manufacturers in the 21st century will be those that can respond the fastest to unpredictable changes in customer tastes. This writer was fortunate enough to tour Toyota's Motomachi Plant located in Toyoda City, Japan. What was particularly impressive was the ability to produce several different models in the same plant. In fact, each successive car on the assembly line was a different model. A right-hand drive Crown sedan, for the domestic market, was followed by a left-hand drive Lexus coupe, designated for shipment to the United States. Each car carried unique sets of instructions that could be read by both robot welders and human assemblers. This flexibility allowed Toyota to adjust the product mix on a real-time basis and to embark on a system in which customers could order custom-configured cars directly from terminals located in dealer showrooms (Port, 1999).

Hence, one way to think of operations strategy is the strategic positioning the firm chooses along one of the dimensions of cost, quality, delivery speed, delivery reliability, and flexibility. Operations management is concerned with implementing the strategy to achieve leadership along one of these dimensions.

### 1.3 COMPETING IN THE GLOBAL MARKETPLACE

International competitiveness has become a national obsession. Americans are concerned that their standard of living is eroding while it seems to improve elsewhere. Evidence exists that there is some truth to this perception. Our balance of trade with Japan has been in the red for decades, with no evidence of a reversal. American firms once held a dominant position worldwide in industries that have nearly disappeared domestically. Consumer electronics, steel, and machine tools are some examples. All the news is not bad, however. The American economy is strong and continues to grow. American firms still have the lion's share of the world market in many industries.

In his excellent study of international competitiveness, Porter (1990) poses the following question: Why does one country become the home base for successful international competitors in an industry? That certain industries flourish in certain countries cannot be disputed. Some examples are

1. Germany: printing presses, luxury cars, chemicals.
2. Switzerland: pharmaceuticals, chocolate.
3. Sweden: heavy trucks, mining equipment.
4. United States: personal computers, software, films.
5. Japan: automobiles, consumer electronics, robotics.

What accounts for this phenomenon? One can offer several compelling explanations, but most have counterexamples. Here are a few:

1. *Historical*. Some industries are historically strong in some countries and are not easily displaced. *Counterexample*: The demise of the steel industry in the United States is one of many counterexamples.
2. *Tax structure*. Some countries, such as Germany, have no capital gains tax, thus providing a more fertile environment for industry. *Counterexample*: However, there is no reason that favorable tax treatment should favor certain industries over others.
3. *National character*. Many believe that workers from other countries, particularly from Pacific Rim countries, are better trained and more dedicated than American workers. *Counterexample*: If this is true, why then do American firms dominate in some industry

segments? How does one explain the enormous success Japanese-based corporations have had running plants in the United States with an American workforce?

4. *Natural resources.* There is no question that some industries are highly resource dependent and these industries have a distinct advantage in some countries. One example is the forest products industry in the United States and Canada. *Counterexample:* Many industry sectors are essentially resource independent but still seem to flourish in certain countries.
5. *Government policies.* Some governments provide direct assistance to fledgling industries, such as MITI in Japan. The role of the U.S. government is primarily regulatory. For example, environmental standards in the United States are probably more stringent than almost anywhere else. *Counterexample:* This does not explain why some industries dominate in countries with strict environmental and regulatory standards.
6. *Advantageous macroeconomic factors.* Exchange rates, interest rates, and government debt are some of the macroeconomic factors that provide nations with competitive advantage. For example, in the 1980s when interest rates were much higher in the United States than they were in Japan, it was much easier for Japanese firms to borrow for new projects. *Counterexample:* These factors do not explain why many nations have a rising standard of living despite rising deficits (Japan, Italy, and Korea are some examples).
7. *Cheap, abundant labor.* Although cheap labor can attract new industry, most countries with cheap labor are very poor. On the other hand, many countries (Germany, Switzerland, and Sweden are examples) have a high standard of living, high wage rates, and shortages of qualified labor.
8. *Management practices.* There is evidence that Japanese management practices are more effective in general than Western-style practices. *Counterexample:* If American management practices are so ineffective, why do we continue to dominate certain industries, such as personal computers, software development, and pharmaceuticals?

Talking about competitiveness is easier than measuring it. What are the appropriate ways to measure one country's success over another? Some possibilities are

- Balance of trade.
- Share of world exports.
- Creation of jobs.
- Low labor costs.

Arguments can be made against every one of these as a measure of international competitiveness. Switzerland and Italy have trade deficits, and at the same time have experienced rising standards of living. Similar arguments can be made for countries that import more than they export. The number of jobs created by an economy is a poor gauge of the health of that economy. More important is the quality of the jobs created. Finally, low labor costs correlate with a low standard of living. These counterexamples show that it is no easy task to develop an effective measure of international competitiveness.

Porter (1990) argues that the appropriate measure to compare national performance is the rate of productivity growth. Productivity is the value of output per unit of input of labor or capital. Porter argues that productivity growth in some industries appears to be stronger in certain countries, and that there are reasons for this. In some cases we can find the reasons in domestic factor advantages. The factor theory says all countries have access to the same technology (an assumption that is not strictly true) and that national advantages accrue from endowments of production factors such as land, labor, natural resources, and capital.

There are some excellent examples of factor theory. Korea has relatively low labor costs, so it exports labor-intensive goods such as apparel and electronic assemblies. Sweden's iron ore is low in impurities, which contributes to a strong Swedish steel industry. As compelling as it is, there are counterexamples to the factor endowment theory as well. For example, after the Korean War, South Korea developed and excelled in several highly capital-intensive industries such as steel and shipbuilding even though the country was cash poor. Also, many countries have similar factor endowments, but some seem to excel in certain industries, nonetheless. These examples suggest that factor endowments do not explain all cases of nations with dominant industry segments.

Porter (1990) suggests the following four determinants of national advantage:

1. Factor conditions (previously discussed).
2. Demand conditions. If domestic consumers are sophisticated and demanding, they apply pressure on local industry to innovate faster, which gives firms an edge internationally. Consumers of electronics in Japan are very demanding, thus positioning this industry competitively in the international marketplace.
3. Related and supporting industries. Having world-class suppliers nearby is a strong advantage. For example, the Italian footwear industry is supported by a strong leather industry and a strong design industry.
4. Firm strategy, structure, and rivalry. The manner in which firms are organized and managed contributes to their international competitiveness. Japanese management style is distinctly different from American. In Germany, many senior executives possess a technical background, producing a strong inclination to product and process improvement. In Italy, there are many small family-owned companies, which encourages individualism.

Even though Porter makes a very convincing argument for national competitive advantage in some industries, there is a debate among economists as to whether the notion of international competitiveness makes any sense at all. Companies compete, not countries. This is the point of view taken by Paul Krugman (1994). According to Krugman, the United States and Japan are simply not competitors in the same way that Ford and Toyota are. The standard of living in a country depends on its own domestic economic performance and not on how it performs relative to other countries.

Krugman argues that too much emphasis on international competitiveness can lead to misguided strategies. Trade wars are much more likely in this case. This was the case in mid-1995 when the Clinton administration was planning to impose high tariffs on makers of Japanese luxury cars. Most economists agree that trade wars and their consequences, such as tariffs, benefit no one in the long run. Another problem that arises from national competitive pride is it can lead to poorly conceived government expenditures. France has spent billions propping up its failing computer industry. (Certainly, not all government investments in domestic industry can be considered a mistake. The Japanese government, for example, played a major role in nurturing the flat-panel display industry. Japanese-based firms now dominate this multibillion dollar industry.)

Another point supporting Krugman's position is that the lion's share of U.S. gross domestic product (GDP) is consumed in the United States, thus making a firm's success in our domestic market more important than its success in the world market. Krugman agrees that productivity growth is a valid concern. He argues, however, that we should be more productive in order to produce more, not to better our international competitors.

The debate over competitive advantage will continue. Policy makers need to be aware of all points of view and weigh each carefully in formulating policy. Although Krugman makes several telling points, there is no question that globalization is a trend

# Snapshot Application

## GLOBAL MANUFACTURING STRATEGIES IN THE AUTOMOBILE INDUSTRY

Consider the following four foreign automobile manufacturers: Honda, Toyota, BMW, and Mercedes Benz. As everyone knows, Honda and Toyota are Japanese companies and BMW and Mercedes are German companies. The four account for the lion's share of foreign nameplates sold in the U.S. auto market. However, many assume that these cars are manufactured in their home countries. In fact, depending on the model, it could be more likely that a consumer buying a Honda, Toyota, BMW, or Mercedes is buying a car manufactured in the United States.

Honda was the first of the foreign automakers to commit to a significant investment in U.S.-based manufacturing facilities. Honda's first U.S. facility was its Marysville Motorcycle plant, which started production in 1979. Honda must have been pleased with the Ohio-based facility, since an automobile plant followed shortly. Automobile production in Marysville began in 1982. Today, Honda operates four plants in west-central Ohio, producing the Accord sedan and coupe, the Acura TL sedan, the Honda Civic line, and the Honda Element, with the capacity to produce a whopping 440,000 vehicles annually.

Next to make a significant commitment in U.S. production facilities was Toyota. Toyota's plant in Georgetown, Kentucky, has been producing automobiles

since 1986 and accounts for all of the Camrys sold in the domestic market. It is interesting to note that the Honda Accord and the Toyota Camry are two of the biggest-selling models in the United States, and are also produced here. They also top almost all reliability surveys.

The two German automakers were slower to commit to U.S.-based manufacturing facilities. BMW launched its Spartanburg, South Carolina, plant in March of 1995. BMW produces both the Z series sports cars and its SUV line in this plant. It is interesting to note that BMW's big sellers, its 3, 5, and 7 series sedans, are still manufactured in Germany.

Mercedes was the last of these four to make a significant commitment to production facilities here. The facility in Tuscaloosa, Alabama, is dedicated to producing the line of Mercedes SUVs. As with BMW, the more popular C, E, and S class sedans are still manufactured in Germany.

(One might ask why Volkswagen is not on this list. In fact, Volkswagen has 45 separate manufacturing facilities located in 18 countries around the world, but no significant manufacturing presence in the mainland United States.)

**Sources:** Honda's Web site (<http://www.ohio.honda.com/>), Toyota's Web site (<http://www.toyota.com>), AutoIntell's Web site ([http://www.autointell-news.com/european\\_companies/BMW/bmw3.htm](http://www.autointell-news.com/european_companies/BMW/bmw3.htm)), Mercedes Benz's Web site (<http://www.mbusi.com/>).

that shows no sign of reversing. We cannot stick our heads in the sand and say that foreign markets are not important to us. Economic borders are coming down all across the globe.

## Problems for Sections 1.1–1.3

1. Why is it undesirable for the United States to evolve into a service economy?
2. What disadvantages do you see if the chief executive officer (CEO) is primarily concerned with short-term ROI?
3. Can you think of companies that have gone out of business because they focused only on cost and were not able to achieve a minimum quality standard?
4. What are the different quality standards referred to in the example comparing the Honda Civic and the Ferrari?
5. Discuss the pros and cons of trade barriers from the industry point of view and from the consumer point of view.
6. What are the advantages and disadvantages of producing new products in existing facilities?
7. What are the four determinants of national advantage suggested by Porter? Give examples of companies that have thrived as a result of each of these factors.
8. What factor advantage favors the aluminum industry in the United States over Japan and makes aluminum much cheaper to produce here? (Hint: Aluminum



production is very energy intensive. In what part of the country is an inexpensive energy source available?)

9. Paul Krugman argues that because most of our domestic product is consumed domestically, we should not dwell on international competition. What industries in the United States have been hardest hit by foreign competition? What are the potential threats to the United States if these industries fail altogether?
10. Krugman points out some misguided government programs that have resulted from too much emphasis on international competitiveness. What risks are there from too little emphasis on international competitiveness?
11. Consider the Snapshot Application in this section concerning foreign automakers locating manufacturing facilities in the United States. Discuss the advantages and disadvantages of the strategy of locating manufacturing facilities where the product is consumed rather than where the company is located.
12. The North American Free Trade Agreement (NAFTA) was established in 1994 under the Clinton administration.
  - a) What was the purpose of NAFTA?
  - b) At the time, political opponents characterized “the big sucking sound” as jobs would be lost as a result. Is there any evidence that this was, in fact, the case?

## 1.4 STRATEGIC INITIATIVES: REENGINEERING THE BUSINESS PROCESS

Seemingly on schedule, every few years a hot new production control method or management technique comes along, almost always described by a three-letter acronym. While it is easy to be skeptical, by and large, the methods are sound and can have substantial value to corporations when implemented intelligently. *Business process reengineering* (BPR) caught on after the publication of the book by Hammer and Champy (1993). BPR is not a specific technique, such as materials requirements planning or a production-planning concept like just-in-time. Rather, it is the idea that entrenched business processes can be changed and can be improved. The process is one of questioning why things are done a certain way, and not accepting the answer, “because that’s the way we do it.”

Hammer and Champy, who define BPR as “starting over,” provide several examples of successful reengineering efforts. The first is the IBM Credit Corporation, a wholly owned subsidiary of IBM, that, if independent, would rank among the *Fortune* 100 service companies. This arm of IBM is responsible for advancing credit to new customers purchasing IBM equipment. The traditional credit approval process followed five steps:

1. An IBM salesperson would call in with a request for financing and the request would be logged on a piece of paper.
2. Someone carried the paper upstairs to the credit department, where someone else would enter the information into a computer system and check the potential borrower’s credit rating. The specialist wrote the results of the credit check on a piece of paper, which was sent off to the business practices department.
3. A third person, in the business practices department, modified the standard loan document in response to the customer request. These modifications, which were done on yet another computer system, were then attached to the original request form and the credit department specialist’s report.

4. Next the request went to a pricer, who keyed the information into a spreadsheet to determine the appropriate interest rate to charge the customer. The pricer's recommendation was written on a piece of paper and delivered (with the other papers) to the clerical group.
5. The information was turned into a quote letter that would be delivered to the field salesperson by Federal Express.

This process required an average of six days and sometimes as long as two weeks. Sales reps logged endless complaints about this delay: during this time, the customer could find other financing or another vendor. In an effort to see if this process could be streamlined, two senior managers decided to walk a new request through all five steps, asking personnel to put aside what they were doing and process it as they normally would. They found that the entire five-step process required an average of only 90 minutes of work! The rest of the time, requests were either in transit from one department to another or queuing up on somebody's desk waiting to be processed. Clearly the problem did not lie with the efficiency of the personnel but with the design of the credit approval process itself.

The solution was simple: the four specialists handling each loan request were replaced by a single loan generalist who handled each request from beginning to end. Up-to-date software was designed to support the generalist, who had no trouble dealing with most requests. The credit approval process was designed assuming that each request was sufficiently complex to require someone with special knowledge in each area. In truth, most requests were routine, and specialists generally did little more than a simple table lookup to determine the appropriate figure.

What was the result of this change? The six-day turnaround for loan requests was slashed to only four hours! And this was accomplished with fewer personnel and with a hundredfold increase in the number of deals handled.

While each reengineering effort requires careful thought and no two solutions will be exactly alike, Hammer and Champy (1993) suggest that reengineering efforts utilize the following general principles:

1. *Several jobs are combined into one.* Few examples of BPR are as dramatic as that of IBM Credit, but there are other success stories in the literature as well. Many of the successful cases have a common thread: the reduction of a complex process requiring many steps to a simpler one requiring fewer steps. In the case of IBM Credit, a five-step process was reduced to only a single step. This suggests a general principle. The IBM Credit process was a natural evolution of the concept of division of labor. The economist Adam Smith espoused this principle as far back as the 18th century (see the quote from *The Wealth of Nations* at the beginning of Section 1.10 of this chapter). However, a good thing can be carried too far. If one divides a process into too many steps, one eventually reaches the point of diminishing returns. BPR's most dramatic successes have come from complex processes that were simplified by reducing the number of steps required.

2. *Workers make decisions.* One goal is to reduce the number of levels of reporting by allowing workers to make decisions that were previously reserved for management. In the case of IBM Credit, most decisions once reserved for specialists are now done by a single generalist. Giving workers greater decision-making power may pose a threat to management, who might see such a step as encroaching on their prerogatives.

3. *The steps in the process are performed in a natural order.* Process steps should not be performed necessarily in rigid linear sequence, but in an order that makes sense in the context of the problem being solved. In particular, in many cases, some tasks can be

done simultaneously rather than in sequence. (These ideas, of course, are well known and form the basis for the concepts of project management in Chapter 10.)

4. *Processes should have multiple versions.* One should allow for contingencies, not by designing multiple independent processes, but by designing one flexible process that can react to different circumstances. In the case of IBM Credit, for example, the final credit issuance process had three versions: one for straightforward cases (handled by computer), one for cases of medium difficulty (handled by the deal structurer), and one for difficult cases (performed by the deal structurer with help from specialist advisers).

5. *Work is performed where it makes the most sense.* One of the basic principles of reengineering is not to carry the idea of division of labor too far. Another is not to carry the idea of centralization too far. For example, in most companies, purchasing is done centrally. This means that every purchase request is subject to the same minimum overhead in time and paperwork. A consequence might be that the cost of processing a request exceeds the cost of the item being purchased! A great deal can be saved in this case by allowing individual departments to handle their own purchasing for low-cost items. (Hammer and Champy discuss such a case.)

The authors list several other basic principles, involving minimizing checks and reconciliations, having a single point of contact, and being able to employ hybrid centralized/decentralized operations.

It is easier to list the steps one might consider in a reengineering effort than to actually implement one. In the real world, political realities cannot be ignored. For many of the success stories in the literature, not only are the processes simplified, but the headcount of personnel is reduced as well. It is certainly understandable for employees to see BPR as a thinly veiled excuse for downsizing (euphemistically called “right-sizing”). This was exactly the case in one financial services company. When word got out that management was planning a reengineering effort, most assumed that there would be major layoffs. Some even thought the company was on the verge of bankruptcy. In another instance, union leadership saw reengineering as a means for management to throw away the job categories and work rules they had won in hard-fought negotiations over the years, and persuaded the members to strike. In a third case, a senior manager was unhappy with the potential loss of authority that might accompany a reengineering effort. He resigned to start his own company. (These examples are related in a follow-up book by Hammer and Stanton, 1995.)

These stories show that starting a reengineering effort is not without risks. Rarely is the process as simple as IBM’s. Reengineering has been described by Ronald Compton, the CEO of Aetna Life and Casualty, as “agonizingly, heartbreakingly, tough.” There needs to be some cost–benefit analysis done up front to be sure the potential gains compensate for the risks.

Process optimization is not new. In its early years, the field of industrial engineering dealt with optimal design of processes, setting standards using time and motion studies, and flowcharting for understanding the sequence of events and flow of material in a factory. Why is BPR different? For one, BPR is concerned with business process flows rather than manufacturing process flows. Second, the concept is not one of optimizing an existing process, but one of rethinking how things should be done from scratch. As such, it is more revolutionary than evolutionary. It is likely to be more disruptive but could have larger payoffs. To make BPR work, employees at every level have to buy into the approach, and top management must champion it. Otherwise, the reengineering effort could be a costly failure.

## 1.5 STRATEGIC INITIATIVES: JUST-IN-TIME

*Just-in-time (JIT)* is a manufacturing process on one hand and a broad-based operations strategy on the other. The process elements of JIT will be discussed in detail in Chapter 8 as part of a complete analysis of push and pull inventory systems. However, JIT (or lean production, as it is also known) is a philosophy that includes treatment of inventory in the plant, relationships with suppliers, and distribution strategies. The core of the philosophy is to eliminate waste. This is accomplished by efficient scheduling of incoming orders, work-in-process inventories, and finished goods inventories.

JIT is an outgrowth of the **kanban system** introduced by Toyota. Kanban is a Japanese word meaning card or ticket. Originally, kanban cards were the only means of implementing JIT. The kanban system was introduced by Toyota to reduce excess work-in-process (WIP) inventories. Today, JIT is more ambitious. Both quality control systems and relationships with suppliers are part of an integrated JIT system. JIT systems can be implemented in ways other than using kanban cards. Integrating JIT philosophies with sophisticated information systems makes information transfer faster. The speed with which information can be transferred from one part of the firm to another is an important factor in the success of the JIT system.

JIT is a philosophy of operating a company that includes establishing understandings and working relationships with suppliers, providing for careful monitoring of quality and work flow, and ensuring that products are produced only as they are needed. Although JIT can be used simply as it was originally designed by Toyota, namely as a means of moving work-in-process (WIP) from one work center to another, proponents of the method recommend much more. They would have a firm integrate the JIT philosophy into its overall business strategy.

Inventory and material flow systems are classified as either **push** or **pull systems**. A push system is one in which decisions concerning how material will flow through the system are made centrally. Based on these decisions, material is produced and “pushed” to the next level of the system. A typical push system is materials requirements planning (MRP), which is discussed in detail in Chapter 8. In MRP, appropriate production amounts for all levels of the production hierarchy are computed all at once based on forecasts of end-product demand and the relationship between components and end items. In JIT, production is initiated at one level as a result of a request from a higher level. Units are then “pulled” through the system.

JIT has many advantages over conventional systems. Eliminating WIP inventories results in reduced holding costs. Less inventory means less money tied up in inventory. JIT also allows quick detection of quality problems. Since units are produced only as they are needed, the situation in which large amounts of defective WIP inventory are produced before a quality problem is detected should never occur in a properly running JIT system. JIT also means that relationships with suppliers must be tightened up. Suppliers must be willing to absorb some uncertainty and adjust delivery quantities and the timing of deliveries to match the rates of product flows.

Part of what made the kanban system so effective for Toyota was its success in reducing setup times for critical operations. The most dramatic example of setup time reduction is the so-called SMED, or single-minute exchange of dies. Each time a major change in body style is initiated, it is necessary to change the dies used in the process.

The die-changing operation typically took from four to six hours. During the die-changing operation the production line was closed down. Toyota management heard that Mercedes Benz was able to reduce its die-changing operation to less than one hour. Realizing that even more dramatic reductions were possible, Toyota set about focusing on the reduction of the time required for die changing. In a series of dramatic improvements, Toyota eventually reduced this critical operation to only several minutes. The essential idea behind SMED is to make as many changes as possible off-line, while the production process continues.

An important part of JIT is forming relationships with suppliers. What separates JIT purchasing from conventional purchasing practices? Freeland (1991) gives a list of characteristics contrasting the conventional and JIT purchasing behavior. Some of these include

<b>Conventional Purchasing</b>	<b>JIT Purchasing</b>
1. Large, infrequent deliveries.	1. Small, frequent deliveries.
2. Multiple suppliers for each part.	2. Few suppliers; single sourcing.
3. Short-term purchasing agreements.	3. Long-term agreements.
4. Minimal exchange of information.	4. Frequent information exchange.
5. Prices established by suppliers.	5. Prices negotiated.
6. Geographical proximity unimportant.	6. Geographical proximity important.

In his study, Freeland notes that the industries that seemed to benefit most from JIT purchasing were those that typically had large inventories. Companies without JIT purchasing tended to be more job-shop oriented or make-to-order oriented. Vendors that entered into JIT purchasing agreements tended to carry more safety stock, suggesting manufacturers are reducing inventories at the expense of the vendors. The JIT deliveries were somewhat more frequent, but the differences were not as large as one might expect. Geographical separation of vendors and purchasers was a serious impediment to successful implementation of JIT purchasing. The automotive industry was one that reported substantial benefit from JIT purchasing arrangements. In other industries, such as computers, the responses were mixed; some companies reported substantial benefits and some reported few benefits.

Although reducing excess work-in-process inventory can have many benefits, JIT is not necessarily the answer for all manufacturing situations. According to Stasey and McNair (1990),

Inventory in a typical plant is like insurance, insurance that a problem in one area of a plant won't affect work performed in another. When problems creating the need for insurance are solved, then inventories disappear from the plant floor.

The implication is that we merely eliminate all sources of uncertainty in the plant and the need for inventories disappears. The problem is that there are some sources of variation that can never be eliminated. One is variation in consumer demand. JIT is effective only if final demand is regular. Another may be sources of variation inherent in the production process or in the equipment. Can one simply legislate away all sources of uncertainty in the manufacturing environment? Of course not. Hence, although the underlying principles of JIT are sound, it is not a cure-all and will not necessarily be the right method for every production situation.



## 1.6 STRATEGIC INITIATIVES: TIME-BASED COMPETITION

Professor Terry Hill of the London School of Business has proposed an interesting way to look at competitive factors. He classifies them into two types: “qualifiers” and “order winners.” A product not possessing a qualifying factor is eliminated from consideration. The order winner is the factor that determines who gets the sale among the field of qualifiers.

Two factors about which we hear a great deal are quality and **time to market**. In the past decade, the Japanese and Germans gained a loyal following among U.S. consumers by producing quality products. American firms are catching up on the quality dimension. From the discussion in Section 1.6, we see that successful U.S.-based companies have been able to produce products that match the defect rates of foreign competitors. If this trend continues, product quality will be assumed by the consumer. Quality may become an order qualifier rather than an order winner.

If that is the case, what factors will determine order winners in years to come? Japanese automobile companies provided and continue to provide high-quality automobiles. In recent years, however, the major automobile producers in Japan have begun to focus on aesthetics and consumer tastes. They have branched out from the stolid small cars of the 1970s and 1980s to new markets with cars such as the Toyota-made Lexus luxury line and Mazda’s innovative and successful Miata.

The timely introduction of new features and innovative design will determine the order winners in the automobile industry. In the computer industry, Compaq built its reputation partly on its ability to be the first to market with new technology. Time-based competition is a term that we will hear more and more frequently in coming years.

What is **time-based competition**? It is not the time and motion studies popular in the 1930s that formed the basis of the industrial engineering discipline. Rather, according to Blackburn (1991),

Time-based competitors focus on the bigger picture, on the entire value-delivery system. They attempt to transform an entire organization into one focused on the total time required to deliver a product or service. Their goal is not to devise the best way to perform a task, but to either eliminate the task altogether or perform it in parallel with other tasks so that over-all system response time is reduced. Becoming a time-based competitor requires making revolutionary changes in the ways that processes are organized.

Successful retailers understand time-based competition. The success of the fashion chains The Gap and The Limited is due largely to their ability to deliver the latest fashions to the customer in a timely manner. Part of the success of the enormously successful Wal-Mart chain is its time-management strategy. Each stock item in a Wal-Mart store is replenished twice a week, while the industry average is once every two weeks. This allows Wal-Mart to achieve better inventory turnover rates than its competition and respond more quickly to changes in customer demand. Wal-Mart’s strategies have enabled it to become the industry leader, with a growth rate three times the industry average and profits two times the industry average (Blackburn, 1991, Chapter 3).

Time-based management is a more complex issue for manufacturers, and in some industries it is clearly the key factor leading to success or failure. The industry leaders in the dynamic random access memory (DRAM) industry changed four times between 1978 and 1987. In each case, the firm that was first to market with the next-generation

DRAM dominated that market. The DRAM experience is summarized in the following table (Davis, 1989):

Product	Firm	Year Introduced	First Year of Volume Production	Market Leaders in First Year of Volume Production
16 K	Mostek	1976	1978	Mostek (25%) NEC (20%)
64 K	Hitachi	1979	1982	Hitachi (19%) NEC (15%)
256 K	NEC	1982	1984	NEC (27%) Hitachi (24%)
1 MB	Toshiba	1985	1987	Toshiba (47%) Mitsubishi (16%)

I am aware of no other example that shows so clearly and so predictably the value of getting to the market first.

## 1.7 STRATEGIC INITIATIVES: COMPETING ON QUALITY

What competitive factors do American managers believe will be important in the next decade? Based on a survey of 217 industry participants, the following factors were deemed as the most important for gaining a competitive edge in the coming years; they are listed in the order of importance.

1. Conformance quality
2. On-time delivery performance
3. Quality
4. Product flexibility
5. After-sale service
6. Price
7. Broad line (features)
8. Distribution
9. Volume flexibility
10. Promotion

In this list we see some important themes. **Quality** and **time management** emerge as leading factors. Quality control was brought to public attention with the establishment of the prestigious Malcolm Baldrige Award (modeled after the Japanese Deming Prize, which has been around a lot longer). Quality means different things in different contexts, so it is important to understand how it is used in the context of manufactured goods. A high-quality product is one that performs as it was designed to perform. Products will perform as they are designed to perform if there is little variation in the manufacturing process. With this definition of quality, it is possible for a product with a poor design to be of high quality, just as it is possible for a well-designed product to be of poor quality. Even granting this somewhat narrow definition of quality, what is the best measure? Defect rates are a typical barometer. However, a more appropriate measure might be reliability of the product after manufacture. This measure is typically used to monitor quality of products such as automobiles and consumer electronics.

There has been an enormous groundswell of interest in the quality issue in the United States in recent years. With the onslaught of Japanese competition, many American

industries are fighting for their lives. The business of selling quality is at an all-time high. Consulting companies that specialize in providing quality programs to industry, such as the Juran Institute and Philip Crosby Associates, are doing a booming business. The question is whether American firms are merely paying lip service to quality or are seriously trying to change the way they do business. There is evidence that, in some cases at least, the latter is true.

For example, in a comparison of American and Japanese auto companies, quality as measured by defects reported in the first three months of ownership declined significantly from 1987 to 1990 for U.S. companies, narrowing the gap with Japan significantly. The Buick Division of General Motors, a winner of the Baldrige Award, has made dramatic improvements along these lines. Between 1987 and 1990 Buick decreased this defect rate by about 70 percent, equaling the rate for Hondas in 1990 (*Business Week*, October 22, 1990).

There are many success stories in U.S. manufacturing. Ford Motors achieved dramatic success with the Taurus. Ford improved both quality and innovation, providing buyers with reliable and technologically advanced cars. In 1980, James Harbour reported that Japanese automakers could produce a car for \$1,500 less than their American counterparts. That gap has been narrowed by Ford to within a few hundred dollars. Part of Ford's success lies in former CEO Donald Petersen's decision not to invest billions in new plants incorporating the latest technology as GM did in the mid-1980s. This is only part of the story, however. According to Faye Wills (1990),

If you are looking for surprise answers to Ford's ascendancy, for hidden secrets, forget it. Good solid everyday management has turned the trick—textbook planning and execution, common-sense plant layouts and procedures, intelligent designs that not only sell cars, but also cut costs and bolster profit margins. It's that simple.

We can learn from our successes. The machine tool industry was one in which the Japanese made dramatic inroads in the 1980s. Many American firms fell to the onslaught of Asian competition, but not the Stanley Works of New Britain, Connecticut. In 1982, the firm's president was considering whether Stanley should remain in the hardware business as Asian firms flooded the U.S. market with low-priced hammers, screwdrivers, and other tools. Stanley decided to fight back. It modernized its plants and introduced new quality control systems. Between 1982 and 1988 scrap rates dropped from 15 percent to only 3 percent at New Britain. Stanley not only met the competition head-on here at home, but also competed successfully in Asia. Stanley now runs a profitable operation selling its distinctive yellow tape measures in Asia.

Where are most PC clones made? Taiwan? Korea? Guess again. The answer may surprise you: Texas. Two Texas firms have been extremely successful in this marketplace. One is Compaq Computer (now part of HP), which entered the market in the early 1980s with the first portable PC. It continued to build well-designed and high-quality products, and rose to command 20 percent of the world's PC market. Compaq established itself as a market leader. The other successful PC maker, Dell Computer, is also from Texas. The sudden rise of Dell is an interesting story. Michael Dell, a former University of Texas student, started reselling IBM PCs in the early 1980s. He later formed PC's Limited, which marketed one of the first mail-order PC clones. Dell is now a market leader in the PC marketplace, offering a combination of state-of-the-art designs, high-quality products, and excellent service.

Another American firm that has made a serious commitment to quality is Motorola. Motorola, winner of the Baldrige Award in 1987, has been steadily driving down the

rate of defects in its manufactured products. Defects were reported to be near 40 parts per million at the end of 1991, down from 6,000 parts per million in 1986. Motorola has announced that its goal is to reach six-sigma (meaning six standard deviations away from the mean of a normal distribution), which translates to 3.4 parts per million. Motorola feels that the process of applying for the Baldrige Award was so valuable that it now requires all its suppliers to apply for the award as well.

Success stories like these show that the United States can compete successfully with Japan and other overseas rivals on the quality dimension. However, total quality management must become ingrained into our culture if we are going to be truly world class. The fundamentals must be there. The systems must be in place to monitor the traditional quality measures: conformance to specifications and defect-free products. However, quality management must expand beyond statistical measures. Quality must pervade the way we do business, from quality in design, quality in manufacture, and quality in building working systems with vendors, to quality in customer service and satisfaction.

### Problems for Sections 1.4–1.7

13. What is an operational definition of quality? Is it possible for a 13-inch TV selling for \$100 to be of superior quality to a 35-inch console selling for \$1,800?
14. Studies have shown that the defect rates for many Japanese products are much lower than for their American-made counterparts. Speculate on the reasons for these differences.
15. What does “time-based competition” mean? Give an example of a product that you purchased that was introduced to the marketplace ahead of its competitors.
16. Consider the old maxim, “Build a better mousetrap and the world will beat a path to your door.” Discuss the meaning of this phrase in the context of time-based competition. In particular, is getting to the market first the only factor in a product’s eventual success?
17. What general features would you look for in a business process that would make that process a candidate for reengineering? Discuss a situation from your own experience in which it was clear that the business process could have been improved.
18. In what ways might the following techniques be useful as part of a reengineering effort?
  - Computer-based simulation
  - Flowcharting
  - Project management techniques
  - Mathematical modeling
  - Cross-functional teams
19. What problems can you foresee arising in the following situations?
  - a. Top management is interested in reengineering to cut costs, but the employees are skeptical.
  - b. Line workers would like to see a reengineering effort undertaken to give them more say-so in what goes on, but management is uninterested.
20. Just-in-time has been characterized as a system whose primary goal is to eliminate waste. Discuss how waste can be introduced in (a) relationships with vendors,

(b) receipt of material into the plant, and (c) movement of material through the plant. How do JIT methods cut down on these forms of waste?

21. In what ways can JIT systems improve product quality?

## 1.8 STRATEGIC INITIATIVES: SERVICIZATION

Hyundai is a huge multinational company based in South Korea, known as a chaebol, meaning a collection of diverse companies under a single umbrella. Prior to spinning off several of its businesses as separate companies following the Asian financial crisis in 1997, Hyundai was the largest chaebol in South Korea. The Hyundai Motor Company was established in 1967 and first began selling cars in the United States in 1986. At that time, Japanese, American, and European carmakers were firmly entrenched in the lucrative U.S. market. One way in which Hyundai sought to differentiate itself from its competitors was by offering an exceptional warranty. Today Hyundai offers a comprehensive warranty package, including a seven year/100,000 mile powertrain warranty. Sales of Hyundai models have risen steadily since 1986, with the company now offers high-end luxury vehicles, along with its low-cost entry models.

While there is no question that competitive pricing and improving reliability and performance of its products account for much of the company's success, one cannot deny that their exceptional warranties played a role as well. We will use the term "servicization" to describe the trend of manufacturing companies to bundle additional services with their products. Adding services is a means for firms to gain an edge over their competitors, and to provide an alternative to inexpensive Asian labor. (Note that the Europeans have coined the term "servitization". The term appears to have been first used by Vandermerwe and Rada (1988).

Cost-only considerations have driven much of the worldwide manufacturing to China. The Chinese economy has benefitted enormously from the investments from foreign economies, led by the United States and Japan. However, there is more to being an effective manufacturer than low labor rates. The quality of service in many overseas factories can be disappointing. Quality problems are common and turnaround times can be crippling. Such factors have lead many firms to rethink their decision to subcontract their manufacturing to Chinese factories.

Consider the case of Sleek Audio, a producer of high-end earphones. Following the trend of his competitors, the CEO, Mark Krywko, decided to have his product manufactured in a factory in Dongguan, China. Unfortunately, Krywko and his son Jason found it necessary to travel to Dongguan every few months because of persistent quality problems. For example, an entire shipment of 10,000 earphones had to be scrapped because of improper welding. Delivery delays resulted in emergency air freighting to meet promised deadlines. Furthermore, design changes took months to be implemented. As problems continued to mount, the Krywko's finally decided they'd had enough. Once the decision to come back to the states was made, Sleek Audio had no problem finding a suitable domestic partner. The earphones are now manufactured by Dynamic Innovations, whose facility is located only 15 minutes away from the company's headquarters in Palmetto, Florida. And how has the decision panned out? After more than a year producing in the United States, Sleek Audio is projecting 2011 to be the most profitable year in the company's history (Koerner, 2011).

### Servicization: Moving Downstream

Wise and Baumgartner (1999) have noted that many manufacturing companies have moved their energies downstream to remain competitive. As the installed base of products increase, and the demand for new products decrease, firms are changing their business model in order to remain competitive. The focus is no longer on the manufacturing



function alone, but on those services required to operate and maintain products. During the 40-year period of 1960–2000, the service sector share of the U.S. economy grew 16 percentage points while manufacturing's share declined by 10 percentage points. What are some of the downstream activities that manufacturers are becoming more involved with? The answer is financing, after sales parts and services, and possibly training. The profit margins on service typically exceed those of manufacturing, thus providing an incentive for firms to move in this direction. Of course, the model of vertical integration is far from new. Part of Henry Ford's success was the complete vertical integration of the firm. Ford not only produced the cars, but owned the dealerships where the cars were sold and even owned the stands of rubber trees used to make tires.

As firms became more specialized, they moved away from vertical integration. However, changing patterns of demands and profits are leading many companies back in this direction. As an example, the Boeing Company, the world's foremost manufacturer of commercial aircraft, has significantly broadened its view of the value chain. The company now offers financing, local parts supply, ground maintenance, logistics management, and even pilot training. Servicization can be the key to maintaining competitiveness.

### **The IBM Story**

IBM has become almost synonymous with computing, but few realize that IBM had its roots in mechanical tabulating machines dating to the late 1800s. The company's start came in 1890 when the German immigrant, Herman Hollerith, developed a new process to track the U.S. census. Hollerith's concept involved the use of punched cards, which persisted into the 1960s. The original firm established by Hollerith was the Tabulating Machine Company. In 1924, 10 years after T.J. Watson joined the firm, the name was changed to International Business Machines, or IBM. IBM continued to innovate mechanical computing machines, but was actually a relative late comer into the electronic computer business. In fact, the first commercial computer was produced by Engineering Research Associates of Minneapolis in 1950 and sold to the U.S. Navy. Remington Rand produced the Univac one year later, which was the first commercially viable machine. They sold 46 machines that year at a cost of over \$1 million each. IBM entered the fray in 1953 when it shipped its first computer, the 701. During three years of production, IBM only sold 19 machines. In 1955, AT&T Bell Laboratories announced the first fully transistorized computer, the TRADIC, and a year later the Burroughs Corporation threw its hat into the ring and later became a major player in the computer business. Eventually, Burroughs merged with Sperry Rand to form Unisys.

In 1959, IBM produced its first transistorized-based mainframe computer, the 7000 series. However, it was not until 1964 that the firm became a leader in computer sales. That was the year that IBM announced the system 360. This was a family of six mutually compatible computers and 40 peripherals that worked seamlessly together. There is little question that the system 360 computers were state of the art at the time. Within two years IBM was shipping 1000 systems per month. IBM has been dominant in the mainframe business ever since. While all of us are familiar with personal computers of various types and configurations, the mainframe business has not gone away. Even today, IBM continues to be a presence in the mainframe business with their newest system z architecture.

While the quality of their hardware was an important factor in IBM's success, it was not the only factor. What really sealed IBM's domination of the business market was the total customer solution. IBM's industry-specific software and the 360 operating system were a large part of attracting customers away from its competitors. IBM not only had one of the most successful sales forces in the business, but also was a master of after-sales service. Each client would have an SE (systems engineer) assigned to make sure that their needs were met. As much as anything else, it was IBM's commitment to after-sales service that locked in their position as market leader in mainframe

computing. Clearly, the idea of edging out competitors by bundling services with products is not new, however, today the servicization concept is becoming an increasingly important means of gaining competitive advantage. (Information was gathered from [www.computerhistory.org](http://www.computerhistory.org) and the IBM company website for this section).

### Performance Based Contracts

The impetus behind performance based contracting (PBC) was to reduce excessive costs in government contracting. Costs were being driven up by unnecessary provisions that specified exactly how each contract was to be carried out. According to Jon Desenberg of the Washington-based Performance Institute, a think tank dedicated to improving government performance, the idea “is to let the contracted group come up with the best possible solution and only pay them based on solving the problem . . . not on the individual steps and minutia that we have for so many years required.”

Government contracts are a “why,” “how,” and “what” proposition. The “why” is established by the funding agency. Under PBC the “how” is shifted from the government to the contractor to determine the best way to achieve the “what”. This is not always a win-win for the contractor. The task of pricing a contract now becomes much more onerous. It can be difficult to estimate all costs in advance, and who pays for contract changes can be problematic.

PBC’s are typical for consumers seeking professional services. A plumber may quote a fixed price in advance for a simple job, but if there’s uncertainty about the time required, might want to be compensated on a time plus materials basis. Anyone who has had a major remodeling of their homes is likely to have entered into a PBC with their contractor. However, it is rare that the final cost matches the quoted number for a variety of reasons: weather delays, poor estimation of material costs, difficulty in finding subcontractors, and more often than not, changes made in the original project by the homeowner.

While PBC’s sound like a good solution for government contracting, it can lead to the wrong kind of behavior. As an example, Shen (2003) examines the result of PBC’s in the Maine Addiction Treatment System. Because the system was being measured on the success of curing addicts, the center had a strong incentive to only treat the less severe cases. This, of course, runs counter to the purpose of a treatment center; it is the most severe cases of abuse that need attention. We can conclude that a PBC is not appropriate in all circumstances. For any contract it is important that incentives be properly aligned with desired outcomes.

### Leasing Versus Buying

Leases may be viewed as a service provided to the consumer by the seller. In most cases, leasing is simply another way for the consumer to finance a purchase. It can also be viewed as a means for the consumer to reduce risk. The trend towards leasing of goods and services has increased substantially in recent years for several reasons.

Car leasing has long been an option for consumers. Leases are more popular when financing is difficult or expensive to obtain. The prospect of a low monthly payment attracts consumers, who may ultimately pay more in the long run. Consider the buyer that likes to drive a relatively new car and trades in their automobile every three years. This buyer faces the risk of not being able to accurately predict the trade-in value of the car three years down the road. In a lease situation, this residual risk is assumed by the seller. The terms of the lease are predicated on an assumption about the residual value of the car at the end of the lease. If the manufacturer overestimates the residual value of the car, the consumer benefits by simply turning the car in at the end of the lease period. If the manufacturer underestimates the residual value, the leaser wins by purchasing the car at the end of the lease and selling it for a higher market price. Hence, the manufacturer absorbs the risk of estimating the depreciation, which provides an incentive to the consumer to lease rather than buy. Of course, since automobiles tend to depreciate most in the first several years, buying and holding a

car will be a less expensive alternative in the long run for most vehicles—especially those that are more durable and more reliable. Since auto leases are typically two to four years, the buyer that keeps cars for a long time will not choose to lease.

Leasing (that is, renting) versus buying is also an important choice for the consumer when it comes to choosing how and where to live. While owning a home has been touted as the “American Dream,” there are clearly many who should not be homeowners. In the United States, most homeowners have a mortgage on their primary property. A mortgage is simply a loan provided to homeowner, with the home itself as the collateral. In periods when housing prices are rising faster than inflation, homeowners have done very well. However, as we’ve seen in recent years, rising housing prices is not a certainty. There have been several periods in which housing prices have dropped precipitously, including the Great Depression of the 1930s. In fact, as of this writing, the housing industry has been in a slump since 2008.

The mortgage crisis of 2008 led to a total collapse of many major financial institutions, and nearly caused a worldwide depression. What precipitated this crisis? In a nutshell, it was awarding mortgages to individuals that did not qualify for them. Why did this happen? There were a variety of factors including government deregulation, unscrupulous mortgage brokers, and naive consumers. The stringent standards that banks traditionally applied before awarding mortgages were thrown out the window. When real estate prices were on an apparent never-ending upward spiral, homeowners borrowed well beyond their means to finance other houses, or large capital expenditures such as boats or cars. People who had never owned a home in their lives were cajoled by unscrupulous mortgage brokers into taking loans they had no chance of paying off. Housing prices climbed far beyond reasonable levels, and when the bubble burst, millions of homeowners found themselves underwater (meaning their houses were worth less than the balance of their mortgage loans). Since many loans were granted with little or no down payment, many just walked away from their homes leaving entire neighborhoods vacant. Homes were looted for valuable materials, such as copper piping, thus assuring that these homes would never be sellable.

Renting is a sensible choice for many. While there appears to be a stigma associated with being a renter, it became clear from the subprime loan debacle that, in fact, many folks have no business owning a home. Landlords must absorb the risks of repairs and price fluctuations. It is no longer obvious that real estate is necessarily a safe investment. Perhaps the mortgage crises can be viewed as a case of servicization gone out of control.

## **Green Leasing**

A recent trend has been towards green leasing. According to the U.S. Green Building Council, buildings account for more than one-third of all energy use, carbon dioxide emissions, waste output, and use of raw materials in the United States. While green leasing is a relatively new concept to American companies, it has been a practice in other parts of the world for years. Several foreign governments have promulgated environmental-based rules for their properties. In America, however, the movement is far less centralized.

Most green leasing initiatives in the United States have been proposed by state and local governments. Government agencies and academic institutions have been the front runners in green building technology, representing approximately 26 percent of all LEED certified buildings. LEED, developed by the Green Building Council, is an internationally recognized certification system that measures building performance in categories such as: energy savings, water efficiency, carbon dioxide emissions, indoor environmental quality, and resource management. LEED also provides a framework for stages throughout a building’s lifecycle, from design and construction to operation and management. LEED provides several levels of certification. Most green building initiatives provide either incentives or penalties based upon a building’s LEED certification level.

## Problems for Section 1.8

22. Define “servicization” and provide an example from your own experience of a case where services were the deciding factor in a purchase.
23. What are some of the services that IBM provided for its mainframe customers during its meteoric rise in sales in the 1960s?
24. Why can car leasing be viewed as a service? What are the advantages and disadvantages of car leasing from the buyer’s point of view? Why do manufacturers offer leases?

## 1.9 MATCHING PROCESS AND PRODUCT LIFE CYCLES

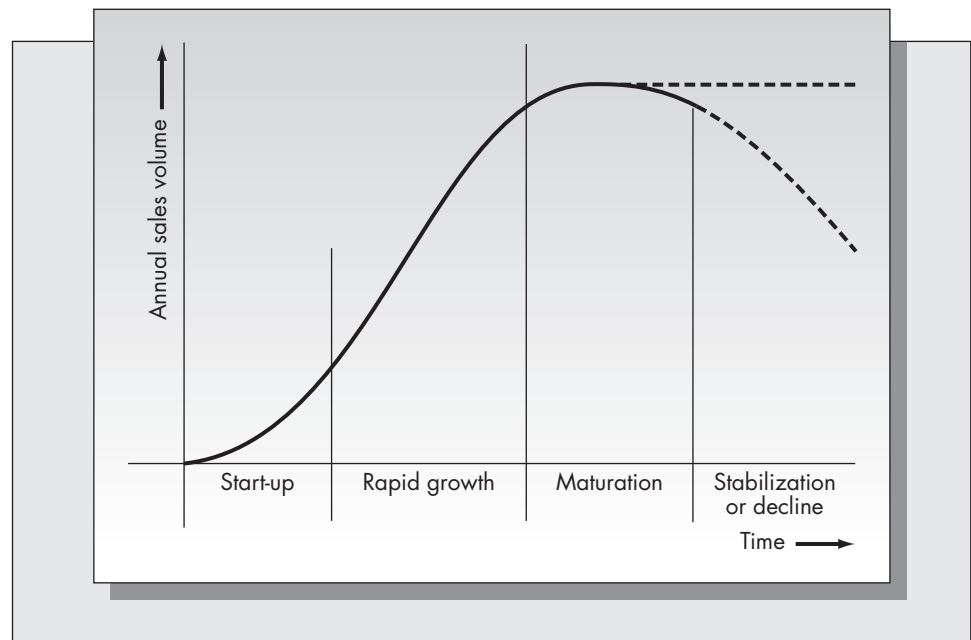
### The Product Life Cycle

The demand for new products typically undergoes cycles that can be identified and mapped over time. Understanding the nature of this evolution helps to identify appropriate strategies for production and operations at the various stages of the product cycle. A typical product life cycle is pictured in Figure 1–3. The product life cycle consists of four major segments:

1. Start-up
2. Rapid growth
3. Maturation
4. Stabilization or decline

During the start-up phase, the market for the product is developing, production and distribution costs are high, and competition is generally not a problem. During this phase the primary strategy concern is to apply the experiences of the marketplace and of manufacturing to improve the production and marketing functions. At this time, serious design flaws should be revealed and corrected.

**FIGURE 1–3**  
The product life-cycle curve



The period of rapid growth sees the beginning of competition. The primary strategic goal during this period is to establish the product as firmly as possible in the marketplace. To do this, management should consider alternative pricing patterns that suit the various customer classes and should reinforce brand preference among suppliers and customers. The manufacturing process should be undergoing improvements and standardization as product volume increases. Flexibility and modularization of the manufacturing function are highly desirable at this stage.

During the maturation phase of the product life cycle, the objective should be to maintain and improve the brand loyalty that the firm cultivated in the growth phase. Management should seek to increase market share through competitive pricing. Cost savings should be realized through improved production control and product distribution. During this phase the firm must listen to the messages of the marketplace. Most problems with product design and quality should have been corrected during the start-up and growth phases, but additional improvements should also be considered during this phase.

The appropriate shape of the life-cycle curve in the final stage depends on the nature of the product. Many products will continue to sell, with the potential for annual growth continuing almost indefinitely. Examples of such products are commodities such as household goods, processed food, and automobiles. For such products the company's primary goals in this phase would be essentially the same as those described previously for the maturation phase. Other products will experience a natural decline in sales volume as the market for the product becomes saturated or as the product becomes obsolete. If this is the case, the company should adopt a strategy of squeezing out the most from the product or product line while minimizing investment in new manufacturing technology and media advertising.

Although a useful concept, the product life-cycle curve is not accurate in all circumstances. Marketing departments that base their strategies on the life-cycle curve may make poor decisions. Dhalla and Yuspeh (1976) report an example of a firm that shifted advertising dollars from a successful stable product to a new product. The assumption was that the new product was entering the growth phase of its life cycle and the stable product was entering the declining phase of its life cycle. However, the new product never gained consumer acceptance, and because of a drop in the advertising budget, the sales of the stable product went into a decline and never recovered. They suggest that in some circumstances it is more effective to build a model that is consistent with the product's history and with consumer behavior than to blindly assume that all products follow the same pattern of growth and decline. Although we believe that the life-cycle concept is a useful way of looking at customer demand patterns in general, a carefully constructed model for each product will ultimately be a far more effective planning tool.

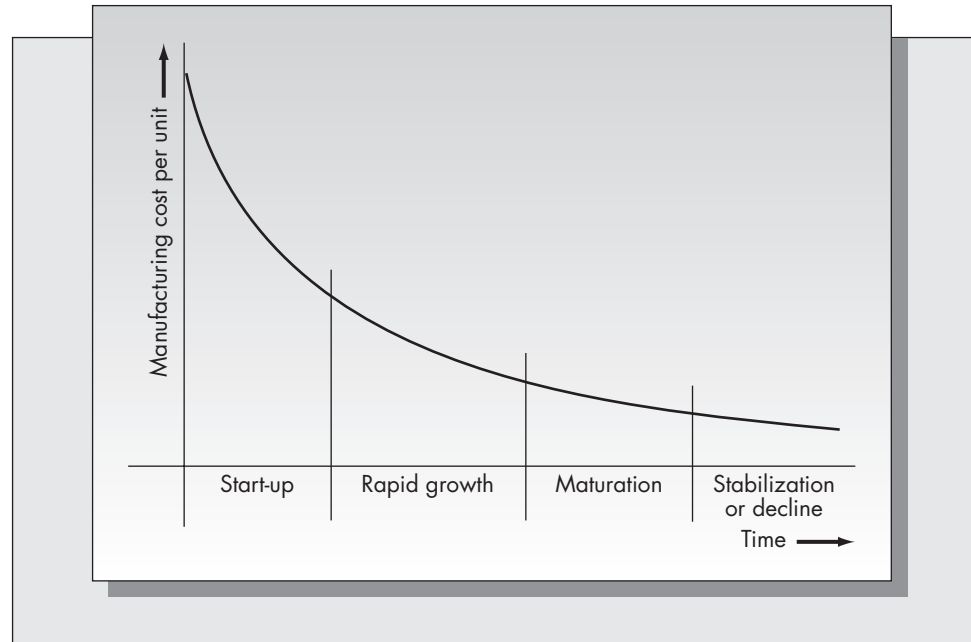
## The Process Life Cycle

Abernathy and Townsend (1975) have classified three major stages of the **manufacturing process life cycle**: early, middle, and mature. These phases do not necessarily coincide exactly with the stages of the product life cycle, but they do provide a conceptual framework for planning improvements in the manufacturing process as the product matures.

In the first phase of the process life cycle, the manufacturing function has the characteristics of a job shop. It must cope with a varied mix of relatively low-volume orders and be responsive to changes in the product design. The types and quality of the inputs may vary considerably, and the firm has little control over suppliers.

In the middle phase of the process life cycle, automation begins to play a greater role. The firm should be able to exert more control over suppliers as the volume of production

**FIGURE 1-4**  
The process life cycle  
and the experience  
curve



increases. Unit production costs decline as a result of learning effects. The production process may involve batch processing and some transfer lines (assembly lines).

In the last phase of the process life cycle, most of the major operations are automated, the production process is standardized, and few manufacturing innovations are introduced. The production process may assume the characteristics of a continuous flow operation.

This particular evolutionary scenario is not appropriate for all new manufacturing ventures. Companies that thrive on small one-of-a-kind orders will maintain the characteristics of a job shop, for example. The process life-cycle concept applies to new products that eventually mature into high-volume items. The issue of matching the characteristics of the product with the characteristics of the process is discussed subsequently.

Experience curves show that unit production costs decline as the cumulative number of units produced increases. One may think of the experience curve in terms of the process life cycle shown in Figure 1-4. An accurate understanding of the relationship between the experience curve and the process life cycle can be very valuable. By matching the decline in unit cost with the various stages of the process life cycle, management can gain insight into the consequences of moving from one phase of the process life cycle into another. This insight will assist management in determining the proper timing of improvements in the manufacturing process.

### The Product-Process Matrix

Hayes and Wheelwright (1979) consider linking the product and process life cycles using the **product-process matrix** pictured in Figure 1-5. The matrix is based on four phases in the evolution of the manufacturing process: (1) jumbled flow, (2) disconnected line flow, (3) connected line flow, and (4) continuous flow. This matrix may be viewed in two ways. One is to match the appropriate industry in its mature phase with



**FIGURE 1-5**

The product–process matrix

Source: Robert H. Hayes and Steven C. Wheelwright, “Link Manufacturing Process and Product Life Cycles” in the *Harvard Business Review* (January–February 1979). © 1979 by the President and Fellows of Harvard College; all rights reserved. Reprinted by permission.

	I	II	III	IV
Process structure Process life-cycle stage	Low volume, low standardization, one of a kind	Multiple products, low volume	Few major products, higher volume	High volume, high standardization, commodity products
I Jumbled flow (job shop)	Commercial printer			Void
II Disconnected line flow (batch)		Heavy equipment		
III Connected line flow (assembly line)			Auto assembly	
IV Continuous flow	Void			Sugar refinery

the appropriate process. This point of view recognizes that not all industries necessarily follow the process evolution described in the previous section on the process life cycle. Certain companies or certain products could remain in an early phase of the process life cycle indefinitely. However, even firms that do not evolve to a position in the lower right-hand corner of the matrix should, in most cases, be located somewhere on the diagonal of the matrix.

Located in the upper left-hand corner of this matrix are companies that specialize in “one of a kind” jobs in which the manufacturing function has the characteristics of a jumbled flow shop. A commercial printer is an example of a jumbled flow shop. Production is in relatively small lots, and the shop is organized for maximum flexibility.

Farther down the diagonal are firms that still require a great deal of flexibility but produce a limited line of standardized items. Manufacturers of heavy equipment would fall into this category because they would produce in somewhat higher volumes. A disconnected line would provide enough flexibility to meet custom orders while still retaining economies of limited standardization.

The third category down the diagonal includes firms that produce a line of standard products for a large-volume market. Typical examples are producers of home appliances or electronic equipment, and automobile manufacturers. The assembly line or transfer line would be an appropriate process technology in this case.